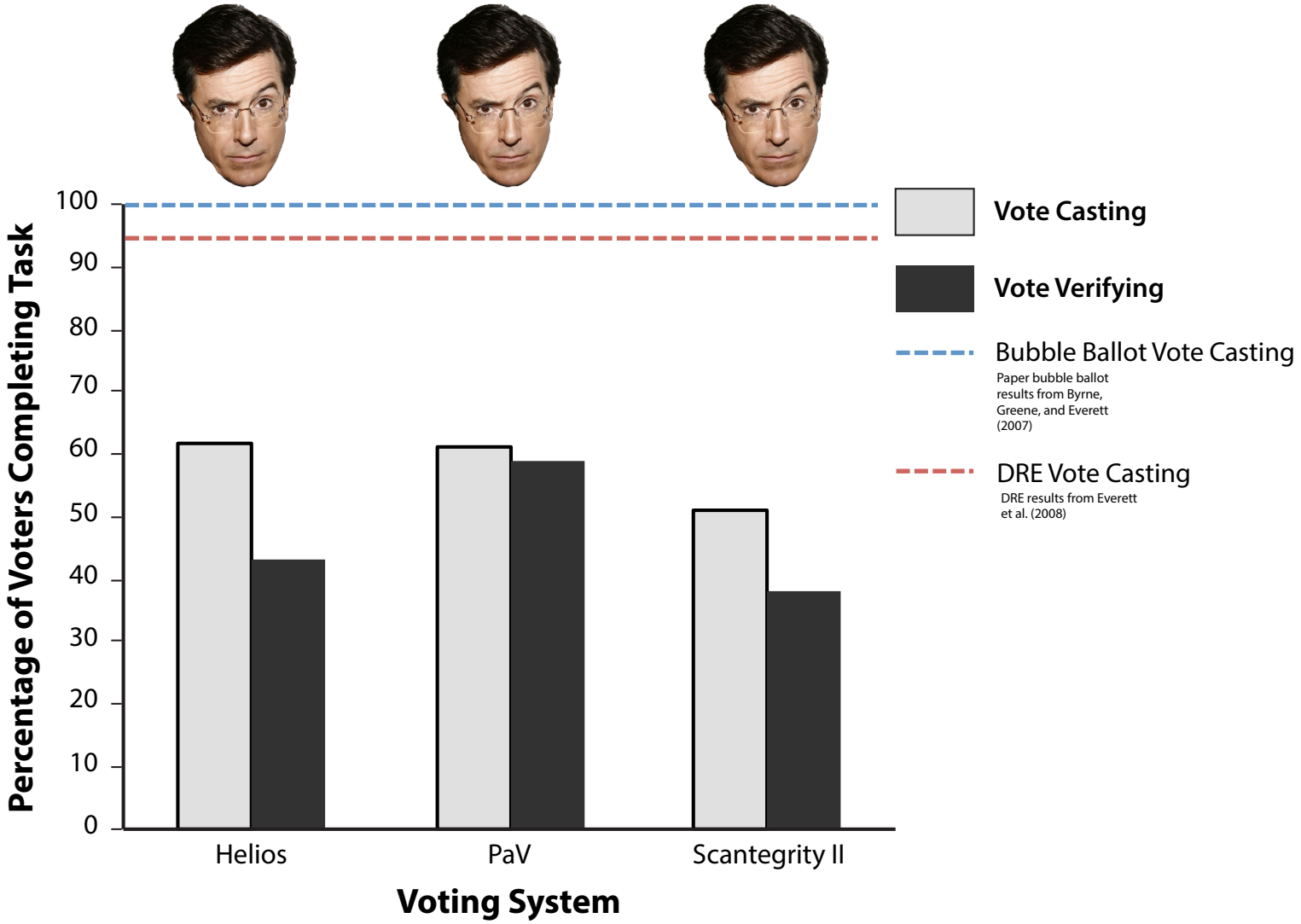
From Error to Error: Why Voters Could Not Cast a Ballot and Verify Their Vote with Helios, Prêt à Voter, and Scantegrity II

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Rice University

JETS 2015

LAST YEAR'S **SUMMATIVE** ASSESSMENT



Percentage of voters completing vote casting and vote verification as a function of e2e voting system (Acemyan et al., 2014)

THIS YEAR'S **FORMATIVE** ASSESSMENT

What happened?! And why?



WHY YOU SHOULD CARE

Yes, the systems have evolved and may differ from those tested in our study….



Scantegrity II optical scanners being set up for the election in Takoma Park (Essex, 2009)

Methods

METHODS

Participants and Sample Size

- Participants were 37 U.S. eligible voters who were representative of the Houston voting population
- Why 37 and not 37,000 participants?
  - Sample was more than adequate to identify the majority of usability problems (e.g., Lewis, 1994; Schmettow, 2012)
  - By the time we got to the 37th participant, we were not observing any "new" problems
  - 37,000 participants might not really help us, and it would waste resources

METHODS

Participant Procedures

- Completed IRB informed consent
- Listened to instructions
- Vote cast and then vote verified in a mock election using all three e2e systems (all orders used; participants were randomly assigned an order)
- Completed several surveys
- Debriefed, thanked, and paid

METHODS

General Experimenter Procedure

Gave Instructions →  → Administered Surveys

Observed

METHODS

What if a participant asked for help?



METHODS

Withholding Help



Why?!



Election officials help voters

METHODS

Withholding Help





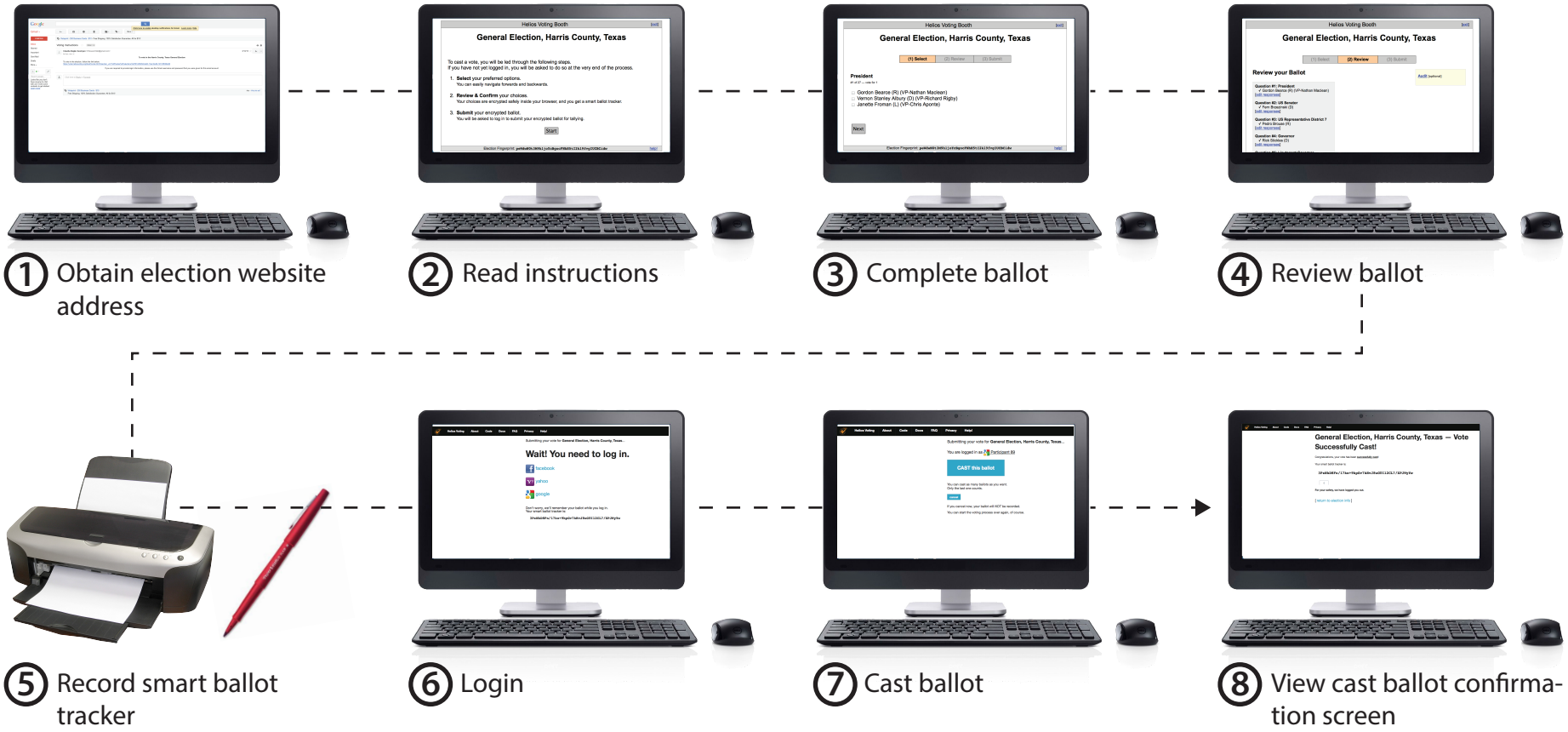
Why?!

STANDARD USABILITY TESTING PRACTICE!

METHODS

Helios

Vote Casting

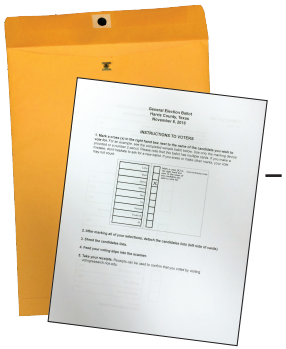


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2. Read instructions
3. Complete ballot
4. Review ballot
5. Record smart ballot tracker
6. Login
7. Cast ballot
8. View cast ballot confirmation screen

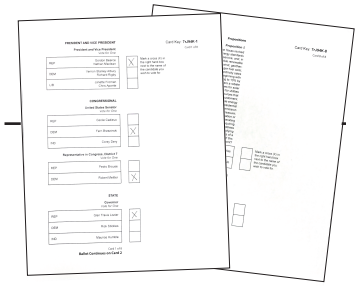
METHODS

Prêt à Voter RICE VERSION

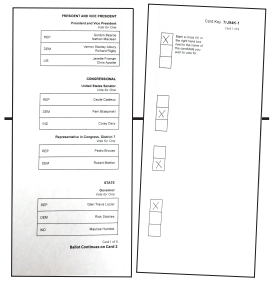
Vote Casting



① Read voting instructions



② Mark ballot



③ Detach candidates lists from selections



④ Shred candidates lists

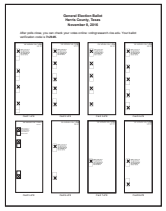


⑤ Scan voting slips



6a Voting slips placed in ballot box



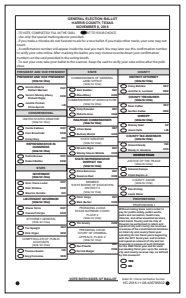


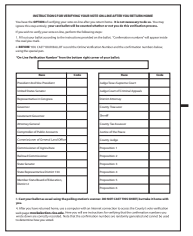
6b Receipt printed

METHODS

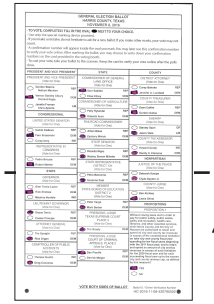
Scantegrity II RICE VERSION

Vote Casting



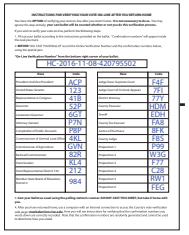


① Read instructions on ballot and vote verification sheet





② Mark ballot with special ballot marking device



③ Complete vote verification sheet--record ballot ID and revealed confirmation codes



④ Scan ballot



⑤ Ballot placed in ballot box



⑥ Have polling station worker stamp "Cast Ballot" on verification sheet

METHODS

What were we looking for (dependent variables)?

We recorded details observed about user mistakes and struggles while voting and checking on their votes

We were especially concerned with **two kinds of critical incidents:**

1. Reasons voters could not cast a vote
2. Reasons voters could not verify their votes

METHODS

Critical Incident Technique

1. Identify events that have a major impact on system objectives (like not being able to vote cast and vote verify)
2. Develop a taxonomy in which to categorize the events (e.g., user errors involving the scanning equipment)
3. Analyze these events to identify root causes of issues so that system changes can be suggested (i.e., pinpoint why the error occurred)

METHODS

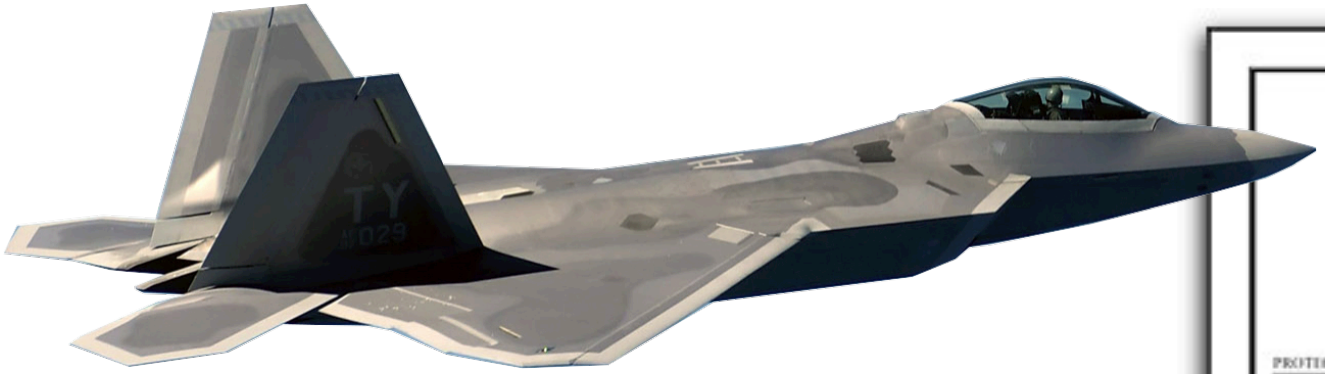
Critical Incident Technique

This method was selected because it

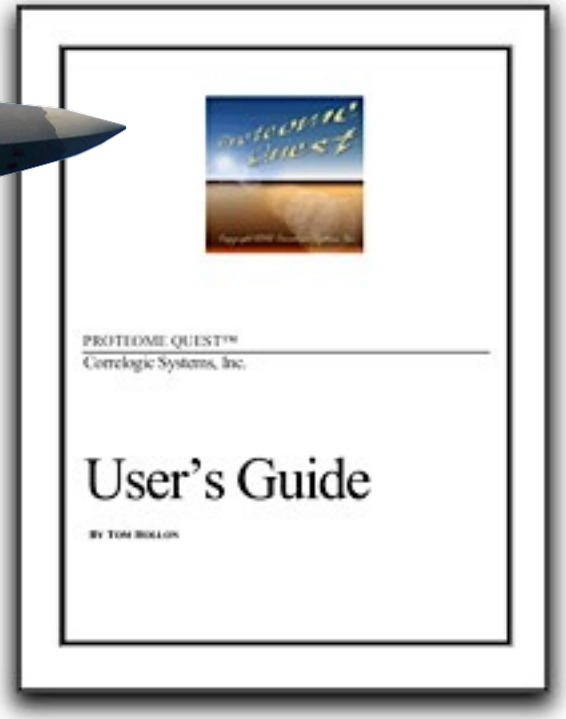
- Is widely used in engineering studies of human error
- Is useful as a rapid trouble shooting technique in initial, global system analyses
- Has significantly contributed to the reduction of human error

METHODS

Critical Incident Technique



Aircraft



Software documentation



Medical devices

METHODS

Critical Incident Technique

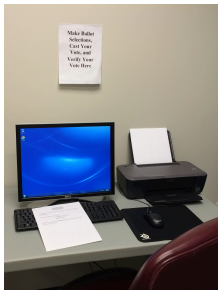


It can be used to improve voting systems too!

METHODS

Experimental Setup

Helios



Ballot completion
Vote casting
Vote verifying

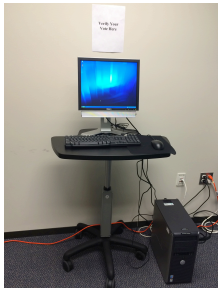
PaV



Ballot completion



Vote casting

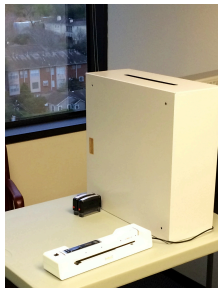


Vote verifying

Scantegrity II



Ballot completion



Vote casting



Vote verifying

METHODS

Usability Problems Can Occur on Election Day Too



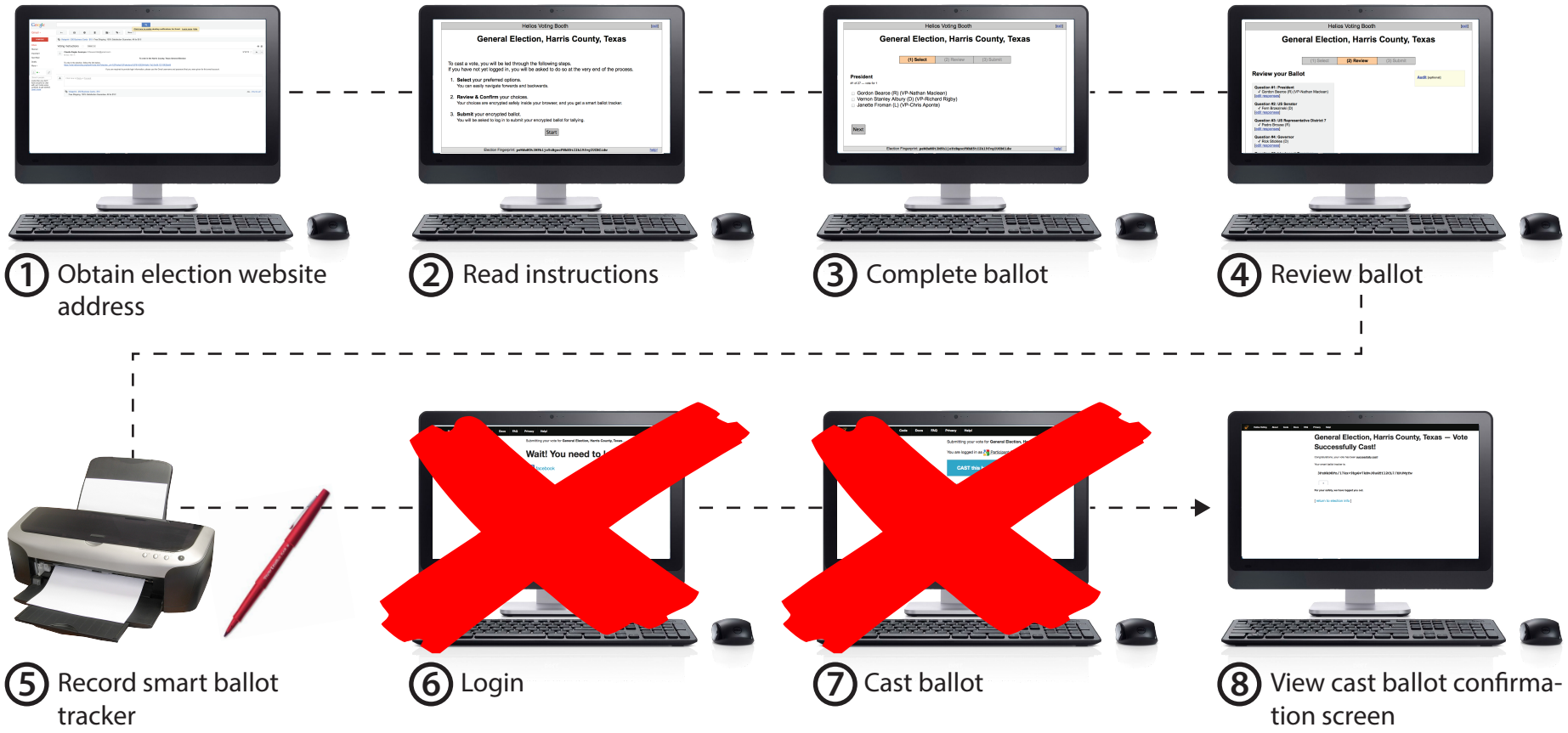
Results

Helios: Vote Casting

RESULTS

Helios

Vote Casting



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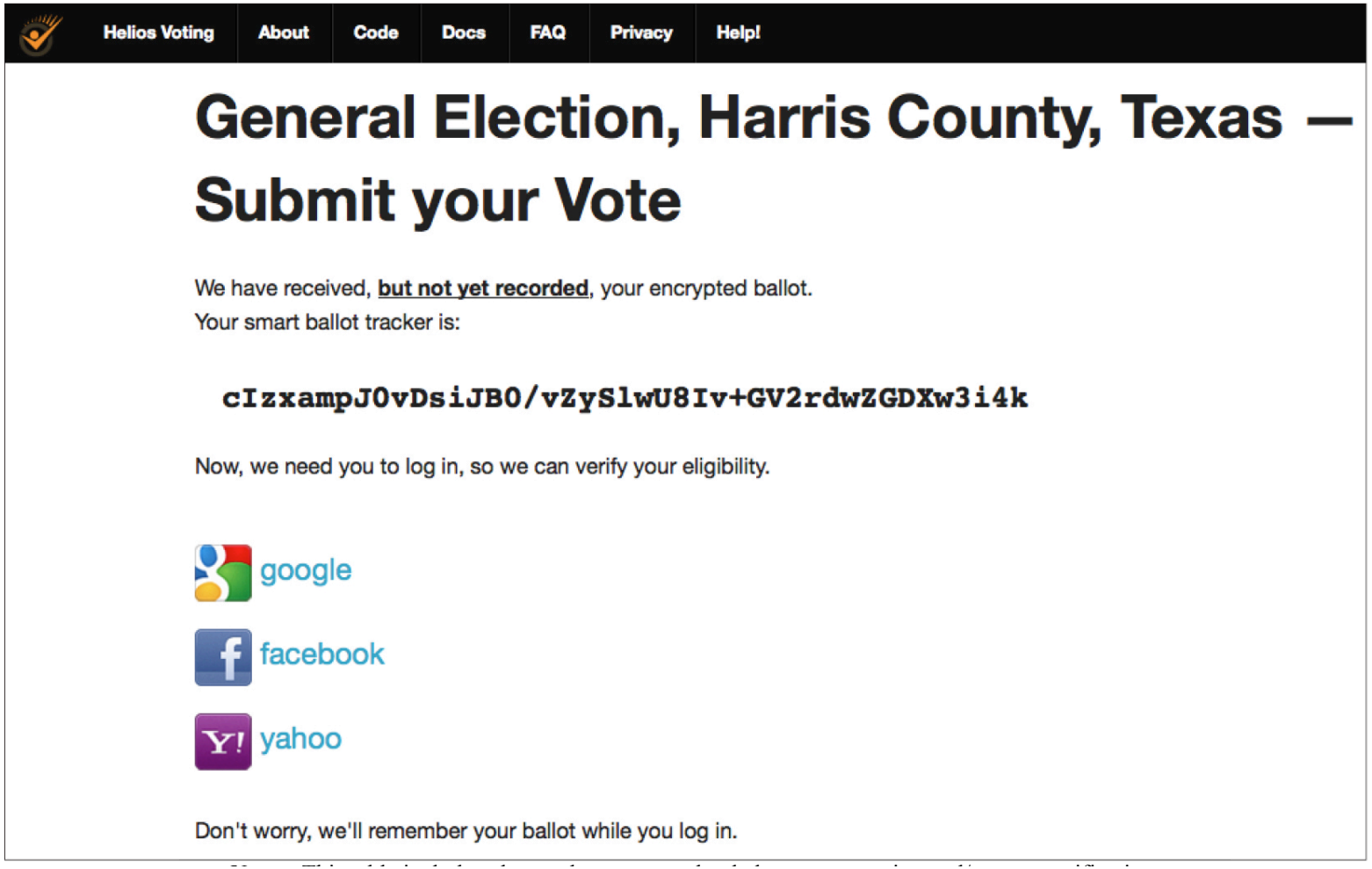
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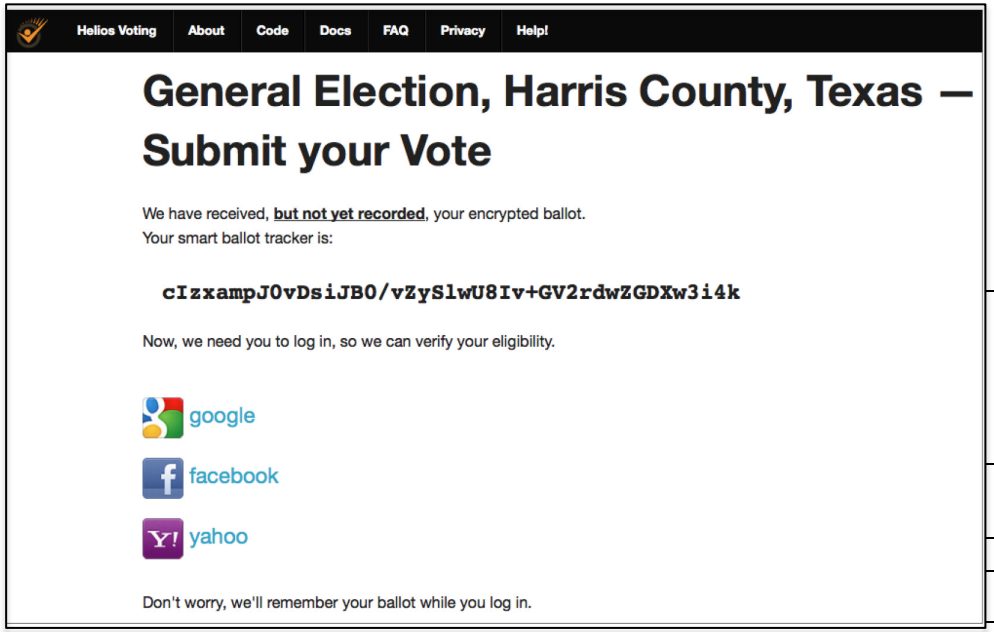
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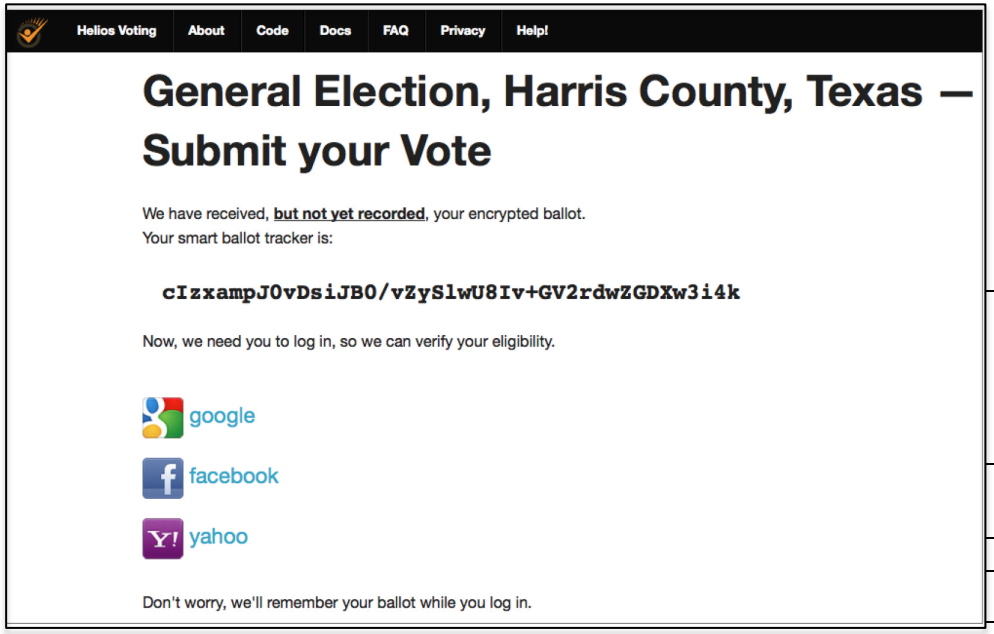
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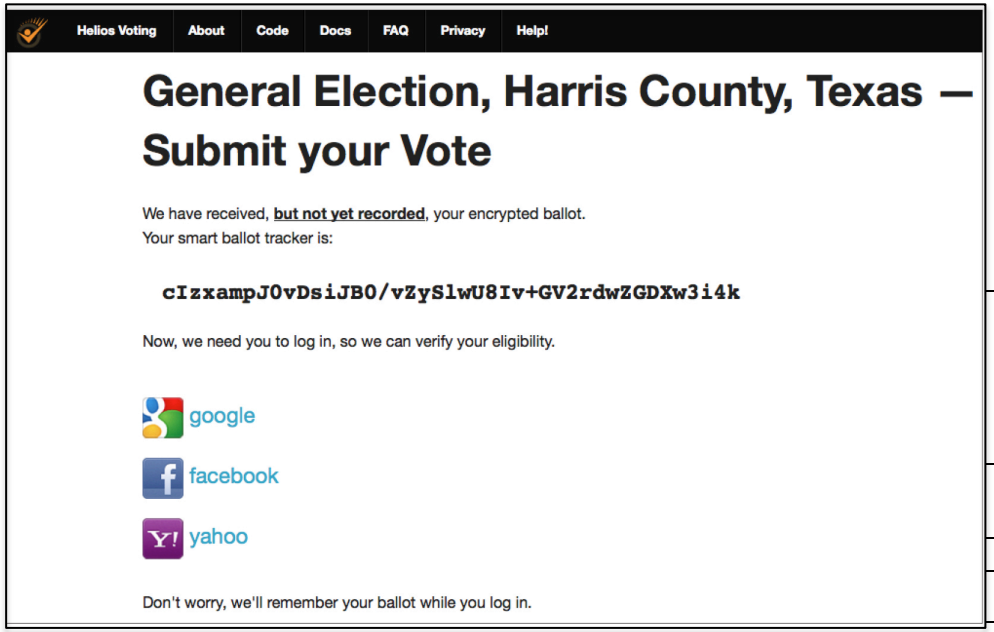
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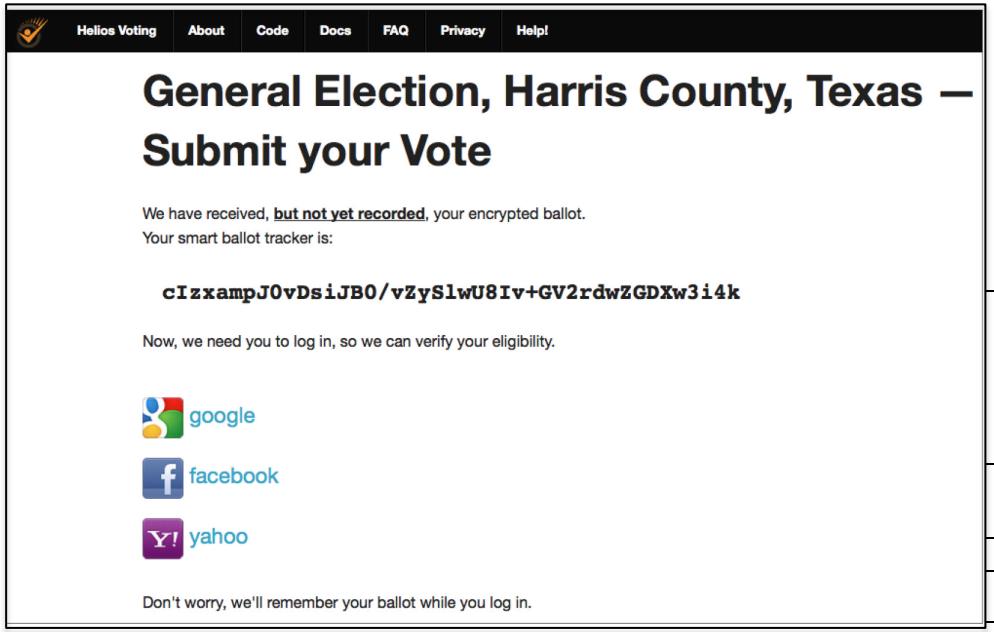
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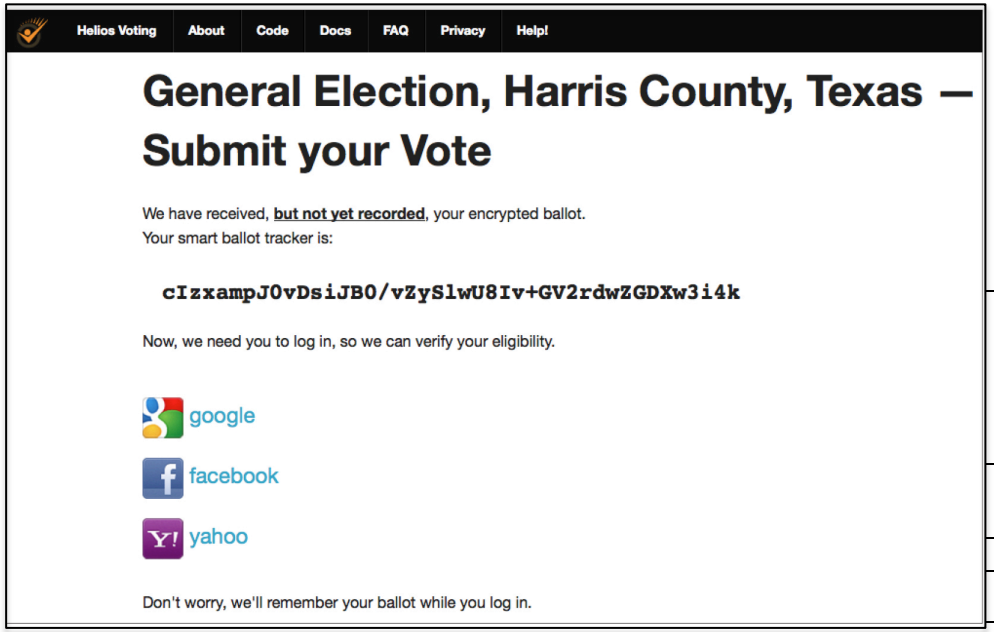
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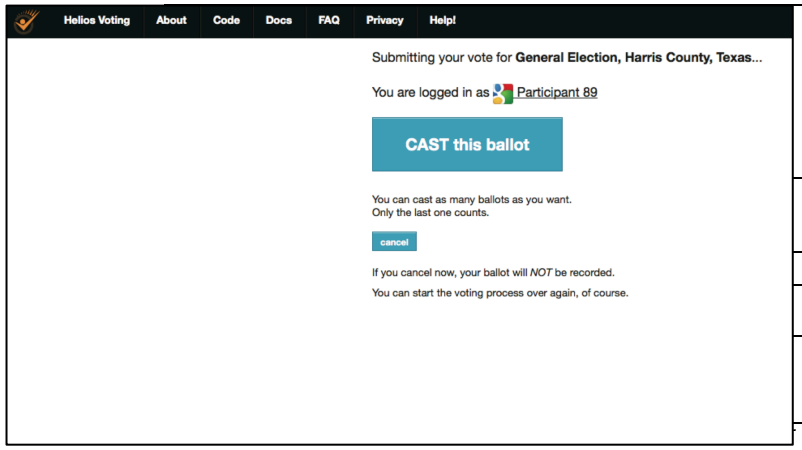
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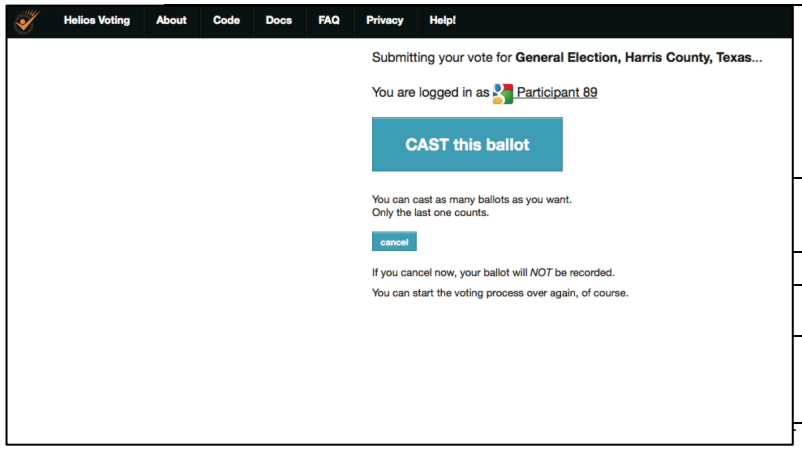


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HELIOS RESULTS

Errors and likely contributing design deficiencies that led to **Helios** vote-casting and vote-verification failures

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Helios: Vote Verifying

RESULTS

Helios

Vote Verifying



① View cast ballot confirmation email, then click archived ballot link

② View SBT on cast vote page, then click election link

③ Click voters & ballots link to access Voter and Ballot Tracking Center

④ Find SBT within list of cast votes

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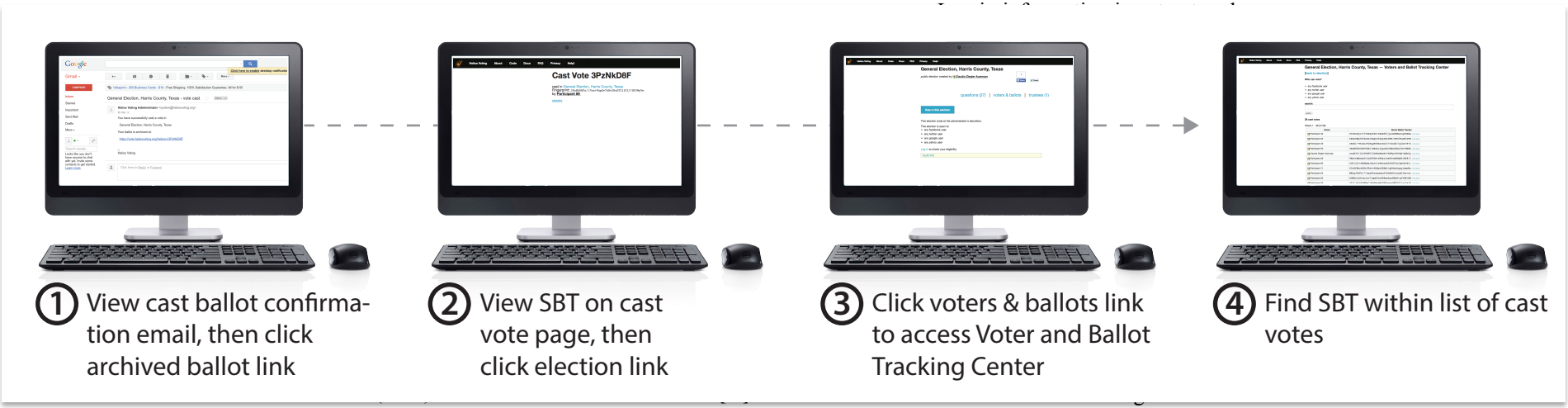
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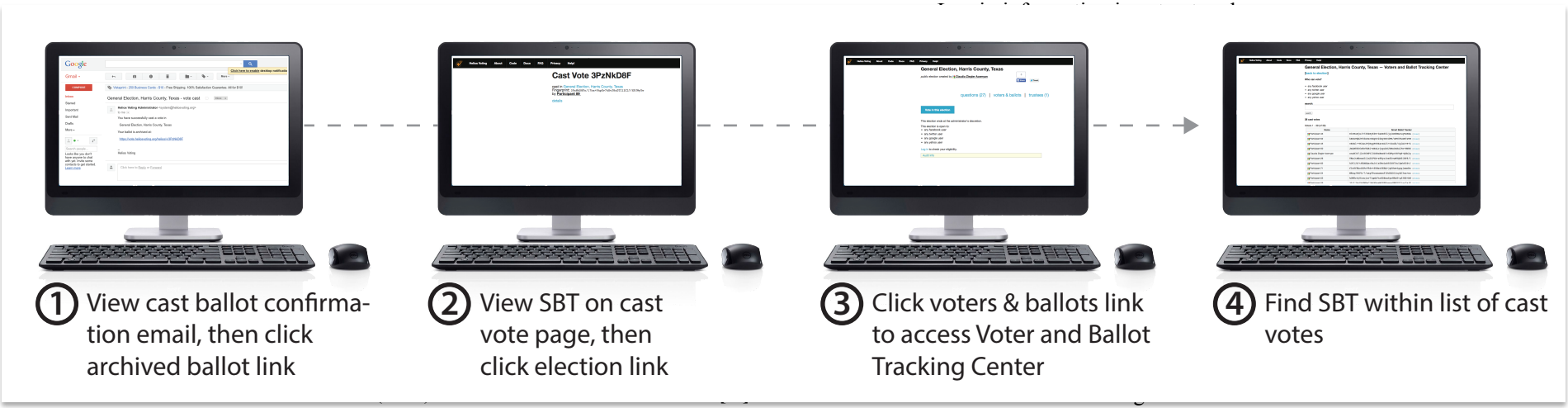
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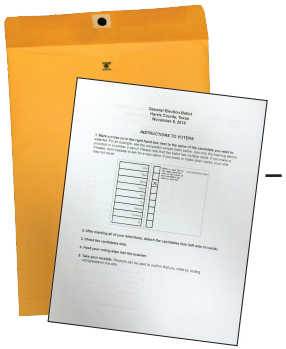


PaV: Vote Casting

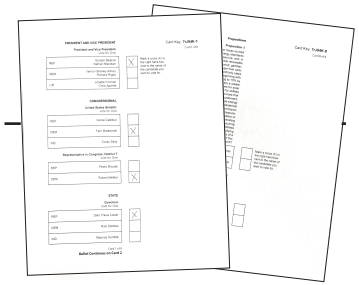
RESULTS

PaV RICE VERSION

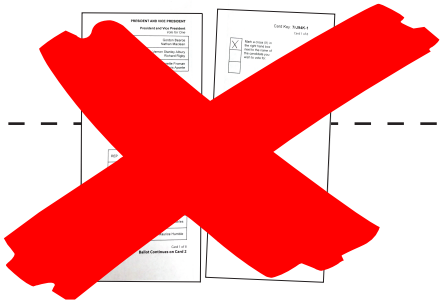
Vote Casting



① Read voting instructions



② Mark ballot



③ Detach candidates lists from selections



④ Shred candidates lists



⑤ Scan voting slips



6a Voting slips placed in ballot box



6b Receipt printed

PaV RESULTS

Errors and likely contributing design deficiencies that led to **PaV** vote-casting and vote-verification failures

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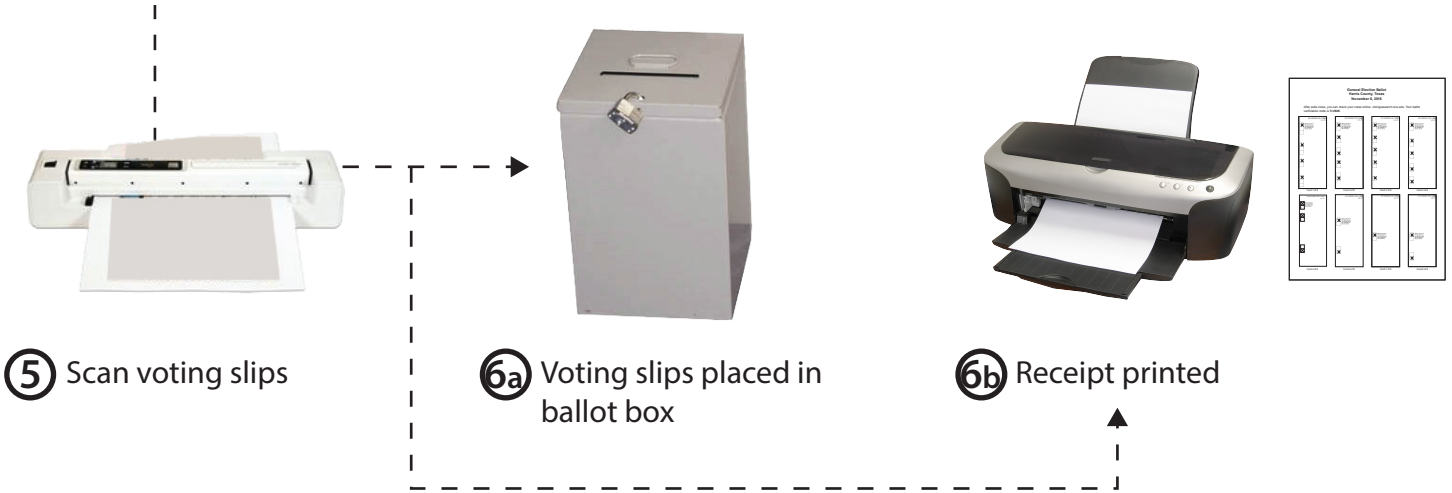
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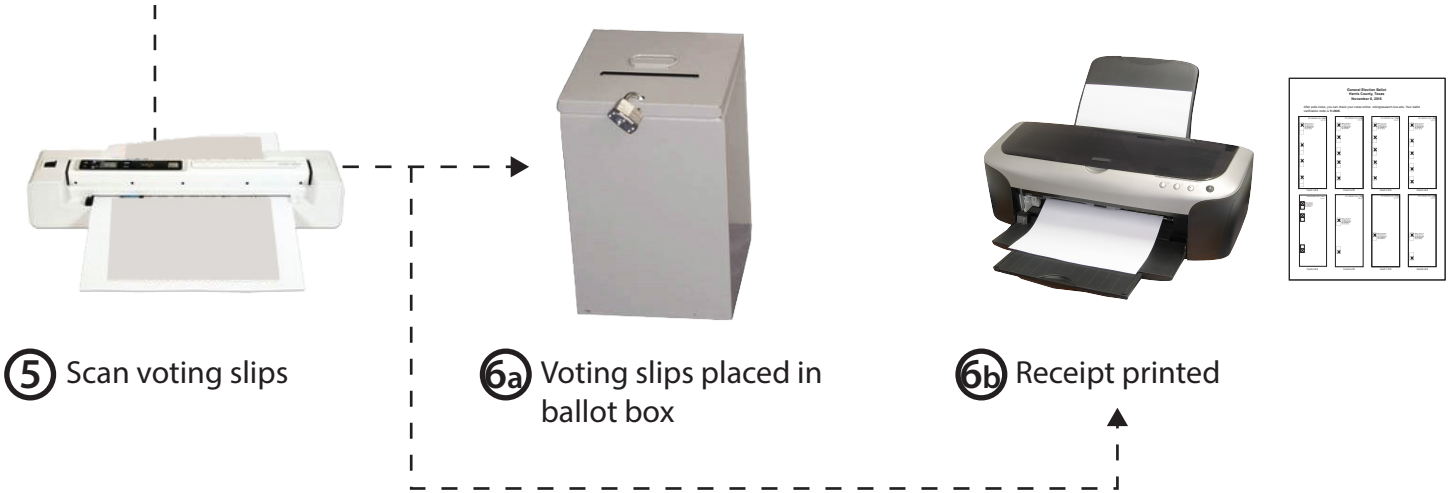
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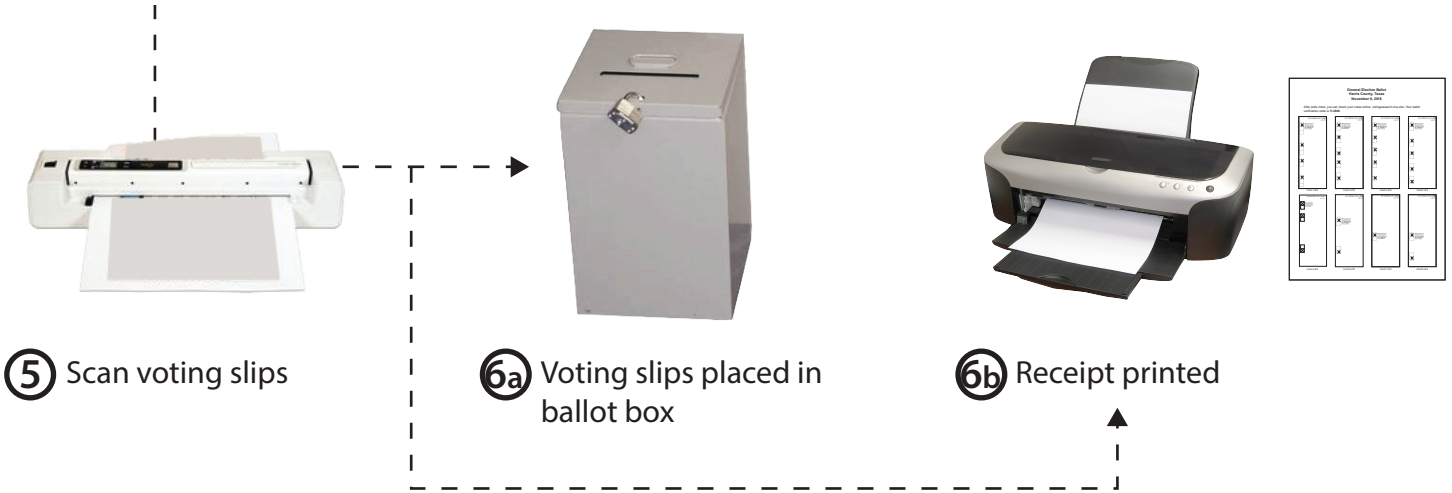
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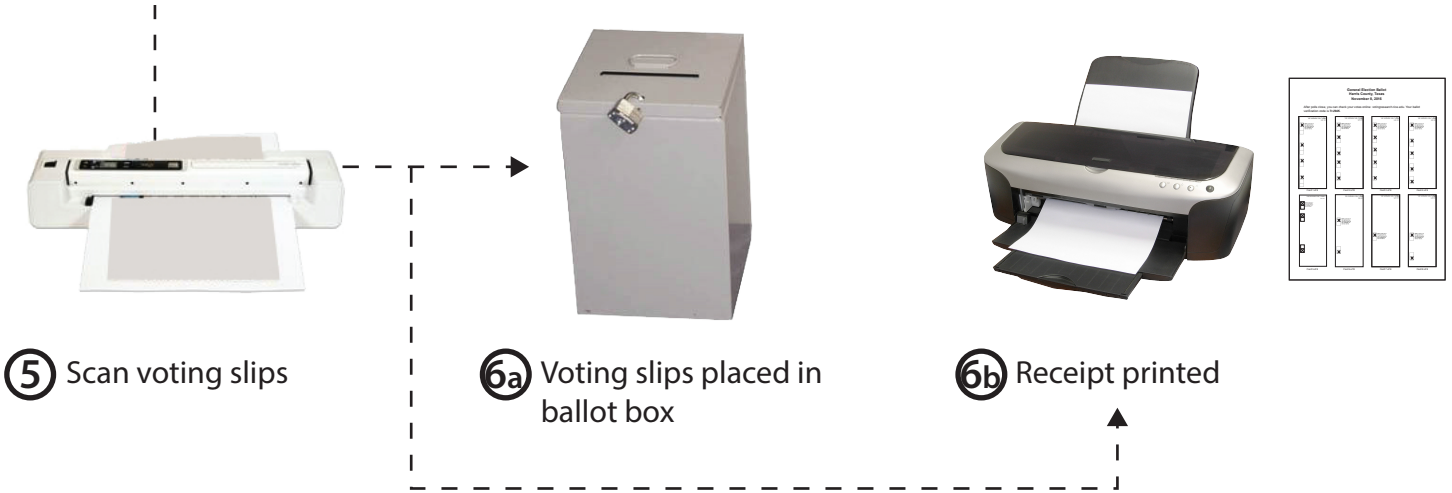
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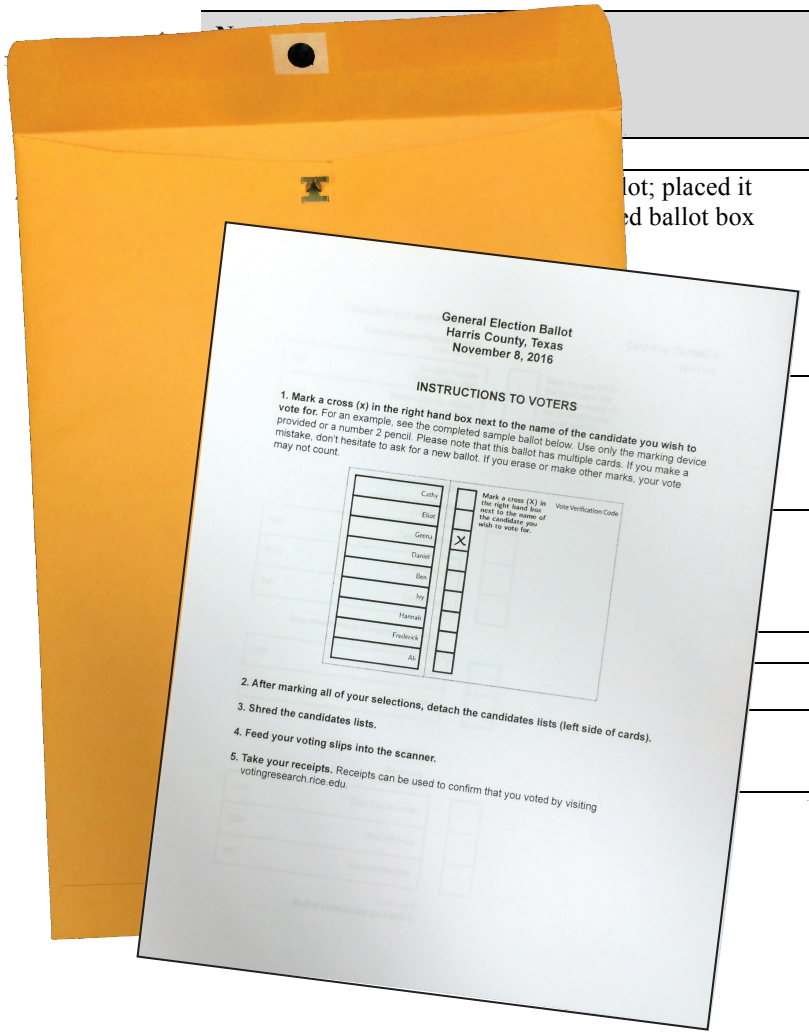
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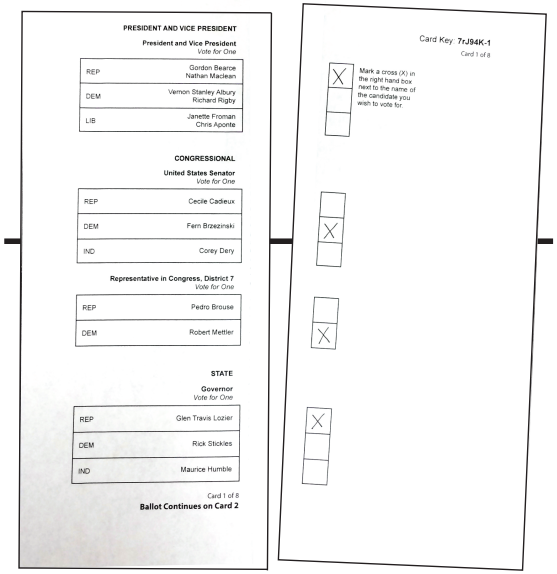
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Shred this half *Cast this half*

PaV RESULTS

Errors and likely contributing design deficiencies that led to **PaV** vote-casting and vote-verification failures

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Vote Casting		
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PaV: Vote Verifying

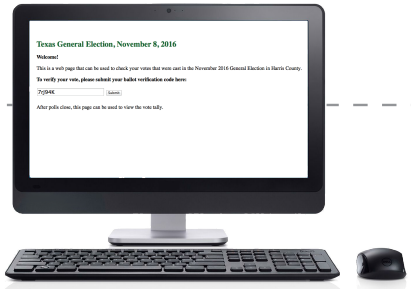
RESULTS

PaV RICE VERSION

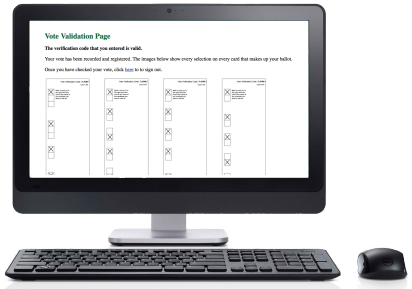
Vote Verifying



① Refer to receipt for election verification website information, then goto election site



② Enter ballot verification code on election homepage and submit it



③ View vote validation page

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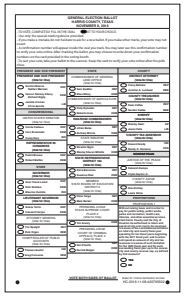
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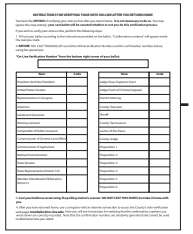
Scantegrity II: Vote Casting

RESULTS

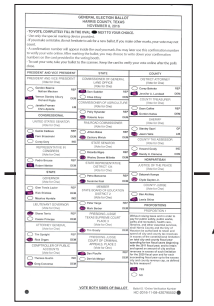
Scantegrity II RICE VERSION

Vote Casting



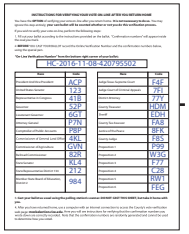


① Read instructions on ballot and vote verification sheet





② Mark ballot with special ballot marking device



③ Complete vote verification sheet--record ballot ID and revealed confirmation codes



④ Scan ballot



⑤ Ballot placed in ballot box



⑥ Have polling station worker stamp "Cast Ballot" on verification sheet

SCANTEGRITY II RESULTS

Errors and likely contributing design deficiencies that led to **Scantegrity II** vote-casting and vote-verification failures

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SCANTEGRITY II RESULTS

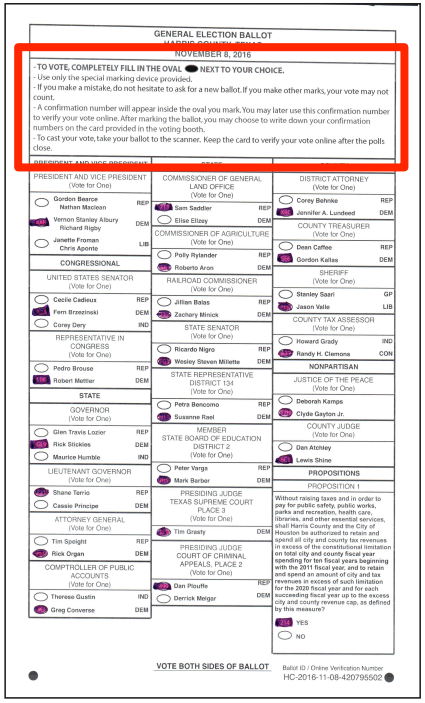
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Same issues as PaV

SCANTEGRITY II RESULTS

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GENERAL ELECTION BALLOT

NOVEMBER 8, 2016

- TO VOTE, COMPLETELY FILL IN THE OVAL ● NEXT TO YOUR CHOICE.
- Use only the special marking device provided.
- If you make a mistake, do not hesitate to ask for a new ballot. If you make other marks, your vote may not count.
- A confirmation number will appear inside the oval you mark. You may later use this confirmation number to verify your vote online. After marking the ballot, you may choose to write down your confirmation numbers on the card provided in the voting booth.
- To cast your vote, take your ballot to the scanner. Keep the card to verify your vote online after the polls close.

PRESIDENT AND VICE PRESIDENT (Vote for One)
Gordon Bearce / Nathan Maclean — REP
Vernon Stanley Albury / Richard Rigby — DEM
Janette Froman / Chris Aponte — LIB

CONGRESSIONAL
UNITED STATES SENATOR (Vote for One)
Cecile Cadieux — REP
Fern Brzezinski — DEM
Corey Dery — IND

REPRESENTATIVE IN CONGRESS (Vote for One)
Pedro Brouse — REP
Robert Mettler — DEM

STATE
GOVERNOR (Vote for One)
Glen Travis Lozier — REP
Rick Stickles — DEM
Maurice Humble — IND

LIEUTENANT GOVERNOR (Vote for One)
Shane Tarrio — REP
Cassie Principe — DEM

ATTORNEY GENERAL (Vote for One)
Tim Speight — REP
Rick Organ — DEM

COMPTROLLER OF PUBLIC ACCOUNTS (Vote for One)
Therese Gustin — IND
Greg Converse — DEM

COMMISSIONER OF GENERAL LAND OFFICE (Vote for One)
Sam Saddler — REP
Elise Ellzey — DEM

COMMISSIONER OF AGRICULTURE (Vote for One)
Polly Rylander — REP
Roberto Aron — DEM

RAILROAD COMMISSIONER (Vote for One)
Jillian Balas — REP
Zachary Minick — DEM

STATE SENATOR (Vote for One)
Ricardo Nigro — REP
Wesley Steven Millette — DEM

STATE REPRESENTATIVE DISTRICT 134 (Vote for One)
Petra Bencomo — REP
Susanne Rael — DEM

MEMBER STATE BOARD OF EDUCATION DISTRICT 2 (Vote for One)
Peter Vargo — REP
Mark Barber — DEM

PRESIDING JUDGE TEXAS SUPREME COURT PLACE 3 (Vote for One)
Tim Grady — DEM

PRESIDING JUDGE COURT OF CRIMINAL APPEALS, PLACE 2 (Vote for One)
Dan Plouffe — REP
Derrick Metger — DEM

DISTRICT ATTORNEY (Vote for One)
Corey Behnke — REP
Jennifer A. Lundeed — DEM

COUNTY TREASURER (Vote for One)
Dean Caffee — REP
Gordon Kallas — DEM

SHERIFF (Vote for One)
Stanley Saari — GP
Jason Vale — LIB

COUNTY TAX ASSESSOR (Vote for One)
Howard Grady — IND
Randy H. Clemons — CON

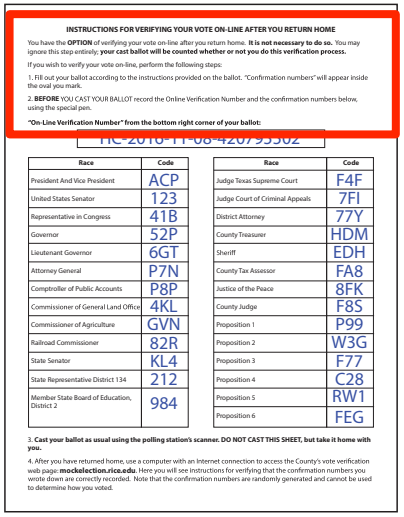
NONPARTISAN
JUSTICE OF THE PEACE (Vote for One)
Deborah Kamps
Clyde Gayton Jr.

COUNTY JUDGE (Vote for One)
Dan Atchley
Lewis Shine

PROPOSITIONS
PROPOSITION 1
Without raising taxes and in order to pay for public safety, public works, parks and recreation, health care, libraries, and other essential services, shall Harris County and the City of Houston be authorized to retain and spend all city and county tax revenues in excess of the constitutional limitation on total city and county fiscal year spending for ten fiscal years beginning with the 2011 fiscal year, and to retain and spend an amount of city and tax revenues in excess of such limitation for the 2020 fiscal year and for each succeeding fiscal year up to the excess city and county revenue cap, as defined by this measure?
YES
NO

VOTE BOTH SIDES OF BALLOT

Ballot ID / Online Verification Number
HC-2016-11-08-420795502


INSTRUCTIONS FOR VERIFYING YOUR VOTE ON-LINE AFTER YOU RETURN HOME

You have the **OPTION** of verifying your vote on-line after you return home. **It is not necessary to do so.** You may ignore this step entirely; **your cast ballot will be counted whether or not you do this verification process.**

If you wish to verify your vote on-line, perform the following steps:

1. Fill out your ballot according to the instructions provided on the ballot. "Confirmation numbers" will appear inside the oval you mark.

2. **BEFORE** YOU CAST YOUR BALLOT record the Online Verification Number and the confirmation numbers below, using the special pen.

"On-Line Verification Number" from the bottom right corner of your ballot:

HC-2016-11-08-420795502

Race	Code
President And Vice President	ACP
United States Senator	123
Representative in Congress	41B
Governor	52P
Lieutenant Governor	6GT
Attorney General	P7N
Comptroller of Public Accounts	P8P
Commissioner of General Land Office	4KL
Commissioner of Agriculture	GVN
Railroad Commissioner	82R
State Senator	KL4
State Representative District 134	212
Member State Board of Education, District 2	984

Race	Code
Judge Texas Supreme Court	F4F
Judge Court of Criminal Appeals	7FI
District Attorney	77Y
County Treasurer	HDM
Sheriff	EDH
County Tax Assessor	FA8
Justice of the Peace	8FK
County Judge	F8S
Proposition 1	P99
Proposition 2	W3G
Proposition 3	F77
Proposition 4	C28
Proposition 5	RW1
Proposition 6	FEG

3. **Cast your ballot as usual using the polling station's scanner. DO NOT CAST THIS SHEET, but take it home with you.**

4. After you have returned home, use a computer with an Internet connection to access the County's vote verification web page: **mockelection.rice.edu**. Here you will see instructions for verifying that the confirmation numbers you wrote down are correctly recorded. Note that the confirmation numbers are randomly generated and cannot be used to determine how you voted.

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Same issues as PaV

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Same issues as PaV

SCANTEGRITY II RESULTS

Design of Scanners to Record Votes



Scantegrity,
Tacoma Park (2009)



ES&S,
DS200



Premier/Diebold,
AccuVote OS



STAR-Vote,
Usability Testing Ballot Box Prototype

Scantegrity II: Vote Verifying

RESULTS

Scantegrity II RICE VERSION

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② Enter unique online verification number associated with ballot

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1 (3%)	Could not navigate to the website **[P]**	• Voter did not know how to use the internet **[P1]** • Website address too complex **[P2]**

SCANTEGRITY II RESULTS

Errors and likely contributing design deficiencies that led to **Scantegrity II** vote-casting and vote-verification failures

Number of Participants (Percentage of Participants)	**Error**	**Contributing Design Deficiencies**
Vote Casting		
16 (43%)	Did not scan-in the ballot; placed it directly in the locked ballot box **[K]**	• No physical mechanisms are on the ballot box that prevented an unscanned ballot from being placed in it **[K1]** • System does not support prior voting mental models **[K2]** • No inline instructions **[K3]**
1 (3%)	Could not operate scanner **[L]**	• Scanner is not explicitly identified **[L1]** • Operating instructions are not available **[L2]** • Design of scanner **[L3]**
1 (3%)	No data available **[M]**	
Vote Verification		
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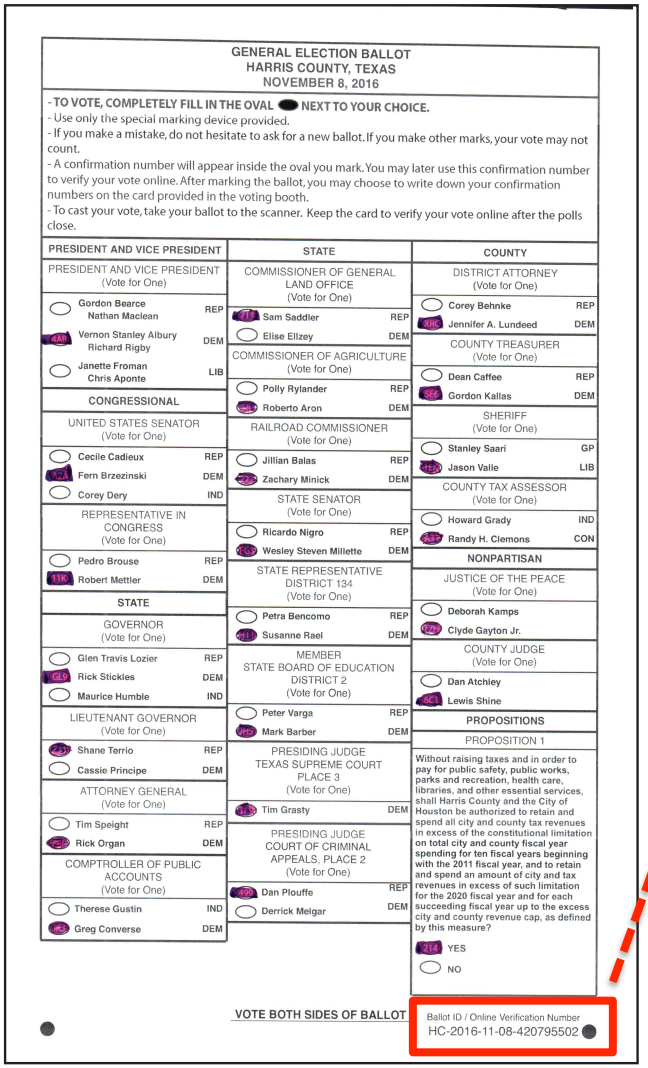
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GENERAL ELECTION BALLOT
HARRIS COUNTY, TEXAS
NOVEMBER 8, 2016

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PRESIDENT AND VICE PRESIDENT

PRESIDENT AND VICE PRESIDENT (Vote for One)
- Gordon Bearce / Nathan Maclean — REP
- Vernon Stanley Albury / Richard Rigby — DEM
- Janette Froman / Chris Aponte — LIB

CONGRESSIONAL

UNITED STATES SENATOR (Vote for One)
- Cecile Cadieux — REP
- Fern Brzezinski — DEM
- Corey Dery — IND

REPRESENTATIVE IN CONGRESS (Vote for One)
- Pedro Brouse — REP
- Robert Mettler — DEM

STATE

GOVERNOR (Vote for One)
- Glen Travis Lozier — REP
- Rick Stickles — DEM
- Maurice Humble — IND

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- Shane Terrio — REP
- Cassie Principe — DEM

ATTORNEY GENERAL (Vote for One)
- Tim Speight — REP
- Rick Organ — DEM

COMPTROLLER OF PUBLIC ACCOUNTS (Vote for One)
- Therese Gustin — IND
- Greg Converse — DEM

STATE

COMMISSIONER OF GENERAL LAND OFFICE (Vote for One)
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- Zachary Minick — DEM

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- Ricardo Nigro — REP
- Wesley Steven Millette — DEM

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- Susanne Rael — DEM

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- Peter Varga — REP
- Mark Barber — DEM

PRESIDING JUDGE TEXAS SUPREME COURT PLACE 3 (Vote for One)
- Tim Grasty — DEM

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- Derrick Melgar — DEM

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DISTRICT ATTORNEY (Vote for One)
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- Stanley Saari — GP
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- Howard Grady — IND
- Randy H. Clemons — CON

NONPARTISAN

JUSTICE OF THE PEACE (Vote for One)
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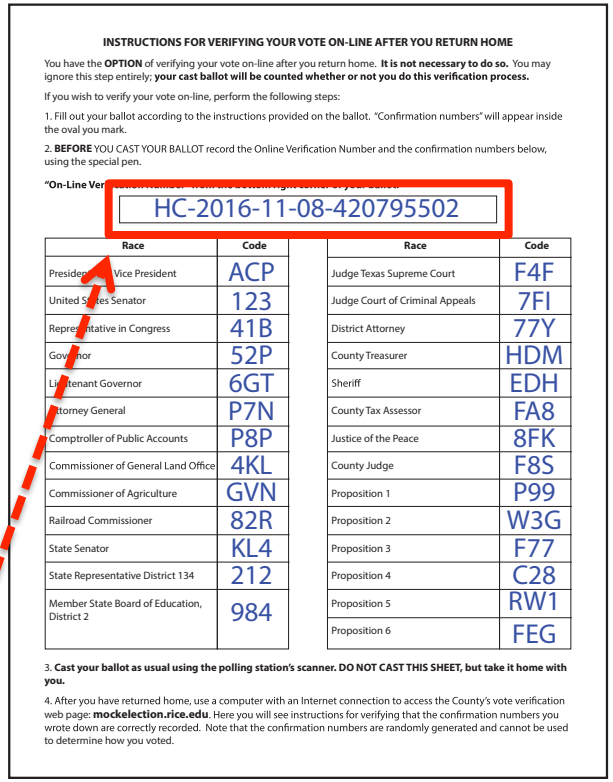
PROPOSITIONS

PROPOSITION 1

Without raising taxes and in order to pay for public safety, public works, parks and recreation, health care, libraries, and other essential services, shall Harris County and the City of Houston be authorized to retain and spend all city and county tax revenues in excess of the constitutional limitation on total city and county fiscal year spending for ten fiscal years beginning with the 2011 fiscal year, and to retain and spend an amount of city and tax revenues in excess of such limitation for the 2020 fiscal year and for each succeeding fiscal year up to the excess city and county revenue cap, as defined by this measure?
- YES
- NO

VOTE BOTH SIDES OF BALLOT

Ballot ID / Online Verification Number
HC-2016-11-08-420795502



INSTRUCTIONS FOR VERIFYING YOUR VOTE ON-LINE AFTER YOU RETURN HOME

You have the **OPTION** of verifying your vote on-line after you return home. **It is not necessary to do so.** You may ignore this step entirely; **your cast ballot will be counted whether or not you do this verification process.**

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"On-Line Ver

HC-2016-11-08-420795502

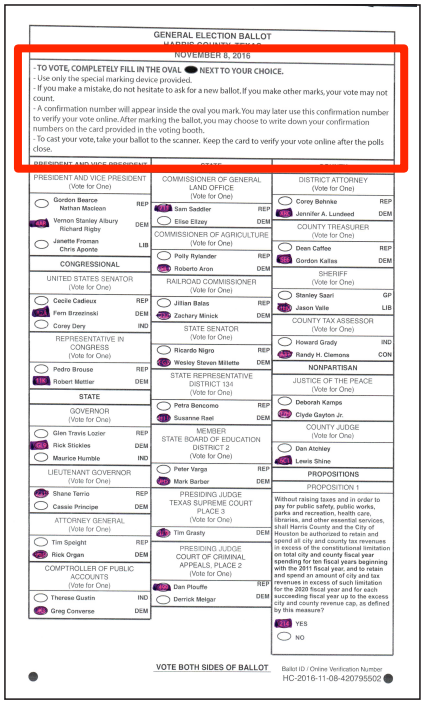
Race	Code	Race	Code
Presid / Vice President	ACP	Judge Texas Supreme Court	F4F
United S tes Senator	123	Judge Court of Criminal Appeals	7FI
Repres tative in Congress	41B	District Attorney	77Y
Gov nor	52P	County Treasurer	HDM
Li tenant Governor	6GT	Sheriff	EDH
ttorney General	P7N	County Tax Assessor	FA8
Comptroller of Public Accounts	P8P	Justice of the Peace	8FK
Commissioner of General Land Office	4KL	County Judge	F8S
Commissioner of Agriculture	GVN	Proposition 1	P99
Railroad Commissioner	82R	Proposition 2	W3G
State Senator	KL4	Proposition 3	F77
State Representative District 134	212	Proposition 4	C28
Member State Board of Education, District 2	984	Proposition 5	RW1
		Proposition 6	FEG

3. **Cast your ballot as usual using the polling station's scanner. DO NOT CAST THIS SHEET, but take it home with you.**

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SCANTEGRITY II RESULTS

Errors and likely contributing design deficiencies that led to **Scantegrity II** vote-casting and vote-verification failures


GENERAL ELECTION BALLOT

HARRIS COUNTY, TEXAS

NOVEMBER 8, 2016

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PROPOSITIONS

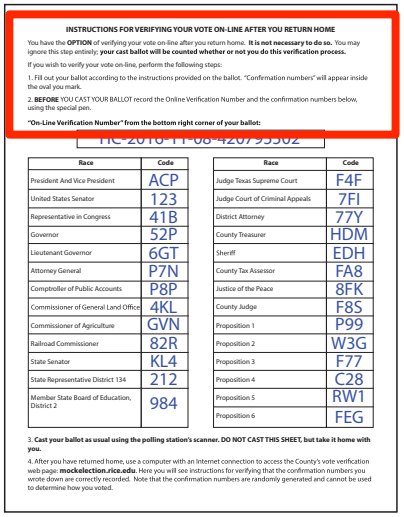
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YES
NO

VOTE BOTH SIDES OF BALLOT

Ballot ID / Online Verification Number
HC-2016-11-08-420795502


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HC-2016-11-08-420795502

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United States Senator	123
Representative in Congress	41B
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Lieutenant Governor	6GT
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Comptroller of Public Accounts	P8P
Commissioner of General Land Office	4KL
Commissioner of Agriculture	GVN
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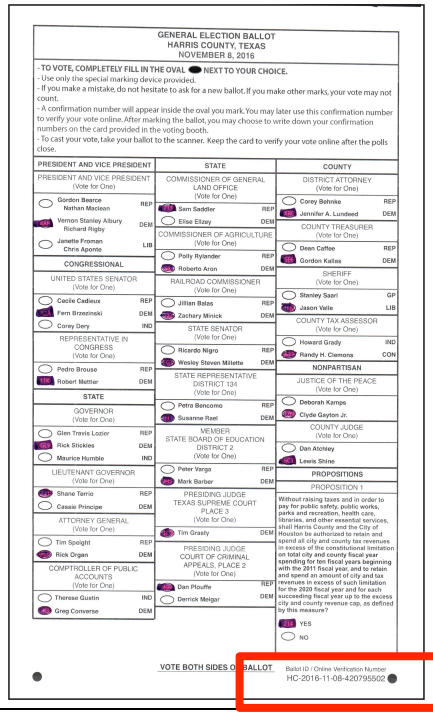
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Errors and likely contributing design deficiencies that led to **Scantegrity II** vote-casting and vote-verification failures



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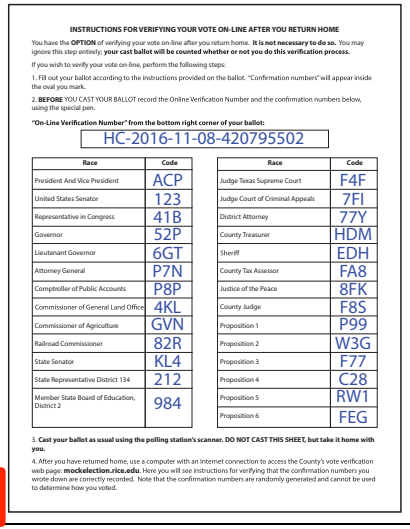
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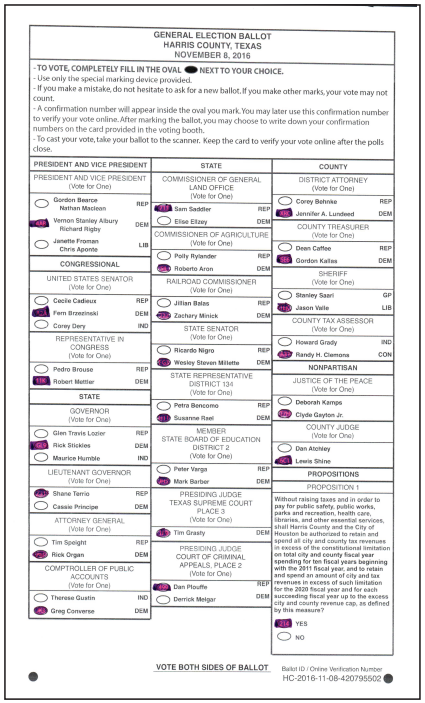
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Zachary Minick DEM

STATE SENATOR (Vote for One)
Ricardo Nigro REP
Wesley Steven Millette DEM

STATE REPRESENTATIVE DISTRICT 134 (Vote for One)
Petra Bencomo REP
Susanne Reel DEM

MEMBER STATE BOARD OF EDUCATION DISTRICT 2 (Vote for One)
Peter Varga REP
Mark Barber DEM

PRESIDING JUDGE TEXAS SUPREME COURT PLACE 3 (Vote for One)
Tim Grasty DEM

PRESIDING JUDGE COURT OF CRIMINAL APPEALS, PLACE 2 (Vote for One)
Dan Plouffe REP
Derrick Melgar DEM

COUNTY
DISTRICT ATTORNEY (Vote for One)
Corey Behnke REP
Jennifer A. Lundeed DEM

COUNTY TREASURER (Vote for One)
Dean Catfee REP
Gordon Kallas DEM

SHERIFF (Vote for One)
Stanley Saari GP
Jason Valle LIB

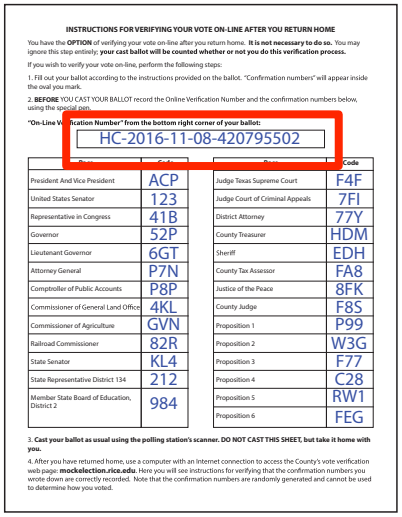
COUNTY TAX ASSESSOR (Vote for One)
Howard Grady IND
Randy H. Clemons CON

NONPARTISAN
JUSTICE OF THE PEACE (Vote for One)
Deborah Kamps
Clyde Gayton Jr.

COUNTY JUDGE (Vote for One)
Dan Atchley
Lewis Shine

PROPOSITIONS
PROPOSITION 1
Without raising taxes and in order to pay for public safety, public works, parks and recreation, health care, libraries, and other essential services, shall Harris County and the City of Houston be authorized to retain and spend all city and county tax revenues in excess of the constitutional limitation on total city and county fiscal year spending for ten fiscal years beginning with the 2011 fiscal year, and to retain and spend an amount of city and tax revenues in excess of such limitation for the 2020 fiscal year and for each succeeding fiscal year up to the excess city and county revenue cap, as defined by this measure?
YES
NO

VOTE BOTH SIDES OF BALLOT
Ballot ID / Online Verification Number
HC-2016-11-08-420795502



INSTRUCTIONS FOR VERIFYING YOUR VOTE ON-LINE AFTER YOU RETURN HOME

You have the **OPTION** of verifying your vote on-line after you return home. **It is not necessary to do so.** You may ignore this step entirely; **your cast ballot will be counted whether or not you do this verification process.**

If you wish to verify your vote on-line, perform the following steps:

1. Fill out your ballot according to the instructions provided on the ballot. "Confirmation numbers" will appear inside the oval you mark.
2. **BEFORE** YOU CAST YOUR BALLOT record the Online Verification Number and the confirmation numbers below, using the special pen.

"On-Line Verification Number" from the bottom right corner of your ballot: HC-2016-11-08-420795502

	Code		Code
President And Vice President	ACP	Judge Texas Supreme Court	F4F
United States Senator	123	Judge Court of Criminal Appeals	7FI
Representative in Congress	41B	District Attorney	77Y
Governor	52P	County Treasurer	HDM
Lieutenant Governor	6GT	Sheriff	EDH
Attorney General	P7N	County Tax Assessor	FA8
Comptroller of Public Accounts	P8P	Justice of the Peace	8FK
Commissioner of General Land Office	4KL	County Judge	F8S
Commissioner of Agriculture	GVN	Proposition 1	P99
Railroad Commissioner	82R	Proposition 2	W3G
State Senator	KL4	Proposition 3	F77
State Representative District 134	212	Proposition 4	C28
Member State Board of Education, District 2	984	Proposition 5	RW1
		Proposition 6	FEG

3. **Cast your ballot as usual using the polling station's scanner. DO NOT CAST THIS SHEET, but take it home with you.**
4. After you have returned home, use a computer with an Internet connection to access the County's vote verification web page: **mockelection.rice.edu**. Here you will see instructions for verifying that the confirmation numbers you wrote down are correctly recorded. Note that the confirmation numbers are randomly generated and cannot be used to determine how you voted.

3 (8%)	Did not record ballot ID **[O]**	• No inline instructions **[O1]** • Ballot ID is not located in a prominent location on the ballot **[O2]** • Ballot ID is too long and complex, which deterred voter from making the effort to record it **[O3]**
1 (3%)	Could not navigate to the website **[P]**	• Voter did not know how to use the internet **[P1]** • Website address too complex **[P2]**

SCANTEGRITY II RESULTS

Errors and likely contributing design deficiencies that led to **Scantegrity II** vote-casting and vote-verification failures



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SCANTEGRITY II RESULTS

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Number of Participants (Percentage of Participants)	**Error**	**Contributing Design Deficiencies**
Vote Casting		
16 (43%)	Did not scan-in the ballot; placed it directly in the locked ballot box **[K]**	• No physical mechanisms are on the ballot box that prevented an unscanned ballot from being placed in it **[K1]** • System does not support prior voting mental models **[K2]** • No inline instructions **[K3]**
1 (3%)	Could not operate scanner **[L]**	• Scanner is not explicitly identified **[L1]** • Operating instructions are not available **[L2]** • Design of scanner **[L3]**
1 (3%)	No data available **[M]**	
Vote Verification		
18 (49%)	Did not cast a ballot **[N]**	• See above deficiencies **[N1]**
3 (8%)	Did not record ballot ID **[O]**	• No inline instructions **[O1]** • Ballot ID is not located in a prominent location on the ballot **[O2]** • Ballot ID is too long and complex, which deterred voter from making the effort to record it **[O3]**
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Same issues as PaV

SCANTEGRITY II RESULTS

More on Vote Verifying

- Of the 15 study participants who were able to complete some form of vote verification, only 3 (8%) completed procedures as outlined in the Scantegrity II papers

Discussion

DISCUSSION

- Errors resulting in a total failure to vote cast and vote verify were caused by only a few contributing design deficiencies
  - Some fixes to the system designs could likely solve the majority of the issues that caused voters to fail at vote casting
  - As for the verification methods, Helios and Scantegrity II methods should be reconsidered if a full verification needs to be completed for security reasons

SOME CAUTIONARY NOTES

Errors and contributing design deficiencies listed for each system are not punch lists.

SOME CAUTIONARY NOTES

Helping voters, instructions, and training are not "fixes."

SOME CAUTIONARY NOTES



Design the system the right way in the first place!

SOME CAUTIONARY NOTES

Test, iterate, and retest.

SOME CAUTIONARY NOTES





Test, iterate, and retest.

FUTURE RESEARCH

- Focus on e2e usability problems beyond those that resulted in failures to vote cast and vote verify
- Iterate and run usability testing throughout the development process to refine e2e and non-e2e systems
  - Determine the best means to integrate the ballot box and scanner into one unit or eliminate the need to scan
- Study the usability of e2e systems for disabled populations

Conclusion

CONCLUSION

- Deviations from the standard paper/ballot box voting method can lead to failures
- Going forward, need to understand any deviations that are made from the voters' expected voting model and ensure that these changes have minor repercussions for user success

CONCLUSION

- The complex security mechanisms found in e2e systems likely don't comprise an insurmountable barrier to the development of usable designs
- By addressing the design deficiencies and implementing solutions using industry-standard methods like iterative design, secure e2e systems can become usable enough to be deployed in large-scale, actual elections

ACKNOLEDGEMENTS

- Researcher supported by NIST grant #60NANB12D249
- PaV researchers Peter Ryan and Thea Peacock
- Scantegrity II researchers Richard Carback and Alex Essex

The views and conclusions expressed are those of the authors and should not be interpreted as representing the official policies or endorsements, either expressed or implied, of NIST, the U.S. government, or any other organization.

THANK YOU!