

# The Promise and Perils of New Voting Technologies

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# Voting Systems:

## Minimal Requirements

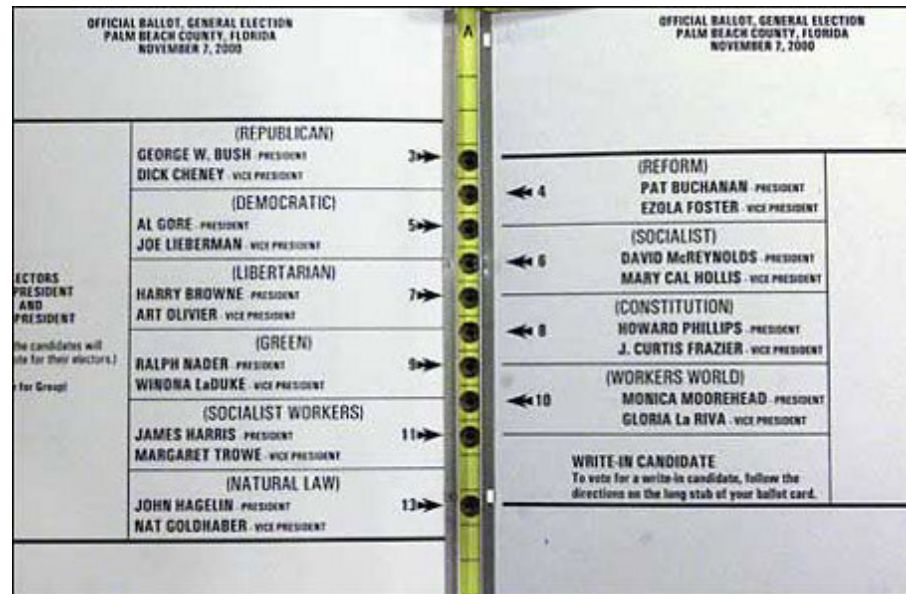
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- ❑ Enable voters to accurately register their voting intentions
- ❑ Accurately record votes
- ❑ Instill Voter Confidence
- ❑ Accurately count votes
- ❑ Prevent coercion or vote tampering



# Ballot Design Matters

## The “Butterfly Ballot” used in Palm Beach County, Florida



# Voting Technology Matters

- ❑ Votomatic Vote III
  - Used in Palm Beach County, Florida in 2000



- ❑ Punch card systems used by 28% of voters in 2000

# Poor Design Can Lead to Big Problems

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- ❑ Is this chad...  
Pregnant?  
Dimpled?  
Hanging?
- ❑ For whom did this  
person mean to vote?  
Actually vote?



## Study Objectives

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- ❑ Test ***usability*** and ***accuracy*** of existing technology and ballots
- ❑ Examine different populations

NSF-funded study with  
University of Rochester and  
University of Michigan



# NOT a Consumer Report

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- ❑ Not all voting systems were tested
- ❑ Not all features were assessed
- ❑ No evaluation of:
  - Security
  - Auditability
  - Affordability
  - Durability
  - Transportability
  - Universal access
  - Back office



# Study Design

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Focus today ►

- Expert review (10 experts)
- Field study (1,500 participants in 3 states)
- Lab study (40 participants)
- Natural study
  
- Collaborators
  - Governmental
    - Federal Election Commission
    - Board of Elections, State of Maryland
    - Board of Elections, Prince Georges County, Maryland
    - National Institute of Standards and Technology
  - Voting System Manufacturers
    - Avante    Diebold    ES&S    Hart InterCivic    Nedap
  
- Machines selected to illustrate specific design principles

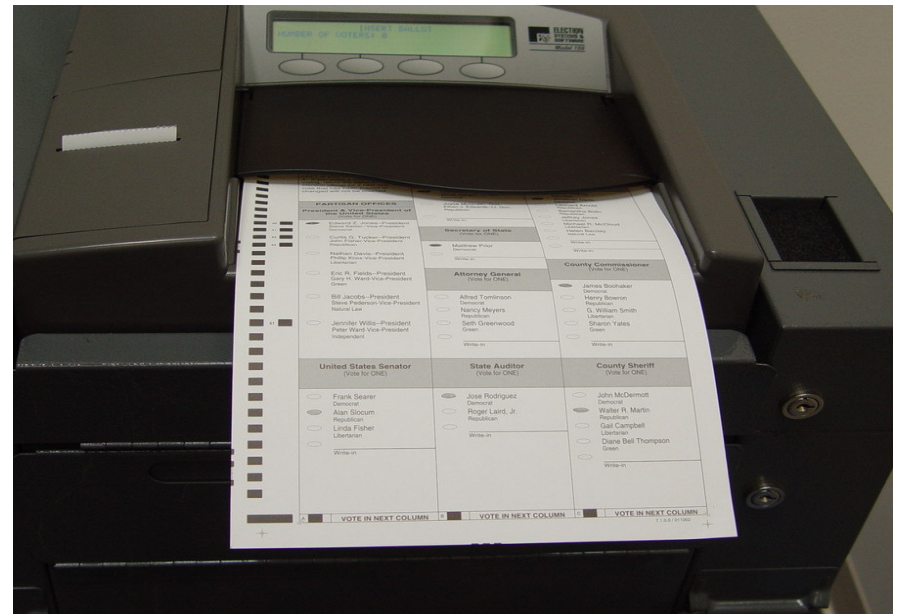




# ES&S Model 100

## System Type:

- ❑ Paper ballot/optical scan
- ❑ Intake similar to a fax machine
- ❑ Warnings for overvotes
- ❑ No warning for undervotes
- ❑ Can cast a flawed ballot



# Diebold AccuVote-TS

## System Type:

- ❑ Touch screen
- ❑ Smart card activation
- ❑ Manual navigation
- ❑ Ballot review
- ❑ Impossible to overvote
- ❑ Highlights undervotes



# Avante Vote Trakker

## System Type:

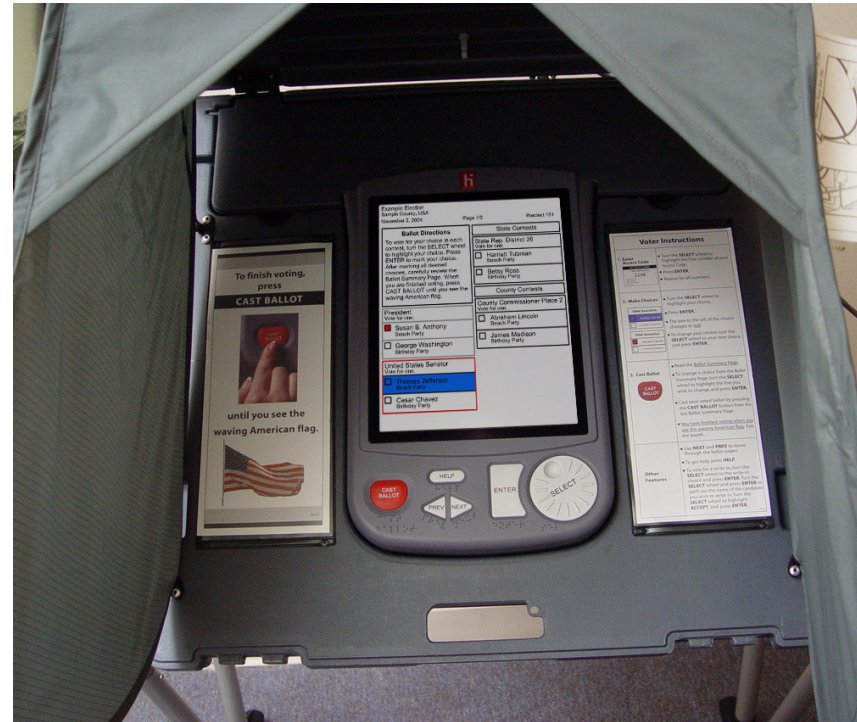
- ❑ Touch screen
- ❑ Automatic advance navigation
- ❑ Paper printout for verification
- ❑ Impossible to overvote
- ❑ Highlights undervotes



# Hart InterCivic eSlate

## System Type:

- ❑ Mechanical buttons and dial for navigation and candidate selection
- ❑ Impossible to overvote
- ❑ Highlights undervotes





# Nedap LibertyVote

## System Type:

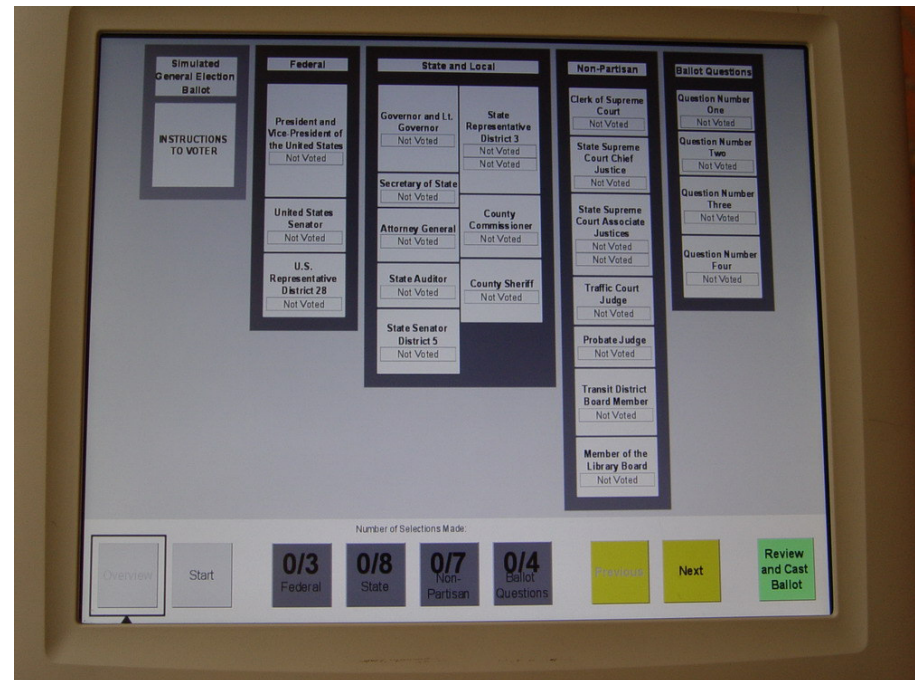
- ❑ Full-face voting system
- ❑ Membrane buttons to select candidates
- ❑ Blue lights indicate selections
- ❑ Impossible to overvote
- ❑ Warning for undervotes



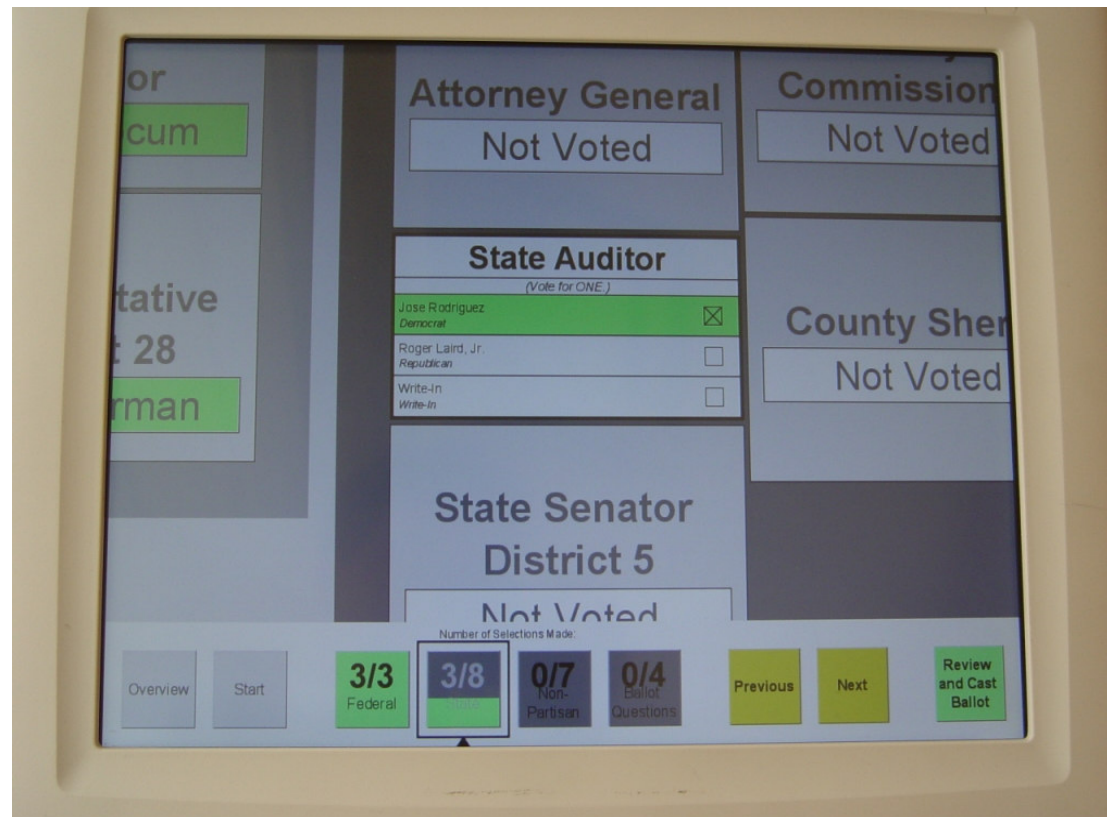
# Zoomable Prototype

## System Type:

- ❑ Zooming navigation
- ❑ Overview of full ballot
- ❑ Voting decisions replace names of offices
- ❑ Impossible to overvote
- ❑ Highlights undervotes
- ❑ Developed at the University of Maryland



# Zooming in on One Election



# Office Bloc Ballot

<p><b>INSTRUCTIONS TO VOTER</b></p> <p>1. To vote, completely blacken the CIRCLE (?) to the LEFT of the candidate. Do not vote for more than the authorized number of candidates.</p> <p>2. Use only the #2 pencil provided.</p> <p>3. To vote for a person whose name is not on the ballot, write in the candidate's name on the Write-In line AND completely blacken the CIRCLE (?) to the LEFT of your choice.</p> <p>4. If you make a mistake while voting, return the ballot to the election official for a new one. A vote that has been erased or changed will not be counted.</p>	<p><b>United States Senator</b> (Vote for ONE.)</p>	<p><b>State Auditor</b> (Vote for ONE.)</p>
	<p><input type="radio"/> Frank Searer Democrat</p>	<p><input type="radio"/> Jose Rodriguez Democrat</p>
	<p><input type="radio"/> Alan Slocum Republican</p>	<p><input type="radio"/> Roger Laird, Jr. Republican</p>
	<p><input type="radio"/> Linda Fisher Libertarian</p>	<p><input type="radio"/> _____ Write-In</p>
<p><b>PARTISAN OFFICES</b></p>	<p><input type="radio"/> _____ Write-In</p>	<p><b>State Senator District 5</b> (Vote for ONE.)</p>
<p><b>President &amp; Vice-President of the United States</b> (Vote for ONE.)</p>	<p><b>U. S. Representative District 28</b> (Vote for ONE.)</p>	<p><input type="radio"/> Bill Forbes Democrat</p>
<p><input type="radio"/> Edward Z. Jones--President Steve Kaiser--Vice-President Democrat</p>	<p><input type="radio"/> Larry Herman Democrat</p>	<p><input type="radio"/> Victoria Snyder Republican</p>
<p><input type="radio"/> Curtis G. Tucker--President John Fisher--Vice-President Republican</p>	<p><input type="radio"/> Rebecca Rehberg Republican</p>	<p><input type="radio"/> Joseph A. Jackson Libertarian</p>
<p><input type="radio"/> Nathan Davis--President Phillip Knox--Vice-President Libertarian</p>	<p><input type="radio"/> William Petelos Natural Law</p>	<p><input type="radio"/> _____ Write-In</p>
	<p><input type="radio"/> _____ Write-In</p>	<p><b>State Representative District 3</b> (Vote for no more than TWO.)</p>
	<p><b>Governor &amp; Lt. Governor</b> (Vote for ONE.)</p>	<p><input type="radio"/> Cheryl Adams Democrat</p>
	<p><input type="radio"/> Conrad Schweitzer--Gov. James Milligan--Lt. Gov. Democrat</p>	<p><input type="radio"/> Jonathan Davic Democrat</p>
	<p><input type="radio"/> Joyce McGrath--Gov. Ethan J. Edwards--Lt. Gov. Republican</p>	<p><input type="radio"/> Leonard Arnold Republican</p>
	<p><input type="radio"/> _____ Write-In</p>	<p><input type="radio"/> Samantha Bolin Republican</p>
	<p><b>Secretary of State</b> (Vote for ONE.)</p>	<p><input type="radio"/> Jeffrey Jones Libertarian</p>
	<p><input type="radio"/> Matthew Prior Democrat</p>	<p><input type="radio"/> Michael R. McCloud Libertarian</p>
	<p><input type="radio"/> _____ Write-In</p>	<p><input type="radio"/> Helen Barclay Natural Law</p>
	<p><b>Attorney General</b></p>	<p><input type="radio"/> _____ Write-In</p>



# Office Bloc Ballot with Straight-Party Voting Device

Straight-party device ►

<b>INSTRUCTIONS TO VOTER</b>	<b>United States Senator</b> (Vote for ONE.)	<b>State Auditor</b> (Vote for ONE.)
1. To vote, completely blacken the CIRCLE (●) to the LEFT of the candidate. Do not vote for more than the authorized number of candidates.	<input type="radio"/> Frank Searer Democrat	<input type="radio"/> Jose Rodriguez Democrat
2. Use only the #2 pencil provided.	<input type="radio"/> Alan Slocum Republican	<input type="radio"/> Roger Laird, Jr. Republican
3. To vote for a person whose name is not on the ballot, write in the candidate's name on the Write-In line AND completely blacken the CIRCLE (●) to the LEFT of your choice.	<input type="radio"/> Linda Fisher Libertarian	<input type="radio"/> _____ Write-In
4. If you make a mistake while voting, return the ballot to the election official for a new one. A vote that has been erased or changed will not be counted.	<input type="radio"/> _____ Write-In	<b>State Senator District 5</b> (Vote for ONE.)
5. To vote for every candidate of one party, blacken the CIRCLE (●) to the LEFT of the name of the party for which you wish to vote. To vote for non-partisan offices, blacken the CIRCLE (●) to the LEFT of the candidate for whom you wish to vote.	<b>U. S. Representative</b> <b>District 28</b> (Vote for ONE.)	<input type="radio"/> Bill Forbes Democrat
	<input type="radio"/> Larry Herman Democrat	<input type="radio"/> Victoria Snyder Republican
	<input type="radio"/> Rebecca Rehberg Republican	<input type="radio"/> Joseph A. Jackson Libertarian
	<input type="radio"/> William Petelos Natural Law	<input type="radio"/> _____ Write-In
<b>STRAIGHT PARTY VOTING</b>	<input type="radio"/> _____ Write-In	<b>State Representative</b> <b>District 3</b> (Vote for no more than TWO.)
<input type="radio"/> Democratic Party	<b>Governor &amp; Lt. Governor</b> (Vote for ONE.)	<input type="radio"/> Cheryl Adams Democrat
<input type="radio"/> Republican Party	<input type="radio"/> Conrad Schweitzer--Gov. James Milligan--Lt. Gov. Democrat	<input type="radio"/> Jonathan Davic Democrat
<input type="radio"/> Libertarian Party	<input type="radio"/> Joyce McGrath--Gov. Ethan J. Edwards--Lt. Gov. Republican	<input type="radio"/> Leonard Arnold Republican
<input type="radio"/> Green Party	<input type="radio"/> _____ Write-In	<input type="radio"/> Samantha Bolin Republican
<input type="radio"/> Natural Law Party	<b>Secretary of State</b> (Vote for ONE.)	<input type="radio"/> Jeffrey Jones Libertarian
<b>PARTISAN OFFICES</b>	<input type="radio"/> Matthew Prior Democrat	<input type="radio"/> Michael R. McCloud Libertarian
<b>President &amp; Vice-President of the United States</b> (Vote for ONE.)	<input type="radio"/> _____ Write-In	<input type="radio"/> Helen Barclay Natural Law
<input type="radio"/> Edward Z. Jones--President Steve Kaiser--Vice-President Democrat	<b>Attorney General</b>	<input type="radio"/> _____ Write-In
<input type="radio"/> Curtis G. Tucker--President John Fisher--Vice-President Republican		
<input type="radio"/> Nathan Davis--President Phillip Knox--Vice-President Libertarian		

# Party Column Ballot

## **INSTRUCTIONS TO VOTER**

1. To vote, completely blacken the CIRCLE (●) to the LEFT of the candidate.  
Do not vote for more than the authorized number of candidates.
2. Use only the #2 pencil provided.
3. To vote for a person whose name is not on the ballot,  
write in the candidate's name on the Write-In line  
AND completely blacken the CIRCLE (●) to the LEFT of your choice.
4. If you make a mistake while voting, return the ballot  
to the election official for a new one.  
A vote that has been erased or changed will not be counted.

## **PARTISAN OFFICES**

### **President & Vice-President of The United States (Vote for ONE.)**

<input type="radio"/> Edward Z. Jones -- President Steve Kaiser -- Vice-President Democrat	<input type="radio"/> Curtis G. Tucker -- President John Fisher -- Vice-President Republican	<input type="radio"/> Nathan Davis -- President Phillip Knox -- Vice-President Libertarian
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### **United States Senator (Vote for ONE.)**

<input type="radio"/> Frank Searer Democrat	<input type="radio"/> Alan Slocum Republican	<input type="radio"/> Linda Fisher Libertarian
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### **United States Representative District 28 (Vote for ONE.)**

<input type="radio"/> Larry Herman Democrat	<input type="radio"/> Rebecca Rehberg Republican	
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## Selected Voting Tasks

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- ❑ Vote for individual candidates
- ❑ Vote for multiple candidates
- ❑ Change a vote

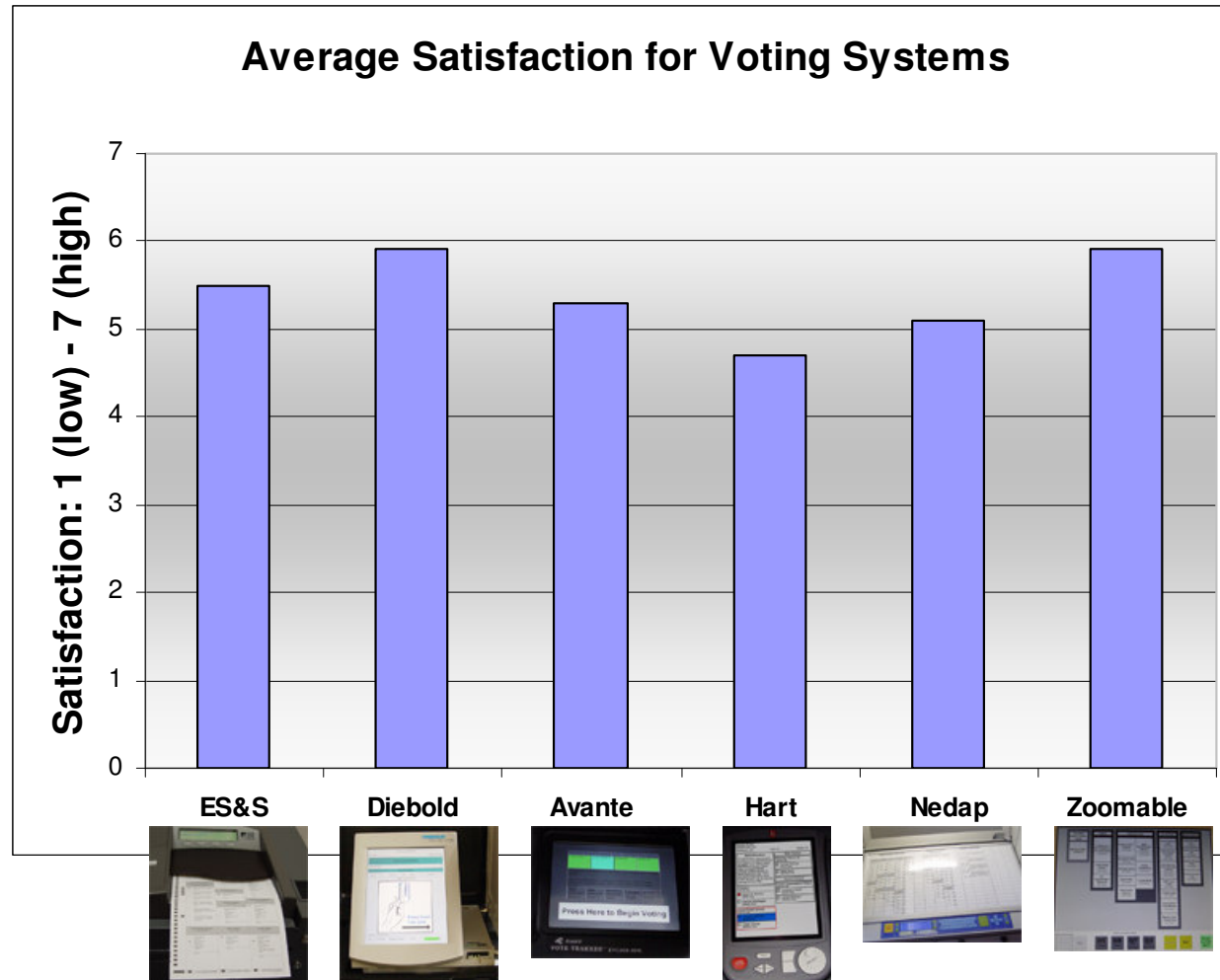


# Experimental Procedures

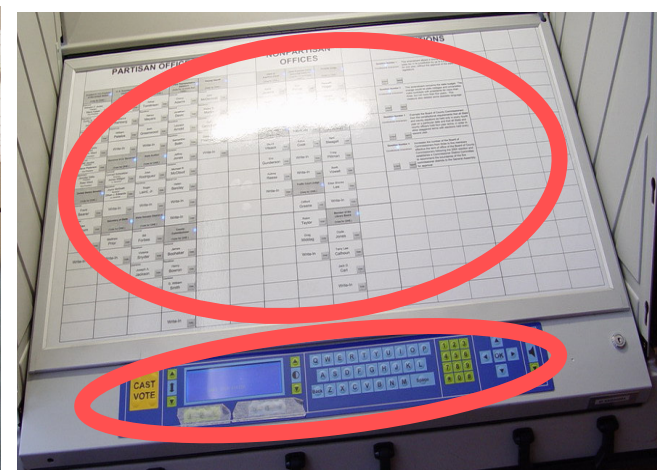
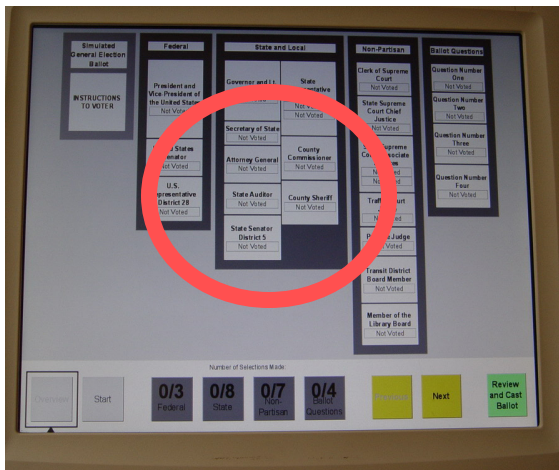
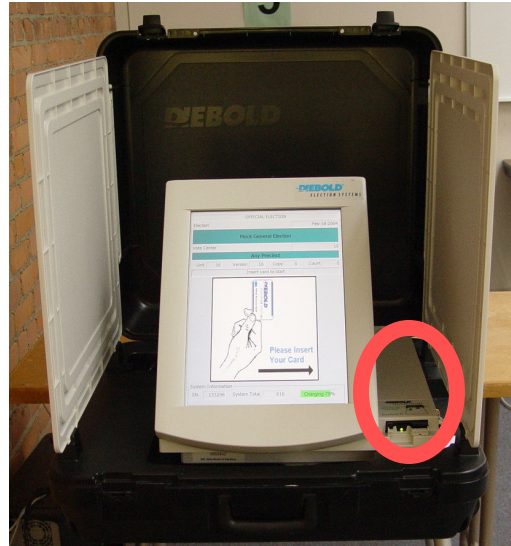
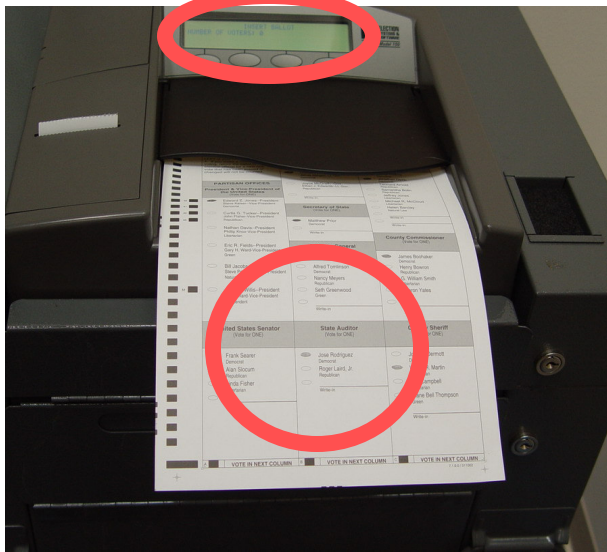
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- ❑ Complete sheet that lists intended votes
- ❑ Vote according to sheet
- ❑ Fill out evaluation form for each system
- ❑ Complete questionnaire on demographics
  
- ❑ Selected dependent variables:
  - Voter satisfaction
  - Need for assistance
  - Accuracy of votes cast

# Findings for Voter Satisfaction

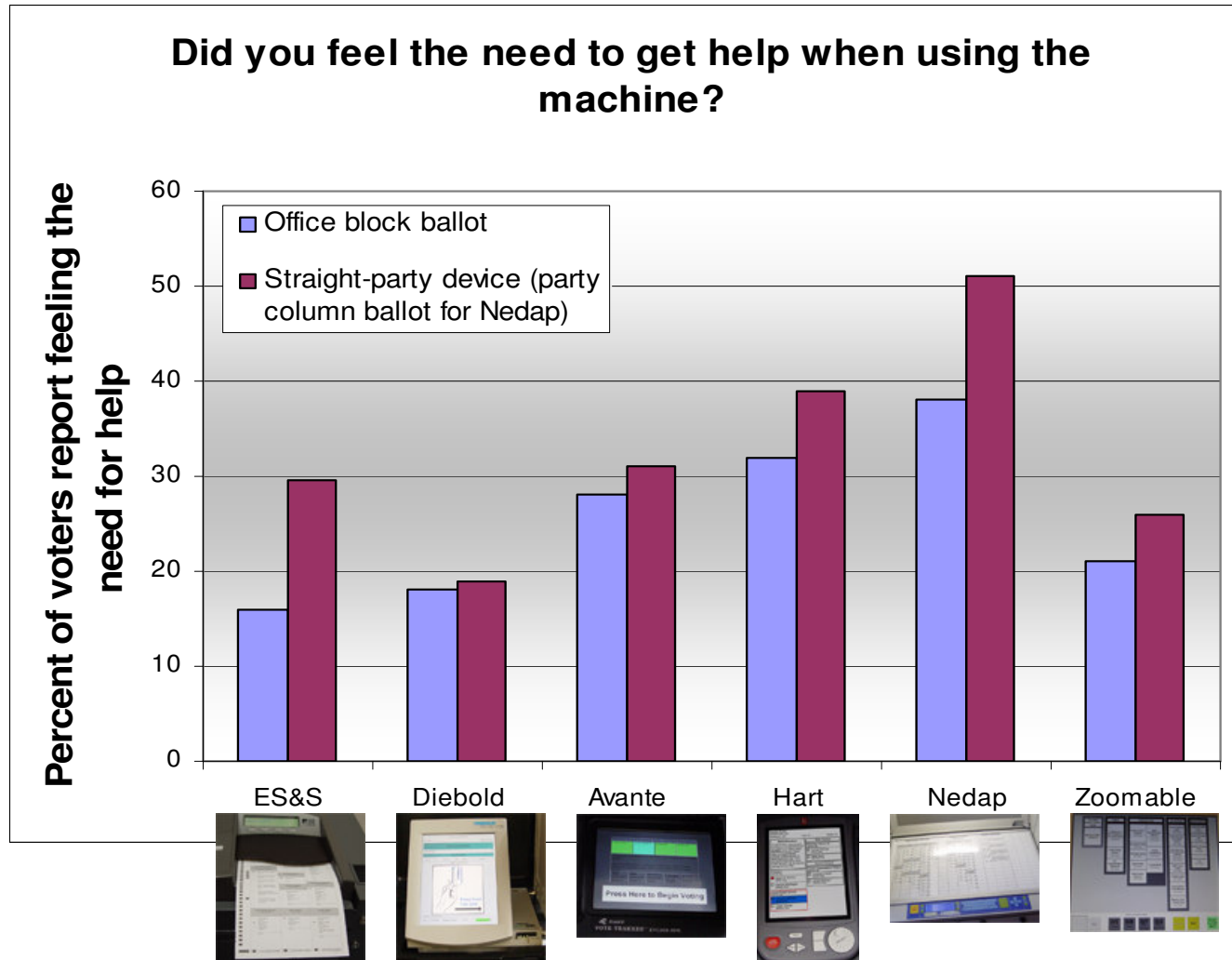


# Features Criticized





# Need for Assistance



# Accuracy Measures

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## □ Correct Vote

- Selection matches candidate indicated in booklet

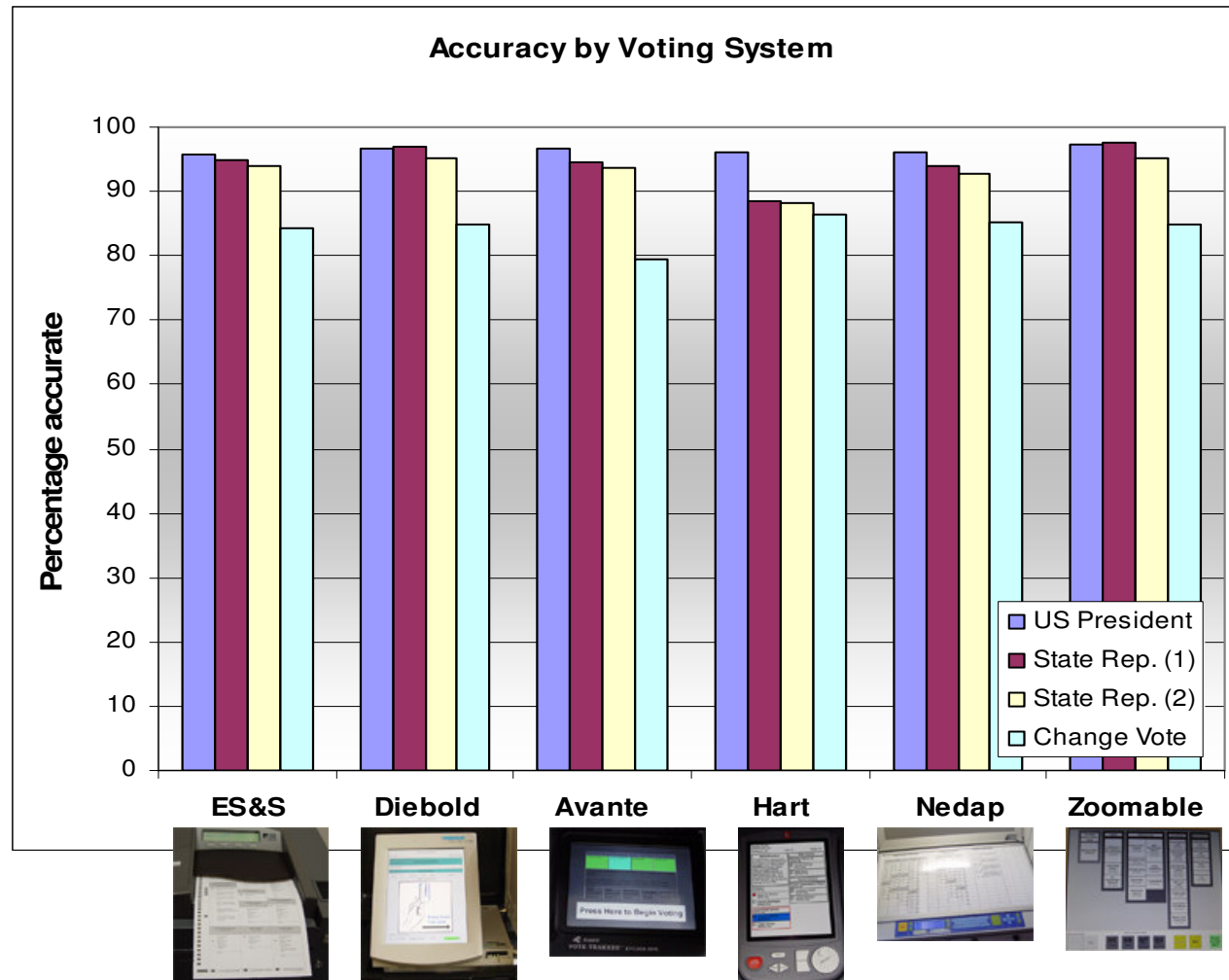
## □ Types of errors

- Vote incorrectly cast for the candidate listed before or after candidate in booklet (slip)
- Vote cast for some other candidate
- No vote cast
- Write-in incorrectly cast





# The Impact of Voting Systems on the Accuracy of Voting



# Overview of Multivariate Findings

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- ❑ Confidence not affected by Paper vs. DRE
- ❑ Office bloc ballots performed better independent of voting system
- ❑ Digital divide affects
  - Satisfaction
    - ❑ Frequent computer users preferred touch screens
    - ❑ Elderly disliked mechanical and zoomable interfaces
  - Request for Help
    - ❑ Computer usage English as primary language
    - ❑ Education Sex
    - ❑ Age
  - Accuracy
    - ❑ Computer usage English as primary language
    - ❑ Education Sex
    - ❑ Age Race/ethnicity



## Impact of Study

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- ❑ Spoke at NASED and NASS annual events
- ❑ Voting system manufacturers have changed some aspects of their systems
  - Auto-advance
  - “Standard” ballot layout
  - Notification of undervotes
  - Visual design of ballot
- ❑ Our evaluation framework is being applied by others (Utah, NIST)



# Conclusions

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- ❑ Voting technology and ballot styles influence
  - Voter trust, confidence, & satisfaction in general
  - Need for assistance when voting
  - Accuracy with which votes are cast
- ❑ The way people cast their votes is important
  - Can influence some close elections
  - Influences confidence and faith in the political system

## For More Information

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[www.capc.umd.edu](http://www.capc.umd.edu)

[www.cs.umd.edu/~bederson/voting](http://www.cs.umd.edu/~bederson/voting)

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**Thank you!**

