The Promise and Perils of New Voting Technologies
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Voting Systems:
Minimal Requirements

- 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

- Is this chad...
  - Pregnant?
  - Dimpled?
  - Hanging?

- For whom did this person mean to vote?
  - Actually vote?
Study Objectives

- 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

- 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

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

**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.)

- Edward Z. Jones--President
- Steve Kaiser--Vice-President

**Secretary of State**
(Vote for ONE.)

- Curtis G. Tucker--President
- John Fisher--Vice-President

**Attorney General**
(Vote for ONE.)

- Nathan Davis--President
- Phillip Knox--Vice-President

**United States Senator**
(Vote for ONE.)

- Frank Searer
  Democrat
- Alan Slocum
  Republican
- Linda Fisher
  Libertarian
- Write-In

**State Senator District 5**
(Vote for ONE.)

**U. S. Representative**
District 28
(Vote for ONE.)

- Larry Herman
  Democrat
- Rebecca Rehberg
  Republican
- William Petelos
  Natural Law
- Write-In

**State Representative**
District 3
(Vote for no more than TWO.)

**Governor & Lt. Governor**
(Vote for ONE.)

- Joyce McGrath--Gov.

**State Auditor**
(Vote for ONE.)

- Jose Rodriguez
  Democrat
- Roger Laird, Jr.
  Republican
- Write-In

**Natural Law**

- Michael R. McCloud
  Libertarian
- Helen Barclay
  Natural Law
- Write-In

- Matthew Prior
  Libertarian
INSTRUCTIONS TO VOTER

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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.
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.

<table>
<thead>
<tr>
<th>STRAIGHT PARTY VOTING</th>
<th>United States Senator (Vote for ONE.)</th>
<th>State Auditor (Vote for ONE.)</th>
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<tr>
<td>O Democratic Party</td>
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| PARTISAN OFFICES      |                                      |                              |
| President & Vice-President of the United States (Vote for ONE.) | O Edward Z. Jones–President Steve Kaiser–Vice-President Democrat |
|                       | O Curtis G. Tucker–President John Fisher–Vice-President Republican |
|                       | O Nathan Davis–President Phillip Knox–Vice-President Libertarian |

| U.S. Representative District 28 (Vote for ONE.) | O Matthew Prior Democrat |
|                                               | O Write-In               |

| State Senator District 5 (Vote for ONE.) | O Victoria Snyder Republican |
|                                          | O Write-In                 |

| Governor & Lt. Governor (Vote for ONE.) | O Cheryl Adams Democrat |
|                                        | O Write-In                 |

| Secretary of State (Vote for ONE.) | O Michael R. McCloud Libertarian |
|                                   | O Write-In                 |

| State Auditor (Vote for ONE.) | O Helen Barclay Natural Law |
|                              | O Write-In                 |

| Attorney General             | O                       |
|                             | O                       |
### INSTRUCTIONS TO VOTER
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Selected Voting Tasks

- Vote for individual candidates
- Vote for multiple candidates
- Change a vote
Experimental Procedures

- 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

Average Satisfaction for Voting Systems

Satisfaction: 1 (low) - 7 (high)

ES&S  Diebold  Avante  Hart  Nedap  Zoomable
Features Criticized
Did you feel the need to get help when using the machine?

Percent of voters reporting the need for help:

- **Office block ballot**
- **Straight-party device (party column ballot for Nedap)**

Options include:
- ES&S
- Diebold
- Avante
- Hart
- Nedap
- Zoomable

Graph showing the percentage of voters needing help for each device.
Accuracy Measures

- 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

Accuracy by Voting System

Percentage accurate

ES&S  Diebold  Avante  Hart  Nedap  Zoomable

US President  State Rep. (1)  State Rep. (2)  Change Vote
Overview of Multivariate Findings

- 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
    - Education
    - Age
    - English as primary language
    - Sex
  - Accuracy
    - Computer usage
    - Education
    - Age
    - English as primary language
    - Sex
    - Race/ethnicity
Impact of Study

- 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

- 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

www.capc.umd.edu
www.cs.umd.edu/~bederson/voting

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Thank you!