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USABILITY OF GEOGRAPHIC INFORMATION. FACTORS IDENTIFIED FROM TASK-FOCUSED USER INTERVIEWS

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INTRODUCTION AND BACKGROUND

Evaluating the usability of a product is in large part dependent on who the users are and what they are using the product for. In this respect, geographic information or indeed other information products (e.g. census information), may present more complexity than other more physical or tangible products such as computer application interfaces or mobile phones, in that the combined range of potential users, purpose of use and environment of use (both physical and technological) is enormously diverse. An architect, for example, may have need for three dimensional (3D) geographic information of a certain specification for purposes of creating a new development proposal, while a risk modeler for insurance applications also requires 3D information but specified differently. The term 'information' is used in this paper to denote a dataset which has meaning added (Devlin 1999). In terms of geographic information, meaning is added in the sense of, for example, descriptive attributes and unique identifiers added to feature geometry. The term 'information product' is used in this paper to denote a dataset with added meaning which is made available, usually with supporting user guides and metadata, for free access or for purchase.

As a provider of geographic information Ordnance Survey, the national mapping agency of Great Britain, produces a range of geographic information products used for many different purposes in diverse organizations including government departments, commercial businesses and by individuals. Understanding user needs for geographical information and the factors which influence the usability of such information in diverse user contexts is an essential part of ongoing user centred development of information content and products. This paper builds on previous work to identify elements of geographic information usability (Harding & Pickering 2007) and discusses results in the context of other research in this area.

A USER AND TASK FOCUSED APPROACH

While much work exists within human factors and design disciplines on usability of physical products, and within the fields of software engineering and Human Computer Interaction on software interface and website usability, relatively little published research appears to focus on usability of information products. Some examples with more of a focus on information, as distinct from applications and interfaces, are cited by Hunter et. al. (2003).

Drawing on and adapting aspects of User Centred Design (UCD) philosophy, we investigated people's needs for geographical information in professional use contexts primarily through identifying the context of use; benefits of UCD in geospatial technology development is discussed by Haklay and Nivala (2010). Building context of use involves profiling characteristics of the user group (e.g. planning officers), their task objectives (e.g. processing new planning applications) and the environment in which the task is carried out. In addition, we also wished to identify specifically how geographic information does or could support the task and any issues surrounding current information usage.

A qualitative approach using semi-structured interviews was used to elicit this information from a sample of geographic information users. Due to the exploratory nature of the investigation with each user and the need for flexibility to follow responses to achieve clarity of understanding, the semi-structured interview approach was preferred to that of a more highly structured questionnaire. This enabled sufficient flexibility to explore key factors whilst maintaining consistency of approach and scope with all participants. The process outlined below was piloted to ensure effectiveness for capturing the required information within an interview duration of between one and two hours .

Prior to each interview, relevant background information was extracted though analysis of documentary sources describing aspects of the user organisations' objectives, areas of work and in particular noting the terms used for real-world (geographical) objects referenced in the context of the areas of work concerned. Such sources included web pages and documents published by the organisation.

Following the document analysis, the interview itself was focused on a specific task or context of use by previously agreeing this with the person to be interviewed; the recruitment approach is described below. A generic outline for user needs interviews (as for example described by Kuniavsky 2003) formed the basis

of the interview structure, beginning with introductory information and general context of use questions followed by more specific focus on the 'product idea' (in this case the use of information about geographic/real-world things in the task context), followed by stepping back to wider perspectives on the use context and finally summarising to conclude the interview.

Within this framework, interview questions covered the following:

• Identifying roles and expertise of those carrying out the task, and identifying stakeholders

• Task objectives, process and task environment

• Identifying information needs in the task context. Specifically, what information about real-world objects mattered in order to help complete the task

• Current use of information sources and issues with existing geographic information

• Future trends and internal and external influences affecting the user and task

To facilitate the identification of information needs a graphical concept mapping exercise was carried out within the interview on a whiteboard with the interviewee, naming real-world objects referred to in the context of the task, identifying essential geometric and other attributes of the objects and any important relationships between them.

Audio recording was used to provide backup to notes taken in the interview as well as enabling checks for accuracy and completeness of the interview record. A copy of the written record was also sent to the interviewee for comment or correction.

RECRUITMENT OF PARTICIPANTS

Participant sampling aimed to represent a wide range of professional domains and diversity of use contexts for large scales geographic information in the UK (in this context meaning uses of geographic information at 1:10000 or larger scale). Essential recruitment criteria included that participants for the interview must work with geographic information on a day to day basis or within critical tasks (e.g. an ambulance control centre officer responding to emergency calls). In total, 56 interviews were completed across diverse professional use contexts in local government, central government and commercial organisations.

RESULTS

Besides documentation as individual interview records, the collated, anonymised interview content is stored in a research database, providing a resource for further analysis. It is from qualitative analysis of this collective knowledge base that factors contributing to usability of geographic information are identified and discussed in the rest of this paper.

Participants were found to reveal insights or make specific comments concerning geographic information usability in response to interview questions investigating task process, environmental constraints of the task context, issues or difficulties experienced with information in the task context and in terms of how they see the task developing in the future. These were identified as geographic information usability issues if the information (or lack of it) impeded the desired progress of the task in the participant's view.

Types of issues repeatedly occurred across interviews, leading to identification of a proposed set of high level categories applicable to geographic information usability. It should be noted that these categories are derived qualitatively from the interviews by the author grouping apparently similar issues together. These categories are not exhaustive or determined through application of rigorous methodology, though further work of this nature is referred to in the conclusions of this paper. It is hoped that they might serve as useful groupings to help focus further research. A summary of these usability categories are presented here, together with points to illustrate the scope of each.

Information content

Central to the usability of geographic information is the abstraction or model of the real world as represented in the data and how well this fits with the user's conceptual model of the real world for the purpose of a specific task. Usability of content will depend on what data is provided about physical features (such as roads, buildings, land) and about what might be termed 'fiat' features (such as administrative boundaries) that the user needs to know about in the task context. Levels of detail (in 2 or 3 dimensions) and attribution required to achieve task goals are part of this. For example, the identification of flood defence structures in geographic data is important to those interviewed in the context of flood risk assessment tasks.

Terminology used to describe or name features in geographic information may also present usability issues if the terms do not correspond to those in use within the user's domain. For instance interviews focused on emergency response identified that place names used by people reporting an emergency incident sometimes do not correspond to those within datasets used by police, ambulance or fire command and

control officers for incident response. It could be more useful if alternative place names were also provided.

Also included in considerations of data content may be classifications of, for example, land cover and land or building use. Categories of interest tend to be task dependent though there may be a degree of equivalence at some level between certain categories in different user domains. For example as found in interviews focused on local authority planning tasks and other interviews focused on risk modeling tasks, there is common need to identify residential building use, whilst their respective requirements for classification of commercial buildings use differ.

Data content needs to be accurately and meaningfully described in documentation and metadata to contribute to its usability for the end user.

Information quality

Besides including required data content about real world features, it is important that the data for those features are of sufficient quality for the purpose. Usability with respect to data quality may be considered in terms of the data quality elements identified in the ISO standard for 'Geospatial Information - Quality principles' (ISO, 2002). These cover: lineage (describing the history of a dataset), data currency, positional accuracy, attribute accuracy, logical consistency, completeness and coverage. An interview with urban design and construction consultants, for example, recorded that for certain tasks positional accuracies to the nearest millimetre are required for certain buildings related features, rendering many available geographic datasets unsuitable for the purpose.

One or more quality element may be significant in the task context, with values or measures rendering data fit or not fit for purpose. As for data content, good metadata for communicating data quality is a part of this usability component.

Information structure and interoperability

In all the task contexts investigated, users are associating geographic information with other spatial or non spatial information sets, often from multiple sources, in order to achieve their overall task goals. For example, association of demographic data to urban areas for emergency planning or chemical hazards information to specific building premises for emergency response. In diverse task contexts the user needs to georeference data sets by, for example, coordinates or postal address in order to associate them to base geographic information. Example use contexts include risk modelling for insurance purposes, health service patient transport planning and epidemiological analysis. It is important that the geographic information itself is referenced to suitable 2 or 3 dimensional referencing systems enabling the required association.

Geometric data structure may also affect the effectiveness with which other data may be associated to geospatial information. For example, in interviews with traffic managers and road asset managers it was noted that the way in which road network data is structured affects how data on traffic volumes or road surface condition may be meaningfully associated. Further, elements of data quality will affect how successfully different datasets may be integrated. For example, in interviews with urban design and construction consultants, and with analysts concerned with flood risk assessment, the 3-dimensional positional accuracy with which a terrain model can be integrated with 3-dimensional building models is important.

Availability of data in raster or vector format can be a key usability issue. Some types of analyses require integration of raster based geospatial data, for example as evidenced in a habitat analysis task involving monitoring species migration, whereas certain epidemiological analyses (for example from an interview focused on assessment of populations affected by specific hazards) require vector and raster data integration.

Information file format

Though file format is largely a consideration with respect to the systems used for data management, manipulation and sharing, it nevertheless influences the user's overall perception of geospatial information usability. The need to invest in file format translators or the difficulty in sharing information with other users involved in the task was cited in a number of diverse user contexts as impairing efficiency and overall usability of a geographic dataset. This situation was noted, for example, in the context of county council emergency planning across county boundaries, where different organisations may operate different systems requiring data in different file formats.

Information volume

Data volume was also highlighted in certain use contexts as an issue for data management and manipulation by the user in the task context, affecting usability with respect to system capacities. This can

be especially acute where large scales geographic information with national or large area coverage is needed, as is the case for example in risk modelling for insurance purposes.

Information presentation

Cartographic representation including symbology, line widths, colours and text placement can all contribute to the ease and effectiveness with which data are used. For instance in the context of interviews focused on crime analysis and health service emergency planning, users said that underlying contextual mapping detail and colours used in geospatial datasets can conflict with the graphical representation of their own statistical information by colour coded zones.

Besides the above outlined components of spatial information itself, the cost, delivery and selectability of information may also be considered as three further components influencing whether or not geospatial information is ultimately usable for a specific user.

Information cost

Where geospatial information costs outweigh the benefits of using the data for the range of task contexts that a user or user's organisation could apply it within, then the information may not be acceptable in efficiency terms. For example, in the context of an interview on health service patient transport planning, planners ideally need access to national coverage for address information, but acquisition of this data coverage (at the time of interview) was not justified by the frequency with which data from all parts of the country is required.

Information delivery

The medium with which data may be delivered, whether on-line, on digital media or paper, is also a usability factor with respect to user and task context, relating to systems and task processes. As was found in the context of, for example, an interview on re-configuring health service locations, data delivered by CD can segment coverage in an inconvenient way, necessitating further data administration.

Information selectability

A number of task areas require data on a comparatively narrow set of real world features in order to achieve their goals. For these users in particular, it may be preferable to have access to data on selected features that are relevant, and not have to take data on features that they do not need information about. For instance, in the context of an interview focused on journey planning, the geometry of buildings that are not salient to the navigation task (i.e. most buildings) was of no significance. Extra data with no relevance can be perceived as clutter, impeding efficiency in managing and working with the data.

DISCUSSION

To an extent the categories of geographic information usability identified from the interview records align with some of the possible elements of spatial data usability put forward in discussion by Hunter et. al (2003). They suggest through examples that: data integration adds value to spatial information thereby enhancing its usability; cost, presentation and data integrity affect usability; the elements of data quality together with metadata are important factors in data usability. Hunter et. al (2003) also identify that perception of authoritativeness of a dataset, validity and reliability can enhance perception of usability in the sense of the user having confidence in the data. While this didn't come across explicitly from interview participants, it may be inferred as an important quality of information used in some task contexts where critical decisions are made on the basis of information available, such as in emergency response.

Hunter et. al. (2007) further organise elements of spatial data usability under the three components of usability as defined by the ISO 9241-11 standard (for Visual Display Terminal ergonomics) and widely used in discussions of usability namely: efficiency, effectiveness and satisfaction. Looking at the categories identified in this paper, the issues raised by interview participants mainly concern efficiency and effectiveness in the task, with less discussion of elements of satisfaction listed by Hunter et. al. (2007) such as certification, legal defensibility, trust. This is perhaps as a result of taking a task focused approach to the semi-structured interviews rather than a specifically product focused approach. The element 'trust' has been further highlighted as important in the context of usability of geographic information produced by social networks (Bishr & Kuhn 2007).

CONCLUSIONS AND FUTURE PLANS

Besides building knowledge of user needs for large-scales geographical information content, the task focused interviews have provided evidence for identifying elements of geographic information which influence usability from the perspective of the user. Categories identified in this paper support elements of geographic information usability put forward by Hunter et. a.l (2003, 2007) .

Usability issues identified from the interview records have formed a key input to further work into the development of specific formative and summative methods for evaluating usability of geographic

information products. In a more recent analysis of the usability issues raised by the interview participants, a grounded theory approach has been applied to this and other sources of user feedback to identify key factors in geographic information usability (Brown et. al. 2010). Eleven categories of factors were determined from that analysis, independently encompassing the qualitatively identified categories in this paper. These factors then formed the basis for development of a set of heuristics for evaluation of geographic information usability. Work is ongoing to further build tools for the evaluation of geographic information products.

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