

A Design Space for Location-Sensitive Aids for Older Users

Joy Goodman
Department of Computing Science
University of Glasgow
GLASGOW, UK
+44 (0)141 330 3541
joy@dcs.gla.ac.uk

Phil Gray
Department of Computing Science
University of Glasgow
GLASGOW, UK
+44 (0)141 330 4933
pdg@dcs.gla.ac.uk

ABSTRACT

When designing navigation and other location-sensitive aids for older people, there are many important issues that need to be considered and questions that need to be answered. It is important that these are clearly identified as otherwise there is a risk that they will be glossed over. This paper maps out a design space for such aids, identifying and discussing several of the key issues for design for older people. It examines challenges related to investigating navigation with older people and discusses how the design space has helped in the design of a particular case study.

Keywords

Navigation, Mobile devices, Design space, Older people.

1. INTRODUCTION AND CONTEXT

The proportion of older people in developed countries is rapidly increasing. In 2000, 16% of the UK population was over 65; by 2050, this is expected to increase to 26% [13]. This increase, together with the challenges and possibilities this user group brings to design, has prompted work on their inclusion, including the UTOPIA project (Usable Technology for Older People: Inclusive and Appropriate) [3]. As part of this project, we have focused on helping older people outside the home.

Potential mobility has increased for older people due to better general health and wealth. However, there remain serious problems for realising this opportunity; declining perceptual, cognitive and motor abilities, plus social isolation, place impediments in the way of full and trouble-free travel outside the home.

Handheld electronic navigation and other location-sensitive aids offer a possible solution. They often use systems such as GPS (Global Positioning System) to identify the users' location and therefore provide guidance on how to reach their destination.

However, the design of such devices is still relatively new and it is not yet certain how best to present navigation information and

services, especially given the constraints of handheld delivery. This paper presents an initial exploration of the main design issues identifiable in the literature. For each we consider its potential importance from the standpoint of older users. Some of these observations are speculative and require further study. We continue by discussing the challenges and possibilities of investigating navigation with older people. Finally, we consider the design of a particular navigation aid and discuss how the design space helps to illuminate the issues involved.

2. AN INTERACTIVE SYSTEM DESIGN SPACE

The design space describes the main categories of factors involved in the design of a location-sensitive aid. Our model of the design space contains three main parts, as shown in Figure 1:

- Core functionality issues - the system's information content, structure, services, and the tasks it can support;
- Form of delivery, both more general issues of dialogue and more specific ones of the user interface;
- Context of use, particularly the physical and social factors that may affect usage (note that for navigation aids, physical location becomes an issue of core functionality, rather than one of context of use).

These parts all need to be considered during design.

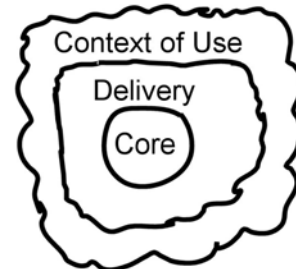


Figure 1. The Main Parts of the Design Space

3. KEY ISSUES

There are a number of important design issues that impact on part or all of this design space. Although it is possible to design a device without considering these issues, this is likely to result in a less than optimal solution to them.

This section lists several of these key issues in the design of location-sensitive aids, starting with those dealing mostly with core aspects and progressing through delivery to issues of practical and social context. Although they are listed in this order, it should be remembered that each affects or is affected by several parts of the design space.

3.1 Core Functionality

3.1.1 Type of Service

There are a few basic types of services that a location-sensitive system can offer. Firstly, it can assist with navigation, finding a route to a known place (e.g., the safest route home by bus) and guiding the user along it. Secondly, it can identify the location of something the user wants to find (e.g., the nearest café, a friend or policeman). Security and safety applications are also possible, for example, identifying the user's location to family members if he or she needs help.

It is important to match the type of service provided with that required by users. From our initial studies with older people, it seems likely that they make fewer trips to unfamiliar places than younger people and so may need the latter type of service less. However, when in these situations, older users may find navigation problems to be more acute.

3.1.2 Type of Location Information

Different kinds of location information may be useful in different situations. In particular, there are three main cognitive representations of environments, corresponding to three kinds of information: landmark information (about objects and places), route information (routes between locations) and survey information (an overall picture of the environment) [4, 7].

Hunt and Waller [7] and Prestopnik and Roskos-Ewoldsen [11] indicate that different people use different navigation strategies related to these kinds of information. In particular, route strategies follow a sequence of instructions with decision points (corresponding to route information) and orientation strategies involve maintaining a sense of one's position within the environment (using overview information). The most commonly used strategies vary with gender [9] and possibly with age, although this is as yet uncertain.

3.1.3 Detailed Environment Information

On a more detailed level, there are different kinds of information (or cues) that can be used to describe the environment. These may be stored, processed and presented to users to help them orient themselves and show them where to go next. Such cues include street-names, landmarks and cardinal directions. There is some evidence that cues chosen by users when giving directions change with age [1].

An aid can provide more than one type of cue at once and different types at different times. However, too many types are likely to be confusing, especially for older users who often have increased difficulties with divided and selective attention [15].

3.1.4 Uncertainty and Approximation

The information provided by GPS is not 100% accurate, even when the accuracy is increased using other methods. It may therefore be necessary to approximate the user's location, affecting the way data is dealt with and directions are calculated.

It is important to take steps to ensure that ambiguous information like this is delivered to the user in a non-confusing way. Although important for design generally, there is no reason to believe that this is a particular problem for older people.

3.2 Delivery Issues

3.2.1 Information Representation

Location data must have a concrete representation within the device and when delivering it to the user. Lynch [10] identifies five elements of location information - paths, edges, districts, nodes and landmarks. Hunt and Waller [7] suggest that cognitively these are organized into a hierarchy of regions. Including these elements and using this kind of organisation ensures that the main environmental information is covered and that it corresponds to methods that people understand and use.

The user's age has an influence on the most appropriate representation. For example, Caplan and Lipman [2] found that maps improve older men's route memory but negatively affect older women's. In light of the larger proportion of women in the older population, this indicates that it is important to provide alternatives to map-based information. In addition, learning new methods of representation may be particularly difficult for older users.

3.2.2 Query-based vs. Overview

Two key methods of information delivery are the use of queries and overviews. In a query-based system, the user asks the device for specific information, such as a particular landmark or route. Alternatively the system can present an overview of the information or environment and let the user extract more specific information from this. It is also possible to combine these two methods, at least to some extent, e.g., by responding to a query by returning information located on an overview.

3.2.3 Push vs. Pull

A related issue is whether the system or the user decides what information is given when. In the push method, the information is "pushed" at the user by the system, for example through alarms or directions. The system is in control and determines what information is given when. On the other hand, in the pull method, the user "pulls" information from system, for example by making requests. The user decides what information is provided when.

For mobile devices, such as navigation aids, there are additional factors to be considered as well as standard principles (e.g., allow the user a sense of control). In particular, mobile users cannot give their devices as much attention, indicating that a "push"-based interface, which tells the user when changes or decisions need to be made, may be more suitable. Furthermore, decreasing abilities mean that older users may be more cognitively and perceptually challenged by the use of small devices on the move.

3.2.4 Interaction Style

Various interaction styles are possible, including standard methods such as direct manipulation, menu selection and command language. However, mobile devices have different contexts of use than desktop computers and reduced attention (particularly visual attention) from the user. This means that standard desktop styles may not be the best styles for these

devices and it may be necessary to investigate other methods as well as evaluate existing ones in a different light [8].

In addition, older people are less accustomed to the latest UI metaphors and may have difficulty using them [12]. It is important to use a style and metaphors that they understand and, if possible, are familiar with.

3.2.5 *Modality*

It is particularly important to consider modality when designing mobile devices because the visual (and possibly auditory) channels may be occupied and standard methods of input more difficult. In addition, older people often have reduced sensory abilities and/or dexterity affecting their ability to use particular modalities. Therefore it is useful to consider a range of modalities for input and output, including text, graphics, speech, non-speech sounds, vibration and other tactile information.

3.2.6 *Interface Details*

Other interface aspects to consider include details of the interface such as button and font size. This is especially important when designing for older people who often have reduced sight and dexterity.

3.3 **Issues of Context of Use**

3.3.1 *Hardware*

The choice of hardware affects the forms of delivery that are possible and the amount of the processing power available. It is also important to consider how heavy and cumbersome the device is, particularly for older people, many of whom have reduced strength. The choice may also be constrained by issues of security and stigmatisation discussed below.

3.3.2 *Environment*

Different environments require the provision of different kinds of information and help. Key issues include familiar vs. unfamiliar environments; indoor vs. outdoor; and mobile vs. static use. However, little is known about the effect of the environment on the likelihood and nature of navigation problems in older people.

3.3.3 *Security*

Our initial discussions with older people indicate that many of them are concerned about security aspects of using mobile devices. They are afraid that they will be more likely to be mugged because the devices look expensive. This issue should be addressed both to increase uptake and use and to protect users. Of particular concern is how expensive the device appears, particularly those parts of it in plain view.

3.3.4 *Sociability*

Social aspects are very important and this may be particularly true for older people due to dwindling social networks. Although this issue is orthogonal to the main design of a navigation aid, it could provide some interesting possibilities for design, such as collaborative use and communication.

3.3.5 *“Techno-phobia”*

Many older people are reluctant to use devices that they are not used to, especially when it comes to new technology [5]. They may prefer more traditional methods, even if they are less

efficient. It is important to take steps to overcome this barrier to prevent limited uptake of the device.

3.3.6 *Embarrassment*

Reluctance to use devices that single the user out has also been observed (e.g. [14]), especially if they are singled out as disabled or needing extra help. This is likely to affect uptake of navigation devices for older and disabled people, but can be addressed, in part, by careful design.

4. **INVESTIGATING NAVIGATION WITH OLDER PEOPLE**

We still understand far too little about the navigational problems of older users and the ways in which mobile devices might, or might not, help. Some of the claims made in Section 3 are speculative and require further study and refinement. It is particularly important to involve older people in this process because they can have significantly different wants and needs from researchers and younger users.

However, studies to elaborate the annotated design space, such as those we have begun, are subject to particular challenges when working with older people. This section suggests a few of these.

Several of the challenges of doing participatory design with older people in general are documented elsewhere (e.g. [3]). These challenges are caused by two main kinds of barriers, although other problems do also exist: declining physical, sensory and cognitive abilities; and users' unfamiliarity with the subject area. As well as their effect on participatory design in general, these factors have particular impacts when investigating navigation and mobile devices.

4.1 **Declining Abilities**

Declining abilities can be barriers in any area of user involvement. In particular, declining sensory abilities can make it difficult for users to be involved in many traditional requirements gathering methods – poor hearing can prevent useful contributions to a focus group; poor sight can hinder someone from filling in a questionnaire.

Of particular relevance to navigation is the effect of failing memory on standard methods of elicitation. Navigation difficulties are likely to be particularly difficult to recall because they only happen occasionally. Navigation strategies may also cause problems because they often depend on immediate environmental information, which is not always used consciously. This is likely to be compounded by memory decline in older people, making it difficult to obtain accurate information. It may be necessary to use prompts and probes and allow a greater amount of time than usual. In-situ studies may also help to prompt responses.

However, in-situ studies outside the home are also affected by the special needs and requirements of older people. While many older people are fit and healthy, many face increased frailty and instability, thus posing special levels of risks. Extra care and effort must be taken to maintain their safety and security.

4.2 **Unfamiliar Subject Area**

Any area of computing science faces the barrier of an unfamiliar subject area when involving older people. Jargon and specialist

language can isolate participants and make it difficult for them to understand the researcher. In addition, participants may feel (inaccurately) that they are unqualified to contribute in such an area, and lack of knowledge of the area *can* provide a real barrier to the contributions that they can make.

This unfamiliarity is likely to be a particular problem when dealing with navigation and mobile devices as it deals with two areas both with specialist terms. Navigation can be particularly misleading as its words don't sound like technical terms. For example, one older person criticised some of our material for including the words "navigation" and "way-finding" saying that they were unnecessarily complicated.

Although computers in general are still unfamiliar to many older people, desktops are becoming more widely used and now frequently appear in the media. However, handheld devices (except for mobile telephones) do not have these advantages. In a survey of participants over 50 years old in Scotland, several of whom were recruited from computer classes, we found that only 6% of participants had ever used a handheld computer and 26% admitted that they'd never heard of one before [5].

In light of this high level of unfamiliarity with mobile devices, it is especially important to take efforts to help the users understand the area, for example, by demonstrating how devices work, illustrating how they could be used in practice and allowing users the opportunity to try them out for themselves.

5. CASE STUDY

As part of our exploration of helping older people outside the home, we are now beginning a case study examining navigation support. The design space described earlier has helped with the choice of topic and areas of investigation by clarifying the options available and what interesting points might be. It is now helping to focus the study by guiding key decisions about system requirements and highlighting issues that need to be considered.

After considering the issues mentioned in Section 3, we identified as particularly interesting the provision of detailed environment information (or cues) described in Section 3.1.3. As described in that section, there is a wide range of kinds of cues that can be used to describe the environment, as well as different specific cues that can be chosen. For example, both a church and a red brick house may be suitable landmark cues to indicate a point on a route, but one person would choose one and another would choose the other. This indicates that personalisation of cues may be useful, adapting the cue types provided and the specific cues used to the individual user.

Cue personalisation is likely to be particularly useful for older people. The wide variation in the older population in terms of experience and both perceptual and cognitive abilities [6] means that a single cue set is unlikely to be suitable for everyone. Personalised cues can exploit what individuals already know and what they find meaningful and attention-grabbing.

There are two dimensions of personalisation of relevance here: personalisation of content, as we have just discussed, and personalisation of presentation. Modality stands out as a particularly important aspect of presentation, as discussed in Section 3.2.5. Our investigation will centre on assessing the value of cue content and modality personalisation for older users.

The design space is helping to further define our study. At this point, we have fixed the type of service and location information to be examined in our study (see Sections 3.1.1 and 3.1.2). A navigation-type service is more suited to a study of cues, as they can be used to guide the user along a route. This kind of service uses and provides mainly route information. Other core functionality issues, such as uncertainty and approximation (Section 3.1.4), are not so closely connected to cue effectiveness, although the accuracy of the user's location may be significant, depending on the types and size of the cues and the way in which they are provided.

We are just starting to tackle the role of delivery issues (apart from modality) and context of use.

6. CONCLUSIONS AND FURTHER WORK

This paper has set out several key questions and issues in the design of location-sensitive aids for older people, considering their impact on core, delivery and context aspects. These have been discussed using previous results and observations from our preliminary investigations. Difficult questions, possible answers and possibilities for further work have been highlighted and the challenges of working in this context with older people discussed. We will investigate some of these issues in greater depth as we develop and evaluate a navigation aid for older people, offering personalised navigation cues.

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