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PRACTICAL SOLUTIONS FOR A COMPLEX WORLD

Voting is as simple as 1,2,4… The Human Factors of Voting

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The right to vote is one of the fundamental liberties granted to American citizens by our Constitution. It is our duty to employ this right in order to maintain a free society. Ideally, all citizens who chose to exercise their right to vote should be afforded the opportunity of doing so. In theory, the process of casting a ballot appears simple. Unfortunately, even in the 21st century, the process of voting and vote counting is so varied and complex that confidence in the system wanes. Differences occur in voter registration, absentee and early voting, ballot design, the type of equipment used to cast votes, vote counting, and certification of the vote. What is needed is a simplified process that minimizes voter error (i.e., overvotes, undervotes, etc.) and guarantees that cast votes will count. When these requirements aren't achieved, the system breaks down and our democracy is put at risk.

Voting Issues in the 21st Century

Voting issues are not new. Since the first election, officials have had to deal with issues such as who has the right to vote, election tampering, registration inaccuracies, and vote tabulation errors. In these situations every form of voting, from paper to technology, have failed to withstand scrutiny. Although voting issues are as old as voting itself, problems surrounding the act of casting a vote came to the forefront in the 2000 presidential election.

2000 Presidential Election

In the 2000 presidential election, a poorly designed ballot used in Palm Beach County, Florida contributed to a disproportionate number of votes being unintentionally cast for Reform candidate Pat Buchanan, instead of the intended recipient, Democratic candidate Al Gore. The problem with the butterfly ballot stemmed from its double-column design. The two main party candidates, George W. Bush and Al Gore, were located in the first and second positions on the left-hand column, but their corresponding punch holes were in the first and third positions, while the second punch hole was reserved for Pat Buchanan who was located in the first position on the right-hand column. Thus, people who

intended to vote for Al Gore by punching the second hole instead voted for Pat Buchanan.

The overall state vote yielded a difference of 1,784 votes in favor of Bush, triggering an automatic recount. After the recount the difference was decreased to 537. During the recount process, a further ballot design flaw was revealed with the existence of hanging, swinging, tri-, and dimpled chad (paper debris left attached to a ballot of a punched hole), and votes were not counted. Moreover, 19,120 ballots were considered "spoiled," and thus not counted, because voters, in an attempt to correct their "mistake," punched a second hole after realizing they had voted for Pat Buchannan and not Al Gore (Vicente, 2004). Ultimately, due to unintentionally miscast and uncounted votes, it was the US Supreme Court, and not the voters, who determined the outcome of the election in favor of George W. Bush.

Help America Vote Act of 2002

The 2000 presidential election problems highlighted the need to reform the voting process, a goal of the Help America Vote Act of 2002 (P.L. 107-252). This act:

- Provided states the funds to replace punch card machines with electronic voting machines
- Established the independent, bipartisan Election Assistance Commission (EAC)
- Developed minimum election administration standards for states to follow

Nationally, election officials reviewed their voting procedures and many moved to modernize by replacing antiquated voting equipment (e.g., paper ballots, mechanical lever machines, and punch cards) with more contemporary voting methods (e.g., optical ballot scanning and direct recording electronics). For many, technology was the solution to their problems. Unfortunately, instead of fixing existing problems, this new technology replaced old problems with new ones.

2004 Presidential Election

During the 2004 election, these new problems became apparent. New electronic voting systems were plagued by a variety of issues including reliability, security, auditability, and inadequately trained poll workers (GAO, 2005; Kohno, et al., 2004; Lovgren, 2004; Selker, 2004). Concerns about these issues were borne out during a 2006 election in Florida.

2006 Florida 13th Congressional District

The 2006 election for the 13th Congressional District of Florida consisted of a tight race between Republican candidate Vern Buchanan and Democratic candidate Christine Jennings, with the former winning by 369 votes. Voters used the ES&S iVotronic direct recording electronic voting machines to record their votes. Given the close finish, a mandatory recount was performed which consisted of re-querying the machines, and Mr. Buchanan was again declared the winner. Mrs. Jennings challenged the results, among other reasons, due to an alleged voting machine error. Her protest centered on the fact that 18,000 people (15% of the voters), who cast votes for other offices, did not record a vote for either her or Mr. Buchanan - referred to as an "undervote." It was suggested that the design of the electronic touch screen ballot contributed to the undervote because it inconsistently used a blue banner to highlight the races. Jennings argued that voters may not have noticed the 13th Congressional District race on the ballot because the banner was missing. Investigations by the Government Accountability Office have been inconclusive (GAO, 2007).

A common denominator in many voting issues, particularly those that involve the actual act of casting a vote, revolves around an inadequate understanding of the qualities, characteristics and differences among voters, including how they interact with voting systems. The discipline of human factors can shed valuable insight that can promote the reliability and effectiveness of today's voting systems.

What is Human Factors and Why is it Important to Voting System Issues?

Human factors is a unique scientific discipline that systematically applies the knowledge of human abilities and limitations to the design of systems with the goal of optimizing the interaction between people and other system elements to enhance safety, performance, and satisfaction. In simpler terms, human factors focuses on designing the world to better accommodate people. In the case of voting, it would focus on making the process of voting compatible with voters.

Voting, although simple by definition, is complex when put in practice. Voting involves voters, poll workers, election officials, voting equipment, ballots, booths, facilities, registration, absentee and early voting, counting, recounts, certifications and all of the individual processes that make recounts and certifications possible. All of these tasks and sub-processes are interdependent so that changes in one aspect of the process are likely to affect other process components. Let's look at the large components of the voting process: people; voting technology; voting task; and voting environment.

People

Three groups of individuals are vital to the voting process – voters, poll workers, and election officials. The diversity of the voting public, while great from a multicultural perspective, adds significant challenges to designing voting systems that are sufficiently accommodating. These differences include first-time voters, older adults, low-literacy, limited English skills, people with disabilities, and novice computer users. Thus, it is important to provide the necessary accommodations for each of these groups to foster successful voter participation. This would include providing voter education materials in multiple formats (e.g., text, audio, video, etc.), via different avenues (e.g., mail, email, Internet, etc.), and in multiple languages. Also, voters should have the opportunity to see their specific ballot prior to voting so they can familiarize themselves with its format and content.

Poll workers are important to the voting process in several ways. They ensure voting progresses smoothly, aid voters who need assistance, and ensure the polling place is safe and secure. Despite their key role, many poll workers are unable to adequately explain the use of voting technology, are unable to properly instruct voters in its use, and cannot problem solve issues onsite. Interestingly, many of the problems stem from poorly designed voting technologies and not a lack of training. But, in the absence of properly designed and tested voting technology, poll workers need to be provided with sufficient training so they can successfully assist voters who need it.

Election officials play a vital role in making sure the voting process performs smoothly for voters. Their importance comes to the forefront when challenges like the 2000 and 2004 Presidential elections occur. Within state government, the Secretary of State oversees the electoral process for their state, which includes putting out voter guides, determining how funds are spent on the procurement of voting equipment, how electoral reform should progress, and certifying candidates and election results. Given the lack of uniformity of the voting process across the US, the importance of the decisions they make cannot be overstated. Thus, it is imperative that only voting technology that conforms to basic human factors principles be purchased and implemented.

Voting Technology

Voting Methods

Currently, there are five different methods for voting in the US - paper ballots, mechanical lever machines, punch cards, optical scan, and direct recording electronic. Three of the methods make use of computer technology (punch cards, optical scan, and direct recording electronic) and three have some form of a paper trail (paper ballots, punch cards, and optical scan). With respect to

Idaho, three methods are used – paper, punch card, and optical scan (arrow & oval).

Paper ballots have been used since our independence, with the secret ballot being introduced at the end of the 19th century. This method has voters mark a box placed next to their voting choice and completed ballots are placed in a sealed ballot box.

Mechnical lever machines were first introduced in the late 19th century and were the most common method of voting through the mid 1980s. This method has voters activate a lever next to their voting choice and the machine records it on a vote counter that is opened and tallied by election officials at the end of the voting day.

Punch cards were first implemented in the early 1960s and replaced the mechanical lever machine as the most frequently used method until the 2000 elections. This method was the first to use computer technology by incorporating a computer-readable card that required voters to use a stylus to punch out a box next to their desired voting choices. The votes are tallied by feeding the card into a tabulation machine that electronically reads the punched holes.

Optical scan systems were first used in the 1960s and currently are the most common method of voting. Voters fill in either an arrow or oval next to their voting choice on a computer-readable paper ballot and the completed ballot is fed into a tabulation machine that reads and tallies the marks.

Direct recording electronic (DRE) was introduced in the mid-1970s and currently is the second most used method. This method has voters either push a button or touch the screen next to their voting choice. The completed ballot is submitted by pressing the vote button, which stores their votes on the computer's memory chip

Each of the five methods has its own set of potential issues:

- Paper Ballots - stuffed, lost or stolen ballots and/or boxes
- Mechanical Lever Machines - no voter-verifiable paper audit trail
- Punch Cards - hanging, swinging, tri-, and dimpled chad
- Optical Scan - computer malfunctions (e.g., misreads, crashes, etc.); Inability to recognize ink used to mark ballot
- Direct Recording Electronic - security; poll workers need greater levels of technical experience; no voter-verifiable paper audit trail

Ballots

Depending on the voting method, ballots come in one of two basic forms - paper or electronic. These, in turn, can present the entire ballot on one page/screen or separated into many individual pages/screens. On top of these

differences, ballot choices and design often vary between districts, states, and elections. Moreover, besides just listing candidates for federal, state, and local offices, ballots often include bond issues, propositions, and constitutional amendments – many of which are written in confusing language. Each of these factors contributed to the complexity of the ballot, thus increasing the likelihood of voting issues such as overvotes, undervotes, and uncounted ballots to occur.

A number of authors (Herrnson, et al., 2008; Kimball & Kropf, 2005; Niemi & Herrnson, 2003) have identified issues that should be considered when designing ballots, including:

- Readability - upper & lowercase san-serif type; don't use all caps; minimize number of fonts; left justify text, etc.
- Comprehensibility - clear instructions; simple language; consistent use of candidate names; etc.
- Layout - order of candidate's names; candidates for the same office listed in one column or page; minimize clutter; avoid mirror images; etc.
- Features - appropriate use of color, highlighting, shading, bolding, etc.

Voting Booths

Voting booths allow voters to cast their ballots in private, while improving voting accuracy by minimizing distractions. They take many forms from curtain-partitioned stalls to individual stations divided by screens. Concerns that have been raised include the instability of fold-up stands used by some voting methods (Herrnson, et al., 2008). Moreover, the height of the voting booth can make it challenging for voters with height extremes (i.e., short or tall) to comfortably complete the voting process.

Voting Task

There are several factors that can negatively impact voting and need to be considered when designing voting systems. These include increased mental workload when using poorly design voting technology, increased time pressure due to long voting lines, and distraction from a noisy voting environment. Each of these factors can contribute to a situation where errors might invalidate a vote for a given office – or the entire ballot. Also, when the voting task becomes too challenging, voters are forced to enlist the assistance of poll workers, thus suffering a loss of voting privacy.

Voting Environment

Typically, voting is held in facilities (e.g., schools, churches, fire stations, etc.) that are less than optimal environments for tasks requiring concentration. Added to this, are long voting lines, high ambient noise levels, having to deal with pollsters when entering and exiting the voting facility, and the potential for accessibility issues. Each of these issues needs to be considered and addressed at

every polling place to ensure an environment that minimizes the likelihood for voter error.

How Can Human Factors Minimize Future Voting System Issues?

Heuristic evaluations and usability testing are two human factors methods that can be used to analyze current voting systems, along with voting technology prior to procurement and implementation. These methods are directly applicable to voting systems and can be performed either by election officials or with the assistance of a human factors consultant. Ideally, both techniques will be used, given that they each have their own strengths and weaknesses.

Heuristic Evaluations

Heuristic evaluations consist of expert evaluators using a list of human factors principles (heuristics) to independently identify usability issues with a given device. The evaluators should be individuals who are familiar with the voting system, potential conditions under which voting will occur, and have an understanding of human factors. Heuristic evaluations consist of three steps: comparing the heuristic list against the voting technology, identifying heuristic violations, and determining the severity of each violation. For example, one set of heuristics used to evaluate voting equipment (Herrnson, et al., 2008, p. 37), includes:

- Simple and natural language - Messages should not contain information that is irrelevant or rarely needed.
- Speak the user's language - Dialogues should be expressed clearly in words, phrases, and concepts familiar to the user rather than in system-oriented terms.
- Minimize the user's memory load - The user should not have to remember information from one part of the interface to another.
- Consistency - Users should not have to wonder whether different words, situations, or actions mean the same thing.
- Feedback - The system should always keep users informed about what is going on through appropriate feedback within reasonable time.
- Reversal of actions - As much as possible, actions should be easily reversible.
- Clearly marked exists - Users should be able to leave the system at will and not need assistance to do so.
- Good error messages - All errors should be avoided if possible, but any error messages should be expressed in plain language (no codes) precisely indicating the problem and constructively suggesting a solution.
- Help - Even though it is better if the system can be used without documentation, it may be necessary to provide help. Any such information should be easy to navigate and should be focused on the user's task.

Heuristic evaluations are used for three reasons. First, they are used to identify potential usability issues that might arise from the voting technology itself or after its integration in the current voting system, which in turn, might lead to voting errors. Second, they are useful when comparing multiple voting devices by helping to "weed out" voting technology that violates basic human factors principles, thus saving the time and cost of performing subsequent usability tests. Finally, the outcome of heuristic evaluations can help guide training efforts by identifying what needs to be addressed when training poll workers and educating voters.

Heuristic evaluations have several strengths and weaknesses, including:

Strengths

- Easy to learn and use
- Requires minimal training
- Cost effective to implement

Weaknesses

- Does not discover missing functionality
- Relies on the knowledge and the experience of the evaluator

Usability Testing

Usability testing consists of having voters perform the process of voting with actual voting technology in a realistic setting. The steps required to complete a usability test include: (1) design the test; (2) performing a dry run and making modifications to the test design if necessary; (3) recruiting voters; (4) conducting the test; (5) analyzing the results; and (6) determining the appropriate action to take based on the test results.

Usability testing can capture objective and subjective outcome performance data. The former typically includes time to perform individual votes, voting accuracy, and number and type of errors made by the voters. The latter includes user feedback regarding strengths and weaknesses of the voting technology and perceived ease of use.

Usability testing has several strengths and weaknesses, including:

Strengths

- A small number of voters are needed to identify most problems
- Identifies the severity of voting problems
- Detects voting problems not identified by heuristic evaluations

Weaknesses

- Can be time consuming and costly to perform
- Requires testers that are knowledgeable with the method

Final Thoughts

Election officials are encouraged to incorporate both heuristic evaluations and usability testing to identify potential problems with the current voting process and to determine how best to implement voting technology in the future. Heuristic evaluations are useful for identifying potential usability issues that might occur from the voting technology itself or after its integration in the current voting system. However, heuristic evaluations cannot capture all the potential usability issues for new voting technology or the level of voter acceptance and voting accuracy. Thus, it is necessary to also conduct usability testing with voters in a realistic setting to identify problems that might arise during the voting process. While both methods have their place, when used in tandem, they can have the greatest impact and success. Ultimately, both methods help achieve the overall goal of minimizing voter error by improving voting system design.

Most of the previously discussed issues from the 2000, 2004, and 2006 elections could have been prevented by the appropriate implementation of human factors methods, thus making the voting process compatible with voters. Unfortunately, failure to do so undermined voter confidence, led to feelings of disenchantment by those whose votes were not counted, and raised concerns about the integrity of the voting process. Even more seriously, in the case of the 2000 presidential election, it removed the power from the hands of the electorate and temporarily placed it with the judicial branch.

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