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Interfaces for Electronic Voting: Focus Group Evidence

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Abstract:

Electronic voting poses unique design challenges, simultaneously requiring extensive security, universal access, and strict privacy. Results of British focus group research into electronic voting usability are presented. Recommendations flow, that follow the principle that electoral processes must be designed around the accurate transmission and aggregation of all voters' uncoerced wishes.

Keywords:

Electronic Voting, Usability, Disability, Equality, Interfaces, Simplicity, Colour, Audio, Identification, Undervoting

Biographical Notes:

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Introduction

The US Presidential Election of 2000 has resulted in substantial investment in new electronic voting technology by local administrations, while increasingly wide use of the Internet has resulted in politicians who wish to appear 'modern' advocating its use for elections throughout the world. In the United Kingdom, the Government has been seeking to hold an 'electronically enabled' General Election at the General Election after next (sometime between 2006 and 2011)(UK Government, 2002, p48), and as part of the preparation for this has begun trials of Internet voting in local elections, and part-funded research (by a team that included the authors of this paper) into the barriers to the implementation of electronic voting in the hope of finding ways to overcome them. Elsewhere, Internet voting is planned in South Korea (Ferguson, 2003) and Estonia, while early trials are taking place in Switzerland (Council of Europe, 2003, p8, pp19-21).

The main interest has been in the technical challenge of getting a system that works (or at least appears to work). It is interesting to note that Volume 47 Number 10 October 2004 of Communications of the ACM had a special section on "Problems and potentials of voting systems" containing 8 papers. None of these addressed usability or interface design. While those that study the issues seriously recognise that "Human factor research is needed to determine how best to design user interfaces and ballots" (Internet Policy Institute, 2001, p42) and that "Usability evaluation is important as the underlying reason for the failure of information systems is behavioural, not technical in nature." (Siau, 2003, p20), systems are repeatedly being implemented with interfaces designed either by electoral administrators with little experience of HCI, or by suppliers who do not fully appreciate the requirements on election systems or their implications. This is hardly surprising in a world where a large majority of major websites exhibit at least one basic website design mistake (Nielsen, 1999).

This paper focuses on concern for users and how the principle of equal access to democracy can be translated into the electronic sphere. It draws on focus group evidence to outline what might be expected of a morally defensible *interface* for remote electronic voting which supports independent access for all. There are other important questions about electronic voting, meaning that even if the questions of interface design are answered, electronic voting from unsupervised locations that adequately meets a fair definition of system requirements appears a remote prospect. Many of these other questions have been considered by the authors elsewhere. Despite the importance of these other questions, the question of interface design is still significant: questions of interface design can, and do, affect the results of elections (Wand, et al 2001, Niemi & Herrnson, 2003, p317-8), for reasons that include inaccurate recording of the wishes of the voter (Evans & Paul, 2004, p26). Moreover questions of interface design should eliminate certain technical 'solutions' to security problems. Since interface design *is* a significant issue, there has been a need for research into public attitudes towards interfaces for electronic voting.

This research draws on focus group data from a population who were exposed to the idea and an implementation of electronic voting for the first time in the course of the focus group session. If used appropriately, "Focus groups appear to have high validity" (Preece et al. 2002, p397) as a source of information about usability. Our use of focus groups was "to extract user requirements prior to initial design" of an electronic voting system at a stage equivalent to the "very early stages of development, when the product requirments [sic] are still not firm." (Hom,1996). As such they are not intended to be the "only source of usability data" (Nielsen, 1997a): rather the authors would expect that any supplier intending to develop an electronic voting system would incorporate full iterative usability assessment as part of that development process, even if they draw on the research reported here. This paper aims to advance the starting point of that development process, and help reduce the chances that electronic voting systems with particularly bad usability will continue to be developed.

Field Research

Twelve focus groups (see Key, below) were conducted by British Market Research Bureau (BMRB) Qualitative Division with members of the general public. This was part of a project commissioned by the UK government bodies: the Department of Transport Local Government and the Regions, the Electoral Commission, the Society of Local Authority Chief Executives, the Local Government Association, the Improvement and Development Agency, the Association of Electoral Administrators, and the Office of the e-Envoy. This paper draws on a reanalysis of the data generated from the focus group research, and further research. At the time of the fieldwork in Britain during October and November 2001, less than 100,000 of the 44 million voters in the UK had had even a single opportunity of voting electronically in public elections. As such, the research gives an indication of what members of the electorate think before their views have been distorted by experience of a particular implementation of electronic voting, and uniquely during the process of exposure to a mock-up implementation for the first time.

Key to the Groups:

Age groups:
18-25 years, 26-44, 45-retirement age (60 for women, 65 for men), retirement age and over

Occupational category of household main income
The six categories (A, B, C1, C2,D,E) commonly used by market researchers were grouped into two as follows:
ABC1: Professional; managerial; through to office workers, nurses, technicians, police officers etc
C2DE: Skilled manual workers/craftspeople, foremen; through manual workers and labourers; to casual workers, those with minimal income.

Voting status at previous UK General Election:
Voters - had voted (or wanted to vote, but had been prevented)
Non-Voters

The focus groups enabled volunteers from within the focus group to experience operating the electronic voting mock-up and talk about their experience while they were using it. The focus groups *did not* rely on “a product demo” given by the focus group moderator (Nielsen, 1997a). Further, professional facilitators were used, meeting the need for skilful facilitation (Preece et al. 2002, p397). As such, the findings are unusually reliable for usability findings from focus groups.

Our research focused on electronic voting contexts where voters are presented with a sequence of images on a display. We are aware of electronic voting machines and other types of electronic voting that do not conform to this model[1], such as some touch-screen electronic voting machines. The prevalence of PCs and the introduction of interactive digital TV, however, make it increasingly likely that this form of electronic voting will be adopted,

[1] Including in Eire, Belgium, the Netherlands (Ferguson, 2003), the UK and the United States (Roth, 1998, p2).

especially if an attempt is made to introduce electronic voting from unsupervised locations[2]. In the United Kingdom, a large majority of the pilots of electronic voting that have taken place have followed the model of a sequence of images on a display (Electoral Commission, 2003a, pp49-50).

The focus of the research of Bederson et al. (2003)(see also Bederson and Herrnson, 2003) is related, in that the touch-screen electronic voting machines that they were studying did present voters with a sequence of images on a display. However, the attitudes of their respondents will have been affected by making implicit and explicit comparisons with previous punch card and mechanical lever systems, rather than the paper and pencil system that our focus groups had been familiar with, and which are the status quo for most voters globally. This is particularly important because usability problems with punch card and mechanical lever voting systems have been well known for many years (eg Roth, 1998, pp4-8, Cranor, 2001).

A key difference between this research and that of Bederson et al. (2003) is that in our research contemporaneous data is obtained from transcripts of recordings of focus groups with participants selected to be representative of the full range of the electorate of Great Britain[3]. The contemporaneous element of the Bederson study relies on studying members of the University of Maryland, who will be far from typical of the electorate, and for a "more representative" element Bederson et al. (2003, p 150) rely on an exit poll that asks voters to comment on the experience after they have left the polling place, which does not enable the same depth, and to some extent relies on what statistical significance can be found from a sample of 415 voters in two counties of a single US state. Each study, thus, provides evidence with different strengths and weaknesses.

Template for Electronic Voting Interfaces

Interfaces need to be designed with the aim of universal independent access being a key design principle. Businesses might be prepared to lose the custom of a proportion of disabled people on the basis that it would be more expensive to meet their needs than to lose their custom. They may also expect a proportion of customers to seek assistance in using systems. By contrast, the right to vote in secret is held equally by all members of the electorate, and "Voters who ask for help risk compromising their anonymity" (Evans & Paul, 2004, p27) Furthermore, once users become familiar with a system they become tolerant of poor interface design (Liu et al, 2003, p608), yet voting is only an occasional activity with no time to achieve familiarisation. Thus "Voting systems present a unique challenge to interface designers" (Bederson, 2003, p145). The approach of many business applications of designing for the 'normal' user and then adapting to include access for those disabled people and users of minority languages who can easily be accommodated is inappropriate and immoral. However it is worth first briefly considering some aspects of good interface design in general. These influence the specific interface for electronic voting that is subsequently discussed.

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[2] As indicated above, the authors do not believe this would be a wise move in the foreseeable future.

[3] On street approaches were made by professional market researchers from BMRB using a quota system to ensure those chosen were representitive. Participants in the focus groups were paid a fee and also child care was funded where necessary.

Northern Ireland was excluded since the nature of politics and elections in Northern Ireland is wildly different from that in the rest of the United Kingdom. Any attempt to include Northern Irish participants would have distorted results from the rest of the United Kingdom without any benefit. Thus focus group members represented the range of voters in Great Britain, rather than the United Kingdom as a whole.

Interface design

No matter how resilient the inner workings of a system it is the interface which determines those components readily accessible and by whom they are accessible. Indeed Henneman (1999) concluded that the extent to which an interface was easy to use would define the acceptance of a new technology. This is a view supported by Kuo et al (2004, p718) in their findings on electronic commerce websites. For this reason Meyers (2004, p14) argues that the most important general interface design principle is to "make interfaces easy to use correctly and hard to use incorrectly". Furthermore Merrill and Feldman (2004) maintain that the commonplace features-first interface design approach is exactly the reverse of what it should be. The primary driver must be genuine user needs.

In designing a software interface for disabled people with cognitive impairments Destounis et al (2004) point out that this can lead to a universal interface which is easy to use and straightforward to execute. This work is an exemplar of the general strategy outlined above. In their research Destounis et al designed an interface for an office suite based on a set of established interface design principles and then collected robust empirical evidence from targeted users which showed it was very effective in ease of use and sustaining activity. A key element of their design was to address in detail IBM's software accessibility checklist "in an effort to follow a wider approach to assuring accessibility". This checklist is a set of guidelines on keyboard access, display, sounds and multimedia, timing, object information and documentation. The discussion that follows on the electronic voting interface aligns with this approach in addressing the items in the checklist.

Overall considerations

Overall, "It is worth remembering that not everybody is computer literate or has the confidence to gain the relatively complex skills needed to vote." (SCOPE, 2002, p15). Designs need to enable unassisted use even by voters who are not at all familiar with ICT (Information and Communication Technologies) (as were some members of our focus groups) and/or have significant learning difficulties. "Recent studies conducted in Georgia and Maryland concluded that although most voters can use DRE [electronic voting] machines without difficulty, a significant proportion of voters, especially older ones, required assistance." (Evans & Paul, 2004, p27). Thus, for electronic voting, as with e-government, "societal and social issues may be key ... and ... measures of success should shift in focus from provision to usage" (Lee-Kelley and Kolsaker, 2004, p130).

There are a variety of implications that flow from this. For example, designs should attempt to eliminate any need for scrolling (see SCOPE, 2002, p44). While a higher proportion of web users can now cope with scrolling than previously, scrolling still reduces usability (Nielsen, 1997b). Since voting should be universally available on equal terms, the fact that a proportion of the electorate cannot cope with scrolling (SCOPE, 2002, p44) is an incomparably more severe problem for electronic voting than it is for commercial websites.

The interface trialled by our focus groups, which was seen as easy-to-use by *some* (e.g. Voter, C2DE, 45-retirement age, South of England), despite intentionally being designed to illustrate typical rather than good usability, drew the reactions from *others* that "With the best will in the world we're all not as clever or intelligent as everybody else and this is causing me grief already" (Voter, C2DE, retirement age and over, Cardiff) and "I'm definitely not going to go through that lot" to vote (Non-voter, 45-retirement age, North of England).

It is appropriate that security issues should, in general, take priority over other issues of interface design. This is because the aim of the electoral process should be accurate transmission and aggregation of the wishes of the voters; and for electronic voting, and especially remote electronic voting, the greatest threat to that accurate transmission and aggregation comes from security threats. Because security issues may need to take priority, while it is preferable for display settings for font sizes and colour contrast to be taken from extant settings, this must not compromise security. It may be permissible to relax the priority of security over interface considerations for specialised interfaces (for example Braille), since interfaces that are only used by a tiny proportion of voters are unlikely to attract significant security attacks. However, security must not be achieved at the expense of confusing voters (in principle security could be aided by omitting any reference to the political party, since this is most likely to exploited by virus attacks). This is because confusing voters would, itself, be a barrier to the accurate transmission and aggregation of the wishes of the voters (Evans & Paul, 2004, p26).

A key requirement is that the system should be user-customisable for font sizes (Nielsen, 2002) and colour choices to facilitate voting by all (Edwards, 1995, p38). Ideally these should be set through the voter registration process (SCOPE, 2002, p38), and communicated to the interface at the stage of identification and authentication of the voter. Other preferences should also be set and communicated to the interface in this way whenever possible. These would include linguistic preferences and preferences for audio output even for confidential parts of the voting process, "to let the visually impaired vote without assistance" (Evans & Paul, 2004, p26). Whether or not this is done, since many users will not have a computer or digital TV for their personal use and many voters will not have sufficient technical abilities to navigate menus, on-screen options should enable setting of font sizes and colour choices which persist until the end of the voting transaction.

It is particularly important that there is "multilingual support for a sufficient range of languages" (Fairweather and Rogerson, 2002, p19). In the United States, the voting rights of linguistic minorities have been protected since the 1982 amendment to the Voting Rights Act (Davidson, 1984, p8). Usability is clearly promoted by having the possibility to operate the system in the language that you understand most easily. Beyond this, privacy violations may arise from failure to allow voting in voters' own languages in a way that would enable coercion to prevent the accurate transmission of the true wishes of the voter. Given that complexity of the interface is deprecated (see below), the number of languages available as on-screen options[4] may need to be restricted. We would anticipate that language selection would be accomplished in three ways.

1) For voters who have indicated a language preference at registration, as soon as they initially identify themselves to the system (even before entry of any further short PIN or other security code), the system would re-set its language to the language they have registered as their preference (but with an option to change language as outlined in 2).

2) All voters will be presented with an on-screen 'change language' option on each of the screens a normal voter would see prior to the 'ballot paper' screen (and changing language would be an option that could be obtained from a multi-purpose 'options' selection on that screen).

3) For voters who have not already indicated a language preference (at registration, or earlier in the voting interaction), or a preference for a simplified interface (for example due to disability), following the identification and authentication screens, there would be a language selection screen, from which any of the languages of more than 5%[5] of the electorate can be

[4]It may be possible to allow other languages to be seen by voters as their default language if they indicate a language preference at registration stage.

[5]5% would restrict the number of languages available for selection on the one screen to manageable numbers

immediately selected (if that language is supported). It may be possible for further languages to be selected via an 'other languages' option.

In terms of appearance, Preece et al (1993, p76) suggest that "colour should be used ... as ... an additional form of coding". Thus where appropriate a change in background colour should indicate which options are selected (a feature of one version of the mock-up tested by our focus groups which was appreciated (Non-voters, 45-retirement age, ABC1, Scotland)). Non-confidential parts of the process should also, by default, be presented in audible form. Indications of who the voter has chosen to vote for, if presented in audible form, by contrast, could violate secrecy of the ballot in a way that would enable coercion incompatible with the accurate transmission of the true wishes of the voter, if there are those inclined to coercion able to hear the audio output.

According to Preece et al (1993, p63), touch screens are "Very easy for people without any prior computer experience to use". As such they could be particularly useful for electronic voting, however it seems unlikely that they will be used in a significant number of homes or workplaces for the foreseeable future, since they are more expensive than plain displays, and can be expected to offer substantial ergonomic challenges if used interactively for extended periods. They can also be expected to be problematic for a proportion of disabled voters (SCOPE, 2002, p12), unless keyboard and mouse inputs are also available and technically enabled. Provided there is adequate maintenance (Bederson et al, 2003, p146), touch screens accompanied by ready availability of alternative input devices should be preferred for voting in supervised locations. If electronic voting from unsupervised locations such as home and the workplace *is* attempted, however, usability assessments with mouse and keyboard inputs (such as from the focus groups reported in this paper) will be more relevant than assessments with touchscreen input (eg Bederson et al, 2003).

One combined effect of these considerations, including the need for independent access by the full range of disabled voters is that interfaces generally need to be designed to work with a variety of input and output devices (SCOPE, 2002, p10-11), including screen enlargers and screen readers; the availability of audible output; and keyboard and mice as alternatives to each other.

The call that any interface be made "as simple as possible" (Voter, 26-44, ABC1, Cardiff) gives us an appropriate starting point. Indeed it is this ease of use that increases the perception of usefulness (McCloskey, 2004, p53); a condition paramount to successful electronic voting. Selker reports (2004) that in an election he observed "Voters adapted to the new technology better than I had expected they would". One of the aims must be to minimise the amount of adaptation that voters need to make. Simplicity aids this, although this begs the big question: how simple is it possible for any voting interface to be, while still meeting the various requirements (Preece, et al. 2002, p27)? A totalitarian state could have the simplest interface, without any of the complications that arise from paying heed to privacy or security concerns. In our circumstances, however, some simplicity has to be foregone to achieve other aims. For example with electronic voting we would favour the use of both audio and textual reminders of the right to vote in secret prior to the presentation of the vote selection screen whenever there is the possibility, even though it would be simpler to omit them[6]. It is also important that voters can gain access to the instructions to voters at any stage in the process (cf Evans & Paul, 2004, p27). As with any implementation of an information system, substantial and appropriate testing will be needed to ensure that the right

[6] We are deeply concerned by proposals to allow electronic (and, equally, widespread postal) voting in contexts where secrecy cannot be assured by polling station staff.

balance has been struck between simplicity and other aims. This presents another reason for simplicity, since "Complex interfaces also make preelection ballot reviews more difficult." (Evans & Paul, 2004, p27)

Given the other aims, electronic voting is "never going to be as simple as using a pen and paper… all you've got to do now is make your cross in the right place" (Voter, ABC1, retirement age and over, North of England), giving a strong argument for allowing voters the continued option of pen-and-paper voting.

Voter authentication screen

Wherever possible, the bulk of identification should not require typing (numeric or alphabetic) or the use of a touch screen or similar. Identification numbers in a national election need to be of the order of 16-20 digits to prevent guessing (see, for example, CESG, 2002, p50). When our focus groups were asked to type a full identification number, the response was that 'it was a real effort to get it done' (Voter ABC1 18-25). In preference the entry of full identification numbers should be done by inserting a CD-Rom, or a smartcard or presenting a card to an optical reader or a similar procedure. This may be accompanied by typing a much shorter number or sequence of letters, since shorter sequences do not present such a substantial problem to so many people[7].

While in terms of the interface considerations biometric identification may appear advantageous, security considerations relating to the storage of votes over timescales that render encryption standards obsolete (Mercuri, 2001, pp62-3) require that identifiers used are of temporary validity, and thus biometric identification should be rejected for failing to offer long-term secrecy of the ballot. Biometric identification also met with opposition in the focus groups: "it would freak people out – it's too futuristic" (Voter ABC1 18-25), "I think that's really invading my privacy" (Non-voter, ABC1, 26-44, South of England).

Vote selection screen(s)

It is useful for voters to have information on how to vote available throughout the process of selecting their vote. Information on how to vote can, and should, be presented *both* by information on the normal vote selection screen and an audible message that is heard as the screen is displayed.

The use of colour logos as in our mock-up (Non-voters 45-retirement age, ABC1, Scotland), and party colours will improve the interface for most voters. Where party colours include a light colour it is important that text must have sufficient contrast, and in all cases, colour combinations should be chosen to avoid colour-blindness problems. Users should be able to alter colour combinations to their preferences.

In the United States "Originally, symbols were probably designed to serve an electorate that had a significant number of illiterate members." (Niemi & Herrnson, 2003, p318), but have led to confusion with different logos being used in different states. Considerations of equal access for all voters, regardless of their abilities, require that the initial display of ballot paper shows a party logo. The party logo should be consistent from place to place[8] (Niemi &

[7] For a proportion of disabled users, however, this would still be problematic. Thus the security advantages need to be weighed carefully against issues of equality in independent use for all, even if a disabled person needing assistance at this stage is a slightly less sensitive question than their needing assistance at the vote selection and confirmation stages.

[8] Within the European Union elections currently take place for the European Parliament with party names and logos that are not consistent from place to place, in much the way Niemi & Herrnson illustrate in the United

Herrnson, 2003, p319) and party logos should be the dominant part of the display. Clicking on a logo should be sufficient to select that party or candidate. To enable this, voters should not be required to click on a button marked 'enter', or press return. By contrast, our mock-up replicated the British implicit ability to spoil a ballot, and enabled this by allowing under-voting or over-voting to be registered[9] by an 'enter'. The ability to spoil a ballot would be better achieved by presenting the voters with that as an explicit option. Our focus groups also suggested that it would be better to 'just have a box saying no vote' (Voter ABC1 18-25) rather than having to spoil by over- or under-voting (cf Evans & Paul, 2004, p27).

Printed ballot papers in many jurisdictions require significant amounts of information other than the party symbol to be presented to the voter (Niemi & Herrnson, 2003, p320). Statistical analysis of election results suggests[10] that inclusion of such information on paper ballots may cause some voters problems (Kimball & Kropf, 2003, p34, p15). When we move to on-screen display, some of this information can be presented on the initial display of the ballot 'paper', but to enable reasonable font sizes without scrolling being required on minimum specification displays, much needs to be on a second screen, that could be viewed by selecting a link from the initial display. Links to information that is not currently presented on ballot papers could also be provided on this second display. This could include information such as official election statements and manifestos, information about the post and body for which the election is being held, and perhaps even links to party websites[11], meeting the call of our focus groups (eg Non-voters, 18-25, North of England). If this is done, it must be done in a way that does not "cause voters to get lost while voting" (California Task Force, 2000, 10 v). It should be possible to vote from this second display without returning to the initial display.

Even with the screen being simplified as far as possible, it is likely that users who are not familiar with computers will still be at a disadvantage: one member of a focus group (Voters ABC1, retirement age and over, North of England) who had no previous experience of computers required the facilitator to reassure at every stage.

It is especially important that scrolling is not required on vote selection screens, since if some of the candidates or parties can only be seen by scrolling, they are especially likely to be at a disadvantage. In the 2003 pilot of electronic voting using Digital TV in Swindon, it was only possible to see the names of candidates later in the alphabet by procedures equivalent to scrolling, yet there was no mention of this usability problem in the official evaluation of the pilot (Electoral Commission, 2003b). Fairness suggests that the ordering of candidates on screens should be random[12], so that different voters view the list of candidates in different orders. This may have slight adverse consequences for usability for some voters, since it will

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States. Key differences are that most (but by no means all) EU voters access media broadcasts specific to their member state, whereas the US has Union-wide broadcast media; and that European Parliamentary elections are much less significant than the election of the US president, which is "far and away the most visible election in the United States" (Niemi & Herrnson, 2003, p323). It is unclear at present how to resolve this inconsistency in elections to the European Parliament.

[9] Users were then presented with confirmation screen that explained that a spoilt ballot would not be counted for or against any candidate.

[10] Although only at 10% significance even for the clearest results.

[11] Although we are aware of security concerns with this: According to Mercuri (2001, p34) "interfacing to the Internet could be, in itself, considered to constitute a security breach, in that wide attack and monitoring opportunities are provided that would not be possible with individual DRE [voting machine] kiosks, or in a closed network setting".

[12] The evidence of Rallings et al (1998 pp123-5) is clear that alphabetical listing gives an advantage to candidates with surnames nearer the beginning of the alphabet even with paper ballots where all candidate names can be seen simultaneously.

prevent parties from telling voters that (for example) 'we are third on the ballot paper', however the failure of voters to see names of candidates at the end of the alphabet is itself a usability problem, and its net effect on the accurate transmission and *aggregation* of the wishes of the voters can be mitigated by random ordering. Since there is a cost in usability in this randomisation, however, there is a need for research into the effect of the order of listing of candidates in a particular race on voter choice in electronic voting[13].

Vote confirmation

A key aspect of usability of a computer system is giving the user confidence that their attempt to use the system will have the intended effect, or feedback to the contrary (Preece et al 2002, pp20-21) coupled with a way to enable them to correct matters. Our research confirmed that voters are especially anxious that they receive confirmation both of the vote selection that they have made, and also that their vote has been received and will be counted. For example a focus group member said it 'should come up you have voted …… which is then confirmed' (Voter, 18-25, ABC1). In part this seems to be because of a fear of hacking and other forms of computer abuse, coupled with a misplaced belief that receipt of on-screen confirmation would provide meaningful reassurance that the vote that was cast has been received at a remote point.

However, there is a significant objection that any definitive voting acknowledgement in unsupervised locations opens the voter to coercion of sorts that was previously more difficult or impossible, or enables vote buying schemes. Thus there may be a conflict between the confirmation aspect of usability and the accurate transmission of the *uncoerced* wishes of the voter.

For electronic voting from supervised locations, there is a growing academic consensus that confirmation should be provided to voters in the form of a printout of the vote, which the voter can view (but not remove, or photograph[14])(Mercuri, 2001, p54, Evans & Paul, 2004, p29). Such a printout would either be confirmed as correct by the voter, and the confirmation paper allowed to fall into a ballot box; or alternatively rejected by the voter and placed in another box. If the voter rejected the 'confirmation' they would be able to make a further attempt(s) to vote. Such a procedure would also have the inestimable advantage that it would enable a meaningful audit of the functioning of the electronic voting system. Clearly, however, this procedure cannot be employed for voting in unsupervised locations without specialised equipment: a fact which, on current technology, is a substantial argument against electronic voting in unsupervised locations.

For remote electronic voting, it is technically possible to devise systems whereby voters have 'ballot papers' with combinations of code numbers distributed to them (see, for example, CESG, 2002, p50, and SureVote, 2001), that voters can use to both vote and check that their vote has been received correctly. The 'expected response' confirmation number is meaningless to anyone intercepting it, and a virus or 'man in the middle' attack would not be able to replicate such codes reliably if they are generated according to a suitable method. A system of this sort was implemented in the electronic voting pilots of 2003 in Shrewsbury and Kerrier (Electoral Commission, 2003c, p6 & 2003d, p6). Such a system has severe usability problems, since "Requiring voters to enter and compare numbers is likely to be problematic for many users." (Bederson et al, 2003, p147), and this takes place precisely at the most sensitive part of the process, when seeking assistance is most problematic.

[13] There is a body of literature on the effects of the order of races that are voted on in a single voting session. See, for example, Kimball & Kropf, 2003.

[14] Thereby thwarting many attempts at coercion and vote buying.

A further problem with this is that voters will have to accept assurances that the confirmation numbers really do match candidates in the way that is indicated on the 'ballot paper' that is distributed to them: to ensure this distribution does not open the door to electronic interception it is important that it is "out-of-band", through the post (CESG, 2002, p16, p50). Unfortunately the implementation in the electronic voting pilots of 2003 in Shrewsbury and Kerrier (Electoral Commission, 2003c, p6), it was possible for voters, or those intercepting communications, to request the code numbers to be sent electronically. Thus, as implemented, the system had the usability problems of "Requiring voters to enter and compare numbers", but without the full security advantages that should have been achieved through the use of the code numbers, and the system gave the illusion of being more secure than it really was.

However, even eschewing electronic distribution it is technically facile to generate 'ballot papers' with both candidate numbers and confirmation numbers transposed between candidates. The only assurance against this is having the process of generating such 'ballot papers' open to inspection. A further significant problem with a scheme that used 'expected response' confirmation numbers, is that combination of the 'ballot paper' (which would be retained by the voter in remote electronic voting) and an image of the 'expected response' confirmation number would be sufficient to enable effective vote buying and coercion.

Possible reconciliation of the desire for acknowledgement with the need to prevent vote buying was suggested by the focus groups (Non-voters, 45-retirement age, ABC1, Scotland). An intermediate stage might be added so that the application at the voters' end displays a message along the lines of "Your vote is for party y, do you wish to cast this vote, or change it to vote for another candidate?" While it does not support audit in the way paper confirmation in supervised polling places does, it does meet the desire expressed in the focus groups for a confirmation screen, and the possibility that a voter might later change that vote means that any attempt to use an image of it for coercion or vote buying will be fatally flawed. Later in the voting process a confirmation can be sent that a vote has been received, provided that the confirmation cannot reveal how the vote was cast.

Confirmation does add an extra stage to the voting process (Evans & Paul, 2004, p31), which may be problematic for voters with limited abilities, and thus it would be preferable for choices made in the voter registration process (SCOPE, 2002, p38) to allow this step to be bypassed if necessary.

Conclusion

Electronic voting poses some particular challenges in interface design. Among these challenges are extensive security requirements and a requirement to design for universal access. A range of interface design strategies has been put forward that are based on empirical evidence from a representative sample of the electorate and founded on acceptable general interface design guidelines. Three key elements have been discussed. Firstly, simplicity of the interface is a prime requirement, since a significant proportion of the electorate will be unfamiliar with the technology and some disabled people will find even a small amount of added complexity a significant barrier. Access to more complex features should be possible, to enable user-customisation and access to further information. Similarly, it is vital that the interface can work well in conjunction with alternative input and output devices. Secondly, input of identification data must be possible using some machine-readable card or disk, since identification numbers that are long enough for security are too long for many voters to input manually. Thirdly, vote selection screens should be designed in such a way that, if a personal computer was used, for example, a single click of the mouse over a large graphic would be enough to generate a vote for the desired candidate, prior to a vote confirmation process that would enable it to be cast or changed (although preferences might be set to bypass a need to interact at this stage). For the entire system, substantial and appropriate usability testing is essential.

The introduction of electronic voting is not the same as the introduction of a commercial application. The electorate is a special user group with disparate interface needs. The ability to vote cannot be tainted by poor interface design. This paper has attempted to raise awareness of the importance of excellence in electronic voting interface design. Anything less could damage the very fabric of the democratic world.

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