Editorial Introduction

A major boost to the acceptance of visual thinking and virtual worlds has been provided by the development of the World Wide Web. Initially accessed through test "browsers" with no graphic capabilities this has rapidly matured into an environment characterised by graphics, colour, animation and so on. In effect, what only a few years ago were research topics in scientific visualization have become commonplace and "web design" to make best use of them has become a major industry. Cartographers may have reservations about the absence of what are seen as "good cartographic design" on the WWW, but who are they to impose standards?

What is becoming apparent is that the ability of the WWW to enable social scientists to share graphics affords numerous exciting opportunities for research. It can, for example, greatly assist questionnaire delivery by allowing surveyors to include pictures as stimulii. It can allow research-oriented software to be made widely available. Finally, it allows communities to share in the development of their environment through computer supported decision support. This Case Study by Steve Carver, Richard Kingston and Ian Turton illustrates all of these applications. However such use of WWW graphics to facilitate research is not without its statistical and ethical problems, and these are both explored.

Review of graphical environments on the World Wide Web as a means of widening public participation in social science research

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Abstract

The World Wide Web (WWW or 'web') is viewed as an increasingly important resource for social science researchers that has the potential to provide direct access to vast amounts of relevant data should they be prepared to embrace the technology and the opportunities it represents. The key to the web's attractiveness to the wider public audience is its highly graphical nature and its multi-media content. Social scientists should be tapping into this resource, not only as a means of presenting the results of their research in an exciting and user-friendly format, but also as a new way of gathering data from the information 'cyberspace' and directly from its growing population of users.

This Case Study address the various technical and theoretical issues surrounding the use of the WWW as a source of information and as a mechanism for public participation in social science research. Five detailed examples of selected participatory web sites together with a general overview of the state of web design in relation to public participation in social science research are used to generate discussion from which to draw conclusions and make recommendations.

The main findings are:

There is a great deal of discussion surrounding the potential use of the WWW as a vehicle for social science research. However, with the exception of a few on-line questionnaire surveys, very little of the discussion has yet materialised into action.

There is a great deal of social science relevant information on the web, but there are many difficult issues surrounding both its use and accessibility, including problems of sample bias and confidentiality.

The main advantages of adopting a web-based approach to social science research are increased sample size, targeted sample populations, interactivity, multi-media presentation of surveys and results, and active participation.

The key role of the WWW in the social sciences is principally in the dissemination of the results of social science research and in making data and tools available for public use. This is important in closing the awareness gap between academics and the public and in providing an end-user service.

The main recommendations are:

There is a basic need for education about the opportunities and pit-falls which web-based surveys and systems can offer. A resource of software tools and literature on best practice should be developed to give users the best possible advice on how to undertake web-based social science research and give assistance when and where required.
There is a need to create examples of well designed and innovative interfaces that encourage participation and use. These could be used as models of good practice to encourage other social science researchers to use similar approaches as appropriate.
There is a need to raise public awareness of the value of social science research through the dissemination of research results and tools via the WWW. One way of ensuring nation wide coverage may be through well advertised media events.
There needs to be a greater emphasis on the role that social science can play in providing a WWW-based public service, both in access to datasets and graphics tools. Good examples include the Friends of the Earth Chemical Release Inventory, the Institute of Fiscal Studies' Be Your Own Chancellor model and the East St. Louis Local Action Research Project and associated GIS-based East St. Louis Geographic Retrieval System.
Future developments are likely to see further experimental web-based social science research coming on-line in the next few years, while the wider development of the WWW as an accepted information medium will see improved public and political awareness of what is possible in this growing field. The social science community as a whole needs to be aware of these developments and exploit the new technology as appropriate.

1. Introduction

The World Wide Web (WWW or 'web') is viewed as an increasingly important resource for social science researchers. The WWW is the source of a burgeoning amount of information, a significant volume of which has either some direct or indirect relevance to the social sciences. The web and other associated Internet Based Communications (IBCs) techniques have the potential to provide the social scientist with direct access to vast amounts of social science relevant data should they be prepared to embrace the technology and the opportunities it represents. A key element of the web's attractiveness to the wider public audience is its highly graphical nature and its multi-media content. Social scientists should be tapping into this resource, not only as a means of presenting the results of their research in an exciting and user-friendly format, but also as a new way of gathering primary and secondary data from the information 'cyberspace' and directly from its growing population of users.

These case studies address the technical, methodological, conceptual and ethical issues surrounding the use of the WWW as a source of social science relevant information and as a mechanism for public participation in social science research.

1.1 Defining participation

For the purposes of this report *public participation in social science* is taken to mean any form of active involvement by the public in the wider realm of social science research. At least four different levels of public participation in social science research can be identified:

public access to results of social science research through any available medium (*the informed public*);
public use of social science research for the benefit of the individual, social groups or wider community (*public as user*);
public participation in social science research as the subject of study, whether as an individual or member of a wider population (*public as subject*); and
public involvement in social science research through defining research objectives, agendas and carrying out research (*public as researcher*).
Although the public may be quite deeply involved in defining research agendas under certain participatory grass-roots community research schemes, the first category is quite a grey area as it begs the question as to what point does the researched become the researcher? The substantive focus of this Case Study, however, is on the use of the WWW as a mechanism for facilitating public participation in social science research. The above four categories of public participation need to be viewed in this context with the web as the principal mechanism of participation.

2. Aims and objectives

This aim of this Case Study is to investigate the role of the WWW in encouraging and facilitating wider public participation in social science research. With this in mind, we review the available literature and develops a small number of detailed case studies of existing web sites whose principal aim is public participation in social science research in order to identify (a) the current state of web-based social science research; (b) problem areas; and (c) the need for new visualisation tools and methods in this field.

Specific objectives pursued in achieving the above aims are as follows:

A review of published literature on computer graphics and public participation in social science research with particular reference to the WWW;
An extensive on-line search for social science web sites with a significant participatory element in meeting their stated research objectives;
A selection of a small number of representative web sites;
A detailed examination of case study web sites; and
Interviews/discussion with web site managers/authors.
Existing published literature on the use of computer graphics for improving public participation in social science research is quite limited, especially that concerning the use of the WWW. On-line searches for potentially relevant web sites have been completed using standard search-engines (e.g. Alta Vista and Yahoo!). A total of five representative case studies have been selected on the basis of their:

- substantive focus and social science content;
- opportunity for public participation;
  method of interaction; and
  graphical and visualisation techniques employed.

These five case studies are presented in the report in order of increasing complexity and level of participation, starting with some simple on-line questionnaire surveys and working towards immersive first-person 3D virtual reality systems.

The potential and realised benefits of adopting on-line participatory environments in social science research are outlined using evidence gathered from these case studies and other sources as appropriate. Potential disbenefits are also reviewed to give a balanced picture of this rapidly advancing field of computer graphics and social science research.

3. Literature review

Existing published literature on the use of computer graphics for improving public participation in social science research is rather limited, but even more limited when specific to the potential role of the WWW. The literature that is available in this field falls into one of two emerging categories. The first, which appears to dominate the current focus of research, relates to the debate surrounding the benefits, pit-falls and practicalities of using the WWW as a tool for carrying out social surveys. The second relates to research which has either taken place or is underway and illustrates actual cases where the WWW has been used for survey research.

Exhaustive use of various search engines on key word searches produces very little evidence of existing web sites. However, it is noted that some surveys have limited shelf-lives and unless you are actually using the WWW at the time a survey is taking place there is the possibility of missing its existence. The majority of sites found focus on surveys of web users with details of who uses the web, the type of connection and software used, and reports of its ever increasing size as opposed to undertaking a survey on other specific subjects. Web-based social survey work appears to be most active in psychology where a number of on-line questionnaire surveys have been found. One such example is given in the case studies.

The categorisation of the literature is demonstrated in the research undertaken by a number of authors. Schmidt (1997), a psychologist, discusses the benefits, potential problems and solutions to using the WWW for survey research, while Coomber (1997) reports on his work of conducting a survey on the Internet. While it is apparent that there was no use of graphics in the survey, the research at least demonstrates the usefulness of such an approach. Mumford (1996) goes on to discuss the technical issues of using graphics on the WWW although not necessarily as part of on-line surveys. The work undertaken by Wherrett (1996, 1997) in landscape preference and Carver *et al*. (1997) on the siting of Britain's nuclear waste offer insights into the use of graphics on the web for social science based research. Finally, the potential of 3D virtual environments and virtual reality (VR) for social science research are reviewed, highlighting the benefits that this new technology presents.

It is recognised that the WWW provides immense potential for increasing public participation is social science research. Schmidt (1997) notes:

> "*The World-Wide Web presents survey researchers with an unprecedented tool for the collection of data. The costs in terms of both time and money for publishing a survey on the web are low compared with costs associated with conventional surveying methods. The data entry stage is eliminated for the survey administrator, and software can ensure that the data acquired from participants is free from common entry errors. Importantly, web surveys can interactively provide participants with customized feedback. These features come at a price of ensuring that appropriately written software manages the data collection process. Although the potential for missing data, unacceptable responses, duplicate submissions, and web abuse exist, measures can be taken when creating the survey software to minimize the frequency and negative consequences of such incidents.*" (p.274)

While Schmidt provides no current example of on-line questionnaires, he has developed software which allows prospective researchers to up-load their questionnaire to a web site where it can administered. The potential researcher can choose from various questionnaire packages allowing the automatic creation of

HTML and CGI (Common Gateway Interface) files along with the ability to display the survey results on-line as they appear (see http://or.psychology.dal.ca/~wcs/).

The use of the WWW for survey research presents the researcher with an opportunity to reach much wider populations than the previous scope of traditional surveys. As the available literature in this field illustrates, there are several noticeable benefits, coupled with issues to bear in mind.

The benefits of publishing a survey on the web range from increased population access to saving time and money and providing dynamic and interactive surveying. As the web community continues to increase, sample populations will become larger and therefore biases will, in time, decrease. Surveys can also be focused at particular groups who are interested in very specific issues. The administration of an Internet based survey eliminates many obvious processes which a paper based survey entails. These include the elimination of traditional data input, distribution, collection and checking processes. Summary statistics of the respondents input can be provided instantaneously and provide immediate response for their time and effort in completing the survey.

The most obvious requirement of using web-based surveys is access to a computer with an Internet link so that participation or the execution of a web-based survey can take place. There is also a minimum level of software required to be able to view and run on-line questionnaires and this is discussed in great detail by Schmidt. As with any new technology there is bound to be the potential for problems and, as with any good idea, the suggestion of solutions. The potential problems which Schmidt identifies range from incomplete response forms where questions may be left blank, unacceptable responses due to mis-understanding and problems associated with multiple submissions. This creates the problem of having biases in the data which are being collected through deliberate intent to hamper the survey by multiple submissions. Further issues concerning security and data integrity are discussed, but, while this may appear to be a problem to the novice researcher, it appears to be easily overcome through the use of secure CGI programming. It would appear reasonable to assume that a researcher considering using the web for survey work would be well advised to consult with someone who has knowledge of this computer language to safe guard against some of the potential problems that Schmidt identifies.

After taking the time and effort to compose an on-line questionnaire several issues need to be addressed so that the survey is completed and operates successfully. Matters relating to ethics, the validity of the results (especially considering the current web user population) and the fact that not all browsers operate equally need to be accounted for. Finally it is also necessary to publicise the survey, either focusing it to particular Internet groups or to a more general audience.

Large market research organisations such as NOP are also starting to carry out limited web-based research, usually amongst specialist target audiences. They appear to have no plans in the near future to extend this to ‘traditional’ social/political research for the time being as they see “the problems of representativeness and self selection still remain” (personal communication, NOP, 6th February 1997).

Of the web-based surveys that they have conducted, most have used graphics, either to demonstrate concepts, or to improve attractiveness to respondents. In the future, it would appear that sound and video will play some part in on-line surveys. Survey authors also realise the convenience and accessibility of Internet based research being of major help with co-operation rates, although in the short term they believe that there is unlikely to be any significant impact.

A recent web-based survey discussed by Coomber (1997) takes the concepts and ideas discussed previously a step further and reports on research where the Internet was used to survey drug dealers. Recognising that the 'target' population would be difficult to identify through traditional survey methods, the work by Coomber highlights how surveys using the WWW can benefit from a respondent remaining anonymous. The author highlights how evidence is emerging which will overcome the problems associated with sample biases.

> *"While Internet users still tend to be upscale, their overall characteristics are coming more in line with general population averages", and, "Internet access and use are becoming increasingly mainstream" (CommerceNet and Nielson Media Research, 1996).*

Once again, the actual questionnaire for this specific piece of research is no longer on-line to view, something which appears to be the norm whereby once a questionnaire has been completed its virtual presence seems to disappear from the web. The work by Coomber concludes that using the web for this type of research offers "*exciting new possibilities to the research"* (Coomber, 1997) but the limitations of such work, similar to those identified earlier, must be understood.

The literature identified until now in this study has lacked any evidence of the use of graphics within the limited number of web-based surveys. Literature which discusses the use of graphics on the WWW, but not necessarily as part of on-line surveys, focuses attention on the need to widen the data formats which current and future web browsers are capable of handling (Mumford, 1996). Graphics need to be more than just add-ons to web pages and serve more than just an aesthetic purpose. They need to be functional, but at the same time not too large in file size so as to cause long download times which can be off-putting and cause participants, particularly those using a modem, to quit a particular web site. Mumford believes that there needs to be a wider vision with regard to graphics on the web for two reasons:

> *"graphics can indeed be used to illustrate a point and add interest. We can however move beyond this and have graphical interfaces to information. In the same way as we can display text in a range of styles, we have the technology to allow graphical interfacing to, for example numeric, information to allow it to be displayed in different ways and to be manipulated by the user."*
>
> *"it is also necessary to think of the information being transported across the network and to consider the relationship between the size of that transferred information and the processing carried out locally. We currently have a situation where a great deal of network traffic is being taken up with simple pictures transferred using a format which minimises local processing needs. Would we be better reducing file size and increasing the processing required of the server? The demands on the network do require some serious thinking about a range of other possibilities."*
>
> *Source: http://www.agocg.ac.uk:8080/TechReports/Thirty/Intro.html*

These ideas have great potential for on-line surveys. Graphical images can be used within a survey, particularly qualitative research, rather than simple multiple choice or preference choices. Problems generated by graphical file size can also be overcome through local rather than remote processing of graphics and image files. Survey based web pages which are currently making extensive use of graphics, while limited, appear not to be facing major problems with download times. Work being undertaken at the Macaulay Land Use Research Institute on landscape scenic preference makes

extensive use of graphics as an integral part of the survey. Participants in the survey are presented with a series of photographs of rural landscapes and asked to give them a preference ranging from a low scenic preference of 1 to a high scenic preference of 7. Further details of this work are discussed in the third case study of this report (Section 4.3).

Carver *et al*. (1997) discuss the need to develop *"easy-to-use graphic user interfaces"* if participation in social science research over the Internet is to gain any momentum. Sophisticated Internet based systems will only be popular if they provide the participants with the types of interfaces which they can understand. Carver et al. go on to explain the that *"different front-ends... ...can be engineered depending on the background of the individual (e.g. layperson, professional, academic, etc.)."* By tailoring the front end to particular audiences, research can be directed and targeted to specific sectors. The forth case study (Section 3.4) discusses of this work in greater detail.

An area within the Internet community which is receiving increasing amounts of attention and research is that of 3D virtual worlds. The abundance of web sites and literature available in this area highlights the vast array of activity currently taking place in this field to an extent whereby a review of this work justifies a separate report. A virtual world can be describes as *"an interactive computer simulation which lets its participants see, hear, use and even modify the simulated objects in a computer-created world."* (Hughes and Moshell, 1995).

The ability of the WWW to provide three-dimensional worlds is provided through Virtual Reality Modelling Language (VRML) 'plug-ins' to current web browsers. The viewing of VRML through appropriate browsers provides excellent tools for the modelling and internal representation of three dimensional environments which can be transformed into fully immersive systems. As VRML continues to be developed anticipated advances include greater interactivity, behaviour and functionality in shared and multi-user environments. As virtual reality type technologies evolve the applications become almost unlimited. The use and development of virtual worlds is likely to reshape the interface between people and information technology. New ways of communicating with information, the visualisation of information and methods of exchanging information will enhance the current methods and processes of collecting and using the information which can be interchanged between the client and server.

A virtual environment can represent any three-dimensional world that is either real or abstract. This includes real systems like buildings, landscapes, archaeological excavation sites, crime scene reconstruction's and so on. Of special interest is the visual and sensual representation of abstract systems like population densities, information flows, and any other conceivable system including artistic and creative work of abstract nature. These virtual worlds can be animated, interactive, shared, and can expose behaviour and functionality which has the potential to be of great benefit for social science research.

The National Center for Supercomputing Applications (NCSA) is at the forefront of VRML development. Much of the development work and applications of the VRML technology by NCSA provide examples of the future potential of this technology. Examples of the work can be view at the dedicated NCSA VRML web site (http://www.ncsa.uiuc.edu/General/VRML/VRMLHome.html).

4. Case studies

A total a five representative web sites have been chosen on the basis of their specific area of application, substantive focus, the methods and techniques of interaction (interface) used, and the level of public participation involved.

The five chosen web sites are:

Psychology Survey, Psychology Department, York University, Toronto, Ontario, Canada.

A Review of Web-based Tools for Creating Questionnaires and Inputting and Analysing Survey Results.

Landscape Preferences, Land Use Science Group, Macaulay Land Use Research Institute, Aberdeen.

Where to Dispose of Britain's Nuclear Waste, School of Geography, University of Leeds.

Virtual Environments.

All five of the sites chosen include at least some participation, be it actual or planned, as a key element of their research objectives. The level and methods of participation range from the use of simple on-line questionnaires to gather survey information through to sophisticated 3D virtual worlds aimed at gathering real-time perception/response/action information (although it is noted that the latter are still experimental and may not have both a true participatory element or social science aims).

Detailed examination of chosen case study sites was carried out on-line and through the review of associated site specific literature. This has been followed up by interviews and discussions with the web site managers and authors by the most appropriate means (e.g. email and telephone). This follow-up was vital to correctly identify the salient characteristics of the web site and the *raison d'être* behind its inception. Information of particular interest to this case study review includes:

the reason behind choosing a web-based approach over other more traditional methods of social science research;

the level and methods of graphical visualisation deemed necessary to communicate the substantive social science element of the problem/research to the client (user);

the level and methods of interaction, particularly that of a graphical nature, deemed necessary to engage the public in the social science objectives of the server (web site);

the quality and quantity of the responses gained by these methods and how these compare (or are seen to compare) to responses gained by more traditional methods of social science research; and

the perceived level of success and/or failure of the case study web-sites based on evidence from the above.

4.1 Case Study 1: Psychology Survey, Psychology Department, York University, Toronto, Ontario.

Psychology has always had a tradition of undertaking extensive experimenting and surveying of the human population. It therefore appears as no surprise that compared to other social science disciplines psychologists are already relatively active in web-based surveying. This case study is typical of the many studies which can now be participated in on-line. This particular web site involves answering a personality test with the specific objective of being...

> *"used to find out who likes to respond to WWW questionnaires, and how well people are able to answer psychology questionnaires on the Web"*
>
> (Pettit, 1997, URL: http://www.yorku.ca/faculty/academic/apettit/index.htm)

The researcher acknowledges the fact that the web has great potential for researchers who need to collect a lot of data quickly and easily.

The methods of interaction with the web interface involves three types of action. Respondents are asked a series of questions (see Figure 4.1 below) and have to decide if they either *'Disagree Strongly'*, *'Disagree'*, were *'Neutral'*, *'Agree'* or *'Agree Strongly'* with the question by clicking in the appropriate box. A set of true/false questions are also presented together with numerous questions which require the participant to fill in boxes using the keyboard. A total of 104 questions are included in the survey, 82 concerning personality and 22 about individual characteristics. The justification for choosing a web-based approach is indicative of the research due to its main aims of investigating how people respond to computer based surveys on the WWW as opposed to more traditional paper-based methods.

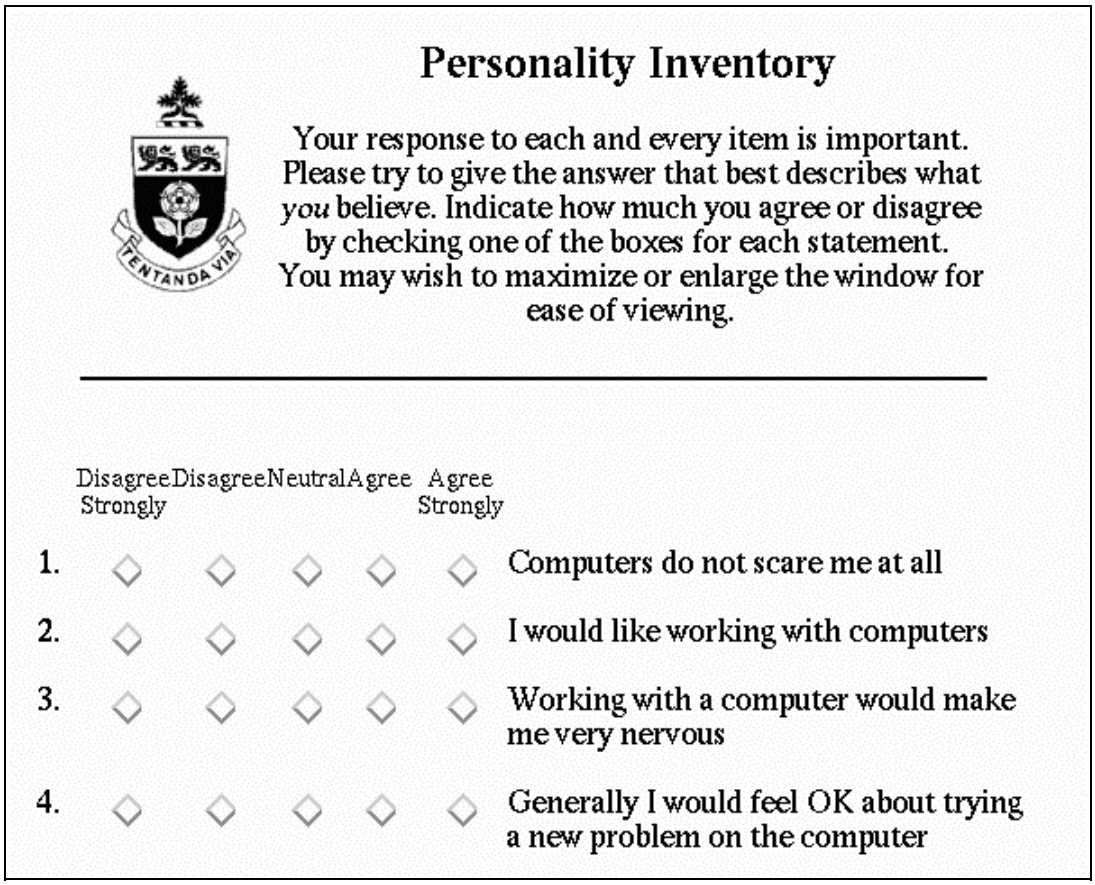
A further aim of the research was to identify which groups of people enjoyed answering psychology surveys on the WWW. Care and attention needs to be paid to the fact that there will be inevitable biases in the sample population due to the current levels of access to the Internet. This will limit the generalisations which can be made in any conclusions of web-based surveying and research, although these problems are likely to become less important as Internet access increases. Traditionally based methods are also used by the researcher to compare the results of the two techniques being used. The reasoning behind doing this is so that the...

> *"answers will be compared with answers from people who filled out the same questionnaire on paper. The information will then indicate if people are able to complete on-line surveys as easily as they can complete paper and pencil surveys."*
> *(Pettit, 1997, URL: http://www.yorku.ca/faculty/academic/apettit/survey/thankyou.htm)*

The use of graphical visualisation is not a necessary requirement of this type of survey to communicate the substantive element of the research. Several psychological experiments which examine the relationship and perceptions of facial features and age have been undertaken on the WWW, see for example <http://www-psych.nmsu.edu/~vic/faceprints/>, although these surveys are no longer active. These types of web-based surveys and experiments involve providing participants with photographs and a series of questions. Obviously in these types of surveys the photograph is an integral part of the research and plays a fundamental role in the survey.

The web site containing the full questionnaire can be viewed and participated in at the following URL: <http://www.yorku.ca/faculty/academic/apettit/index.htm>. Several thousand responses have been received by the researcher since April 1997 when the final version of the questionnaire went on-line. The analysis of the responses at the time of writing is underway and the experiment appears to have been particularly successful.

Figure 4.1: Extract from Pettit's On-Line Questionnaire



Source: *http://www.yorku.ca/faculty/academic/apettit/2.htm*

4.2 Case Study 2: A Review of Web-based Tools for Creating Questionnaires and Inputting and Analysing Survey Results.

Due to a lack of web-based social science research which make extensive use of graphics to gather survey data it is felt appropriate to review software tools which are starting to become available on the Internet which automate the survey process. Two software tools are discussed which provide solutions to allow web-based surveys to be undertaken without having to gain an understanding of the computing languages which many of the current web-based surveys require.

If the future use of the web for carrying out social science surveying is to expand the development of software for the automation of Internet based research surveys needs to be made available. the majority of web-based surveying systems requires the use of CGI and PERL programming (see Section 5.1) which more often than not requires some knowledge of computing languages and scripting. If a researcher wishing to undertake a web-based survey has no or little knowledge of this, the likelihood of not using the web to conduct a survey will be increased.

The WWW Survey Assistant package which has been developed by Schmidt came about due to some of the problems associated with CGI programming which

have been outlined above. As Schmidt realised the problems many researchers would encounter when attempting to develop on-line questionnaires.

> *"WWW Survey Assistant came about as a by-product of my efforts to implement WWW surveys for one of my students. I realized that the process could be automated in order to provide professionals and amateurs alike with wider access to survey research via the web. Nobody would have to go through what I went through: WWW Survey Assistant is my answer to increasing accessibility."*
> *http://or.psychology.dal.ca/~wcs/SAdocs/about.html*

The software creates a HTML web form to display the survey to be administered and then automatically generates a CGI program to run the survey therefore eliminating any problematic programming which may put people off from carrying out web-based surveys. This can either be installed on Schmidt's server or your own. The software has options to dynamically reply to user's responses and can handle dynamic forms. Once the questionnaire is finalised and contains the necessary questions the software package first writes an HTML document which will present your questionnaire then writes a PERL CGI program which is then executed each time a user submits a response to your survey through their WWW browser. The software contains many features which allow the researcher to tailor the questionnaire for specific tasks which overcome many of the problems which are often associated with web-based surveying. The software can filter out respondent's re submissions thus preventing biases in responses. Specific domain names can be incorporated so that access to respondents from the specified domains only can participate in the survey. Essential questions for which the researcher requires a definite response can be set up in a way that the questionnaire cannot be submitted if these are left blank. The software also has capabilities to present sound and images within the survey providing the server which is running the questionnaire contains the appropriate software.

The WWW Survey Assistant software is available from the company's web page at: <http://or.psychology.dal.ca/~wcs/>.

A similar software package which uses the Java programming language is also available from Senecio Software. This benefits from platform independence and therefore problems associated with different client operating systems is over come so long as they are operating Java enabled browsers. Due to its use of Java this software appears to be a little more advanced than the previous package. This allows the researcher to create questionnaires faster and provides more control over the respondent's questionnaire. The software can prevent the respondent from looking ahead in the questionnaire or leaving questions unanswered which often occurs in web-based surveys. The questionnaire can be made randomly to present questions and response categories to each respondent which can be an important factor when trying to reduce the bias from order-effect. The software can deal with adaptive surveys, where previous answers are dynamically inserted into later questions and response categories, or where behind the scene calculations are incorporated into questions and skip logic.

Other features of this web-based surveying software package include the ability to create a questionnaires with contingency skips, adaptive fills, calculations, analogue scales, pictures, rankings and many other necessary survey features which are all integral to the programs environment. Rapid changes to the questionnaire are straightforward with easy to use page layout environments and the simplification of surveying on the web by eliminating the need for extensive CGI and PERL scripts.

Senecio's On-line Survey Product, the MaCATI - ePoll software is available from the company's web page at: <http://www.senecio.com/>.

An on-line tutorial for students at Plymouth University provides an example of how psychology students can put their own surveys on the web with relative ease thanks to the CGI scripting being continued within a programme called Polyform which executes the scripts that deal with data sent back by the forms that users fill in. Students receive questionnaire responses in the form of an e-mail. The URL for the tutorial is: <http://salmon.psy.plym.ac.uk/mscprm/forms.htm>.

4.3 Case Study 3: Landscape Preferences, Land Use Science Group, Macaulay Land Use Research Institute, Aberdeen.

This case study provides one of the few examples of how the extensive use of graphics as a central theme of a survey can be undertaken over the Internet. The overall aim of the research project is to develop a model which will

> *"aid landscape evaluation for visual impact assessment in terms of positive and negative impact of a policy or management change and the relative level of such an impact on the landscape preference of the general public."*
> *(Wherrett, 1996)*

The final objective of the overall research is aimed at producing a planning aid which will be used to examine present and future landscape preferences. The researcher argues that if a landscape is to be changed either naturally of through human intervention it is important to have the capability to visualise and model any proposed changes. By quantifying the public's preferences for what they perceive as a good or bad landscape, it is argued that people's relative preference for a changed landscape may be quantified and compared. To be able to quantify people's preferences for particular landscapes large amounts of preference data applied to specific landscapes are required.

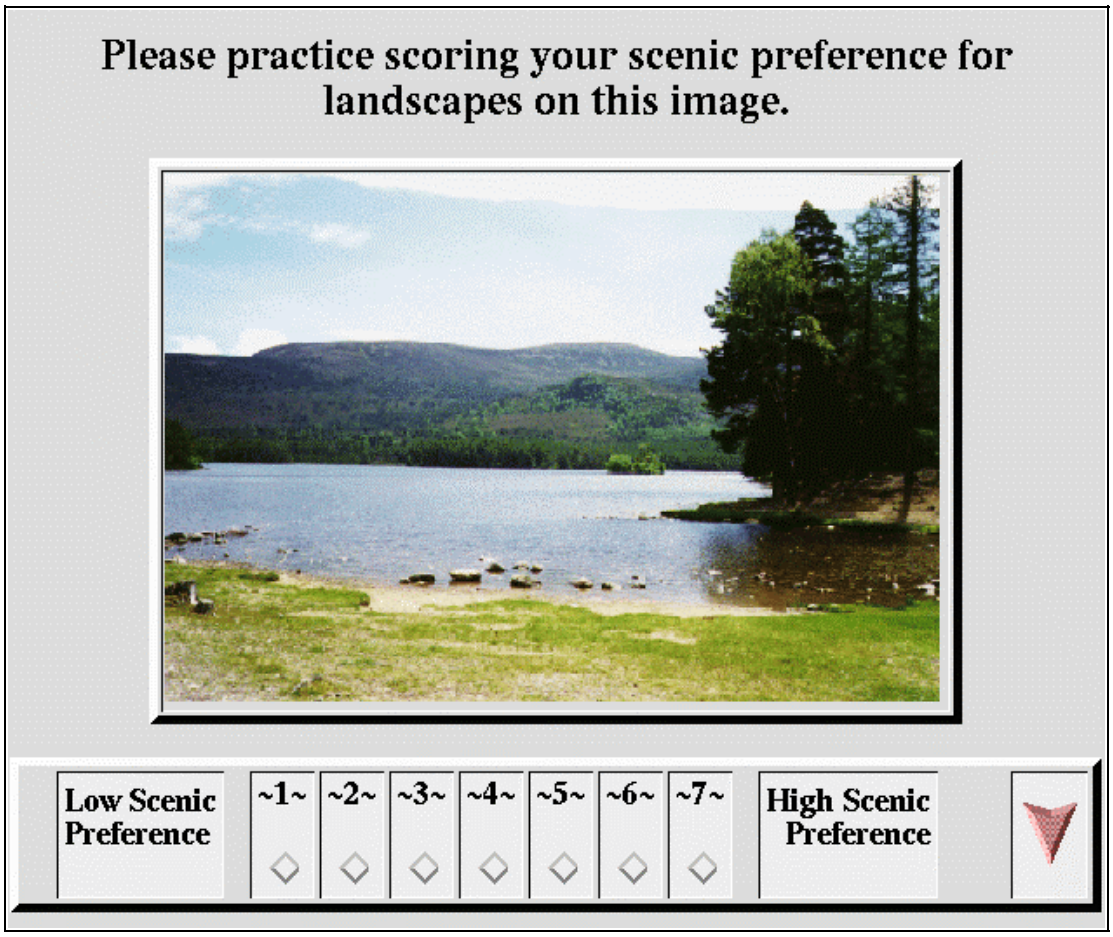
The web's graphical interface made it an ideal tool to use for this type of research. The ability to reproduce extremely high quality images on screen overcomes problems and expense of making many copies of the same photographs which would be required in a postal or doorstep questionnaire. The visual attractiveness of this case study makes it an interesting survey to participate in as opposed to a series of written questions which often become tedious and interest is soon lost.

As an integral part of the data collection process to obtain an understanding of people's landscape preferences the researcher decided to implement a web-based questionnaire in addition to traditional paper based methods to collect data. The aim of the on-line questionnaire is to collect data on participant's landscape preferences by getting them to give a score for each photograph of a Scottish rural landscape ranging from a low scenic preference of 1 to a high scenic preference of 7 (see Figure 4.2 below). Participants first have to choose the size of computer monitor they have as the survey is configured in three ways dependent upon the type of monitor used. This enables the size of the image to be maximised on the monitor being used by the client. An assumption is made on the part of the researcher that a 14 or 15 inch screen will have a resolution of 640 by 480, 17 inch screen 800 by 600 and 21 inch screens 1024 by 780. Participants are also given the choice with regards to which browser they are using - Netscape 3, 4 or Communicator or Microsoft's Internet Explorer.

A series of twelve photographs are presented to the participant after an initial test picture, with each requiring a preference score to be attached to it. At the end of

the questionnaire six questions to gather socio-demographic data relating to age, gender, occupation, nationality and so on are used to classify respondents into broad groups to ensure there are no simple factors influencing the results in any significant way.

Figure 4.2: Extract from Wherrett's On-Line Questionnaire



Source: *http://www.mluri.sari.ac.uk/~mi550/landscape/practicepc.html*

Over 700 *'log-ins'* to the on-line questionnaire have been recorded together with a traditional paper-based survey where people were shown photocopied photographs and then asked to give each landscape a preference in the same way as the web-based survey. Early indications have shown that the results from the paper-based questionnaire were not significantly different to the on-line version indicating that people's ability to participate in web-based surveys did not present any great problem.

As more researchers become aware of the ability of the WWW to facilitate this type of research, tools and techniques in this type of work, as discussed in the previous case study, will continue to improve and become more widespread. The web site containing the full questionnaire discussed in this case study can be viewed and participated in at the following URL:

<http://www.mluri.sari.ac.uk:80/~mi550/landscape/>.

4.4 Case Study 4: Where to Dispose of Britain's Nuclear Waste, School of Geography, University of Leeds.

This case study provides an example of social science research into public perception of a difficult and thorny issue, that of where to dispose of nuclear waste in Britain. A simple GIS-based decision support system has been set up on the WWW to give public users access to relevant datasets and the tools with which to explore the spatial aspects of the problem and arrive at an informed personal decision. (Carver & Openshaw, 1995).

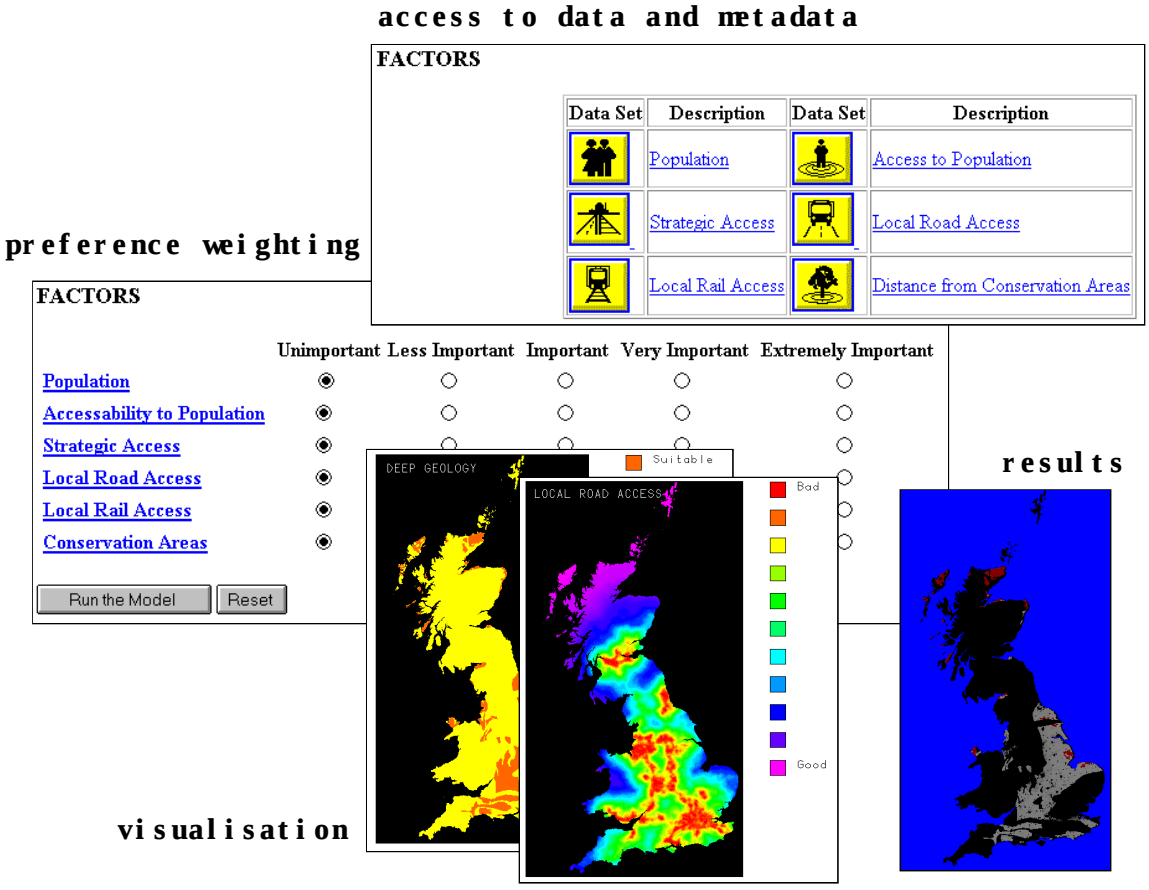
The political risks in developing a new radioactive waste disposal facility are high since no government is likely to win votes on the strength of it. Previous attempts to find a site for the nation's growing stock pile of radioactive waste has shown local people to be strongly opposed to any plans for a disposal facility in their area. This often referred to as the NIMBY (Not In My BackYard) syndrome and has led to vociferous and highly politicised anti-dump campaigns. As a result a number of potential sites have been dropped just before general elections. To make matters worse, the geographical problem of finding a suitable disposal site is accentuated by the small and densely populated nature of the country. IAEA siting guidelines (1983) state that any disposal facility should be within an area of suitable geology, remote from areas of high population, easily accessible and outside of designated conservation areas. The geography of Britain makes this a particularly difficult problem since their are few suitable geological environments and the areas remote from population are generally remote from access and, more often than not, designated as conservation areas. Thus, the relevant siting criteria are conflicting and therefore require careful analysis.

Clearly, radioactive waste disposal is an important and controversial problem, and as such attracts a high level of interest. This makes it an ideal vehicle for investigating public response to web-based decision support techniques. Radioactive waste disposal is also an extremely difficult problem; it is political, it is geographical, it involves multiple, often conflicting criteria and it involves multiple stakeholders. The web site also is designed to investigate some of the social aspects of these complex issues.

A simple decision support system has been developed to address this problem already (Carver, 1991). This suffers from the fact that it runs only on a stand-alone PC and so is isolated from potential users and interest groups. The system developed here applies the same exploratory decision support principles but on the WWW. This immediately makes it accessible to a global audience and increases the participatory element.

The web-based system is controlled via a simple, easy-to-use GUI of hyperlinks, buttons, check-boxes and sensitive maps. There is a high graphical content as demanded by the largely map-based information content. The system is accompanied by a comprehensive information system of hyperlinked text and graphics that provides the user with a full and unbiased view of the nuclear waste disposal problem. Using this, the user is invited to brush-up their knowledge of the problem before entering the decision support system.

Figure 4.3 Selection of images and interfaces from Carver et al. nuclear waste disposal decision support system



The decision support system itself consists of 5 basic steps:

1. initial choice of suitable location;
2. exploration of available datasets;
3. selection and weighting of datasets;
4. running the site search model and viewing the results; and
5. final choice of suitable location.

The user is first asked to make an initial choice as to where they think might be a good location for a nuclear waste disposal facility using the mouse to point to this location on a sensitive map. They are also asked to state how certain they are of their choice (i.e. was it a guess or a confident decision). This information is stored for later use and is taken to represent the user's initial perception and understanding of the siting problem. After making an initial siting decision, the user is asked to explore the relevant datasets pertinent to the siting problem. Each dataset is presented in map form with a linked description explaining why that particular dataset might be of importance, its source and what operations have been carried out on it to get it into its current form. Giving the user access to the relevant datasets allows them to familiarise themselves with the multi-faceted and geographical nature of the problem. The next thing they are asked to do is make personal choices about which datasets to include in the site search process and how to weight them in order of importance. This site

search model used performs two tasks; a series of binary map overlays using datasets chosen by the user, and a simple multi-criteria evaluation (MCE) routine based on datasets and weights specified by the user. The results from the model are displayed as a map showing good and bad areas for a disposal site based on the choices made by the user. If the user is unhappy with the map produced, they can return to earlier stages in the system and re-specify their choices. If the user is happy with the map as it is they are asked to indicate a for a second time where they think might be a good place for a disposal site and how certain they are of their decision. This information is also stored for later analysis. This final choice is assumed to have been made on the basis of a better understanding of the geographical aspects of the siting problem.

All the menus are very easy to use and full instructions and explanations are provided as appropriate. The decision process outlined by the system is prescriptive (i.e. the datasets are provided for the user and only one model can be used), but is flexible in that the user can step backwards through the web pages to any previous stage and review the data or alter selections made. Before leaving the system the user is invited to fill out a profile questionnaire containing categorical questions pertaining to age, gender, occupation and postcode.

From a social science research perspective this web-site provides several interesting pieces of information. These are as follows:

- level of knowledge of a particular problem;
- spatial perspective of a particular geographical, social and political problem;
- ability to make decisions based on limited evidence;
  choice and emphasis attached to specific problem specific criteria;
  ability to make decision based on better information;
  effect of better information on spatial decisions;
  possible effect of the NIMBY syndrome on spatial decision making; and
  effect of user profile on spatial decision making.

The full access logs generated by the web-site, showing the route through the decision support process and choice made along the way, may also help provide more insights into the way that people use information and make difficult decisions.

4.5 Case Study 5: Virtual Environments.

Virtual environments are becoming widespread on the Internet ranging from virtual communities and towns such as the extensive virtual Amsterdam site (see <http://www.dds.nl/>) through to live chat rooms where multiple numbers of participants can get involved in real time discussions (see <http://webchat8.wbs.net/webchat3.so?cmd=cmd_doorway:British_Chat>). While there is an apparent abundance of these types of web sites spread across cyberspace the potential for soliciting information from the users of these environments, or Avatars as they are known, appears not to be being exploited to its full potential. Masses of information could be gleaned from these sites as users movements within the virtual environment can be monitored in real time. This can provide instant information both from the client and from the server in a two way exchange process together with possibilities for the exchanging of information within multi-user environments. The use of VRML technology within these environments has and will continue to increase the depth of the users interaction with the web interface.

The VRML technology represents the most graphical environment within web-based systems through links to other sites and other parts of virtual worlds. The ability of clients to build their own virtual rooms within communities provides facilities for users to gather, produce and publish social science type information in a visual and interactive manner. These virtual world offers the social science researcher the potential to undertake social science experiments and surveys which would normally occur in the real world, but have the potential to involve much larger numbers of participants from diverse geographical locations in real time. Much of the development work in this area is being undertaken at NCSA which provides many examples of real-time virtual worlds, virtual environments and virtual reality systems (see<http://www.ncsa.uiuc.edu/General/VRML/VRMLHome.html>).

The future of this technology is very promising and has great potential for the social science research community. The potential which this type of environment can provide for social science is seemingly endless, whether its for collecting data through surveys or the monitoring of users movements to innovative and accessible means of publishing social science research findings.

5. Discussion

The following discussion is based on information gathered during the research, and preparation of the case studies, and on the authors' knowledge of the subject area. The discussion is broken down into five basic areas: graphical and technical requirements of participatory systems; the potential future role of participatory systems; practical and theoretical difficulties; the need for new visualisation/graphics tools; and social, cultural, political and ethical questions.

5.1 Graphical data and technical requirements of participatory systems

Technically the web and the tools that have been developed specifically to utilise it (e.g. Java and VRML) open up a range of possibilities for graphical interaction with data and information. Everything within the field of graphical exchange of information seems possible, but is on the other hand hampered by practical considerations of restricted band-width, speed of access and hardware/software limitations faced by the client (user). This has significant, if mundane, implications in terms of cost and accessibility to the public user.

Current survey work on the Internet is limited by the software available. Most survey sites use simple forms which are extremely basic graphically, making use of CGI scripts to submit responses in an electronic mail format or as a text file. Advances in this area are likely to make use of the Java programming language mainly due to its platform independence and advanced features allowing greater interaction between the respondent and the survey (see WWW Survey Assistant web pages). Current problems may lie in a lack of understanding with regards to CGI and PERL programming. In a similar way to web authoring only three or four years ago when there were limited numbers of HTML (Hyper Text Mark-up Language) editors around, similar problems with regards to CGI and PERL editors are likely to be overcome. As more custom built and easy to use on-line questionnaire packages become available which automate the CGI and PERL scripting processes, increased use of on-line surveying techniques is likely.

Perhaps the two key aspects regarding the graphical data content and technical requirements of participatory systems are *accessibility* and *usability*. There is a great deal of social science relevant data in existence, while the technical and graphical capabilities of the WWW far surpass anything available ten years ago. At the same time the WWW is hugely distributed; providing networked access to vast amounts of information and computing power from almost anywhere in the world (or absolutely anywhere if you have a portable PC linked to a satellite telephone). The possibilities for the WWW in changing the way people use computers and information may seem almost limitless. Web sites need to be written in standard code as not all browser software supports all formats or the latest versions of HTML, VRML or Java.

Web sites that are full of graphics in the form of banners, icons, wallpaper, images and animation's may look pretty and can at first attract users. However, the graphical content of the web can be a victim of its own success. True, a picture is worth a thousands words, but at what cost in terms of download time? Clients are more likely to quit and jump to another web site if the graphics on the current site slow the loading times to minutes rather than seconds. The average human attention span is limited, but when the client is being charged local call rates for the privilege then it is severely curtailed. Web designers therefore need to be careful in establishing trade-offs between graphical design and graphical information and tread a fine line between making a web site attractive and keeping clients on-line.

Hardware advances, improved bandwidth and reduced (or even free) access rates may help reduce or eradicate this particular problem in the future. In North America local calls are free, making the access times less of an issue. In the UK developments in the near future may also help remove this barrier to more widespread use. These include plans for access to the Internet via digital and cable television networks and the possibility of electricity utilities acting as service providers using their own distribution cables.

5.2 The potential future role of on-line participatory environments

The potential future role of on-line participatory environments in gathering large amounts of data on both general and specific social science topics is real, but may be misleading within the context of this report. The WWW potentially gives social scientists access to human subjects in every household with an Internet connection, making it a potentially huge source of social science data. Current surveys put the number of households with an Internet connection at between 5% and 20% (NOP, 1997). However, despite these encouraging figures, the public have to want to contribute/participate in web-based social science and cannot be forced to fill in on-line questionnaires or use social science web pages. Access to web pages is, like watching television, entirely voluntary. Just as with television thirty years ago, however, market saturation is just around the corner for the WWW or whatever succeeds it, meaning that the potential (however fraught with difficulties) cannot be ignored.

Problems with sample bias

A significant problem facing the use of participatory systems on the WWW to gather social science relevant data is that of sample bias. It can be safely assumed that in most cases those members of the public accessing a social science-based web site

are doing so because they want to. In other words, they have not found the web site by chance (though that is possible) nor have they accessed it through a sense of duty to support social science research, but will have actively sought it out because they have a particular interest in the topic covered. This can create critical problems over bias in the sample generated in any on-line surveys used to address topics and issues requiring a stratified sample across the whole population. Surveys of Internet users suggest that those individuals most likely to be represented are young males, further complicating the bias in the list of likely participants. Those individuals most likely to be under-represented include older people, females and those from lower income groups that are less likely to be able to afford a home PC. In other cases, this bias may be a distinct advantage. Returning to the analogy with television, there is some suggestion that "surfing the web" may have replaced channel hopping in some sectors of the population (Internet service providers have noted marked drop off in service access at times when TV programmes such as the X-files are screened). Bias towards this kind of user may be interesting for certain ethnographic/behavioural studies.

The role of schools and higher education

School children and students in higher education represent a significant user group for particular studies. All higher education institutions have access to the Internet and WWW, and it will not be long before the same situation exists in primary and secondary education. Under these circumstances all children of school age and a significant number of young adults (those in higher education) will have direct access to the web via their place of learning. For certain social science applications this may be advantageous, in particular given the view that today's school children are tomorrow's voters, business people, tax payers, etc. Direct, on-line targeting of these groups by participatory systems (with curriculum assistance from teachers and lecturers) is therefore directly relevant to studies of future society. One further point is that if all schools have web access, then many households have indirect access through their children, further broadening the outreach of the WWW.

The web as a source of secondary data?

The WWW in its wider sense may also present opportunities for gathering potentially massive amounts of social science relevant data from secondary sources. The access logs of web pages whose primary purpose is not social science research may yield data of interest to social sciences. For example, social scientists interested in politics may glean useful data from the access of logs of web sites with a political theme. This route to gathering useful social science data is, however, fraught with difficulties. In particular the use of data from web access logs for purposes other than server monitoring may be in contravention of data protection and privacy laws. In many cases it may not be possible to identify individuals without access to commercially valuable and sensitive information about individual clients held on service provider databases. In essence, using web page access logs to generate massive amounts of social science relevant secondary data is a nice idea, but it may never work for all but a limited number of special cases.

Reviving old areas of social science research

The WWW presents some limited opportunities for reviving and reviewing old areas of social science research with much larger sample sizes and/or populations. The problem here is not just ensuring a representative sample, but capturing a large enough

sample size. Some mechanism other than personal interest and chance are required to attract more than just the casual surfer. Media science events such as the British Association for the Advancement of Science (BAAS) meetings and the Tomorrow's World MegaLab experiments might prove suitable vehicles in advertising a social science web presence and attracting greater response rates.

Developing new areas of social science

Some areas of social science research that have hitherto been unresearched because of a lack of access to suitable subjects and/or insufficient sample sizes may possibly be opened up through recourse to on-line participatory systems. One obvious example used already in this discussion is that of the behaviour and ethnography of web users. A great deal of potentially interesting research is still be carried out into user attitudes and perceptions, social interaction versus isolation, 'netiquette' and on-line behaviour, virtuality, community development and teleworking, among others.

One area where the web can make considerable inroads is in improving public access to software and data tools developed out of social science research. A number of examples of social science relevant software tools are already on the web. Good examples include the Friends of the Earth Chemical Release Inventory (FoE CRI), the Institute of Fiscal Studies' (IFS) Be Your Own Chancellor site, Stan Openshaw's Geographical Analysis Machine (GAM) cluster hunting software and now many examples of Geographical Information Systems (GIS) demonstrations such as Berkeley University's Research Programme in Environmental Planning and GIS (REGIS). Essentially such web sites provide two valuable public services; making software and data publicly available, and making data useful. This important function serves as a public window on social science research.

5.3 Need for new web-based visualisation tools and approaches

The past couple of years has seen the extension of most existing computer graphics tools and interfaces into web-based applications. Many advanced forms of data visualisation and interaction can now be used or at least demonstrated via the WWW. Examples of graphical applications range from computer games and animation through to GIS, virtual reality and artificial life. In some case specialist programming languages such as VRML have been developed specifically to facilitate the generation of computer graphics across a WWW interface.

Within the context of participatory systems within social science, a number of important areas may be identified as requiring research and development.

Interface design

GUI design is fundamental to the development of effective participatory systems. Most web-based interfaces are mouse-driven and based around standard graphical interface devices or 'widgets' such as check-boxes, menus and buttons. Text input from the keyboard is limited. All the main web browsers support this form of interface. Rather, the key problem is user understanding. Whether the system in question is a simple on-line questionnaire or an interactive 3D virtual world, the user must be able to understand and be able to interact with the interface. This becomes problematic when designing GUI for public use due to the wide range of computer experience; from absolute novice to expert. If a GUI is too simple, it may not offer the flexibility and functionality required to address complex visualisation problems.

Alternatively, if the GUI is too complex, then new and novice users may not understand.

The substantive information being presented also needs careful thought. Too many assumptions about the user's knowledge of the subject area can lead to incomplete understanding of the problem or issue and produce misleading results. Too much basic background information can, on the other hand, seem condescending to more informed users and may they loose interest.

Future developments in GUIs need to focus on adaptive user-centred interfaces (AUI) that can profile new users, 'learn' from their responses and alter the level at which information is presented, both in terms of detail and style, and adapt the complexity of GUIs used to present it. For example, a novice user with little or no knowledge of the subject area requires a simple GUI and comprehensive background information, whereas an experienced user with a good knowledge of the subject area requires a more complex (and flexible) GUI with much less background information. Depending on the educational status of the user, the presentation of the GUI and the style in which the background information is written needs to be adapted accordingly. Simple user profile questionnaires including questions such as postcode, profession, age, familiarity with computers, newspaper preferred (i.e. Sun or Guardian) could be used to channel users to a particular style of GUI and information presentation in a multi-level system. Alternatively, more advanced techniques, perhaps employing artificial intelligence, could be employed to analyse each user's successive responses and adapt the GUI and information in real time.

One possible area for research is the development of on-screen 'concept keyboards'. These are based more around physical methods of working and represent a move away from typical menu or command lines modes of human computer interface (HCI). Here the HCI is built up of graphical elements representing real-life work spaces. For example, the digital office is represented as a photo-real graphic showing computer, printer, desk, filing cabinets, telephone, fax machine, copier, etc. rather than the standard MS Windows or Windows 95/Mac type interface. Non-computer users are much more able to interact with this kind of environment than a series of obscure icons and menus. Of course, there is a heavy graphics overhead with any such interface that is web-based.

Exploratory decision-making

Perhaps one of the key areas of potential for participatory systems is in the development of exploratory decision-making. Both the third and fourth case studies involve an element of exploration of a particular problem. In the case of the landscape preference survey, the aim is to determine what elements of the landscape are attractive and to explore what might be the likely effect of a new development in the landscape. In the case of the nuclear waste disposal siting example, the user is encouraged to explore the geographical aspects of the siting problem and arrive at their own informed decisions.

Developing visualisation tools that can help in users explore social science type problems or issues and, if appropriate, arrive at informed decisions is a potentially fruitful area for further R&D. For spatial decision problems, web-based GIS, such as used in the nuclear waste disposal example, are probably the most obvious answer. However, not everyone understands a map (and those produced by a GIS can easily confuse most). Research is required into alternative forms of presenting map-based information to assist in public understanding of spatial data and models.

Again, concept keyboards might present a way-forward in assisting public understanding of GIS-based material. Cognitive maps, photo-real aerial views and VR may each present workable solutions to this problem. For non-spatial problems emphasis should be on clear and concise forms of visualisation. Only where very complex datasets are being presented such advanced graphics such as 3D views and linked displays, be employed.

Computer supported collaborative working

Computer supported collaborative working (CSCW) has been the focus of research attention in the computing sciences for some time and is an area that deserves attention from the social science research community as an approach to local community-based research projects. The increased availability of web-connected PC in the community and the availability of appropriate GUI and visualisation software generates numerous possibilities for social science research projects into a various community level topics such as education, housing, health, crime reduction, environmental enhancement and design, etc. The emphasis in CSCW is on the use of computer environments to support democratic community level decision-making, conflict resolution and compromise planning. The development of participatory CSCW environments or 'community decision spaces' on the WWW is now possible and represents perhaps the most practical means of ensuring future maximum outreach and participation among community members.

5.4 Social, cultural, political and ethical questions

There are a great many social, cultural, political and ethical questions that arise out the use of the WWW in general, and through its specific use as a tool for social science research. Not least of these is the spectre of social exclusion, but other problems of apathy, antagonism, trivialisation, bias, freedom of information, confidentiality and political intransigence also affect the viability of web-based approaches to social science research.

Social exclusion

The issue of social exclusion has already generated much general discussion within the social science literature, but becomes more of a focal point when discussing the web as a vehicle for participation. The fact remains that no matter how many people have direct access to the web, either from home, the workplace or public terminals, there will also be a minority of people who for whatever reason do not. Under-representation is a major problem currently facing any ideas for practical real world use of web-based participatory systems. Not everyone at present has access to the WWW and many people lack essential technical knowledge and/or may not be familiar with new developments. This gives rise to the danger of creating an "Information Underclass" for whom there is no access to information and as a consequence lack even a minimum level of understanding that enables effective participation.

Apathy and antagonism

Apathy and antagonism also play an important role. Many people may simply be uninterested or lack the incentive to participate. On the other hand, many people may be actively hostile to any idea of digital methods of involvement. This

'technophobic' minority is however, likely to reduce with time as more and more people (particularly in the younger generation) become familiar with computers and their use across a broad spectrum of activities from the home to the workplace. Similarly, the passage of time will see an increased market penetration of the WWW (or its future equivalent) just as television re-shaped our home social lives in the 1960s and 70s and just as the mobile 'phone is re-shaping personal communications today. In the short-term, there is likely to be a massive rise in the numbers of people with connections to the WWW. Even those who do not own a PC will have easy access to WWW stations at local libraries, council offices and other public places.

Trivialisation

Another pit-fall for web-based participation is the potential for trivialising social science research. Research can be a complex process of hypothesis generation, observation, data collection, analysis, synthesis and evaluation. Public involvement in research through web-based systems necessitates simplification and therefore increases the danger of missing key points or issues. Web-based social science research may fall foul of the criticism that it is undermining the foundations of rigorous research and replacing it with a digital 'plug and play' version. This criticism gives rise to a real worry over misrepresentation of the true nature of the population. Participants more used to computer games than work-place computer applications may not take the problem seriously and be tempted to play around thereby giving false feedback to researchers.

Bias and (dis)information

For many people who are genuinely interested in a particular social science problem or issue, bias in system development may be a real concern. One of the advantages of the WWW is its independent nature, but this gives rise to the problem of potential bias in system authorage and control. Taking the nuclear waste disposal problem as an example, a web site authored by the nuclear industry is likely to paint a somewhat different picture of the problem than say one authored by an environmental pressure group. The potential for (dis)information in the data, models, web-site structure and associated text is enormous. Essentially the onus is on the user to recognise this and place their (dis)trust accordingly. This is a basic flaw with any information media, be it the press, television, radio or the WWW. Any attempt to police the information provided on WWW is against its basic principles of freedom of information and so is either doomed to failure or if successful, will ultimately kill-off the WWW.

Freedom of information

Freedom of access to information can be a major constraint to researchers and the public alike in the design and implementation of effect participatory systems. At present in the UK several barriers have been erected and kept in place by organisations holding relevant datasets. Comparisons can be drawn between the UK and the USA which has had a Freedom of Information Act for many years. In the UK, citizens have to pay vast sums of money for digital map data from the national mapping organisations. In the USA, access to digital map information is free. Even though certain datasets in the UK are available free of charge, the bureaucratic and physical barriers preventing their effective use can be quite considerable.

A good example is the Chemical Release Inventory compiled by the then Department of the Environment (DoE) from permits issued to companies and institutions to release chemical substances into the environment. This important environmental dataset was freely available for public scrutiny but in such a form as to make it inaccessible to all but the most tenacious of researchers. Friends of the Earth (FoE) have now accessed all this data and produced an excellent interactive web-site which allows users to inspect the emissions permit data and search the database using a simple map interface. Users can also search for the permitted chemical releases nearest to their own postcode. All the FoE Chemical Release Inventory does is remove the barriers to the use of this data making it easily accessible to the public, but it is far in advance of the methods of access employed by the ministry.
The present UK government is now making noises about a Freedom of Information Act for the UK. It remains to be seen what this will mean for freedom of access to key social science relevant datasets.

Confidentiality
One difficult issue facing web-based collection of social science data is confidentiality. If an individual can be identified in data gleaned over the web then it may be deemed confidential under the rules of the Data Protection Act. As it happens, much information pertaining to individuals accessible from web access logs, for example, is very difficult to trace to an individual since most users will be accessing the Internet via a service provider such as CompuServe or AOL. This makes tracing the individual to a specific address impossible. Where information is collected about an individual through an on-line questionnaire for example, it needs to be made very explicit to the respondent that the information they enter about themselves may be used and published. It is probably good practice in such cases to publish a warning notice before and after the questionnaire and not to ask questions that enable the individual to be identified, thereby gaining permission to use any data entered and retaining the anonymity of the respondent.

Political intransigence
Most of the systems discussed in this report are essentially digital versions of paper questionnaires with varying levels of interaction and multi-media content that have been produced to support pure research objectives. The higher end applications such as the nuclear waste disposal decision support system and some of the projected 3D virtual worlds support higher goals; those of participation in decision making. The potential of web-based participatory systems in some sectors of social science research will no doubt in time be realised. The potential of participatory systems in decision making and support is less certain. The ideals of 'cyberdemocracy' (democratic process enhanced and perpetuated through direct public participation in important political decisions via digital means) are noble and yet fraught with difficulties, some of which have been covered above such as under-representation, (mis)representation, trivialisation, bias and (dis)information.
Perhaps the greatest barrier to the development of successful web-based decision support systems, however, is that of political intransigence. Although enlightened political minds have recognised the vast potential of the Internet and WWW as an (dis)information medium, the political machine as a whole is likely to be unenthusiastic. Information is power and most politicians as a result view the WWW and web-based participatory decision support systems as a grave threat, not only to

their role as decision-makers, but also to the current political status quo. Politicians and other decision-makers in industry and commerce invariably subscribe to the "we know best" principle and perhaps rightly so. Whereas the advantages of participatory web-based systems from a social science point of view are that they offer an open, flexible and rational approach to public involvement in the decision-making process, the politician is likely to see these qualities as distinct disadvantages that are likely to undermine positions of power in the decision-making hierarchy.

6. Conclusions and recommendations

There is a great deal of discussion surrounding the potential use of the WWW as a vehicle for social science research. However, with the exception of a few on-line questionnaire surveys, very little of the discussion seems to be materialising into action.

The great potential of the WWW as data source may, in fact, turn out to be a red herring in most cases. There is a great deal of social science relevant information out there in cyberspace, but there are a great many difficult and thorny issues surrounding both its use and access including problems of sample bias and confidentiality. The main advantages of adopting a web-based approach to social science research seem to be increased sample size, targeted sample populations, multi-media and interactive presentation of surveys and results, and active participation.

Perhaps the key role of the WWW in social science research is at the lower levels of participation; principally in the dissemination of the results of social science research and making data and tools available for public use. This is very important in closing the awareness gap between academics and the public and in providing an end-user service.

The following recommendations are made here:

There is a basic need for education about the opportunities and pit-falls which web-based surveys and systems can offer. A resource of software tools and literature on best practice should be developed to give users the best possible advice on how to undertake web-based social science research and give assistance when and where required.

There is a need to create examples of well designed and innovative interfaces that encourage participation and use. These could be used as models of good practice to encourage other social science researchers to use similar approaches as appropriate.

There is a need to raise public awareness of the value of social science research through the dissemination of research results and tools via the WWW. One way of ensuring nation wide coverage may be through well advertised media events.

There needs to be a greater emphasis on the role that social science can play in providing a WWW-based public service, both in access to datasets and graphics tools. Good examples include the Friends of the Earth Chemical Release Inventory, the Institute of Fiscal Studies' Be Your Own Chancellor model and the East St. Louis Local Action Research Project and associated GIS-based East St. Louis Geographic Retrieval System.

Future developments are likely to see further experimental web-based social science research coming on-line in the next few years whilst the wider development of the WWW as an accepted information medium will see improved public and political awareness of what is possible in this growing field. The social science community as a whole needs to be aware of these developments and exploit the new technology as appropriate.

7. Acknowledgements

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