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RECOMMENDATIONS FOR E-VOTING SYSTEM USABILITY: LESSONS FROM LITERATURE FOR INTERFACE DESIGN, USER STUDIES AND USABILITY CRITERIA

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Introduction

These recommendations are for use in the following:

- E-Voting System Interface Design
- User Studies
- Usability Criteria

While studies in the literature focus on a variety of e-voting systems, including voting machines and punch cards, the recommendations here are for Internet-based and cryptographically-verifiable voting systems.

Readers interested in more information in the literature surveyed, and future research directions are directed to the book chapter cited above.

E-Voting System Interface Design

In this section, we present recommendations for the design of e-voting interfaces.

Ballot/Interface Design

R-ID-BD-1: Ballot design should be standardized making ballots familiar to voters, for example, imitating paper ballot design on the e-voting system interface. (Niemi & Herrnson, 2003)
R-ID-BD-2: The interface should indicate to voters when their vote has been successfully cast and if the vote casting process has been completed. (Roth, 1998)
R-ID-BD-3: The interface should alert voters if their vote is invalid due to few or too many candidate selections on the ballot. (Selker, Hockenberry, Goler & Sullivan, 2005)
R-ID-BD-4: The interface should use the bubble ballot design where the ballots and candidate listing supports it. (Greene, Byrne & Everett, 2006; Everett, Byrne & Greene, 2006; Byrne, Greene & Everett, 2007)

Simple and Clear Ballot Instructions

R-ID-BI-1: Use simple and clear instructions for ballots (Roth, 1998). Some best practice recommendations from literature are as follows:

- The consequences of an action should precede the call to act. (Laskwoski & Redish, 2006)
- Instructions should use words that are familiar to voters. (Laskwoski & Redish, 2006)
- Instructions should match the logical order of tasks on the ballot. (Laskwoski & Redish, 2006)
- Instructions should be placed at the upper left-hand corner of the ballot (relevant in contexts where reading is from left to right). (Kimball & Kropf, 2005)
- Instructions should be given before the task to be carried out, e.g., placing instructions how to mark a candidate correctly just above where a voter will carry out this action. (Kimball & Kropf, 2005)

Review/Confirmation Screens

R-ID-RS-1: Integrate review screens to allow voters to check their candidate selections before submitting the vote. (Herrnson et al., 2006; Norden, Creelan, Kimball & Quesenbery, 2006)
R-ID-RS-2: Instruct voters to pay attention to the review screen. (Everett, 2007)
R-ID-RS-3: Draw voters' attention to the review screen using techniques such as additional coloring or highlighting. (Campbell & Byrne, 2009a)

Voting Tasks: Time, Speed and Effort

R-ID-TS-1: Reduce the amount of time and effort that voters need to take in order to cast their vote. (Conrad et al., 2005; Oostveen & Van den Besselaar, 2009; Conrad et al., 2009)

R-ID-TS-2: Allow sequential access rather than direct access through the ballot to minimize voter error. (Everett et al., 2008; Greene, 2008)

Providing Help Features

R-ID-HF-1: Integrate help features in the voting interfaces, e.g., screen tips (Herrnson et al., 2006; Herrnson et al., 2008)

R-ID-HF-2: Provide help just in time when voters need it. (Prosser, Schiessl & Fleischhacker, 2007)

R-ID-HF-3: Have a help link on every web page for Internet voting. (Nielsen, 1994)

R-ID-HF-4: Have a help link next to tasks that are likely to be confusing for voters. (Nielsen, 1994)

Cryptographically-Verifiable Voting

Here we combine findings in the literature that are useful for interface design of cryptographically-verifiable voting systems. We focus on Internet voting systems. In these situations, the voters' *mental model* needs to be identified. *Voter education* is necessary and should take into account the mental model. Effective education should positively influence voters' *understanding* of how cryptographically-verifiable schemes operate.

Identifying Mental Models

R-ID-CV-MM-1: Identify the voters' mental model for new e-voting technology. (Campbell & Byrne, 2009b; Schneider et al., 2011; Karayumak et al., 2011b; Carback et al., 2010)

Educating Voters

R-ID-CV-ED-1: Educate voters on verifiability and cryptographic verifiability. (Herrnson et al., 2005b; Kalchgruber & Weippl, 2009)

R-ID-CV-ED-2: Take into account the voters' mental model regarding e-voting when educating voters. (Campbell & Byrne, 2009b)

R-ID-CV-ED-3: Utilize a variety of techniques e.g. video, handouts, to educate voters, considering the diversity in terms of age, experience with voting, and education level. (Kalchgruber & Weippl, 2009)

Voter Understanding of Cryptographically-Verifiable Voting

R-ID-CV-1: Give voters clear instructions on how to verify their votes. (Bär, Henrich, Müller-Quade, Röhrich, & Stüber, 2008)

R-ID-CV-2: Integrate help features taking into account the different types of voters, ranging from first-time voters, to frequent voters. (Nielsen, 1994)

User Studies

Our recommendations in this section focus on carrying out user studies (both lab studies and field studies) to evaluate the usability of e-voting systems.

Relevant Methodology

R-US-RM-1: Begin by evaluating the interfaces or e-voting system with *experts*. Changes can be made to the e-voting aspect under study based on the feedback received. A *pilot study* should precede the *lab study* which is then carried out. Based on feedback from participants after the user study, the e-voting should be re-designed. The *re-design* should be tested in subsequent user studies, and several

iterations at this stage may be necessary, switching between re-design and small user studies for user feedback. *Field studies* should be carried out, testing the re-designed e-voting system in a real election with real voters. *Exit polls* should accompany the field studies, to obtain voters' feedback on the e-voting system, and related aspects being studied. (Bederson, Lee, Sherman, Herrnson & Niemi, 2003; Herrnson et al., 2006; Traugott et al., 2005; Karayumak, Kauer, Olembo & Volkamer, 2011a; Karayumak et al., 2011b; Sharp et al., 2007)

Ecological Validity

R-US-EV-1: Use real ballots, where possible, based on the names of the candidates listed, the design of the ballot, or the number of races provided. (Schneider et al., 2011)

R-US-EV-2: Use a voting environment similar to that in a real election, for example in Internet voting, set up the study in the participants' own environment, or have participants use their own computers. (Fuglerud & Røssvoll, 2011; Weber & Hengartner, 2009; Carback et al., 2010; Herrnson et al., 2005; De Jong, van Hoof & Gosselt, 2007, 2008)

R-US-EV-3: Give voters tasks similar to tasks in a real election. (Herrnson et al., 2008)

R-US-EV-4: Run an election for which participants are likely to be interested in the results, for example, a charities' election. (De Jong et al., 2008; Winckler et al., 2009)

Maintaining Vote Secrecy

R-US-VS-1: Preserve vote secrecy in the user study, or inform participants when it will not be preserved. (Selker et al., 2006; van Hoof et al., 2007; Conrad et al., 2009)

General Recommendations

R-US-GR-1: Offer financial or in-kind incentives to participants in user studies. (Goggin, 2008)

R-US-GR-2: Studies should have, as a minimum, 15 – 20 participants, depending on the goals of the study. (Lazar, Feng & Hochheiser, 2010)

R-US-GR-3: Field studies should have a large number of participants (minimum 100 participants). (Carback et al., 2010; Herrnson et al., 2005; van Hoof, Gosselt & de Jong, 2007; de Jong, van Hoof & Gosselt, 2008)

R-US-GR-4: Provide participants with both written and verbal instructions on what tasks they are to carry out in the user study. (van Hoof et al., 2007)

R-US-GR-5: Do not violate ethical requirements in designing user studies. Additionally, report how ethical requirements have been met. (Lazar et al., 2010)

R-US-GR-6: Inform participants about the goals of the study either before or after the study. (Everett et al., 2006; Greene et al., 2006; Fuglerud & Røssvoll, 2011)

R-US-GR-7: Obtain participants' consent before they take part in user studies. (Everett et al., 2006; Greene et al., 2006; Fuglerud & Røssvoll, 2011)

R-US-GR-8: Use fully developed and tested equipment in user studies to avoid errors. (MacNamara et al., 2010)

Usability Criteria

In this section, we present recommendations for evaluating the usability of e-voting systems.

Metrics for Usability Evaluation

R-UC-MUE-1: Adopt a standardized approach to evaluate usability, for example, the three ISO measures of effectiveness, efficiency and satisfaction. (Laskowski et al., 2004)

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