Designing Leisure Applications for the Mundane Car-Commute

Karl-Petter Åkesson[1] and Andreas Nilsson[2]

[1]*Swedish Institute of Computer Science, c/o Viktoria Institute, Göteborg, Sweden;* [2]*Viktoria Institute, Göteborg, Sweden*

Abstract: Commuting by car from home to work can be very time consuming. We have conducted a study to explore what people are doing, and want to do, while commuting. People use their time in the car on a wide variety of activities with great innovation. There was no unanimous activity that everyone wanted, rather a wide variety of activities were requested. Three different categories of activity were identified which we refer to as mundane, vocational and traffic related. To demonstrate a possible IT service supporting commuters, a prototype based on speech output and a simple input mechanism from a wheel was developed. This service moves sampling of music from the conventional shop into the car. The prototype was informally tested with users, which resulted in a number of improvements. Preliminary user results indicate good functionality, a comprehensive interaction interface.

Keywords: Audio interface; Commuter; In-car application; Tangible input

1. Introduction

Growing cities with company employees residing outside the city centre often require that we commute between home and work. This activity becomes a daily routine, involving driving at the start and end of each day. Consequently, many of us spend time in a car or other means of transportation. Therefore, one may deem time spent on travelling long distances to work as unproductive and wasteful. The environment surrounding the car-commuter leaves much to be desired in terms of supplementary activity in addition to driving.

This paper explores the context of commuters and potential IT support to improve the situation. The challenge within the car context is to provide the commuter with supplementary activity using IT in a way that does not interfere with safe driving. Hence, few 'traditional' settings where mobile devices or computers are used can really be compared to in-car use with regard to safety aspects. There is a long tradition, both in the car and avionics industries, among others, to design a safe and useful driver environment. However, in this paper our purpose is to explore how the car-commute situation can be augmented with additional activity in terms of interactive IT services, and not to study in-car computer interfaces. A full evaluation of issues regarding the use of our application ShoutCar is beyond the scope of this paper. This remains to be further studied in the future work with ShoutCar.

2. IT as a Component of all Cars

Today there is some sort of embedded computer in almost every car, but the use of these computers is quite different from those we have on our desks or in mobile devices. These computers have a dedicated purpose in the car, and we rarely notice that they are there as they are embedded into the car and used to control different features of the car, such as fuel injection to the engine or the force applied to the brakes in an anti-spin system. Some are more visual than others, such as on-board navigation systems, but these are still dedicated in their task.

Recently, the use of computers in cars has changed, with the appearance of services influenced by the desktop computer. As in-car computers become more available due to smaller size, less power consumption and wireless networks becoming ubiquitous, we are convinced there will be an explosion in the number of applications for in-car use. Companies demonstrate prototypes of general-purpose computers

Personal and Ubiquitous Computing (2002) 6:176–187

(e.g. Sun and General Motor's Java Car [1]), and Microsoft and Clarion have already released a product, AutoPC [2], a general-purpose computer running the Windows CE operating system. When major car companies envisage the future car, a general-purpose computer with Internet connection is always included, but we rarely hear what kind of applications will run on them. We wanted to find some of these applications that are of daily interest, but which do not directly relate to driving.

Today, on-board computers are mainly used for supporting the driver to perform the driving task, e.g. indicating fuel consumption, giving average speed, helping the driver to find the right route. We wanted to move beyond the scope of the actual driving task, and therefore decided to concentrate on car commuters that do not need the same support as other drivers, mainly because they know their daily route by routine. For them, the driving as such is no pleasure, and they would thus be a suitable target group who would welcome new kinds of services.

We wanted to explore the design implications for services that would be of daily interest to most car drivers and would run on a general-purpose car computer. In this paper we present a study of car commuters with the purpose of finding out what they do in the car while commuting, and what they would like to do. Based on empirical data, an application aimed at this group has been developed to demonstrate one method of future use. We have developed an application that provides alternative activity in the car, although the full effects on safety and interface use will need extensive experimenting and testing.

Designing for in-car use is a new challenge for computer-human interface designers and researchers. Our main design criterion was to keep it simple and well structured. To avoid any visual disturbances, only audible feedback was used. In the next chapter we discuss and reflect upon related projects, cases and applications relevant to this research. This is followed by a summary of our research approach. Further, we outline the context of commuting by car based on data from our fieldwork. We then give a brief presentation of our prototype system, ShoutCar. After we have described our application, we illustrate the use of this service with a scenario. Finally, we discuss and reflect upon preliminary results, findings and outline future work.

3. Related Work

Within the Human-Computer Interaction (HCI) community, researchers have just recently started to look at the design of applications for in-car use. CommuterNews [3] is such an example, where the Stanford Persuasive Technology Lab has developed a prototype for presenting daily news stories in the form of multiple-choice questions. The goal of CommuterNews is to actively engage the driver while gathering news. This goal highlights an interesting issue, the difference of traditions in interface design. From a car designer's perspective, the goal of CommuterNews is questionable, as the driver should not lose concentration on the task of driving [4]. This makes the design of an in-car application for a general-purpose computer an interesting meeting point of HCI design and Human-Machine Interface (HMI) design for in-vehicle systems. Researchers from the latter branch have a main objective: to make the car and the transportation as safe as possible. On the other hand, HCI researchers have other objectives, such as more effective use, more pleasurable experience or ease of understanding [5, 6]. At first glance, these objectives can seem to be contradictory, but in the long run the design has to achieve objectives from both communities. There is a long tradition, both in the car and avionics industries, among others, to design a safe and useful driving environment, and guidelines have been compiled as standards for these kinds of environments [4, 7–11]. These guidelines range from common sense to rigorous, precise statements. Until principles have been developed in this new field, these standards should be followed, but conflicts that arise should be debated among members from both communities, and though this is not the aim of this paper, others have started addressing these issues [12].

Speech technology is already used for in-car development, and is the most obvious choice of interaction when ones eyes and hands are occupied most of the time. The recommendations tell the designer not to use speech recognition alone, other than for a restricted range of non-safety functions [12]. This is mainly based on the non-foolproof recognition rate of the systems. However, studies of car phone usability indicate better driving performance for voice-operated services over hand-operated ones

[13]. On the other hand, HCI research indicates that spoken commands demand a higher cognitive load on the user than hand input [14]. Studies of speech interfaces in cars have also indicated driver distraction while using them, but have not made a distinction between spoken word and listening [15]. We have tried to address this to some extent in our design by having a tactile input device and spoken output.

Today, speech interfaces for computer software have become mature technology, and are an established media for interface design. Speech technology has become easily accessible for developers, and does not only exist in research labs around the world. It is available for several well known development platforms or operating systems such as Windows [16] and Java [17]. Guidelines for developing speech-based applications can both be found from industry [18] and academia [19–21]. Several commercial software products use a speech interface, like Philip's FreeSpeech, and we can find these in almost any computer store today. Speech interfaces are also used in several daily services, such as phone-based train-ticket booking or e-mail and message access (e.g. VoxWay's [22] or Wildfire [23]). Both computer generated or pre-recorded voices are used as output, e.g. phone banking or car navigation. The quality of computer-generated voices has reached a level that is quite easily understood by most people, but pre-recorded voices are still preferred if possible [18, Section 3.3.4]. Research indicates that spoken help is beneficial in a vehicle over visual guidance [24]. Speech recognition for input is mainly used in telephone-based services. Even though it has not reached the same maturity as computer generated voices, it is used in products like Clarion's AutoPC [2]. On the other hand, a speech interface, along with a more traditional car-radio interface based on buttons and graphics, allows the user to interact with the system.

4. Research Approach

The research reported in this paper originates from the field of *informatics*, which constitutes the exploration of information technology use. It is a research perspective with a pluralistic paradigm tradition, although the dominating interest has been the creation and refinement of system development methods. Recently, the conception of informatics research has been framed as a *design oriented study of information technology use with the intention to contribute to the development of both the use and the technology itself* [25], which has influenced much of the informatics community. The information technology studied has primarily been of a stationary nature (e.g. desktop computers), but as mobile information technology becomes a part of our daily life, both vocational and mundane, a new field of research has emerged, referred to as Mobile Informatics. Hence, the focus within Mobile Informatics is to study people in diverse mobile contexts [26]. The rapid increase for IT businesses (handheld terminals with wireless network connectivity) implies that use of IT is changing towards increased mobile use. This change applies to work related situations, the way we travel to and from our workspaces, and to more mundane activities.

This research is guided by a generic three-phase research approach [27, 28]. Phase one is an ethnographically inspired field study with the aim of achieving an understanding of the research context, inspired by 'Quick-and-Dirty-Ethnography' [29]. This understanding will then serve as an input for the second phase. Implications and input from this investigation are reported in Section 6, where we describe and discuss the context. Phase two is the design of a mobile application or service based on the findings in phase one. Before taking the design into the third phase, where it is to be evaluated, a number of design iterations were carried out to identify and correct early problems. The evaluation was carried out in the same context as phase one. When discussing empirical work and studies concerning the use of IT, ethnographical studies are often mentioned and used. Observations can be carried out quite easily at a distance with approval from the participants. Given the fact that car-commuters are distributed both in time and space, it is hard for the researcher to actually record the activities without accompanying the driver in the car. During our empirical work, we have learned that this is not the sole constraint in studying the car-commuter. Socially the car is a very private environment, especially for a sole commuter. Hence, it is likely that if a researcher was present, the privacy and time alone to reflect upon things would be disturbed. As a result, on the one hand we decided to conduct relaxed interviews with the car-commuters out of the car as one part, and on the other hand we discussed car commuting in focus-group sessions.

5. Study of Commuters

To gain preliminary insights, a number of commuters were invited to discuss their travelling habits. More precisely, six participants were invited, of which two were female and four male. Their ages ranging between 25 and 65 and they all lived near Gothenburg, Sweden. Most of them spent more than 30 minutes travelling by car between home and work. Eventually interviews were carried out with six other commuters, of which two were female and four male, with an age ranging between 23 and 40. Focus group discussions and interviews indicated that people are already carrying out a variety of activities, such as singing and listening to music. The participants were quite innovative about how they used the time they spend in the car. It provided an opportunity for relaxation, and it was also a time to reflect. Some used their time to listen to the radio, especially the news, as they did not have time to read a newspaper in the morning. One woman devoted her time in the car to one of her hobbies; she practiced choir singing and had a tape with her part. To use a mobile phone was quite common, though someone hesitated to use the phone, as she did not have a hands-free device installed. One man used to call home to get a shopping list and then pass the supermarket before going home. Someone else used a mobile phone to maintain his social network, to keep in contact with friends, specifically those who were commuting as well.

All participants expressed a dislike for rush hours and traffic congestion. One man called colleagues that he knew were 5–10 minutes ahead of him to ask about the traffic situation so he could contemplate an alternative route. To have alternative road choices was quite common, and the decision of which one to take was made while driving based on the current traffic situation. Someone had tried to use public web-cameras [30] that monitored major junctions, but by the time he got there the situation had usually changed – mainly due to the fact that he could only access these cameras in the office, and it took almost 20 minutes to get to the specific junction.

One of the most interesting findings is the difference in activities when going to work and going home. Both from the interviews and discussions, it was found that in the morning when going to work people thought about work. They used the time in the car to plan the day, to call colleagues to synchronize and schedule events. The activities were mainly work related, and on the way back home it was more leisure related, calling a friend or planning the weekend (see Table 1). A remarkable comment from one of the interviewees was that he had noticed a difference when he was sharing the car with colleagues. The type of activities were reversed: on the way to work they talked about leisure (e.g. what they had done the evening before), and on the way from work they continued a discussion that had started in the office, talked about a problem that had emerged during the day.

Table 1. Categories of commuter activities

Categories	Examples	Typical direction of use
Vocational	Read documents	Going to work
Mundane	Keep contact with friends	Going home
Traffic Related	Traffic situation at a certain place	Both ways

When asking people about the kind of things they would like to do if more or less anything was possible, people still thought that a graphical display was necessary to achieve most traditionally computer related tasks, like reading a document or taking notes, and thus believed such tasks would interfere with driving. Explaining that text could be read with the aid of a computer-generated voice and that sophisticated speech recognition existed today changed their focus. Some asked for services like having the news read, taking notes, reading books or documents. Some participants said that they would like to record spontaneous thoughts or ideas. When discussing music with one of the interviewees he expressed the lack of time to buy new music. He did not have time to go to the music store and sample music there as he had used to do. Now, family and work took a lot of his time, but he had enjoyed this activity. Subsequently, he wanted to be able to do that from the car and to be able to purchase music as well.

One participant said that they would like to know if friends or colleagues were in their car at the moment, and if they were busy or not. If they were not busy he would then be able to call them without disturbing them. This would be similar to the awareness mechanism several different instant messenger systems provide [31]. Another idea was to be able to prepare or actually do the daily shopping from the car, and then just pass the supermarket to pick up the goods. Also, reading and replying to emails was something people thought would be useful.

There was a large diversity in the actions people were already carrying out today, but also in the services they would like to see. There was no single thing that the majority wanted to have. This emphasized the need for a general-purpose computer where people install whatever services they like. However, we have found that these can be divided into three different categories: vocational, mundane and traffic related (illustrated in Table 1). Examples of vocational services would typically be information centred, e.g. reading documents, taking notes. Planning of activities was also found to be important. The mundane part was mainly concerned with communication, such as maintaining contact with friends and family. The traffic related services were situated in the commuting setting. In this case, the driver did not need to find the route. Instead he or she wanted decision support on which route to take.

6. Context of the Car and Commuters

In this section we give a brief outline of the context that surrounds the car commuter based on data derived from our empirical work.

Unlike many mobile settings [26], the car context involves a great emphasis on safety issues. This section aims to shed light on some distinctions between rather conventional mobile settings, where IT is used, and the car.

Research has shown how mobile phones and other devices can influence safety [13, 32], and most of us recognize how hard it is to remain focused on the traffic when changing radio station, hence the latest car models have car stereo controls embedded in the steering wheel. Also, speaking to someone over a mobile phone has been proven to affect driving [33], and it has been debated if driving while using a phone should be forbidden. Several European countries now have laws constraining the use of mobile phones in a car environment. The use of a mobile while driving may result in a fine, yet at the same time you are allowed to talk to passengers.

Statistics [34] show that people spend quite a lot of time commuting: the average Swede spent 65 minutes per day travelling between home and work in 1999. In this paper, we have defined the notion of commuting as someone driving a car on a daily basis between home and work spending approximately 60 minutes in total. The commuter does not need help to find his way – the road he takes every day is familiar, he knows how to get from home to work and back. He even knows such things as where congestion usually appears. What he needs to know are abnormalities and instant information, such as a car accident with a traffic jam as the immediate consequence. Information that is more static is gathered over time through the experience of driving the same way each day.

Tasks on a desktop computer are not limited in time or by visual attention, but in the context of the commuter he or she can only spend a certain amount of time on one single task [4]. However, on the other hand, the road as such is a meeting place. The driver meets and communicates with other drivers or people on and around the road, i.e. sounding your horn at a pedestrian or waving to the fellow car to go first. The communication between drivers or others within the vicinity of the road is described as some sort of social interaction essentially to achieve co-ordination [35].

7. ShoutCar Design Limitations

Within the interviews a number of different applications were suggested. The project, due to time constraints, focused on a single prototype. To be able to implement more services in the future, we wanted one that had similarities with other services found in the study to be able to create a platform. Several participants had mentioned that they used the time to relax, which we found an appealing design challenge. It is common for people to listen to music in the car [36], and as one asked for sampling of music in the car, we decided to develop a service that would address this issue.

To be able to implement more services in future, we deliberately aimed the design at a platform level. As the car is such a different usage environment, careful decisions on output and input media had to be made. As noted earlier, studies of car phone usability indicate better driving performance for voice-operated services over hand-operated ones [13], but on the other hand, HCI research indicates that spoken commands demand a higher cognitive load on the user than hand input [14]. Studies of speech interfaces in cars have also indicated driver distraction while using these interfaces [15]. Our conclusion of these results is that a sound output only interface is the most feasible in a car, rather than a system combining visual and audio output.

Speech recognition today does not provide 100% recognition rate, and never will, especially in a noisy environment such as a car [37]. Our prime design criterion was to achieve a simple and easily understood interface. The conceptual model has to be easily understood [5], and the input-manipulation direct [6]. Therefore, we decided on having a simple mechanical wheel as the only input device, and not using speech activation. Although introducing yet another control device into the car is not desirable [12], one can imagine this device as the only control device for a large number of services, as envisioned by BMW and their iDrive [38].

Spoken help for the car stereo has proven to be successful [24], and having audio-only output for a music application was natural and minimized the necessary eye-glances towards the systems, thus providing a much safer application. The application we have developed is called ShoutCar, and it aims to provide the commuter with an online music store that makes it possible to sample music while commuting. By making the service based on web pages, it would be easy to change and develop other services such as an email client or a daily news provider. The following scenario describes a typical use-case of ShoutCar.

8. Usage Scenario

Christmas is just round the corner, and as usual it is a very hectic time for Lucy. But the holiday will be nice and relaxing. Lucy would like to have some new music to listen to during the Christmas week, but there is no time to go to the music store and listen to the latest albums. Luckily she has just got a ShoutCar system installed in her car, so why not give it a try? At the office, just before leaving, she logs on to ShoutCar using a web browser and looks through the list of the latest albums. She finds a new album by her favourite band, which she never thought would do another release. Old memories rush through her mind and she puts the album in her virtual shopping cart together with another album and two singles that appeal to her. Before leaving for the car she logs out of the system, which stores her choices until next time she logs in.

After Lucy has joined the motorway and left the most hectic parts of town behind, she starts the car client of ShoutCar that automatically logs her on to the server over the Internet (see Fig. 1). With a small wheel placed on the steering wheel, which can be rolled and pressed, she can now navigate and select music from her previous choices made in the office. These choices are presented to her by a sound interface. By rolling the wheel she moves upwards or downwards through the menu hierarchy of albums and tracks, and by pressing the wheel she selects or activates the current alternative. The different choices are read back to her via a computer-generated voice, so her eyes do not have to leave the road while she is using the application. Actually, the car client has no graphical interface at all. To eliminate distraction the wheel is placed at a position that is easy to reach while driving the car, like the steering wheel. Lucy selects one of the singles and starts to listen to it. It was not quite what she had expected and she moves on to listen to the next one. This single is much better and she marks it 'buy' in ShoutCar by selecting the 'buy'-menu alternative for that single. Then the time has come for her old favourite band. Suddenly she realizes that she is at home. The music is so good

Fig. 1. ShoutCar prototype in a car with user.

that she gets carried away. She must buy that album and uses ShoutCar again to mark the album before leaving the car and going inside. On the way to the front door, she starts to plan what albums she could listen to tomorrow, and just before opening the door she takes a look at the clock. Until then, she had not been aware of the fact that the drive home took 10 minutes more then usual due to traffic.

9. The ShoutCar Implementation

The ShoutCar system consists of one server application and two different clients to access the same information stored on the server (see Fig. 2). The server is a standard web server, which accesses information about different CDs from a database. The server also stores other information such as the actual music converted into mp3 and scanned covers of the CDs. One of the clients is an ordinary web browser, and the other is a specially designed audio client that uses only audio for output and a very simple input mechanism. The main purpose for using two different clients to access the same information is to use an appropriate client in the current context. Browsing and selecting music requires a lot of user interaction, and it is therefore desirable to have as little as possible of this type of interaction in the car. In a stationary setting where one's visual perception is not occupied with other tasks, a traditional graphical interface like a web-browser works quite well, but not in a setting where someone is driving a car and the most important task is to drive the car safely.

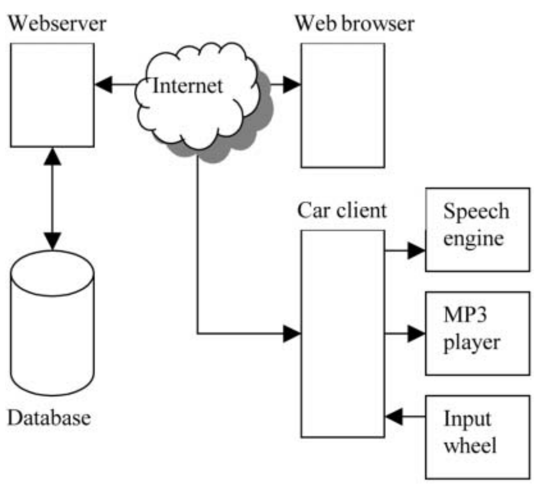

Fig. 2. The different components of the ShoutCar system.

Through the browser one can access the website that could potentially be part of any online music store (see Fig. 3). After login, the user is presented with a list of the latest music, which could be matched to his/her preferences, but for evaluation purposes this was not necessary. From this list of music the user can select any number of albums that he/she finds interesting. These selected albums are the ones that the user accesses through the sound-based interface later in the car. This pre-selection reduces interaction, and keeps as much as possible of it away from the driving situation. The web browser also makes it possible to listen to the albums while not in the vehicle. As this is not a commercial product, we have not put any effort into solving copyright or financial issues. At the moment, the user can listen to any album any number of times, but one could easily imagine in a commercial scenario that the number of times a user can access a certain album is restricted, or the quality of sound is reduced.

The audio-based client is based on a laptop running the software to which the input device and the car audio-system is connected. The laptop also has a wireless Internet network connection that allows a 1 Mbit download rate so the music can be streamed from the server. To minimize the user interaction in the audio-based

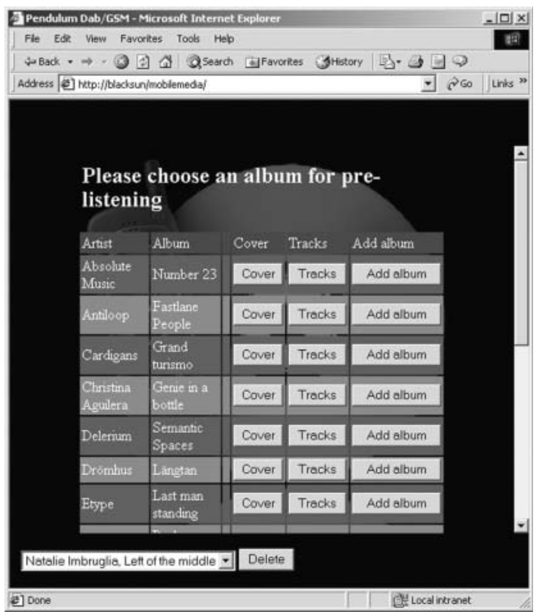

Fig. 3. The web browser interface to be used in more stationary settings.

client, only three types of inputs are possible: navigate *up or down* in a menu structure, or *activate* a menu item.

This type of input is performed with a small wheel, which one can roll in two directions (up or down) and push (activate). This input device is manufactured from a normal wheel-mouse, like Microsoft's IntelliMouse that is taken apart and put into a plastic box where only the wheel part sticks out through a hole (see Fig. 4).

To generate a menu structure for the music, the same web pages from the server are used. Each URL or link becomes an element in the menu, and the action for each element is dependent on what the URL indicates. All other text on a web page is supposed to be guidance information to the user, and is therefore always read to the user each time a page is accessed. The menu hierarchy has two levels: the topmost is a list of the chosen albums, and the bottom one is the tracks for each album (see Fig. 5). Under each album is a list of the tracks from that album. The wheel is used to move up or down these lists, or to select or activate a certain element by pressing the wheel. Whenever the user navigates to a menu element, the synthesized speech function is activated and the menu text is heard through the speakers. When reaching the end points, the top or bottom position, an alert sound is played to indicate to the user that he/she has reached the end.

The application is designed to run with Digital Audio Broadcasting (DAB) as the data network carrier. However, the protocol and DAB network is still immature and unstable. Thus, we tried to avoid network interference and disturbances by not using the DAB network during the first pre-evaluation period. This was accomplished by

Fig. 4. The small wheel built on parts from a mouse.

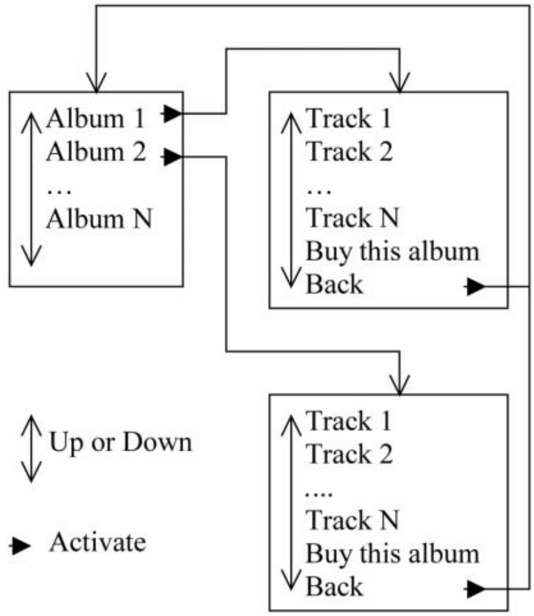

Fig. 5. Navigating through the structure of the menus.

excluding the wireless networking capabilities. Consequently, a laptop hosted both the server service and client software.

10. Design Iterations

To fine tune the design of the audio interface a number of design iterations were carried out. Feedback on the interface was collected during several sessions at different public fairs and exhibitions, and in-between improvements were implemented. At most 200 people tried out ShoutCar on these occasions, where the system was not used while driving, not even in a car. However, these informal user tests provided very useful information regarding the actual interaction and structure of the application.

The users were initiated with a brief introduction to the system, and its purpose and functionality. Depending on the occasion, they either accessed the web browser over the Internet or directly from the laptop. After selecting a number of albums they used the audio client to browse and listen to them. By standing next to the user and observing their interactions with the system, the designers gathered information about which parts of the systems worked and what kinds of improvement were needed. Several minor problems, described below, were found that mainly related to the audio client and how information was presented.

The input wheel has distinct positions, but at the same time it enables the user to pass several positions instantly by rolling it further than one position. Early on in the process it was realized that this made the speech output queue fill up too quickly, and it would take a long time before the user's current selection was located.

Therefore, the speech output had to be interrupted if the user left a position. Without interruption the user could not manipulate the interface in a direct manner due the slow nature of sound for transmitting information. Others had also reported the need to interrupt speech [19]. With interruption it became possible to skip several positions to briefly navigate the lists, i.e. a user who wants to reach the end quickly spins the wheel a couple of times and waits until she hears where she ended up, which usually was at the end.

It was also discovered that it was important to indicate for the user where in the hierarchy she was. Changing the order of items helped the user with this, and it was also possible to browse the lists more quickly. Instead of just giving the name of a track, the system first says 'track', followed by the track index and the title of the track. For albums the systems says 'album', followed by the index of that album in the list of albums, and finally the title. By always saying either 'track' or 'album' first, the user knows where in the hierarchy she is. With the following index the user knows where in the list she is, and thus can browse the list more quickly.

It was also necessary to indicate when the end or start position of a list were reached, which was achieved by explicitly playing a certain alert sound. By making it easier to find either the start or end of a list, it became a natural position for functions like going up one level in the hierarchy or marking an album as interesting to buy.

Another problem encountered that was not possible to solve was that users sometimes found it hard to understand the computer-generated voice. However, a music album that was known to the users was said to be easier to recognize, even though pronunciation faults made some titles or tracks very difficult to identify.

11. A Brief Evaluation

To get a preliminary indication as to whether this kind of interface worked in a car setting or not, and how a driver would experience the service, a small informal evaluation was conducted. It was performed with only three people, of whom two were male and one was female. Their ages ranged from 24 to 28. The participants were given an initial description; proceeded to make the selection of albums, and a laptop with client software was installed into the user's own car for a test drive. All the vehicles had manual transmission. During the short drive, approximately for 25 minutes in an area well known to the drivers, there were also two researchers present in the car; one in the passenger seat next to the driver holding the laptop with the car audio client. The input device was connected to it and the driver decided where to put the box with the input-wheel. The researcher next to the driver assisted him by correcting possible equipment errors and by giving short instructions, if needed. The second person sat in the back seat and took notes on what questions were asked, and other comments or observations of a user's actions that were made during the session. He also surveyed the test user's behaviour with the application with regard to different traffic situations. Afterwards, an interview with the participants was conducted.

None of the drivers who took part in the evaluation had any problems in learning how to use the wheel and the system. We observed that at the beginning of a trip, the driver only operated the service on straight roads or low intensity situations. Further on, after using the wheel for a couple of minutes, most of them learned to operate it quite well, and eventually managed it while manoeuvring around corners and intersections. This was indicated by the drivers, who said it was a bit strange at the beginning, but once you understood how it worked, usually after a couple of minutes, it was easy to use, and they felt safe enough to use it.

The drivers also stated that they found the speech interface non-intrusive on their driving. They claimed it worked much better then the ordinary stereo, and they specifically liked the feature that when left alone it remained silent. Since the degree of attention that the driver can spend on operating a service in the car varies depending upon the traffic situation and other surrounding factors, the ShoutCar system behaviour only gives feedback and output upon the user's initiative. This behaviour was much appreciated in demanding traffic situations, and the drivers claimed to be able to concentrate fully on driving and totally ignore ShoutCar as it was quiet and did not demand any attention. Once the situation was taken care of, they could continue where they had left off.

Our preliminary user results also demonstrate that the wheel is easy to learn to control and to recognize physically. It seems that just as drivers learn the shape of the handbrake handle, one can as easily learn the shape and behaviour of the ShoutCar mouse wheel. One of the drivers compared it with his remote control at home. "You don't need to look at the remote to know which button to press. It was the same with the wheel, but better since it was only one thing".

12. Discussion

ShoutCar has been designed for the single purpose of providing car commuters with alternative activities through interactive services with the aid IT. Activities in the car not related to driving can be questionable, but we believe that carefully designed they can actually provide safer driving. By involving the user to some extent in a stimulating activity, we believe this can prevent tiredness, and thus the driver is more alert than while being drowsy. Also, both from our own experiences and those of the users involved, we have the demand of a large variety of activities that can be carried out within the car. We are convinced that when more general-purpose mobile devices become ubiquitous, these will also be used in the car, and therefore their design has to be considered.

The design of the car interface can, of course, demand too much attention from the user, which is not desirable. Before the design of ShoutCar we had already decided not to use any visual information for the interface, as we believe this demands too much attention. Our design has demonstrated that a working application is possible, even though the users requested improvements to the speech generation. While evaluating a number of different speech activation systems, we experienced frustrating failures due to poor recognition rates. The indications that speech activation demands a higher cognitive load than tactile input convinced us to use a tactile system, even though one can quite easily simulate a reliable working speech recognition system. During the project we have come to believe even more in tactile interfaces in combination with sound output, mainly due to its unobtrusiveness, though this has to be verified by formal studies.

Regarding in-car application design, we believe it to be important to involve users in the design through co-operative design, in the same way that has proven to be successful both in traditional HCI design and in the area of mobile informatics. The users are experts in their environment and, regarding in-car design, are well aware of the risks of introducing more in-car gadgets.

13. Conclusions and Future Work

The scope of this article has been to explore the possibilities of supporting and providing car commuters with alternative activity, while driving with the support of IT. To accomplish this we have studied and interviewed car commuters travelling from home to work on a daily basis. Based on our empirical data, we designed ShoutCar, an interactive service for listening to sample music. This service functions as a virtual way of visiting the music store, choosing potential albums for purchase. The car environment puts interaction issues at the fore, and our preliminary user results show that the ShoutCar service interface is easy to learn and operate. In the design of the interface, we have taken the high priority of visual attention on the road into consideration, hence the mouse wheel. Other important features are the speech feedback, and that the system remains idle until the user interacts with it.

Throughout this work we have documented the room for alternate activities among car commuters while driving that can be divided into three categories: mundane, vocational and driving related. The focus on the driving commuter raises interesting design challenges that we have pursued and investigated. Our very preliminary results show that the control and operation of an in-car service through a small wheel interface simultaneous to driving the vehicle does work. However, this of course needs verification by rigorous usability testing and extensive safety experiments.

Further evaluation of the system has to be conducted before anything definite can be said about its suitability. It is necessary to compare it with other forms of interaction, such as speech activation, but preliminary studies indicate that a tactile interface is superior to a speech activated one. An extensive experimental phase is also needed to refine the system. This phase should include an exhaustive exploration of safety issues regarding application use in a car environment.

Acknowledgements

This research was part of the Mobile Informatics program, which was funded by the Swedish Information Technology Research Institute (SITI). We would like to acknowledge the interviewees, our reference group, our industrial partners Cell Network, Ericsson, FramFab and Teracom, and our colleagues at the Swedish Institute of Computer Science (SICS) and the Viktoria Institute. We are also grateful to Stefan Schmidt who let us use his software for controlling the WinAmp mp3-player software.

References

1. Heiss J. Network is the Car Driven by Java Technology. http://java.sun.com/features/1999/06/concept_car.html (last visited 2000-11-01)
2. Clarion's AutoPC, Product web page http://www.autopc.com/ (last visited 2000-11-01)
3. Tester J, Fogg BJ, Maile M. CommuterNews: A prototype of Persuasive In-Car Entertainment, In Extended Abstract of the Conference on Humans Factors in Computing Systems (CHI2000). The Hague, Netherlands 2000;24–25
4. Ito T. Japan's Safety Guideline on In-Vehicle Display Systems. 4th World Congress on Intelligent Transport Systems Proceedings, Berlin, Germany 1997
5. Norman DA. The Invisible Computer. MIT Press, Cambridge, MA 1998
6. Shneiderman B. Designing the user interface: strategies for effective Human-Computer Interaction. 3rd Ed. Addison-Wesley, Reading, MA 1998
7. European Statement of Principles on Human Machine Interface for In-Vehicle Information and Communication Systems, Telematics applications for transport and the environment, Telecommunications, Information Market and Exploitation of Research, Directorate-General XIII, European Commission, Final Version 12/05/98
8. Campbell JL, Carney C, Kantowitz BH. Human Factors Design Guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO). Technical Report FHWA-RD-98-057. U.S. Department of Transportation, Federal Highway Administration, Washington, DC 1997
9. Ross T, Midtland K, Fuchs M et al. HARDIE Design Guidelines Handbook: Human Factors Guidelines for Information Presentation by ATT Systems, Commission of the European Communities, Luxembourg. 1996
10. Green P, Levison W, Paelke G et al. Preliminary Human Factors Guidelines for Driver Information Systems. Technical Report UMTRI-93-21, Transportation Research Institute, The University of Michigan Ann Arbor, MI 1993
11. Stevens A, Board PA, Quimby A. A Checklist for the Assessment of in-Vehicle Information Systems: Scoring Proforma. Project Report PA3536-A/99. Transport Research Laboratory, Crowthorne, UK 1999
12. Burnett GE, Porter JM. Ubiquitous computing within cars: Designing controls for non-visual use, International Journal of Human-Computer Studies 2001;55(4):521–531
13. Serafin C, Wen C, Paelke G, Green P. Car phone usability: a human factors laboratory test. Proceedings of the Human Factors and Ergonomics Society 37th Annual Meeting, 1993;220–224
14. Karl L, Pettey M, Shneiderman B. Speech-activated vs mouse-activated commands for word processing applications: an empirical evaluation. International Journal of Man-Machine Studies 1993;39(4):667–687
15. Lee JD, Caven B, Haake S et al. Speech-based interaction with in-vehicle computers: the effect of speech-based E-mail on drivers' attention to the roadway. Internet Forum on Driver Distraction, NHTSA 2000
16. Microsoft Speech API. Product web page http://www.microsoft.com/speech/ (last visited 2000-11-01)
17. Java Speech API. Product web page http://java.sun.com/products/java-media/speech/ (last visited 2000-11-01)
18. Designing Effective Speech Applications, In: Java Speech API Programmer's Guide http://java.sun.com/products/java-media/speech/forDevelopers/jsapi-guide/UserInterface.html (last visited 2000-11-01)
19. Yankelovovich N, Lai J. Designing speech user interfaces. Proceedings of ACM CHI Conference on Human Factors in Computing Systems (Summary) 1998;131–132
20. Yankelovich N, Levow A, Marx M. SpeechActs: issues in speech interfaces. Proceedings of ACM CHI'95 Conference on Human Factors in Computing Systems 1995;369–376
21. Shneiderman B. The Limits of Speech Recognition. Communications of the ACM 2000; 43(9):63–65
22. Voxway AB. http://www.voxway.com (in Swedish) (last visited 2000-11-01)
23. WildFire Communications, Inc, http://www.wildfire.com (last visited 2000-11-01)
24. De Vries G, Johnson G. Spoken help for a car stereo: en exploratory study. Behaviour and Information Technology 1997;16(2):79–87
25. Dahlbom B. The new informatics. Scandinavian Journal of Information Systems 1996;8(2):29–48
26. Kristoffersen S, Ljungberg F. Representing modalitites in mobile computing. Proceedings Interactive Applications of Mobile Computing IMC'98 1998
27. Fagrell H. Method. In: Mobile Knowledge, Doctoral Dissertation 2000;23–28.
28. Ljungberg F et al. Innovation of new IT use: Combining approaches and perspectives in R&D projects. Proceedings Fifth Biennial Participatory Design Conference 1998;203–209
29. Hughes J, King V, Rodden T et al. Moving out from the ControlRoom: ethnography in systems design. CSCW'94: Proceedings ACM Conference on Computer Supported Collaborative Work 1994
30. Web camera overlooking the Tingstad tunnel, http://www.reab.se/camera.html (last visited 2000-11-01)
31. Nardi B, Whittaker S, Bradner E. Interaction and Outeraction: instant messaging in action. Proceedings ACM CSCW'00 Conference on Computer-Supported Cooperative Work 2000

32. Dingus T, Antin J, Hulse M et al. Human factors issues associated with in-car navigation system use. Proceedings Human Factors Society 32nd Annual Meeting 1988;1:1448–1452
33. Alm H, Nilsson L. Changes in driver behaviour as a function of handsfree mobile telephones: a simulator study. DRIVE Project V1017, Report No. 47. Swedish Road and Traffic Research Institute, Linköping, Sweden. 1990
34. Statistics Sweden, The National Travel Survey (through email correspondence with Rolf Svensson)
35. Juhlin, O. Traffic behaviour as social interaction – implications for the design of artificial drivers. 6th World Congress on Intelligent Transportation Systems 1999
36. Öblad C, Forward S. The impact of music on driving performance: How important is a 'favourite tune'? Research Report 37, Swedish Road and Transport Research Institute (VTI), Linköping, Sweden 2000
37. Russel S, Harvey J. Applications of speech in technology in vehicle based MMI. Proceedings 2nd World Congress on Inetilligetn Transport Systems 1995;2:596–600
38. Into the future on mobile data highways. BMW Group Press Release, October 12 2000

Correspondence to: K. Akesson, Swedish Institute of Computer Science, c/o Viktoria Institute, PO Box 620, S-405 30 Göteborg, Sweden.Email: kalle@sics.se