Voting Technology
For People With Disabilities

March 2003

A Report on Disabled Voters' Experiences

Manhattan Borough President C. Virginia Fields and
The Center for Independence of the Disabled in New York, Inc.

THE CITY OF NEW YORK
OFFICE OF THE PRESIDENT
BOROUGH OF MANHATTAN

C. VIRGINIA FIELDS
BOROUGH PRESIDENT

April 3, 2003

Dear Colleague:

The Center for Independence of the Disabled in New York (CIDNY) and I are pleased to release the following report, *Voting Technology for People with Disabilities: A Report on Disabled Voters' Experiences*. This report analyzes the feedback from people with disabilities who tested voting machines demonstrated at a recent voting technology fair that CIDNY and I hosted. CIDNY and my office have prepared a list of recommendations that we believe will help New York State election officials, legislators and other decision makers develop and implement a plan that makes voting machines fully accessible to New York voters with all different types of disabilities.

On October 29, 2002, President Bush signed into law the Help America Vote Act (HAVA), which provides nearly $4 billion for states that adopt significant changes to their election systems. In order for New York State to receive a portion of these funds, it must develop a Statewide HAVA Implementation Plan that ensures, among other things, access to voting machines by people with disabilities. It is our hope that the New York State HAVA Task Force will consider broad definitions of disability and access and incorporate the recommendations of this report into its planning and implementation process.

CIDNY and I believe that implementing the recommendations of this report will maximize access to voting machines by New York voters with disabilities. We therefore look forward to working with election officials, legislators, policy makers and the public in this effort to ensure that New York State adopts voting technology that can be used by all New Yorkers.

Very truly yours,

C. Virginia Fields
Manhattan Borough President

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There were many organizations and individuals that were involved in the preparation and implementation of the Voting Technology Fair for People with Disabilities. The Manhattan Borough President's Office and the Center for Independence of the Disabled in New York would first like to thank all of the vendors that participated in this event: Avante International Technology, Diebold Election Systems, Election Systems & Software, Encrypted Voting Machine Systems, Hart InterCivic, Sequoia Voting Systems and Voting Technologies International. Their participation was critical to providing disabled New Yorkers the opportunity to learn about and test the latest available voting technology. In addition, we are thankful for the time vendor representatives spent providing information about their machines to the authors of this report.

We would also like to thank all of the co-sponsoring organizations and volunteers, who invested their valuable resources and time to ensure that the Voting Technology Fair was a great success. Co-sponsoring organizations included: The Disabilities Network of New York City, Disabled in Action, Eastern Paralyzed Veterans Association, Guide Dog Users of New York, International Center for the Disabled, Lighthouse International, Murray Hill Senior Center, New York Public Interest Research Group, Retired Senior Volunteer Program of the Community Service Society of New York, and Stein Senior Center. We would particularly like to thank Hofheimer, Gartlir and Gross, LLP and Visions at Selis Manor for their generous financial and in-kind support.

Jim Dickson, of the American Association for People with Disabilities, and RoseMarie McCaffery, of Guide Dog Users of New York, provided invaluable advice and insight into organizing the Voting Technology Fair and gathering data on participants' experiences. We must also thank Tova Wang and Thad Hall of The Century Foundation for their technical assistance in developing the evaluation forms used by voting machine testers at the fair. On a final note, the Manhattan Borough President's Office and the Center for Independence of the Disabled in New York would like to thank Laura Klein, who devoted countless hours as a volunteer to ensure that the Voting Technology Fair for People with Disabilities was a great success.

Naumi Feldman from the Manhattan Borough President's Office and Julie Hyman from the Center for Independence of the Disabled in New York, were the primary authors of this report. Laura Klein, volunteer for the Manhattan Borough President's Office, also contributed information and text to the report. Jocelyn Jacobson from the Manhattan Borough President's Office was the primary editor of the text. Kenneth Nemchin of the Manhattan Borough President's Office designed the report's cover.

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Executive Summary

Introduction

In the spring of 2002, the Manhattan Borough President's Office and the Center for Independence of the Disabled in New York (CIDNY) decided to sponsor a voting technology fair that would provide an opportunity for people with disabilities to test and evaluate disability access to the latest forms of voting machine technology. Although the New York State Legislature and the New York City Board of Elections had sponsored several opportunities for New Yorkers to examine some voting machines currently on the market, most of the machines displayed at these fairs were not prepared to demonstrate accessibility features for the disabled. The Manhattan Borough President's Office and CIDNY knew that passage of the federal *Help America Vote Act* (HAVA) was imminent and would require states to make voting machines and polling sites accessible to people with mobility and visual disabilities. They were concerned, however, that certification decisions for New York State's voting machines would be made without significant input from voters with disabilities.

Subsequently, major voting equipment manufacturers from around the country were identified and invited based on information from the National Organization on Disability and the New York City Board of Elections. Their participation, however, was contingent on their ability to demonstrate the accessibility features of their machines. Vendors were also told that people with disabilities would be evaluating each machine to provide data for a report on disabled access to voting machine technology. Seven companies agreed to participate in the Voting Technology Fair, one of which demonstrated two machines.

The Manhattan Borough President's Office and CIDNY felt that it was important for disabled participants at the Voting Technology Fair to have an opportunity to evaluate their experiences testing each machine. The two organizations felt that these experiences needed to be shared with election officials, legislators and other decision makers who would have a hand in deciding what types of voting machines could be used in New York State. Approximately 200 individuals attended the fair and 130 individuals participated in an anonymous survey, which included multiple choice and open-ended questions. This gave voters an opportunity to provide detailed feedback on their experiences with the voting systems on display.

This report is based on observation of the voting machines, interviews with manufacturers at and following the Voting Technology Fair and the written comments provided by survey respondents. For each machine, the report describes basic components and functions, accessibility features and a summary of the comments and suggestions for improvement provided by the individuals who attended the fair. This report also provides a comparison of the accessibility features for each machine and recommendations for the New York State HAVA Task Force and other decision makers as they prepare to reform voting equipment used in this state.

This report is only an analysis of the written comments that testers provided at the Voting Technology Fair, and will be followed by a second report examining additional data.

Comparison of Accessibility Features and Recommendations

Each of the eight voting machines demonstrated at the Voting Technology Fair offer unique features to accommodate different disabilities, however some machines were more accessible to disabled testers than others. Below is a comparison of the machines on the different accessibility features designed for people with disabilities. Five disability categories will be discussed: wheelchair access, dexterity and arm range access, visual impairment access, hearing disability access, and cognitive and neurological disability access.

Wheelchair Access

There were varying levels of wheelchair access to each machine. Several of the machines were designed to be portable, lightweight and placed in the lap of a wheelchair user. [1] One compact machine had its own stand whose height could be adjusted. Two machines were desktop computers that would need to be placed on a stand that is low enough for the wheelchair-using voter to be able to comfortably reach the screen. Two machines were full-face ballot style machines. Because of their tremendous size, most wheelchair users had only limited access to the many buttons located on the upper portions of the full-face ballot style machines.

Recommendations

- The ideal machine for most wheelchair users is one that is light, portable and can be held in a person's lap, if necessary. Enabling the wheelchair-using voter to hold the machine minimizes the distance between the two. Additionally, such machines will have controls that are easy to reach by the voter.
- If the machine is too big to be held by wheelchair users, the machine's height and tilt should be adjustable in order to minimize distance between the wheelchair user and the machine's controls.
- Machines that cannot be adjusted for height and tilt should be placed on a stand that is low enough to ensure that a wheelchair user can read the ballot and access the controls of the machine.
- Full-face ballot machines should not have buttons or switches that are more than an arm's length away from a wheelchair user. Although some would be able to use a stick to press hard to reach buttons on a full-face ballot, there are many others who would not. In these cases, wheelchair-using voters would require the assistance of an additional person to press the hard-to-reach buttons.

Limited Dexterity/Range of Arm Motion

Voters with limited dexterity or a neurological disability often times will not have the movement accuracy that is required to press a small tactile button or any touch screen button.[2] Large tactile buttons can be manipulated by some voters with this type of disability, however, if the buttons are placed too close together, they will be difficult to control and to distinguish from one another. Voters who have either limited or no range of arm motion will face great difficulty using machines that have buttons, switches and controls located in multiple parts of the machine. Voters with a limited range of arm motion will also have limited use of his or her hands and fingers. Touch screen voting is not accessible to people with these types of disabilities. Full-face ballots where the buttons are dispersed throughout the ballot are not accessible as well. Dual switch capability, such as sip and puff adapters, blink control devices and light pressure switches are accessible to people with limited dexterity or range of arm motion.

[1] A comparison of wheelchair access features for each machine is available in Table 1., on page 27.
[2] A comparison of limited dexterity/range of arm motion access features for each machine is available in Table 2., on page 29.

Recommendations:

- Voting machines should have a single location for the control and should limit the control to a minimal number of tactile buttons or switches. For example, there was one machine that has one large tactile button in combination with a rotary dial that can be easily manipulated by people with limited dexterity or range of arm motion. The voter does not need to move his or her arm to different parts of a machine in order to make selections.
- Dual switch capability, such as a sip and puff adapter, should be available to enable those who use this equipment to make selections without being limited to tactile controls.
- Touch screen voting is not accessible to people with limited dexterity and range of arm motion, therefore an alternative voting method such as audio capability with a control that is accessible to people with such disabilities should be included as part of the system.

Visual Disability Access

All but one of the machines at the Voting Technology Fair offered an audio ballot for visually impaired or blind voters.[3] Audio ballots were used with a headset and some type of control for the voters to make selections. Controls for audio ballots varied greatly by machine. One machine utilized a computer keyboard as a control while another utilized a telephone keypad. Five machines used a number of color-coded, distinctly shaped buttons. Voters with low vision liked the brightly colored buttons, particularly when the buttons were different colors to distinguish one button from the next. Visually impaired and blind voters also liked buttons that were distinctly shaped.

The sound quality of the audio was frequently cited as an important accessibility feature of the audio ballot. Many testers faced difficulties with the volume level of audio ballots. Testers commented that computer generated voices were difficult to understand, while no tester cited difficulty understanding the human voice ballots. One tester commented that he would have liked a choice between a male and a female voice for all of the audio ballots.

Although a small portion of people who are blind are able to read Braille, many testers at the Voting Technology Fair felt that Braille labels on audio controls made it easier for them to distinguish the different buttons on the controls. Testers indicated that Braille ballots for the two full-face ballot machines would have made their machines easier to use. With respect to visual access for standard methods of voting, large font size and strong contrast between the color of the printed words and the color of the ballot's background, increase the accessibility of standard visual voting for people with low vision and other visual disabilities. Many visually impaired voters would like to simultaneously read the ballot while listening to the audio ballot, however only one machine offered that feature.

Recommendations:

- Color-coded and distinctly shaped buttons should be used for audio ballot controls, in order to facilitate the ability of the visually impaired or blind voter to distinguish one button from the next.
- Buttons that are used to moved forward or backward in an audio ballot should have shapes that indicate direction. For example, such buttons could be designed in an arrow shape that points either up or down, left or right.
- Volume control should be available.
- Audio ballots should be available at two speech rates—standard speech rate and slow speech rate.
- Human voices should be used to record audio ballots instead of computer-generated voices.

[3] A comparison of visual disability access features for each machine is available in Table 3., on page 32.

- If possible, there should be a selection of a male or female voice audio ballot. Some hard of hearing voters have more difficulty hearing higher or lower toned voices.
- Standard size, Braille labels for controls and Braille ballots should be part of the machine. It should be noted however, that because a small portion of the blind population read Braille, Braille should not be used as a substitute for audio ballots.
- Font size and screen contrast controls should be made available to increase access to the standard methods of voting for visually impaired voters.
- The machine should allow the voter to simultaneously use the visual and the audio ballots.

Hearing Disability Access

All of the machines displayed at the voting fair were designed to increase access for people with mobility or visual disabilities, however, none were really designed to address hearing disabilities.[4] Certainly for most hard of hearing people, barriers to communicating with poll workers and election officials are more common than barriers to actually using the voting machines. It should be noted, however, that there are persons who are hard of hearing and have an additional disability who would not be able to use either the standard or the audio method of voting for any of the machines as they are currently designed. Several testers with hearing disabilities at the Voting Fair suggested that assisted listening devices for the audio components of the machine would benefit people with both a hearing and a visual disability.

Recommendations:

- Volume control should be available.
- An assisted listening device for the audio ballot should be made available, in order to accommodate visually impaired voters that are hard of hearing.

Cognitive and Neurological Disabilities Access

Although there were several testers at the Voting Technology Fair with cognitive or neurological disabilities, few offered comments on the accessibility of the voting machines. The authors of this report however, were able to query individuals with such disabilities at the Voting Technology Fair, in order to have a better sense of their ability to use the various voting machines. The authors learned that generally, testers with cognitive disabilities found it easier to understand ballots that did not have too much information on a single page. They preferred viewing only one contest per page and suggested that ballots with multiple page capacity be limited to one contest per page. Generally, testers with cognitive disabilities found full-face ballots to be difficult to understand. The one tester with a neurological disability found that the use of multiple bright lights on a ballot had the potential to initiate a seizure. Unfortunately, there were too few comments from people with such disabilities at the fair to make any true conclusion of this population's ability to use the latest forms of voting machines.

Recommendation:

- Voting machines should not be limited to a full-face ballot, rather, they should be allowed to consist of multiple pages so that one contest can be limited to one page. Voters with cognitive disabilities will find it easier to understand the contest they are voting in and the candidates in that contest, if there is a limited amount of information for them to read at a single point in time.

[4] A comparison of hearing disability access features for each machine is available in Table 4., on page 33.

Conclusion

This report was an analysis of the written comments provided by disabled voters after testing voting machines designed by the following manufacturers: Avante International Technology, Diebold Election Systems, Election Systems & Software, Encrypted Voting Machine Systems, Hart InterCivic, Sequoia Voting Systems and Voting Technologies International. Not all testers provided written comments, and most of the written comments focused on either problems that testers experienced using the machines or suggestions for improvement. It should be noted that because not all testers provided written feedback, the analysis of these comments may not have reflected the majority of testers' experiences using each of the machines. A second report will therefore be issued analyzing how testers rated accessibility features using predetermined multiple choice scales.

The design and level of accessibility varied greatly by machines. Although there were many findings and recommendations based on the data collected for this report, there were several significant access problems faced by testers at the Voting Technology Fair. Full-face ballot machines were generally not accessible to many wheelchair-users, people with limited dexterity or range of arm motion and people with cognitive disabilities. Touch screen machines were also not accessible to people with limited dexterity. Font size and screen contrast need to be controlled by the voter. Audio ballots must have volume control for their headsets. And dual switch capability, such as sip and puff adapters or light pressure switches, should be available for people with mobility impairments.

In addition to the specific accessibility recommendations this report has provided based on testers' concerns and suggestions for accessibility improvements in the voting machines, the Manhattan Borough President's Office and CIDNY also recommend the following:

- Individuals with disabilities must be involved in the process to identify machines that are accessible to various types of disabilities. It is difficult to truly appreciate the challenges that disabled voters face, thus people with disabilities must be involved in New York City and State's election reform planning process.
- Even after New York State has certified voting machines that are concordant with HAVA guidelines, many of the machines' accessibility features are in the hands of ballot designers and election officials (e.g., ballot layout, font size and audio volume level). Thus, it will continue to be important to include disabled individuals in the implementation process after machines have been certified and purchased by localities.
- Accessibility will only be possible with extensive training for poll workers. In addition to manufacturer representatives, the Voting Technology Fair was staffed by a number of sensitive, experienced volunteers. It will be essential to have poll workers who can provide calm and competent assistance, especially for blind voters, most of whom will be voting independently on machines for the first time.
- Disabled access must be broadly defined to include individuals with visual, auditory, physical and cognitive challenges and to address the different levels of disability that individuals face. For example, it is thought that only about 10% of blind individuals read Braille; so, a voting machine that uses Braille as its primary tool for communicating information to blind voters would be problematic.
- Disabled access must also account for multiple disabilities. For example, blind voters who are hard of hearing will have a difficult time using the audio components for machines unless there is some type of assisted listening capability.
- Individuals with disabilities, like all other citizens, strongly desire the opportunity to utilize their right to cast a private and independent vote, and the New York State HAVA Taskforce should strongly

consider the broad definition of disability as it works on the plan for implementation of HAVA in New York State.

New York State's full-face ballot law would preclude certification of nearly all of the machines demonstrated at the fair. There are many voters, however, from wheelchair users to quadriplegics to the cognitively disabled that are simply unable to use full-face ballot machines. Most of these voters would require some type of assistance in order to use any of the full-face ballot machines currently on the market. As long as a full-face ballot law remains in New York State, there will continue to be voters in this state who cannot enjoy the right to cast an independent and private vote. The New York State HAVA Taskforce and the state legislature should strongly consider changing this law. There is no evidence that shows full-face ballots decrease the likelihood of under-voting in elections. The Manhattan Borough President's Office and CIDNY believe that under-voting is more likely to occur with full-face ballots than with multi-page ballots. This is because multi-page ballots force the voter to review each contest in a given election, whereas voters can become confused by the full-face ballot layout and consequently miss voting in certain contests. Furthermore, most of the multi-page ballot machines currently offer a summary of contest selections at the end of the ballot, at which point the machine indicates the contests that had no candidates selected. This type of summary provides an opportunity for the voter to not only change selections, but to vote in races he or she may have overlooked.

Although a more in-depth report that includes an analysis of Voting Fair evaluation data will not be available for several weeks following the release of this report, Borough President Fields and CIDNY hope that the New York State HAVA Taskforce, legislators and other decision makers begin to integrate this report's recommendations into the state's HAVA planning and implementation plan. The Manhattan Borough President's Office and CIDNY believe that implementation of this report's recommendations will maximize access to voting machines by people with disabilities. Borough President Fields and the leadership of CIDNY look forward to working with all relevant parties as New York State moves closer to implementing voting technology that is accessible to all New York voters, including people with disabilities.

Chapter 1/**INTRODUCTION**

On January 29, 2003, the Manhattan Borough President's Office and the Center for the Independence of the Disabled in New York (CIDNY) sponsored a Voting Technology Fair for People with Disabilities. The goal of this fair was to provide people with physical, visual, cognitive, and other types of disabilities an opportunity to test new voting technology and provide feedback on their experiences with this technology to election officials and other decision makers about the extent to which the new technology meets their needs. This report, the first of two, was prepared based on information obtained at the Voting Technology Fair. Its purpose is to assist those who are involved in the process of upgrading New York State's voting equipment in developing machine certification criteria that ensures people with disabilities can cast an independent and private vote.

Background Information

The Voting Technology Fair was planned to address the mandates and opportunities resulting from the passage of the Help America Vote Act (HAVA), which was signed into law by President Bush on October 29, 2002. HAVA sets aside $3.9 billion in federal funds for states to reform their voting practices. The law addresses every facet of the voting process, from registration systems to polling site improvement. In order to receive a portion of these federal monies, a state must develop a Statewide HAVA implementation plan that addresses a wide range of voting issues, including full accessibility for voters with disabilities. The federal law does not define "accessibility" but instead requires states to do so in their plans. States must also plan to provide "one direct recording electronic voting system or other system per polling place that is equipped for individuals with disabilities." This system must offer access for voters with various physical disabilities, as well as non-visual access for voters who are visually impaired or blind, that is equivalent to participation opportunities afforded to non-disabled voters, meaning, a private and independent vote.[5]

While HAVA encourages states to address an array of issues in forming their plans, machinery will likely be a top priority in New York State. Currently almost all New York State voters cast their ballots using lever machines, designed by the Shoup Corporation in 1896. These machines have not been produced since 1978 and replacement parts have not been produced since 1988.[6] Repair has become increasingly problematic due to the lack of parts. The levers on these machines are difficult or impossible to use for voters with mobility and other physical disabilities and there is no provision for blind voters to cast an independent vote (without the aid of a reader). In order to cast a private vote, many New Yorkers must resort to using an absentee ballot.

Even before the passage of HAVA, New York State's election officials were exploring new voting technology and the ways in which it could modernize New York's election process, including making the entire process more accessible to people with disabilities. Recent events sponsored by the New York State legislature and the New York City Board of Elections have offered voters the chance to try out new equipment and provide informal feedback to vendors and event sponsors. While these efforts have not ignored challenges of those with disabilities, the disabled were not expressly involved; there was no chance for voter testing at the Board of Elections presentations and the other events lacked infrastructure

[5] Leadership Conference on Civil Rights, "Recommendations on the Implementation of the Help Americans Vote Act," December 19, 2002.
[6] Glenn Simpson, Ted Brindis and Michael Orey, "US Polling Faces Fresh Criticism," financialexpress.com, November 14, 2000.

(volunteers and specialized equipment features) that would have facilitated testing by individuals with disabilities.

Different types of disabilities and the unique ways in which they affect individuals pose distinct challenges in providing these citizens with equal access to the voting process. The Manhattan Borough President's Office and CIDNY determined that the best way to involve voters with disabilities in the process of improving voting equipment would be to provide an opportunity for hands-on testing of new equipment with features designed for disabled people. Thus, Manhattan Borough President C. Virginia Fields and CIDNY decided to sponsor the Voting Technology Fair in order to bring together people with disabilities and voting machine manufacturers from around the country in a central, accessible location in New York City.

Voting Technology Fair Description

The Voting Technology Fair was spearheaded by staff at the Manhattan Borough President's Office and CIDNY. The Fair took place from 11 a.m. to 7 p.m. on a Wednesday at Visions at Selis Manor, a residence for the blind in a central location in New York City. Major voting equipment manufacturers from around the country were identified and invited based on information from the National Organization on Disability and the New York City Board of Elections. Their participation however, was contingent on their ability to demonstrate the accessibility features of their machines. Vendors were also told that people with disabilities would be evaluating each machine to provide data for a report on disabled access to voting machine technology. Vendors and equipment displayed at the Voting Technology Fair included:

- Avante International Technology, *VOTE TRAKKER EVC308;*
- Diebold Election Systems, *AccuVote-TS System;*
- Election Systems & Software, *iVOTRONIC V2000;*
- Encrypted Voting Machine Systems, *DIRECT Vote;*
- Hart Intercivic, *eSlate 3000;*
- Sequoia Voting Systems, *AVC Advantage* and *AVC Edge;*
- Voting Technologies International, *VOT Center.*

Other companies that were contacted but unable to attend included Accupoll Incorporated, Danaher Controls Corporation and UniLect Corporation.

The Fair received the support of a number of organizations including Hofheimer, Gartlir and Gross, LLP, Visions at Selis Manor, the Disabilities Network of New York City, Disabled in Action, Eastern Paralyzed Veterans Association, Guide Dog Users of New York, International Center for the Disabled, Lighthouse International, Murray Hill Senior Center, New York Public Interest Research Group, Retired Senior Volunteer Program of the Community Service Society of New York, and Stein Senior Center. These organizations generously provided financial and in-kind support to ensure the success of the event.

Approximately 200 individuals attended the fair and 130 individuals participated in an anonymous survey, which included multiple choice and open-ended questions. This gave voters an opportunity to provide detailed feedback on their experiences with the voting systems on display. In addition, voters had the opportunity to talk directly with the representatives from each company and the vendors had the chance to talk with election officials specifically about how their designs could be used by people with disabilities.

Overview of this Report

This report includes a number of important findings that will aid election officials and members of the New York State HAVA Task Force in developing recommendations for new voting equipment in New York State. This report is based on observation of the voting machines, interviews with manufacturers at and following the Voting Technology Fair and the written comments provided by survey respondents. The chapters describing the machines and user comments are organized alphabetically by manufacturer. For each machine, the report describes basic components and functions, accessibility features and a summary of the comments and suggestions for improvement provided by the individuals who attended the fair. This report will also provide a comparison of the accessibility features for each machine and recommendations for the New York State HAVA Task Force and other decision makers as they prepare to reform voting equipment used in this state.

Methodology

Testers were allowed to try all of the machines at the Voting Technology Fair in any order they wished. They were provided an evaluation form packet that asked for basic demographic information and asked testers to rate their experiences using each machine. The evaluation form for each machine asked voters to rate accessibility features and their overall experience using each machine. Multiple choice scales were provided for each survey item. In addition, an optional written comments section was provided for testers to give feedback based on their experiences using the machine. The data used for this report is based solely on the written feedback that testers provided.

It should be noted that only some of the testers provided feedback. Although testers gave some positive feedback for the voting machines, the written comments tended to focus on negative experiences that testers had for each machine as well as their suggestions for improvement. Because the written comments section was clearly optional and not all testers felt compelled to provide feedback, these comments may not have reflected the experiences of many testers who filled out evaluation forms. Nonetheless, Borough President Fields and CIDNY believe that the written feedback is useful for election officials and other election-related decision makers, because it provides them with a better understanding of subtle details that cannot be captured through analyses of multiple choice responses. Clearly, an analysis of the multiple choice date is also useful and will therefore be the focus of a follow-up report, however, such an analysis is still a limited reflection of the actual experiences that these testers underwent.

The follow-up report will soon be made available. It will include a demographic profile of those who completed the survey as well as a tabulation of responses to multiple choice questions about the machines.

Key Findings

As stated, this report is aimed at heightening the interest in, and increasing the discussion of, needs of individuals with disabilities in developing the New York State plan for new voting equipment. One objective was to learn about the positive features and areas for improvement with regard to the machines based on how they are experienced by people with disabilities. Another was to seek out opinions about different valuable approaches to helping people with disabilities vote. The organizers did not intend to conduct a thorough comparison of all of the machines on the market to find "the best one." Based on these aims, we offer the following general findings:

- The best method for identifying machines that will be usable by individuals with disabilities is to include these individuals in the planning process. It is difficult to truly appreciate the challenges that disabled voters face without firsthand knowledge.

- Moreover, because there is a great deal that is left up to election officials even after machines are selected (ballot design, typeface and audio level are several items), it will continue to be important to involve disabled individuals in implementation issues even after machines are selected.

- Accessibility will only be possible with extensive training for poll workers. In addition to manufacturer representatives, the Voting Technology Fair was staffed by a number of sensitive, experienced volunteers. It will be essential, especially for blind voters who are voting on new machines for the first time, to have poll workers who can provide calm and competent assistance.

- Disabled access must be broadly defined to include individuals with visual, auditory and physical challenges and to address the different levels of disability that individuals face. For example, it is thought that only about 10% of blind individuals read Braille; so, a voting machine that uses Braille as its primary tool for communicating information to blind voters would be problematic.

- Disabled access must also account for multiple disabilities. For example, blind voters who are hard of hearing will have a difficult time using the audio components for machines unless there is some type of assisted listening capability.

- Individuals with disabilities, like all other citizens, strongly desire the opportunity to utilize their right to cast a private and independent vote. Many of the attendees were profoundly grateful to the sponsors and the vendors for organizing and attending the Voting Technology Fair.

Specific findings and recommendations for the different machines demonstrated at the Voting Technology Fair will be discussed in the *Comparison of Accessibility Features and Recommendations* chapter of this report, which begins on page 26.

Other Important Considerations for Election Officials Not Addressed by the Voting Technology Fair

While the Voting Technology Fair focused exclusively on disabled access to new machines, a plan for accessibility will also need to examine New York State's full-face ballot law, the accessibility of polling places, training for poll workers and the design and use of absentee ballots as a supplement—not alternative—to fully accessible voting systems. Although polling sites in recently constructed buildings offer features such as wheelchair ramps, wide doors and railings, some sites in older locations cannot be used by those who are unable to navigate stairs or narrow entries. New York State full-face ballot law, which requires the voter to be able to learn about all contests, propositions and other information on one display, was also the subject of concern by some of the voters. A number of the machines that were demonstrated at the Voting Technology Fair and that are in use in other locales nationwide, have many positive accessibility features, but are not designed to offer full-face ballots.

In addition to individuals with disabilities, there are many other citizens who feel disenfranchised from the voting process, particularly citizens who are not native English speakers. The Voting Technology Fair did not focus on the issue of language access, however, this does not diminish the importance of the issue.

Other major considerations for election officials that are included in this report, but not the focus of the report's analysis are cost, data storage and security against fraud. While some of the manufacturers that displayed equipment have been in business for many years, others were presenting their first machines. Moreover, the cost of purchasing voting systems (which includes voting machines, precinct equipment,

software for designing, tabulating and securing votes, voting booths and accessories for disabled access) varies widely. Disabled access must be a priority consideration in the redevelopment of machine certification criteria, however, cost-effectiveness is something that cannot be ignored by localities when they are ready to adopt new voting equipment.

Chapter 2/AVANTE INTERNATIONAL TECHNOLOGY: *VOTE TRAKKER, EVC308*

General Description:

The Vote Trakker EVC308 is a large, rectangular tabletop unit that offers electronic touch screen voting. The voter uses the touch screen to select choices and move from one contest to another. The system also includes an audio ballot component for people with visual disabilities. The Vote Trakker EVC308 is federally certified by an accredited laboratory, which uses Federal Election Commission (FEC) standards for voting system hardware specifications. In addition, the machine is certified for use in eight individual states. It was used in Sacramento, California in the fall, 2002 elections. The system can accommodate 40 languages and can visually display different writing systems. Depending on the size of the market, the system can be purchased for $3500 - $5000 per unit.

Buttons, Switches and Controls:

There are no tactile buttons, switches or controls for the standard voting unit, instead, voters use touch screen buttons to move back and forth and make selections. Audio voting involves the use of computer keyboard keys.

Ballot Design and Preparation:

The ballot consists of a series of touch screens that can accommodate seven columns and seven rows of text. The ballot can be designed to display one or more races per screen. The number of columns and rows can also be adjusted. The ballot utilizes black type on a multi-colored screen with color being used to distinguish between contests, propositions and other information. Each choice is contained in a box which voters touch to make selections.

Voting Process:

The process begins with the voter entering a PIN number from an access card given to them by the election official. Once the machine is activated, the voter uses the touch screen to make selections and move from one contest to the next. A voter does not need to select a candidate for every race. If a voter chooses not to vote in a particular race, however, the ballot is not left blank. Instead, the voter must select "skip contest".

Accessibility Features:

The system can be adapted to various booths and table heights to meet the needs of those in wheelchairs. Because of the high, flat shape of the machine, it would need a fairly low table for many seated voters. The machine is not designed to be held in a voter's lap.

The system for visually impaired voters includes a headset and a keyboard with four "raised" corner keys for the voter to make selections. Users cannot adjust font size or screen contrast, however, election officials have flexibility in these areas when they design the ballot. This system does not include Braille.

The audio ballot uses a synthesized voice. Voters can choose the voice, pitch and speed of the speech that they hear during audio voting. There is no assisted listening device for hard of hearing voters who would need to use the audio ballot in order to vote.

The machine does have dual switch capability, in the form of tongue-activated voting, to allow people with limited dexterity and range of arm motion to control the machine without use of their limbs. The

machine does not have a sip and puff adapter, which is commonly used by quadriplegics and other disabled persons with extremely limited use of their arms and hands.

Security and Data Storage:

This machine requires each voter to enter a pin number on an access card. The machine ensures accuracy of voting by providing each voter with a randomly generated reference number that can be used to track a vote after the election. The data on the receipts is stored in each machine as part of the permanent election audit trail.

User Feedback:

Several testers commented that the machine was easy to use and understand, that the set up of buttons was good and that the set up could accommodate a voter with a guide dog.

There were testers however, who had some difficulty using the machine. Some felt that the screen was too dark, which made a number of the touch screen buttons difficult to locate. Others felt the font was too small. The buttons and controls were also problematic for some testers. Several commented that the presence of an entire keyboard was confusing and the buttons were a bit cumbersome. Others commented that the important keys used for voting need to have Braille labels on them.

Testers commented that the speech for the audio ballot was difficult to understand and that synthesized speech can be problematic for people with hearing impairments. Although the manufacturer says that voters can adjust the speed of the speech, there were testers who commented that they were unable to adjust it.

Some testers found it difficult to follow the instructions.

One tester commented that the machine was not very accurate for a visually impaired person.

Other concerns testers indicated were that the screen was too small and write-in votes were difficult for visually impaired users who do not know the keyboard layout.

Chapter 3/**DIEBOLD ELECTION SYSTEMS:** ***ACCUVOTE-TS SYSTEM***

General Description:

Diebold Election System's AccuVote-TS System is a touch screen voting machine. The dimensions of the entire AccuVote-TS System unit are 24" tall, 20" wide and 7" deep. The unit's 15" screen is part of a tablet that can be removed from the unit. The tablet is 1.5" thick and weighs 9 lbs.

This machine is certified by an FEC-accredited laboratory following Federal Election System Standards. The entire state of Georgia currently uses this machine as well as four counties in Maryland and Los Angeles County in California. The standard rate for the machine (including the audio) is $3295, however Diebold Election Systems will offer discounted rates for larger jurisdictions.

Buttons, Switches and Controls:

The AccuVote-TS System is a touch screen voting machine and therefore does not include tactile buttons, switches or controls. The audio ballot requires the use of a telephone keypad as its control. The keypad follows the universal telephone design code, which includes a raised dot on the number '5' key.

Ballot Design Preparation:

The AccuVote-TS System includes the use of GEMS Application Software, which is a Microsoft based program that generates the appropriate ballot style for each election district or precinct. The standard design for the AccuVote-TS System's ballot is portrait style, however, it can be designed in landscape style as well. The ballot can be formatted to display one, two or three columns and it can be designed to show multiple contests or just one contest. The ballot is able to accommodate greater than 50 candidate names for a single contest on one page. Multiple colors are used to distinguish the direction buttons from the contest headings and from the candidates. The 15" LCD screen provides 117.5 square-inches of viewable area.

Those who design the ballot can program it to be shown in a number of font sizes, which can be adjusted by the voter during the voting process. The screen contrast of the ballot, however, cannot be adjusted by the voter. The voter can write in candidates' names using a touch screen write-in box where the letters can be featured in a keyboard pattern or in the order of the alphabet.

Voting Process:

Voters insert an access card to begin the voting process. The first screen asks the voter which language they would like to vote in. The next screen allows the voter to select the font size of the ballot. After these first two screens, the voting process begins. Touch screen buttons are available to move forward and backward through the ballot. A summary page is displayed at the end after the voter has viewed and voted in all of the contests. Selections are summarized and races for which there are no selections are highlighted in red. The voter has the option to skip contests, however, the highlighting feature of contests for which there are no selections is included to decrease the likelihood of unintentional under-voting. The voter is able to change his or her vote at any time during the entire voting process. The voter's final chance to change his or her vote is when he or she has reached the summary page. Once the voter has determined that he or she is ready to cast the ballot, the voter must then press the CAST BALLOT button to record the vote. The voter access card, which will automatically pop out of the machine, must then be returned to the poll worker.

Accessibility Features:

The tilt of the machine's touch screen can be adjusted to a vertical position or the tablet can be removed from the unit to accommodate wheelchair-users. Visually impaired voters are able to adjust the font size at any point during the voting process, however they cannot adjust the screen contrast.

The AccuVote-TS System has an audio component that includes a headset and a telephone-style keypad that is used by the voter to make selections. The keypad follows the universal telephone design code, which includes a raised dot on the number '5' key. The audio ballot is pre-recorded using a human voice. The voter is able to adjust the volume of the recording, however he or she cannot adjust the speech rate.

Voting instructions are provided at the beginning of the recording and the voter can return to the instructions at any time by rewinding to the beginning of the audio ballot. There is no summary of selections after the voter has listened and made selections for all of the contests, however, the voter may go back to any contest at any point during the audio ballot voting process to change selections. This is unlike the standard voting interface, which does provide a summary of selections for the voters. It is possible to write in candidates' names by using the same telephone keypad that is used to make selections. The voter must press the letter that corresponds to a number on the keypad and then press the pound key.

There is no assisted listening device to accommodate hard of hearing voters who would like to use the audio component. This machine does not have dual switch capability for voters with limited dexterity or range of arm motion.

Security and Data Storage:

When the voter checks in at the polling site on election day, the poll worker creates a Voter Access Card. The only information that is contained on the card is the precinct number, the political party code (if the election is a primary) and whether or not the voter requires use of the audio component. Once encoded, the voter is given the card so that he or she can begin the voting process without the assistance of a poll worker. When it is his or her turn to use the voting machine, the voter inserts the Voter Access Card into a special slot, which features a mechanism that easily glides the card into the machine. After the voter has cast a ballot, the card is automatically deactivated and ejected from the system. Automatic deactivation of the card ensures that the voter is unable to cast an additional vote. The voter must return the card to the appropriate poll worker after it has been ejected from the system.

The AccuVote-TS System includes a ballot station that tabulates the votes. The cast votes information is then transmitted via a modem from the polling place to the central computer system. A paper audit trail can be printed from the machine on demand. Pre- and post-election transaction audit logs are also available.

User Feedback:

Several testers commented that they liked the machine and that it was easy to use. Two testers felt that the keypad is easy to use and one of the two felt that the familiarity of the telephone keypad would make it easy to use by all voters. One hard of hearing person felt that the machine was good for the hard of hearing or deaf, as long as they did not have other physical disabilities.

There were several comments made about the audio component of the machine. Two testers said that the audio needed a clearer speaking voice, with one explicitly stating that the audio sounded a little muffled. One person felt that the speech was slow while another suggested including a control for the speed of the

speech. Lastly, a hard of hearing tester felt that the audio component should be designed to accommodate hard of hearing voters with a visual disability.

Many testers felt it took too long to vote, particularly while using the audio component. Several felt that the instructions were extremely slow and repetitive. One tester said that he felt he needed to ask for help too often. Another felt that the instructions could have been simpler. One tester commented that is was difficult to review the ballot. Although this comment was not totally clear, it is possible that the tester was referring to difficulty with reviewing the selections he made for the different contests.

Several comments were made regarding the buttons and controls. Most comments seemed to be directed at the audio controls, however one tester said that he could not use the touch screen because he has a spasticity-related disability. Another tester also noted that he needed assistance to press the touch screen buttons and felt that the only way he could vote independently using the AccuVote-TS System would be to have a voice recognition system as part of the machine. Referring to the keypad for the audio, a different tester felt there were extra buttons that had no purpose being included as part of the machine. Another commented that the buttons on the keypad should be raised higher so that they could be felt more easily. One tester suggested that separate buttons be used to move between the races and to select the candidates. Two testers felt that Braille labels should be included for the keypad, in particular Braille numbers embossed on the keys.

A couple of the testers felt the write-in feature of the audio component was difficult to use. One person suggested that instead of pressing numbers on the keypad to select the corresponding letter, a voice recording of the alphabet should be given. The voter could then press the pound button for the letter he or she would like to select.

There were also several comments made about the size and set-up of the unit. One person felt that the machine was too small. Another person felt that the physical set up needs to be reviewed to ensure privacy (however, this comment probably stemmed from the fact that the machine was not enclosed within a booth at the Voting Fair, which meant there was no privacy as participants tested the machines).

Most of the comments provided by testers seemed to be geared toward the audio component of the machine. While some of the respondents felt comfortable using the telephone keypad as the control, others felt that the buttons weren't raised high enough or that they complicated the write-in feature of the audio ballot. Multiple participants felt that the instructions were too long and that they were repetitive. Others felt that the instructions could have been simpler than the ones provided.

Chapter 4/**ELECTION SYSTEMS & SOFTWARE:** ***IVOTRONIC V2000***

General Description:

The iVotronic V2000 by Election Systems & Software is a touch screen voting machine.
The screen's dimension is 15" diagonally. The machine weighs 14.35 lbs. and can be placed in the lap of the voter, in order to accommodate wheelchair-users.

This machine is certified by an FEC-accredited laboratory. It is being used in counties in Florida, North Carolina, South Carolina, Ohio, Indiana, Michigan, Arizona, Texas and California. Ten thousand audio components for the machines are used in several counties in Florida. Each unit costs approximately $3000.

Buttons, Switches and Controls:

Voters using the touch screen are required to use one, non-touch screen button, which is the VOTE button located at the top of the machine. This is a red oval-shaped button that is used by the voter to cast his or her ballot. Voters using the audio component will encounter two yellow triangular-shaped buttons indicating "up" and "down". There is also a green diamond-shaped button located to the right of the triangle buttons that is used to select candidates in the contests. The audio ballot also requires use of the red, oval-shaped VOTE button at the top of the machine.

Ballot Design and Preparation:

The machine accommodates a portrait style ballot, using black font on white background, with multiple colors to distinguish contest headings and touch screen buttons. The font and screen contrast cannot be adjusted by the voter, rather, they are pre-determined by the programmer when designing the ballot. The ballot can accommodate nine different languages, including the written characters of Asian languages like Japanese, Chinese and Thai.

Voting Process:

The voting process begins with either the poll worker or the voter inserting a cartridge into the machine. The voter then selects the language that he or she would like to use. The voter can move forward or backward at any point during the voting process by pressing certain keys. It is not possible to over-vote for any given contest. After the voter has voted in all of the contests a summary page is shown to enable the voter to review all of her selections. The summary page will indicate under-voting by letting the voter know that he or she has not made a selection in a given contest.

Once the voter is satisfied with the selections, he or she must then press the oval-shaped VOTE button, which is separate from the LCD screen and located on the top of the machine. The voter then removes the cartridge and returns it to the poll worker.

Accessibility Features:

The lightweight iVotronic machine is portable and wireless, easily enabling curbside voting. It can also be placed in a person's lap, accommodating access needs of many wheelchair users.

The iVotronic has an audio component that can be used by voters with visual impairments. The voter makes selections using the color-coded, uniquely shaped buttons. There are two arrow keys that face up and down, which are used to move forward and backward. When the voter decides to select a candidate,

he or she must press the diamond-shaped SELECT key. The audio ballot voice confirms the selection that the voter has made each time the SELECT key is pressed.

All buttons are embossed with Braille for those who are able to read it. The audio ballot utilizes a human voice for its recording.

The iVotronic does not include an assisted listening device for hard for hearing voters who would like to use the audio ballot. It also does not have dual switch capability for people with limited dexterity or range of arm motion.

Security and Data Storage:

A cartridge is placed in the machine to activate the voting process and is removed once the voter has cast his or her ballot. The iVotronic has three independent, yet redundant, memory paths to ensure that no votes are lost or altered. First, there is a "zero tape" that is used to confirm no votes have been improperly entered prior to the poll opening on election day. Second, a precinct level accumulated totals tape provides printed documentation of the precinct level election results. Third, there is a recount system that replicates all of the cast ballots, which includes ballot images produced on-demand for re-verification.

User Feedback:

A significant number of testers felt that Election System & Software's iVotronic V2000 was an extremely easy machine to use. Many testers felt that the machine was straightforward and simple to learn. One wheelchair-user noted that he liked the fact that the machine is portable and can be placed in a person's lap. Another liked the "simplicity of the controls." There were, however, suggestions for improvements. One tester felt that the font was not dark enough and too small. Another person felt that the screen was generally too bright. Yet another felt that there was not enough contrast between the color of the letters and the background of the screen. Lastly, a visually impaired tester commented that the touch screen technology was difficult to use.

Many of the comments referred to the audio component. Apparently, the headset for the audio component was not working so speakerphones had to be used to demonstrate the audio voting. Noting this fact, several people indicated that they would have liked a control for the speed of the speech and for the volume.

Some testers cited difficulty with the buttons used for the audio ballot. One felt that the set-up of the buttons was difficult to remember and use. Another tester specifically noted that at times, he or she was not sure whether to use the down arrow key or the select key. Yet another tester felt that the names used for the key should be re-evaluated. For example, this person felt that the diamond shaped button should be referred to as the "SELECT" key. There were testers who liked the controls, and one in particular commented that he liked the write-in feature and thought it was a good idea to separate the "VOTE" button from the rest of the buttons.

Compared with other machines shown at the Voting Fair, Election System & Software's iVotronic received a significant amount of positive feedback as comments in the evaluation forms. Many testers felt that the machine was simple to use. Some testers had some difficulty remembering which buttons to use for the audio ballot, while others commented that they would have liked to use controls for the volume of the audio and the rate of speech. In general, however, this machine seemed to be well received by Voting Fair participants that were able to test it.

Chapter 5/**ENCRYPTED VOTING MACHINE SYSTEMS:** ***DIRECT VOTE***

General Description:

The DIRECT Vote is a single panel full-face ballot machine. The display panel is 26" wide by 30" high by 3" deep. Next to the name of each candidate is a push button and light. The light turns on once a voter makes a selection by pushing the appropriate button. The system will be offered at $4,000 per precinct, which includes 1 control unit, 2 voting devices with headsets and software to make the units accessible. This price does not include booths or printers. The DIRECT Vote has not been federally certified by an FEC-accredited laboratory nor has it been certified by a state-level accreditation agency. Because the DIRECT Vote is a full-face ballot machine, it has the potential to be certified in New York State based on the state's current election laws. The machine is still undergoing design changes.

Buttons, Switches and Controls:

The buttons are dome switches about the size of the tip of a thumb. These buttons have a tactile feel and make a clicking sound when pushed. A plastic overlay is used to cover the dome switches and create the buttons. Ballot designers would have control over the color of the plastic overlay for the buttons. The prototype model has blue imprints on the plastic that show where a particular button is located. Only the buttons that will be used in a particular election are visible. All of the buttons used in an election are labeled. The "cast" ballot button is color-coded with a surrounding circle to bring attention to it.

Ballot Design and Preparation:

The ballot is prepared by election officials using standard spreadsheet software. The format of the spreadsheet is adaptable according to the desired ballot layout. Once the ballot information has been entered into the spreadsheet and finalized, the information is transferred to the machine and is set up for the election without further human intervention. The ballot configuration is also automated once the entry into the spreadsheet has been done. Ballots are printed on paper for display on the single panel. The paper ballot is covered with transparent lexan for durability. The ballot is created by the same software used to prepare the spreadsheet.

The ballot is displayed with each candidate's name printed in a 2" x 1" box. The ballot can accommodate 200 candidates and 10 parties. Based on feedback from testers, the company is already planning to enlarge the display area and candidate name box size.

Voting Process:

A poll worker activates the voting process. The voter is then faced with the full-face ballot, which he or she can review at the beginning of the voting process. Next to the name of each candidate is a push button and light. When the voter decides the candidate he or she would like to select in a contest, the voter pushes the button next to that candidate's name. The light next to the candidate's name turns on once the voter makes a selection. Voters can write in candidates' names. Once the voter is satisfied with his or her votes, the voter presses a large red "cast ballot" button at the bottom right of the machine display.

Voters may change their selection at any time. Voters do not need to select a candidate for all contests. A voter can change his or her vote for one of the contests without having to re-cast votes for all of them. The standard (non-audio) version of the machine provides a "help" function that enables the voter to find

an answer to a question without relying on a poll worker. There is a set of directions in seven languages offered to the voter in the booth, on one side of the panel.

Accessibility Features:

A curtain can be suspended from the top of the booth, providing complete wheelchair access from the front or the side of the voting area. Although the machine weighs only eight pounds, it was not designed to be held in a voter's lap. Encrypted Voting Machine Systems does not plan any additional modifications for wheelchair voting.

The DIRECT Vote has an audio voting attachment, although it is still in the design stage and was not demonstrated at the fair. According to Encrypted Voting Machine Systems, this audio component will include a handheld device that enables the voter to move back and forth through the audio ballot and make selections. The audio component will also use a standard headset with volume control. The volume will be reset automatically after each voter. The component will include an assisted listening device in the form of a neck loop to accommodate hard of hearing voters that have hearing aids with telephone switches. The voter will also be able to adjust the speed of the speech. Instructions on how to use the machine controls will be provided via the recording and can be repeated throughout the process of using the machine by pushing a special button. Voters who use the audio ballot can write in candidates.

The prototype model does not include Braille, however it could be printed on the keys by special order.

The machine does not currently have dual switch capability, but Encrypted Voting Machine Systems has indicated that the switch currently used for the audio component's headset could be replaced with a sip and puff switch.

Security and Data Storage:

The DIRECT Vote includes a separate panel for the poll worker to activate the voting process for each voter. This separate panel is located outside each booth. There is also a separate override feature that permits casting a ballot without entering the booth, if a voter should leave without pushing the "cast vote" button. This override mechanism requires entry of a code by poll workers from the state's two predominant political parties.

Each machine records its own tally as well as the vote tally for the entire precinct. The precinct's processor, however, officially tabulates votes for the polling place. A CD-ROM of the vote totals is prepared at the same time the precinct's processor tabulates the votes. In addition, a flash memory card records each vote and the totals at the close of the polls. Each voting machine has the ability to produce a paper audit trail.

User Feedback:

It is important to note that the machine displayed at the fair was a prototype model, not a fully functioning machine. The audio feature was not operational, which barred voters with visual disabilities from testing the machine.

Some testers who were able to use this machine reported that it was easy to understand and to learn. Testers liked the idea of the printed vote verification and felt that their votes would be recorded accurately. Several comments indicated a greater comfort level due to the familiar look and function of the machine.

Regarding the visual presentation, testers commented that the type size on the ballot was very small and difficult to read. A tester with a neurological disorder commented that the lights are too bright and could cause problems for people with neurological disorders.

Several testers commented that the functionality of the buttons was too much like current machines. Some testers also said that the buttons were too small and too close together for users with poor dexterity. Other testers noted that some of the buttons were too high to be reached from a seated position. A quadriplegic tester with spasticity that had use of only one arm said that it was difficult to reach the buttons and accurately touch them in the right places. Another tester with coordination difficulty also found the machine too difficult to use.

It is clear that Encrypted Voting Machine Systems must continue to work with voters with disabilities to test the accessibility of voting machine features not displayed at the Voting Technology Fair, namely the audio component, the neck loop and the sip and puff attachment. As a full-face style ballot, this machine has the potential to meet both federal and current New York State standards for voting machines. Suggestions from testers indicate however, that this vendor should continue to work on the design of the ballot, particularly with respect to the font size, the lights and the location of the buttons.

Chapter 6/**HART INTERCIVIC:** ***ESLATE 3000***

General Description:

The eSlate 3000 is a lightweight (5.2 lbs.), durable electronic device about the size of a legal pad, although somewhat thicker. Ballots are presented to the voter on a color screen. The voter is presented with a series of screens, each of which displays one or more contests. Selections are made by utilizing an integrated, rotary wheel selector. The use of the integrated rotary wheel differentiates the eSlate 3000 from other systems on the market. Hart describes the screen itself as a "tough" durable screen because (1) it is not a touch screen and (2) it is coated with polycarbonate, which resists punctures and scratches. In addition to the eSlate 3000, Hart InterCivic offers the Disabled Access Unit 5000 (DAU 5000). The DAU 5000 is an eSlate 3000 terminal equipped with an audio ballot reader, headphones and two flexible, light pressure jelly switches (one red and one green). Both the eSlate 3000 and the DAU 5000 have a help function. The eSlate 3000 can accommodate 10 languages.

Each eSlate costs $2250 and the DAU 5000 costs an additional $500. The judge's booth controller for each precinct costs $2500 and can accommodate up to 12 eSlates. Software to create ballots, tabulate results and allow multi-lingual capability costs $50,000. Hart InterCivic's eSlate 3000 system is certified for use by an FEC-accredited laboratory and is in use in the following localities: Harris County (Houston), Texas; Arapaho County (Denver), Colorado; Charlottesville, Virginia; Tarant County (Fort Worth), Texas; Travis County (Austin), Texas; and Orange County (Anaheim), California.

Buttons, Switches and Controls:

The eSlate has the following controls: a round rotary wheel for selections; a large, mostly rectangular button that is curved on one side, for entering choices; a small oval "help" button; and two triangular buttons to move to the next or previous contest. All of these controls are colored gray. There is an oval, indented red button, which is used for casting the ballot. There are also two flexible, light pressure jelly switches, which can be used by people with limited dexterity or range of arm motion. A sip and puff adapter is available as well as a blink control device.

Ballot Design and Preparation:

Hart InterCivic's ballot origination software system enables users to define and create ballot styles for all precincts. The ballot can be designed by election administrators to accommodate one or more contests per screen. The mobile ballot box at each precinct contains information about ballot styles as well as other precinct data. The ballot consists of a series of screens, each of which can accommodate one or more contests (depending on the number of candidates) and/or propositions. The screen can be laid out in one, two or three columns.

Voting Process:

The voting process begins with a presentation of written instructions. The voter is then presented with a series of screens, each of which displays one or more contests. The voter uses the two triangular buttons on the machine to move from one contest and screen to another. He or she is then able to select the candidate of choice by using the integrated rotary wheel. Once the voter has selected a candidate, he or she must then press the rectangular button next to the dial to enter the choice. The voter can skip a race using the two triangular buttons. A voter can change his or her vote for one race without having to re-cast votes for the other races. Other buttons on the machine allow the voter to access help or cast the ballot.

Before casting the ballot, the voter is presented with a summary of his or her choices and the chance to make modifications.

Accessibility Features:
A specialized polling booth can be used to accommodate wheelchair users. The eSlate weighs 5.2 lbs. and can be held in the voter's lap. Additionally, the machine includes a battery pack that provides back-up power, which also allows for curbside voting.

Voters cannot currently change the font or screen contrast, however Hart InterCivic is currently readjusting its software so that ballot templates will begin with the option for the voter to select small, medium or large font size for the ballot.

The DAU 5000, the audio ballot component, can be used to accommodate visually impaired and blind voters. The controls for the audio ballot also use the distinctly shaped buttons and rotary wheel on the eSlate 3000 unit. The eSlate 3000, in combination with the DAU 5000, is the only voting machine on the market that does not "black out" the visual ballot on the screen when the voter is using the audio ballot. This feature enables visually impaired voters to look at the ballot while listening to the audio ballot recording. The audio ballot is synchronized with the standard visual interface, so that the audio always reflects what the voter sees on the screen. If the voter presses the HELP button to call a poll worker to the booth for assistance, the screen will automatically change to a blue background with the written instruction that a poll worker is on his way. This feature ensures that the selections the voter has made thus far remain private.

The audio ballot is provided by a human voice. This component does not have an assisted listening device for hard of hearing voters, however it does have volume control. Hart InterCivic representatives recently tested the audio ballot component with a group of blind and severely hard of hearing voters to evaluate this population's ability to hear the audio ballot. It seems that this group was able to hear the ballot through the combination of their hearing aids and a high volume level.

The eSlate 3000 was also the only machine at the Voting Technology Fair that has multiple forms of dual switch capability. This includes the two jelly switches, which are flexible round switches in red and green that are used as light pressure buttons. Mobility impaired people can use their hands, feet, elbows or an adaptive stick to lightly press the red jelly switch to move through the ballot and the green jelly switch to make selections. The machine can also accommodate a sip and puff adapter, which allows voters that are unable to use any of their limbs the ability to control the machine through their breath. Lastly, the eSlate 3000 can accommodate a blink device for people who cannot use the jelly switches or the sip and puff adapter.

Braille labels are available for the unit as part of an attachment to the machine. A new version of the machine's hardware is being designed to include Braille labels that are permanently embossed on the machine.

Security and Data Storage:
Each voter requires an access code that can only be entered by the poll worker. Each precinct has a computer memory card that inserts into the judge's booth controller and provides the data necessary for managing the election at the polling place. This card (also called the mobile ballot box) stores the cast ballot information and is used to deliver election results to central tabulation. Each precinct is a secure network with no external access. Data is stored in three separate locations for back-up and reliability.

Unauthorized individuals cannot alter the data because the database structure is proprietary and protected by encrypted passwords.

User Feedback:

Testers provided a significant amount of positive feedback about the eSlate 3000. Many reported the machine was easy to use and understand and felt that they would be able to vote privately and independently. Testers with disabilities reported that the machine was ideal for people with and without disabilities. Two testers with no or very limited use of their arms and/or hands found that the eSlate 3000 was the only machine they were able to use. One tester said, "I am quadriplegic. I found the [eSlate 3000] simple to use and enjoyable to operate".

A legally blind tester reported that the machine was easy to use. With regard to Braille, testers said that the inclusion of Braille on the controls made the selection process easier. They also noted that this was the only display where Braille controls were pointed out at the beginning of use.

Several testers also commented that the company representative was very helpful and provided direct and useful training on using the machine.

Other comments included:

- " After trying all of them [machines at the fair], I thought this is the simplest and the best."
- "I appreciate that technology is giving me the opportunity to cast a private vote without assistance".
- "This machine should be more readily available and definitely facilitated the voting process."
- "The wheel used to select your candidate on screen was fabulous—easy to use regardless of one's dexterity level".

There were some difficulties encountered by testers. Several testers who were hard of hearing and visually impaired suggested the inclusion of a plug that allows hard of hearing voters to use the audio socket with their own headsets and/or neck loops. A few testers said that the rotary wheel was a bit difficult to get used to, but once they were familiar with it, it was easy. There were a few comments about confusion regarding usage of the rotary wheel and other buttons.

Many of the comments about the font size and screen contrast related to issues that can be addressed in ballot design, such as background color, font size and font color.

Regarding the audio component, one tester suggested that it would be helpful to be able to select a male or female voice (certain types of hearing loss make it difficult to hear either higher or lower tones). Testers also commented that having the ability to control or adjust the speed of the audio track would be very helpful. A few testers felt that the audio instructions were too lengthy and not well organized in relation to the ballot. Other concerns expressed by testers related to confusion in how to review the ballot summary of selections and difficulty in casting a write-in vote.

Chapter 7/**SEQUOIA VOTING SYSTEMS:** ***AVC ADVANTAGE***

General Description:

The AVC Advantage offers a full-faced ballot with all contests and propositions on one display area. The ballot and voting process are similar to what New York State voters are already using. The machine has two positions –voting and storage. The dimensions of the voting position are 75.3" high, 46.5" long and 55" deep. The dimensions of the storage position are 39.3" high, 46.5" long and 24.5" deep. Depending on the system configurations, the machine weighs between 225 and 265 lbs. One unique feature of this machine is that it has a battery-operated back-up system that allows 16 hours of use if a working electrical outlet is not available.

This machine is certified for use by an FEC-accredited laboratory based on Federal Election System Standards. The AVC Advantage is also the only voting machine displayed at the Voting Technology Fair that is certified for use in New York State. This machine is currently used in parts of New Jersey and several counties in New York State. Each machine costs approximately $6000. The cost for having a Braille ballot created is unknown.

Buttons, Switches and Controls:

The buttons are tactile switches that the voter presses to select or de-select a candidate. A small light is used as a visual indicator to confirm the selection. The audio ballot attachment is a tethered device that contains distinctly shaped color-coded buttons.

Voting Process:

The voter presses the tactile buttons that are located directly on the full-face ballot to make selections and cast the ballot. Voters that are unable to reach buttons on the upper portions of the ballot can use a stick to press these buttons. The voter can check a LCD message display to confirm that choices are correctly recorded. There is also an electronic write-in feature, which is accommodated with a keyboard on the front of the ballot, in the lowest position on the ballot to increase access. Selected letters are displayed prominently on the screen next to the keyboard. The voter does not have to vote in all contests in order to cast the ballot. If the voter decides to change his or her vote in one race, the voter does not have to re-select candidates in the other races.

Ballot Preparation and Design:

The ballot is contained on one large display and can be designed by election officials. It consists of black type on a white background. Jurisdictions can purchase only the number of voting positions that they believe they would need (either 252, 336, 420 or 504) to allow sufficient space for all contests and propositions. The display can accommodate additional languages, but this results in smaller font size. The font size cannot be adjusted by voters who need to read print that is larger than the standard size selected by ballot designers. The AVC Advantage however, accommodates Braille ballots for voters who read Braille.

Accessibility Features:

The AVC Advantage can be tilted to accommodate voters in wheelchairs, however due to its size and tremendous weight, the machine cannot be placed in the voter's lap to increase access. Wheelchair users and voters with limited range of motion may use a stick with a plastic tip to reach high selections on the ballot. Voters with limited range of motion who cannot use a stick to reach selections or use the buttons or

controls for the audio component, would require the assistance of another person to use this machine. This machine does not have a sip and puff adapter.

There is an audio attachment, which is a tethered device, for voters with visual impairments. This attachment has distinctly shaped color-coded buttons that allow the voter to navigate through a menu of contests and candidates and select the candidate of choice for a given race. Voters can write in candidates by using the audio to scroll through the alphabet and select letters to spell out the candidates' names. The instructions are provided in the beginning of the audio ballot. The audio ballot is designed using a human voice.

Braille is located on the sides of the audio control buttons as labels. The voter can press a "Help" button on the control at any point during the voting process and the instructions can be re-accessed. The voter is able to adjust the volume of the audio, however he or she cannot adjust the speed of the speech. With the exception of the volume adjustability feature, there is no assisted listening device for hard of hearing voters who would like to use the audio component. The audio component can accommodate several languages.

Security and Data Storage:

A poll worker must press a button to enable either the standard or audio voting. Also available is an optional Smart Card function that would allow the voter to set up the machine instead of the poll worker. Votes are recorded in three different ways to ensure accuracy. The ballot image is redundantly stored in each machine and in a "results" cartridge. In addition, a chronological events log records the time, date and nature of all system events. An audit trail that provides a randomized record of all votes cast can be printed after the election. It is also possible to produce a visual display of vote totals.

User Feedback:

Several testers noted that overall, they thought the AVC Advantage was a good machine, that the staff handling the machines at the fair were professional and knowledgeable about the machines and that they generally thought the machine is well-suited to the needs of disabled voters. The most common feedback was that the full-face ballot on the machine was familiar to voters and would therefore be comfortable to use. One tester wrote that the "…machine is closer to how I vote now. I don't have to change to a new screen or computer." It seems that because the ballot style is similar to that which is currently used in New York State and because the system does not look like a computer, voters who are uncomfortable using computers but have experience using the lever machines would feel more comfortable using this system than the other types of machines displayed at the Voting Technology Fair.

Several testers noted that the print was clear, possibly indicating that they liked the font size and or the contrast between the color of the print and the color of the ballot's background. Another tester felt, however, that the print on the ballot was too dark and was difficult to read from his or her vantage point in a scooter. Yet another tester commented that the ballots should be created with as large a font size as possible.

Several comments were made with respect to the size of the machine. One tester commented that he or she liked the big screen. Another person noted that he or she felt the "…provision for 'short' voters is very adequate." A different tester commented that the machine is more accessible for the blind because there is room in front of the machine for both the voter and a service dog.

Although there were voters who felt the size of machine and the ballot were accessible, there were those who felt there were physical obstacles to using the machine. A tester commented that the machine's height and tilt was not sufficiently adjustable. One tester said that though he was able to use the lower portion of the ballot by hand, a stick with a plastic tip had to be used in order to make selections that were located higher on the ballot. One wheelchair-using respondent with limited range of arm motion and limited dexterity had no ability to use this machine without the assistance of an additional person.

Some testers seemed to experience problems with the audio component of the machine. One felt that the audio instructions did not clearly explain how to cast the ballot. Another tester had difficulty finding the end of the audio ballot and was not sure whether her selection was accurately recorded. This same person felt that the "Help" button did not help her figure out how to reach the end of the audio ballot or how to confirm her selections. One voter wanted to be able to check or change selections without having to move backward and forward through the entire audio ballot. This person realized that he had to re-listen to the candidate names in all of the contests on the ballot in order to change a selection in one of the contests.

A different tester noted that it took a lot of work to figure out the buttons for the audio component, even though the buttons had corresponding labels in Braille. There were a couple of testers who felt that the machine should have had a Braille ballot. Visually impaired voters who are able to read Braille would then be able to forgo use of the audio component by making their selections using the Braille ballot.

For voters who are familiar with and have previously voted using New York City's full-face ballot lever machine, it seems that the similarity between the AVC Advantage and the machines currently used in New York City would make the AVC Advantage easier to use than other machines on the market. It is important to note that many voters who have not been able to use New York City's machine will still have difficulty using the AVC Advantage. For example, voters with limited use of their hands and limited ability to move their head, will not be able to use a stick to reach and select candidate names or contest choices located on the top of the ballot. In these cases, assistance will be required.

Sequoia Election Systems may want to consider working with blind and visually impaired voters to redevelop the audio component's instructions. Sequoia may want to also consider including a summary of selected candidates at the end of the audio ballot, so that voters do not have to move a second time through the entire ballot to confirm selections.

Chapter 8/SEQUOIA VOTING SYSTEMS: *THE AVC EDGE*

General Description:

Sequoia Election System's AVC Edge is a touch screen voting machine. The dimensions of the machine in voting position when optional machine legs are used are 60" in height, 28" in width and 28" in depth. The dimensions of the storage position for the machine are 60" in height, 10" in width and 26" in depth. The machine weighs approximately 38-40 lbs. The machine is self-contained, standing on a tripod with top and side shields. In the case of a power failure, the machine has a back-up battery that allows the system to operate an additional four hours without the use of an outside power source. The compact nature of the machine also allows for curbside voting.

The AVC Edge is certified for use by an FEC-accredited laboratory. This machine is currently being used in New Jersey (Salem County), California (Riverside), and Florida (Palm Beach County). A single unit costs approximately $4000.

Buttons, Switches and Controls:

Touch screen buttons are used to move back and forth and make selections. The audio ballot attachment is a tethered device that contains distinctly shaped color-coded buttons.

Voting Process:

Touch screen scroll buttons are used to move back and forth on the screen and within each contest. Votes are immediately confirmed on-screen with green check marks and selections can be viewed at a glance by selecting the REVIEW button. An additional touch of the REVIEW button allows voters to resume voting. This REVIEW button feature enables voters to verify their selections and change their vote at any time before they cast their ballots. Races can be skipped. Over-voting is not possible with this machine.

Ballot Design:

The AVC Edge has a 15" LCD touch screen. This machine can accommodate up to 2000 different ballot designs. The machine can also accommodate a maximum of 500 pages. A ballot can hold a maximum of 1000 contests and a maximum of 10,000 candidates. When designing the ballot an unlimited number of languages can be programmed. The font size and the screen contrast cannot be adjusted by the voter, however, it can be controlled by the ballot designer. The ballot includes an on-screen typewriter, to allow the voter to write in the candidate of choice.

Accessibility Features:

The size and weight of the AVC Edge is too big to be held in the lap of the voter. Wheelchair users however, can be accommodated by adjusting the screen's height. Voters with limited dexterity may require assistance in order to vote with this machine. The machine does not have dual switch capability.

The AVC Edge uses the same audio component that is used by the AVC Advantage. This attachment is a tethered device, which can be used by voters with visual impairments. The attachment contains distinctly shaped color-coded buttons that allow the voter to navigate through a menu of contests and candidates and select the candidate of choice for a given race. Voters can write in candidates by using the audio to scroll through the alphabet and select letters to spell out the candidates' names. The instructions are provided via the audio component in the beginning once the poll worker has pressed a button to enable the audio voting to begin. This component uses a human voice.

Braille is located as labels on the sides of the buttons. The voter can press a "Help" button on the control at any point during the voting process and the instructions can be re-accessed. The voter is able to adjust the volume of the audio, however he or she cannot adjust the speed of the speech. With the exception of the volume adjustability feature, there is no assisted listening device for hard of hearing voters who would like to use the audio component. The audio component can accommodate several languages.

Security and Data Storage:

Each voter must insert a card processed by the "Card Activator", which the poll worker creates after establishing the voter's identity. The voter takes this card to the machine and inserts it herself. After she has finished voting, the card is automatically disabled and cannot be used again. This ensures that the voter is unable to vote more than once. This feature also eliminates the need for a poll worker to manually activate the voting process for the voter.

The AVC Edge has a printable audit trail feature that provides an unalterable electronic record of all votes cast during the election. Cast votes are also stored in the AVC Edge and in a results cartridge. Lastly, there is also a printable chronological events log that records the time, date and nature of all significant system activity.

User Feedback:

Some testers commented that they liked Sequoia Election System's AVC Edge, however they also provided many suggestions for improvement. Most of the suggestions were specifically for the audio component of the machine. Testers commented that the speech was too fast and that the volume was too low. They also felt that background noise was a problem and sound-proof booths should be used for audio voting. One felt that the audio component had too much static.

Testers felt that the instructions for the audio needed to be revised. One tester specifically said that the instructions were too long. Another noted that the instructions were not clear regarding how to cast a vote. One other tester felt that it was unclear which buttons to use with the audio ballot.

Multiple testers pointed out that it is important to identify buttons by color, shapes, directions and labels. One noted that clear directions (e.g. left versus right, up versus down) were missing from the buttons for the audio component. Another respondent felt that the volume button should be color-coded. One respondent commented that the "large font" size Braille labels were too big and therefore difficult to read.

The primary comment that was made regarding the touch screen style of voting were that larger fonts should be used.

It should be noted that the audio component for the AVC Edge is the same as for Sequoia Election System's AVC Advantage. Respondents generally found that the sound quality of the audio component needed improvement, including better sound-proofing for background noise, elimination of static, and slowing down the rate of speech. Respondents also commented that the instructions were too long and difficult to understand. Sequoia Election Systems may want to consider using a headset that blocks out background noise or developing a sound-proof booth for the machine. The vendor should also consider enlisting a focus group of blind and visually impaired voters to re-develop the instructions for the audio component of the machine.

Chapter 9/**VOTING TECHNOLOGIES INTERNATIONAL:** ***VOT CENTER***

General Description:
The VOT Center machine is a touch screen machine that can also serve as a typical desktop computer. The computer monitor offers the voter touch screen access to each contest. Because the machine's hardware is a standard desktop computer, this machine can be used year-round for other purposes. The VOT Center system can accommodate an unlimited number of languages.

The VOT Center is certified by an FEC-accredited laboratory and several states. It is currently in use in some precincts in Florida. It is difficult to attach a standard price to the VOT Center because its key feature is the software that allows its use on any standard desktop computer. As a result, it is possible to buy only the software and install it on existing computers and servers.

Buttons, Switches and Controls:
There are no tactile buttons and switches on the standard unit rather, votes are cast through a touch screen. The disabled voting station has a keypad with three buttons—a yellow circle in the middle and two yellow triangles at the end.

Ballot Design and Preparation:
Ballots are set up to accommodate one contest per screen. While each screen can list 24-30 candidates per contest, there is scrolling capability so that technically, an unlimited number of candidates can be shown on a single screen.

Voting Process:
A poll worker must set up each vote by entering a PIN number. The computer monitor offers the voter touch screen access to each contest. Touch arrows and ovals allow the voter to move from one contest to the next, to quit or to obtain assistance. Before exiting, the unit provides a summary of the voter's selections, so that the voter has an additional opportunity to make changes or vote in contests that might have been overlooked. A voter does not need to select a candidate for all races. If a voter decides to change his or her vote for one race, all other votes do not need to be re-cast.

Accessibility Features:
Placement of the machine is flexible to accommodate wheelchair users. The standard touch screen attachment for a desktop computer is too big for laptop use, however Voting Technologies International does offer a mobile system for use with a laptop, so that curbside voting is possible. This machine does not have a sip and puff adapter for people with mobility impairments, in particular limited dexterity and range of arm motion.

The user can control the screen contrast but cannot change the font. The machine does not include Braille labels.

Voting Technologies International's disabled voting station includes large, padded headphones for the audio ballot and a keypad unit with three large yellow buttons for visually impaired voters and others who have trouble with the touch screen. The audio voice is computer generated. Speed and volume are not adjustable.

Data Storage and Security:

The poll worker must enter a PIN number to activate the voting process. The voter gets validation that his or her vote is properly cast by viewing a summary before casting the vote. Cast ballot information is stored in a dual system, which includes an encrypted database and picture images of the cast ballots. This allows election officials to compare the data for accuracy. The data can also be saved on CDs.

User Feedback

Testers had a broad range of reactions to this machine. Some felt that it was easy to use, simple and straightforward. One tester said that it would be usable by people with limited use of their hands. Testers experienced some confusion at first, but felt once they learned to use the machine, it was easy and fast. Based on the comments provided it seems that the machine would be easy to use if you did not need the audio component.

Testers noted that they liked the design and simplicity of the buttons and controls. Several said they would like to see Braille labels on the controls.

Some testers commented however, that the font size was too small and the screen contrast was too light, making it difficult for people with low vision to use without the audio component.

The summary feature at the conclusion of voting was considered a positive feature by testers.

Testers who used the audio component commented that the electronically generated voice was difficult to understand. Some also noted that they would have liked controls for the volume and speed of the audio ballot.

Testers found the instructions, both written and audio, difficult to understand. One tester said, “I wasn’t sure what was coming at me. I think they should give instructions about what to expect.” Another tester who found the instructions confusing was disappointed that there was no help button obviously available. The same tester also found the audio component difficult to use because the verbal instructions did not indicate how many choices there were for each office.

Chapter 10/COMPARISON OF ACCESSIBILITY FEATURES AND RECOMMENDATIONS

Each of the eight voting machines demonstrated at the Voting Fair offer unique features to accommodate different disabilities, however some machines were more accessible to disabled testers than others. Below is a comparison of the machines on the different accessibility features designed for people with disabilities. Five disability categories will be discussed: wheelchair access, dexterity and arm range access, visual impairment access, hearing disability access, and cognitive and neurological disability access.

Wheelchair Access:

There are varying levels of wheelchair access to each machine. Diebold Election Systems, Election Systems & Software and Hart InterCivic have all designed machines that are portable, lightweight and can be placed in the lap of a wheelchair user. These machines enable the wheelchair user to have close access to all of the functions of each machine's standard method of voting. Sequoia Voting System's AVC Edge is a compact machine, however it is too heavy to be held by the voter and therefore must remain on its stand. The stand's legs are adjustable, so that the machine can meet the wheelchair user at the height that is most comfortable and accessible to him or her.

Avante International Technology and Voting Technologies International both offer desktop computers as the voting machine unit. Both machines would need to be placed on a stand that is low enough for the wheelchair-using voter to be able to comfortably reach the LCD screen that is used for touch screen voting. Voting Technologies International, however, offers a laptop computer version of its machine, which if light and small enough, could be placed in the lap of the voter.

Sequoia Voting System's AVC Advantage and Encrypted Voting Machine System's DIRECT Vote are both full-face ballot machines. Because of their tremendous size, there is limited access to these machines for most wheelchair users. The AVC Advantage is a free standing machine that can be tilted to a vertical position to bring the top portion of the ballot somewhat closer to the wheelchair using voter. Despite the tilting accommodation, some smaller wheelchair users and those with limited range of arm motion will face difficulty reaching the buttons at the top of the ballot. In some cases, such voters would be able to use a stick to press the top buttons, however those who are unable to manipulate such a stick would require the assistance of another person to vote. Wheelchair users may also face similar barriers to the DIRECT Vote machine. Unlike the AVC Advantage's tilt feature, the DIRECT Vote has no special height or distance accommodation for wheelchair users. The voting booth used with the DIRECT Vote would need to be designed with a low stand that has enough space for a wheelchair or scooter user to pull in close to the ballot.

Table 1. Wheelchair Accessible Features

	Lightweight, Portable and Can Be Held by Voter	Height is Adjustable	Tilt is Adjustable	Curbside Voting is Possible
Avante International Technology	No	Yes	No	No
Diebold Election Systems	Yes	Yes	Yes	Yes
Election Systems & Software	Yes	Yes	No	Yes
Encrypted Voting Machine Systems	No	Yes	No	No
Hart InterCivic	Yes	Yes	No	Yes
Sequoia Voting Systems' AVC Advantage	No	No	Yes	No
Sequoia Voting Systems' AVC Edge	No	Yes	Yes	Yes
Voting Technologies International	Yes*	Yes	No	No

*Machine can only be portable if a laptop is used. Otherwise, the standard desktop computer that is used is not portable.

Recommendations:

- The ideal machine for most wheelchair users is one that is light, portable and can be held in a person's lap, if necessary. Enabling the wheelchair-using voter to hold the machine minimizes the distance between the two. Additionally, such machines will have controls that are easy to reach by the voter.

- If the machine is too big to be held by wheelchair users, the machine's height and tilt should be adjustable in order to minimize distance between the wheelchair user and the machine's controls.

- Machines that cannot be adjusted for height and tilt should be placed on a stand that is low enough to ensure that a wheelchair user can read the ballot and access the controls of the machine.

- Full-face ballot machines should not have buttons or switches that are more than an arm's length away from a wheelchair user. Although some would be able to use a stick to press hard to reach buttons on a full-face ballot, there are many others who would not. In these cases, wheelchair-using voters would require the assistance of an additional person to press the hard-to-reach buttons.

Limited Dexterity/Range of Arm Motion Access:

Voters with limited dexterity, in particular those who have a spasticity disability, often times will not have the movement accuracy that is required to press a small tactile button or any touch screen button. Large tactile buttons can be manipulated by some voters with this type of disability, however if the buttons are placed too close together, they will be difficult to control and to distinguish from one another. Voters who have either limited or no range of arm motion will face great difficulty using machines that have buttons, switches and controls located in multiple parts of the machine. Often times, voters with a limited range of arm motion will also have limited use of his or her hands and fingers.

The standard voting methods for Avante International Technology, Diebold Election Systems, Election Systems & Software, Sequoia Voting Systems' the AVC Edge and Voting Technologies International are all touch screen voting, which is inaccessible to people with dexterity and arm motion related disabilities. Voters with these two types of disabilities are also unable to use a stick to reach and press the buttons on the higher portions of the full-face ballot machines offered by Sequoia Voting Systems and Encrypted Voting Machine Systems.

Quadriplegics and people with spasticity disabilities at the Voting Fair noted that the only machine they were able to use was Hart InterCivic's eSlate 3000. It seems that the rotary wheel was easy to manipulate in order to make selections on the ballot. This machine requires the use of only one large button that is placed next to the dial and is close enough to locate for those with limited range of arm motion. In addition, because there is only one button, people with limited dexterity will not worry about pressing the "wrong" button.

Hart InterCivic's machine was also the only machine at the Voting Fair that has multiple types of dual switch capability for people with limited dexterity or arm mobility. This machine includes a sip and puff adapter, so that people can vote by breath. It offers light pressure jelly switches, which can be manipulated by hands, feet, elbows or an adaptive stick. This machine is adaptable for a blink control device as well. Avante International Technology offers tongue-activated voting. Encrypted Voting Machine System plans to offer a sip and puff adapter, but it is currently in the design phases.

Recommendations:

- Voting machines should have a single location for the controls and should limit the controls to a minimal number of tactile buttons or switches. For example, Hart InterCivic's eSlate 3000 has one large tactile button in combination with a rotary wheel that can be easily manipulated by people with limited dexterity or range of arm motion. The voter does not need to move his or her arm to different parts of a machine in order to make selections.

- Dual switch capability, such as a sip and puff adapter, should be available to enable those who use this equipment to make selections without being limited to tactile controls.

- Touch screen voting is not accessible to people with limited dexterity and range of arm motion, therefore an alternative voting method such as audio capability with a control that is accessible to people with such disabilities should be included as part of the system.

Table 2. Limited Dexterity and Range of Arm Motion Access Features

	Tactile Controls are in Single Location	Limited Number of Tactile Controls	Standard Voting is not Touch Screen	Dual Switch Capability*
Avante International Technology	N/A[?]	N/A	No	Yes
Diebold Election Systems	N/A	N/A	No	No
Election Systems & Software	Yes	Yes	No	No
Encrypted Voting Machine Systems	No	No	Yes	No[O]
Hart InterCivic	Yes	Yes	Yes	Yes
Sequoia Voting Systems' AVC Advantage	No	No	Yes	No
Sequoia Voting Systems' AVC Edge	N/A	N/A	No	No
Voting Technologies International	N/A	N/A	No	No

*Dual switch capability includes a sip and puff adapter, light pressure switches, blink control device or tongue-activated voting.
[?] Not applicable (N/A).
[O] Encrypted Voting Machine Systems is planning to include a sip and puff adapter with its machine, however it is currently not available.

Visual Disability Access:

All of the machines at the Voting Technology Fair, with the exception of Encrypted Voting Machine Systems, offered an audio ballot for visually impaired or blind voters. Audio ballots were used with a headset and some type of control for the voters to make selections. Controls for audio ballots varied greatly by machine. Avante International Technology and Diebold Election Systems utilized controls that they felt were familiar to voters with visual disabilities and therefore easy to manipulate. Avante International Technology's audio ballot requires the use of the four corner buttons of a computer keyboard. Voting Fair testers with experience using computers indicated they were comfortable using a

keyboard as a control, however it seemed that those who were inexperienced using computers noted some confusion with this layout. Diebold Election Systems' telephone keypad control is clearly familiar and simple to control for most visually impaired voters, however some testers indicated that as a voting machine control they would have liked the buttons to be raised higher and were confused using the control to select alphabetic letters for write-in votes.

Election Systems & Software, Hart InterCivic, Sequoia Voting Systems and Voting Technologies International all offer audio ballot controls with color-coded, distinctly shaped buttons. Voters with low vision liked the brightly colored buttons, particularly when the buttons were different colors to distinguish one button from the next. Visually impaired and blind voters also liked buttons that were distinctly shaped. They noted, however, that directional buttons were sometimes confusing. One tester, for example, commented that distinct arrow-shaped buttons pointing either up, down, left or right are simplest to understand.

The sound quality of the audio was frequently cited as an important accessibility feature of the audio ballot. Many testers faced difficulties with the volume level of audio ballots. Diebold Election Systems, Hart InterCivic and Sequoia Voting Systems were the only vendors to offer machines with volume control. Others felt that the speech rate of some ballots was too slow, while for others it was too fast. Avante International Technology's machine was the only one with a control for the rate of speech. Other vendors noted that such a control distorts the speech and could potentially confuse voters.

Testers commented that computer-generated voices used for Avante International Technology's and Voting Technology International's audio ballots were difficult to understand, while no tester cited difficulty understanding the human voice ballots offered by the other vendors. One tester commented that he would have liked a choice between a male and a female voice for all of the audio ballots. This choice would be particularly helpful for visually impaired voters with hearing loss, who have difficulty hearing higher or lower tones. Lastly, testers commented that background noise and static made it difficult to clearly hear the audio ballot. This seemed to be a particular problem with the audio component used with Sequoia Voting Systems' two voting machine models.

Although a small portion of people who are blind are able to read Braille, many testers at the Voting Fair who do read Braille felt that Braille labels on audio controls made it easier for them to distinguish the different buttons. This was indicated in the comments for the machines designed by Election Systems & Software, Hart InterCivic and Sequoia Voting Systems, which all provide Braille labels for the audio controls. Testers did note that the large-size Braille used as labels for Sequoia Voting Systems audio ballot controls were difficult to read and suggested that standard size Braille should be used instead.

Testers indicated that Braille ballots for the two full-face ballot machines designed by Sequoia Voting Systems and Encrypted Voting Machine Systems would have made their machines easier to use. Sequoia Voting Systems does offer a Braille ballot for the AVC Advantage, however it must be specially ordered. Encrypted Voting Machine Systems also offers Braille labels on special order.

With respect to visual access for standard methods of voting, large font size and strong contrast between the color of the printed words and the color of the ballot's background, increase the accessibility of standard visual voting for people with low vision and other visual disabilities. Visually impaired testers who had difficulty reading the ballot commented that it would have been easier to read the ballots had they been able to adjust the font size and/or the screen contrast. Diebold Election Systems' AccuVote-TS System was the only machine that allowed the voter to control its font size. Font size for all of the other

machines is pre-determined by the ballot designers. Voting Technologies International's VOT Center was the only machine displayed at the Voting Fair that allows the voter to adjust the screen contrast.

Many visually impaired voters have some ability to view the ballot but like to use the audio control to ensure that they know in which contest they are voting and who the candidates are. Hart InterCivic was the only machine at the Voting Technology Fair that offered a synchronized audio ballot with the standard voting interface so that visually impaired voters could both read the ballot and hear the ballot at the same time. The screens for Avante International Technology, Diebold Election Systems, Election Systems & Software and Sequoia Voting Systems' AVC Edge all black out when the audio ballot is activated for voting. Sequoia Voting Systems' AVC Advantage's visual ballot also does not reflect selections that are made using the audio ballot component.

Recommendations:

- Color-coded and distinctly shaped buttons should be used for audio ballot controls, in order to facilitate the ability of the visually impaired or blind voter to distinguish one button from the next.

- Buttons that are used to moved forward or backward in an audio ballot should have shapes that indicate direction. For example, such buttons could be designed in an arrow shape that points either up or down, left or right.

- Volume control should be available.

- Audio ballots should be available at two speech rates—standard speech rate and slow speech rate.

- Human voices should be used to record audio ballots instead of computer-generated voices.

- If possible, there should be a selection of a male or female voice audio ballot. Some hard of hearing voters have more difficulty hearing higher or lower toned voices.

- Standard size, Braille labels for controls and Braille ballots should be part of the machine. It should be noted however, that because a small portion of the blind population read Braille, Braille should not be used as a substitute for audio ballots.

- Font size and screen contrast controls should be made available to increase access to the standard methods of voting for visually impaired voters.

- The machine should allow the voter to simultaneously use the visual and the audio ballots.

Table 3. Visual Disabilities Access Features

	Color-Coded, Distinct Shaped Buttons	Clear Directional Buttons	Human Voice vs. Computer Generated	Volume Control	Speech Rate Control	Choice of Male or Female Voice	Braille Labels or Braille Ballot	Font Size Control	Screen Contrast Control	Synchronized Audio and Visual Voting
Avante International Technology	N/A [?]	N/A	Computer Generated	No	Yes	No	No	No	No	No
Diebold Election Systems	N/A	N/A	Human Voice	Yes	No	No	No	Yes	No	No
Election Systems & Software	Yes	Yes	Human Voice	No	No	No	Yes	No	No	No
Encrypted Voting Machine Systems	N/A	N/A	N/A	N/A	N/A	N/A	Yes	No	No	N/A
Hart InterCivic	Yes	Yes	Human Voice	Yes	No	No	Yes	No	No	Yes
Sequoia Voting Systems' AVC Advantage	Yes	No	Human Voice	Yes	No	No	Yes	No	No	No
Sequoia Voting Systems' AVC Edge	Yes	No	Human Voice	Yes	No	No	Yes	No	No	No
Voting Technologies International	Yes	Yes	Computer Generated	No	No	No	No	No	Yes	No

[?] Not applicable (N/A).

Hearing Disability Access:

All of the machines displayed at the Voting Technology Fair were designed to increase access for people with mobility or visual disabilities, however, none were really designed to address hearing disabilities. Certainly for most hard of hearing people, barriers to communicating with poll workers and election officials are more common than barriers to actually using the voting machines. It should be noted, however, that there are persons who are hard of hearing and have an additional disability who would not be able to use either the standard or the audio method of voting for any of the machines as they are currently designed.

Several testers with hearing disabilities at the Voting Technology Fair suggested that assisted listening devices for the audio components of the machine would benefit people with both a hearing and a visual disability. Apparently, Encrypted Voting Machine Systems will offer assisted listening capacity through a neck loop for people who use hearing aides with telephone switches, however at the time of the Voting Technology Fair, this feature was still in the design stages. None of the other machines feature an assisted listening device, although a few (as previously noted in the Visual Disability Access section) provide volume controls for voters who are mildly hard of hearing.

Recommendations:

- Volume control should be available.

- An assisted listening device for the audio ballot should be made available in order to accommodate visually impaired voters that are hard of hearing.

Table 4. Hearing Disabilities Access Features

	Volume Control	Assisted Listening Device
Avante International Technology	No	No
Diebold Election Systems	Yes	No
Election Systems & Software	No	No
Encrypted Voting Machine Systems	N/A[?]	N/A
Hart InterCivic	Yes	No
Sequoia Voting Systems' AVC Advantage	Yes	No
Sequoia Voting Systems' AVC Edge	Yes	No
Voting Technologies International	No	No

[?] Encrypted Voting Machine Systems did not have an audio ballot available.

Cognitive and Neurological Disabilities Access:

Although there were several testers at the Voting Technology Fair with cognitive or neurological disabilities, few offered comments on the accessibility of the voting machines. The authors of this report however, were able to query individuals with such disabilities at the Voting Technology Fair, in order to have a better sense of their ability to use the various voting machines. The authors learned that generally, testers with cognitive disabilities found it easier to understand ballots that did not have too much information on a single page. They preferred viewing only one contest per page and suggested that ballots with multiple page capacity (all machines other than the AVC Advantage and the DIRECT Vote, which are both full-face ballots) be limited to one contest per page. Generally, testers with cognitive disabilities found full-face ballots to be difficult to understand. The one tester with a neurological disability found that the Encrypted Voting Machine Systems' use of multiple bright lights on its ballot had the potential to initiate a seizure. Unfortunately, there were too few comments from people with such disabilities at the fair to make any true conclusion of this population's ability to use the latest forms of voting machines.

Recommendation:

- Voting machines should not be limited to a full-face ballot, rather, they should be allowed to consist of multiple pages so that one contest can be limited to one page. Voters with cognitive disabilities will find it easier to understand the contest they are voting in and the candidates in that contest, if there is a limited amount of information for them to read at a single point in time.

Chapter 11**/CONCLUSION**

This report was an analysis of the written comments provided as part of an evaluation of disabled voters' experiences testing machines designed by the following voting machine manufacturers: Avante International Technology, Diebold Election Systems, Election Systems & Software, Encrypted Voting Machine Systems, Hart InterCivic, Sequoia Voting Systems and Voting Technologies International. Not all testers provided written comments, and most of the written comments focused on problems that testers experienced using the machines or suggestions for improvement. It should be noted that because not all testers provided written feedback, the analysis of these comments may not have reflected the majority of testers' experiences using each of the machines. A second report will therefore be issued analyzing how testers rated accessibility features using predetermined multiple choice scales.

The eight voting machines demonstrated at the Voting Technology Fair varied in design and accessibility. Diebold Election Systems, Election Systems & Software and Hart InterCivic demonstrated machines that were lightweight and portable units. Avante International Technology and Voting Technologies International demonstrated desktop computers as voting machines. Sequoia Voting Systems and Encrypted Voting Machine Systems demonstrated full-face ballot machines. Sequoia Voting Systems also demonstrated a small, freestanding voting machine.

Machines designed by Avante International Technology, Diebold Election Systems, Election Systems & Software, Sequoia Voting Systems and Voting Technologies International utilized touch screen voting technology. The two full-face ballot machines shown by Sequoia Election Systems and Encrypted Voting Machine Systems required voters to make contest selections by pressing tactile buttons. The machine designed by Hart InterCivic required voters to use a rotary wheel in combination with one button to make selections. All of the machines at the Voting Technology Fair, with the exception of Encrypted Voting Machine Systems, offered audio ballots for voters with visual disabilities. All of the audio ballot systems required testers to wear headsets in order to hear the instructions, the type of contest and the candidates for each contest. Avante International Technology required testers to use a computer keyboard as a control and Diebold Election Systems required testers to use a telephone keypad as a control. Other machines required testers to use a number of distinctly shaped buttons as the controls for the audio ballots.

Wheelchair users were concerned about the height of the machines and the tilt of the machines' screens or panels. Comments from wheelchair users indicated greater comfort in using machines that were portable and could be brought as close as necessary to the wheelchair-using voter. Some wheelchair users commented on difficulty reaching buttons located on the upper portions of the full-face ballot machines. Although sticks can be used to press the hard-to-reach buttons at the top of these ballots, wheelchair users that are quadriplegic, have limited dexterity and range of arm motion or cannot hold the stick in their mouths would be unable to use these sticks. Quadriplegics, people with neurological disabilities and others with limited dexterity or arm motion were also unable to use the touch screen technology. Testers with this type of disability were only able to use Hart InterCivic's eSlate 3000, the machine that requires voters to use an integrated rotary wheel.

Visually impaired testers were generally able to use the audio ballot systems for all of the seven machines that demonstrated this feature at the Voting Technology Fair. Testers indicated that they liked distinctly shaped, color-coded tactile buttons. Testers also commented that audio ballots need to have volume controls and rate of speech controls. Many testers felt that the instructions either needed to be more clear or shortened. Testers also commented that the headphones or the voting booth need to be sound-proof in

order to block out background noise. Visually impaired testers that used the standard voting method for machines commented voters should have the ability to adjust the font size and screen contrast for the electronic voting machines. They also felt that the pre-printed ballots for the full-face ballot machines should be printed in large-print font size, so that the ballots can be read by both people with and without visual disabilities.

Hard of hearing testers at the Voting Technology Fair noted that the machines were not accessible to people with dual visual and hearing disabilities. They suggested that the audio ballot components should have assisted listening devices for the hard of hearing.

Finally, comments provided orally to the authors of this report indicate that people with cognitive disabilities had difficulty processing all of the information on the full-face ballot designs. They felt that multi-page ballot designs were easier to follow and recommended that multi-page ballots be designed with only one contest per page.

In addition to the specific accessibility recommendations this report has provided based on testers' concerns and suggestions for accessibility improvements in the voting machines, the Manhattan Borough President's Office and CIDNY also recommend the following:

- Individuals with disabilities must be involved in the process to identify machines that are accessible to various types of disabilities. It is difficult to truly appreciate the challenges that disabled voters face, thus people with disabilities must be involved in New York City and State's election reform planning process.

- Even after New York State has certified voting machines that are concordant with HAVA guidelines, many of the machines' accessibility features are in the hands of ballot designers and election officials (e.g., ballot layout, font size and audio volume level). Thus, it will continue to be important to include disabled individuals in the implementation process after machines have been certified and purchased by localities.

- Accessibility will only be possible with extensive training for poll workers. In addition to manufacturer representatives, the Voting Technology Fair was staffed by a number of sensitive, experienced volunteers. It will be essential to have poll workers who can provide calm and competent assistance, especially for blind voters, most of whom will be voting independently on machines for the first time.

- Disabled access must be broadly defined to include individuals with visual, auditory, physical and cognitive challenges and to address the different levels of disability that individuals face. For example, it is thought that only about 10% of blind individuals read Braille; so, a voting machine that uses Braille as its primary tool for communicating information to blind voters would be problematic.

- Disabled access must also account for multiple disabilities. For example, blind voters who are hard of hearing will have a difficult time using the audio components for machines unless there is some type of assisted listening capability.

- Individuals with disabilities, like all other citizens, strongly desire the opportunity to utilize their right to cast a private and independent vote, and the New York State HAVA Taskforce should strongly

consider the broad definition of disability as it works on the plan for implementation of HAVA in New York State.

The good news is that there are many voting machine manufacturers designing different types of machines with disabled access in mind. New York State's full-face ballot law, however, would preclude certification of nearly all of the machines demonstrated at the fair. There are many voters, from wheelchair users to quadriplegics to the cognitively disabled, that are simply unable to use full-face ballot machines. Most of these voters would require some type of assistance in order to use any of the full-face ballot machines currently on the market. As long as a full-face ballot law remains in New York State, there will continue to be voters in this state that cannot enjoy the right to cast an independent and private vote. The New York State HAVA Taskforce and the state legislature should strongly consider changing this law. There is no evidence that shows full-face ballots decrease the likelihood of under-voting in elections. The Manhattan Borough President's Office and CIDNY believe that under-voting is more likely to occur with full-face ballots than with multi-page ballots. This is because multi-page ballots force the voter to review each contest in a given election, whereas voters can become confused by the full-face ballot layout and consequently miss voting in certain contests. Furthermore, most of the multi-page ballot machines currently offer a summary of contest selections at the end of the ballot, at which point the machine indicates the contests that had no candidates selected. This type of summary provides an opportunity for the voter to not only change selections, but to vote in races he or she may have overlooked.

Although a more in-depth report that includes an analysis of Voting Technology Fair evaluation data will not be available for several weeks following the release of this report, Borough President Fields and CIDNY hope that the New York State HAVA Taskforce, legislators and other decision makers begin to integrate this report's recommendations into the state's HAVA planning and implementation plan. The Manhattan Borough President's Office and CIDNY believe that implementation of this report's recommendations will maximize access to voting machines by people with disabilities. Borough President Fields and the leadership of CIDNY look forward to working with all relevant parties as New York State moves closer to implementing voting technology that is accessible to all New York voters, including people with disabilities.

Voting Machine Usability Survey

Machine Vendor:

Machine Model:

SECTION A.
For each item identified below, circle the number to the right that best fits your judgment of its quality. Use the scale below to select the quality number. Circle "N/A" for any item that does not apply to your experience.

Poor	Fair	Good	Very Good	Excellent	Not Applicable
1	2	3	4	5	N/A

Location of touch screen icons, switches, buttons and/or levers	1	2	3	4	5	N/A
Usability of touch screen icons, switches, buttons and/or levers	1	2	3	4	5	N/A
Machine height and tilt	1	2	3	4	5	N/A
Adjustability of machine height and tilt	1	2	3	4	5	N/A
Visual clarity of screen, monitor or display	1	2	3	4	5	N/A
Quality of speech/audio features	1	2	3	4	5	N/A
Clarity of printed and/or spoken instructions	1	2	3	4	5	N/A
Font size and screen contrast	1	2	3	4	5	N/A
Ability to use visual and audio voting simultaneously	1	2	3	4	5	N/A
Tactile or Braille identifiable controls	1	2	3	4	5	N/A

(OVER)

SECTION B.

For each item identified below, circle the number to the right that best fits your judgment of this action. Use the scale below to select the quality number. Circle "N/A" for any item that does not apply to your experience.

Very Difficult	Difficult	Easy	Very Easy	Not Applicable
1	2	3	4	N/A

Learning to use the machine	1	2	3	4	N/A
Casting your vote	1	2	3	4	N/A
Changing your vote	1	2	3	4	N/A
Understanding the ballot design	1	2	3	4	N/A
Reviewing a summary of your votes	1	2	3	4	N/A
Overall ability to use the machine	1	2	3	4	N/A

SECTION C.

Please circle Yes or No for the following questions:

Does this machine allow you to vote privately and independently?	Yes	No
Do you think this machine would accurately record your vote?	Yes	No

Please share any additional comments about your experience with this voting machine:

_____

_____

_____

_____