A New Approach of Using Network Dialog Structures in Cars

Markus Ablassmeier, Bernhard Niedermaier* and Gerhard Rigoll

Institute for Human-Machine Communication
Technical University of Munich
Arcisstr. 16, 80290 Munich, Germany
phone: +49 89 289-28541

{ablassmeier | rigoll}@ei.tum.de

and

*BMW Group
Knorrstr. 147, 80788 Munich, Germany
phone: +49 89 382-30449

bernhard.niedermaier@bmw.de

ABSTRACT

To keep the numerous functionalities in luxury vehicles easily accessible and controllable while driving, sophisticated presentation and interaction techniques are absolutely necessary. In state-of-the-art systems, these functions are presently realized in a predominant hierarchical menu structure on a central car-display. Thus, several operation steps are required to reach a function X from a function Y. In this context, network dialog structures, as for example the link-based internet, can allow great simplification. For this reason, three different concepts have been developed and exemplarily implemented in a human-computer interaction concept: contextual, parallel, and user-defined menu and function access.

In a usability study it has been approved that these three techniques of network menu access achieved great time savings in interaction. An average time saving of 32.5% compared to the use of hierarchical menu structure has been reached. A significant higher distraction effect from driving has not been noticed.

Keywords: network menus, links, contextual, handling, human-machine interaction, automotive

1. INTRODUCTION

These days, besides the function of merely a transportation system, automobiles take more and more the task of a multi-media and multi-modal information system. Due to the enormous increase of functions, especially over the last ten years, the tendency to integrated menu-driven displays and central handling concepts are unstoppable.

These systems integrate information, entertainment, and communication functions [1]. Communication systems, for example, consist of phone and SMS applications, and the entertainment systems comprises radio, CD-player, and television.

In this case a major problem is the fast retrieval of information and functions. Therefore, the information and functions are mainly structured in a hierarchical, dendriform menu structure. In this regard, hierarchical order requires numerous handling steps in the menu to reach the requested function.

For this reason a new approach of network menu structures has been developed to accelerate and simplify the interaction of the driver with the system, and has been implemented in a graphical user-interface concept for cars.

From: SCI 2004, Ed.: N. Callaos et al., IIIS, Orlando

A further project in this field of information systems was the FERMUS-Project [2], which had been started in March 2000 in cooperation with several industry partners. The primary intention of FERMUS was to localize and evaluate various strategies for dedicated analysis of errors by using various modalities which are mainly recognition-based.

2. BACKGROUND KNOWLEDGE

First of all, some information about menus in user interfaces. Generally, a menu is a list of selectable options, what leads after a choice of the user to a change of the system status [3].

Menu Structure

Usually, the number of options is too large to present them efficiently in a single menu panel. Therefore, it is often necessary to design a menu structure (hierarchical, network, or other logical structure), and to place options into groups. The menu structure is the relationship among a set of menus.

Hierarchical menus are a series of menus which are structured in a hierarchical or "tree-like" manner, where the selection of an initial option leads to another menu containing additional options, until the desired results are obtained. *Network menus* are series of menus structured as a network (consisting of a set of nodes and a set of links connecting the related nodes) providing redundant pathways to either all or some of the menus within the structure.

A special application of network dialogs is the internet. The term *Hypertext* was created by Ted Nelson in 1965 to describe non-linear writing in which you follow associative paths through a world of textual documents [4]. The most common use of hypertext these days is found in the World Wide Web (WWW) pages and is the basis of the internet form today. The user of the WWW follows specially highlighted links on a web page to get from one node to another node within the network (see Figure 1). These links can be intra-, inter- or extrahypertextuell. Intrahypertextuell links connect two areas within one node and interhypertextuell links concatenate two nodes within the same hypertext. Extrahypertextuell links connect two nodes within different hypertexts.

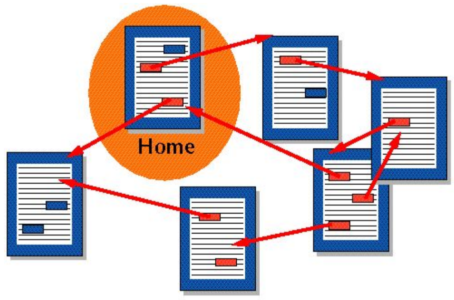

Figure 1 Hypertext links on web pages

Navigation and Orientation Aids

To avoid the problem of “being lost in hyperspace”, especially in network structures, many different solutions have been proposed [5]:

Navigation aids support the user to reach a special information, for example linking, searching, sequentialization, mapping, index, and agents. *Orientation aids* give the user support where he is actually located in the menu structure, e.g. landmarks, breadcrumbs, backtracking and bookmarks.

Widgets

There are several GUI (Graphical User Interface)-methods by which the user obtains menu access on a screen. A *menus bar* for example is a horizontal set of options, usually located at the top of a work area, which invoke lower-level pull-down menus or initiate specific actions. A *pull-down menu* is displayed ("pulled-down") by selecting an option from a horizontal menu (typically from a menu bar) at the top of the screen or window. A *pop-up menu* is displayed ("popped-up") at a specific location on the screen (e.g., near an object or next to a pointer) when a particular condition occurs, a button is engaged, or a command is executed.

There are a lot of other widgets like dialog boxes, icon panels, status panels, pallets, buttons, radio buttons, checkbox buttons, toggle menus, spin boxes, sliders, etc.

From recent research some newer widgets are e. g. alphasliders (see Figure 2) or fisheye menus (see Figure 3) that provide an efficient mechanism to select items form long menus [6].

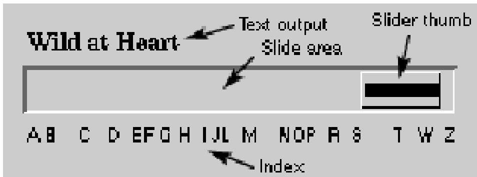

Figure 2 Alphaslider [7]

Figure 3 Fisheye menu [8]

Graphical Visualization Techniques

To present a menu structure to the user, many different graphic visualization techniques exist, e.g., tree view, fisheye map, tree map, hyperbolic browser, cone tree, information cube, and data mountain [5]. They often make use of a zoom metaphor, give the user a graphic overview, and support him to build a mental map of the structure, according to Shneiderman [9]: "Visualization offers a method for seeing the unseen".

Guidelines for Dialog Structures

To improve the usability of an application it is essential to have a well designed interface. Shneiderman's "Eight Golden Rules of Interface Design" [9] are an important guide to good interaction design. These are: strive for consistency, enable frequent users to use shortcuts, offer informative feedback, design dialog to yield closure, offer simple error handling, permit easy reversal of actions, support internal locus of control, reduce short-term memory load.

Several other guidelines are very useful for designing and evaluating dialogue structures:

The ISO 9241 part 10 [10] presents ergonomic dialog principles which apply to the design: suitability for the task, self-descriptiveness, controllability, conformity with user expectations, error tolerance, suitability for individualization, and suitability for learning.

The ISO/DIS15005 2000 [11] describes the ergonomic principles to be applied in formulation of dialogues between the driver of a road vehicle and the information and control system when on the move: The dialog between the system and the driver must therefore take account of the workload on the driver as a whole, including the cognitive, perceptive and physical functions associated with driving, so that the dialog does not prevent the vehicle from being driven properly and safely.

This background knowledge is the basis for the following concept and implementation of using network menu structures for graphical-user-interfaces in cars.

3. CONCEPT AND IMPLEMENTATION

Three different concepts of network menu access have been elaborated in our studies for human-computer-interaction in cars: *contextual*, *parallel*, and *user-defined* function access.

Contextual Menu Access

The first concept idea gives the driver contextual menu access: at any menu item, a specific short pop-up menu can be called directly by pressing an easily reachable option-button, where contextual direct jumps to special menu items are presented and selectable (see Figure 4). After analyzing the user attitudes typical pathways through the menu structure can be presented. To permit easy reversal of actions in network structures, a back- and forward-button in reach to the user has been implemented.

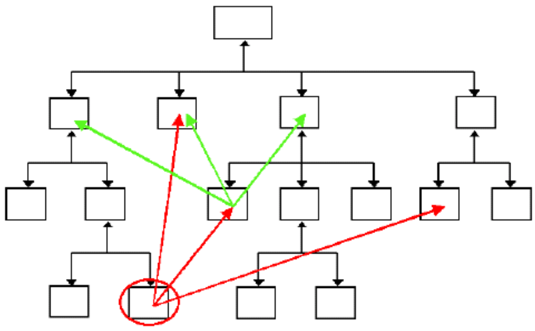

Figure 4 Contextual menu access

The appearing pop-up menu (see Figure 5) is divided into three sections: The first part of the pop-up menu offers the user two context-sensitive functions that are related with the current menu page. In the middle section we allow to jump directly to frequently-used, typical user-paths through the menu. The last section, provides the user with help, and allows him to add the current menu page to the bookmark list (relevant for the following concept idea).

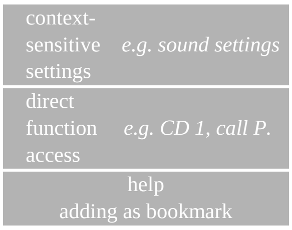

Figure 5 Pop-up menu

User-defined Menu Access
The second concept is based on user-defined menu access (see Figure 6): The driver can jump directly to frequently visited and personal menu items with only one command.

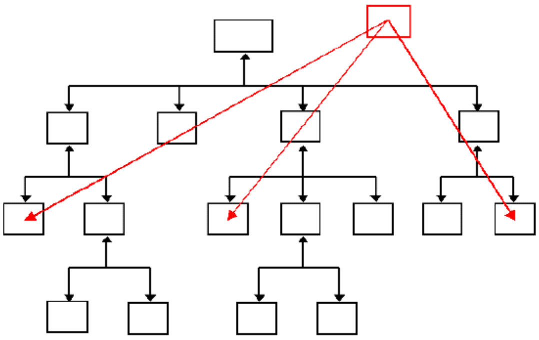

Figure 6 User-defined menu access

In our implementation an individual bookmark list and a history menu can be easily reached from any menu point within one step (see schematic Figure 7). The user can customize the bookmark list through the settings menu or by using the contextual pop-up menus to add the current menu page.

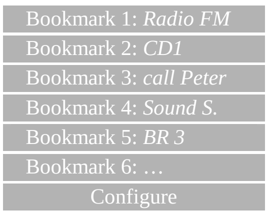

Figure 7 Bookmark list

The history list is generated automatically by frequency of use and user habits.

Parallel function access
The last concept idea provides parallel function access to the user (see Figure 8).

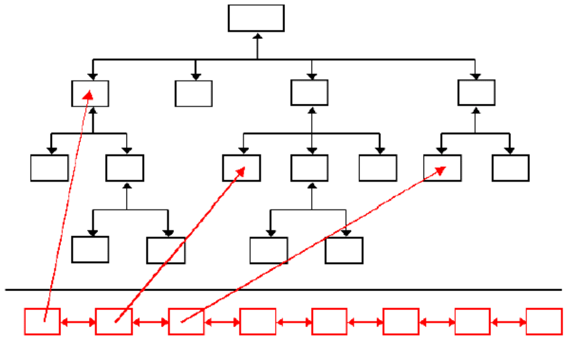

Figure 8 Parallel function access

A navigable icon bar or status string on the bottom of the screen has been presented (see Figure 9). This bar is permanently visible and accessible from anywhere in the hierarchy. It gives the user very fast access to time- and situation-relevant information.

Figure 9 Status bar

Additionally, an optional tree view menu has been integrated on the right section of the screen, to give the user on demand an overview of the menu structure with direct access to the menu pages by selection (see Figure 10).

Figure 10 Tree view menu

These three concept ideas have been implemented with a rapid-prototyping simulation software on basis of an existent driver-information-system simulation.

4. EXPERIMENT

To verify, which concept ideas have a real added value for the driver, a usability examination of the new functions has been arranged. A simulated driving task, the so-called Lane Change Test [12] has been used.
This test was developed within the scope of the project ADAM (Advanced Driver Attention Metrics) for assessing ease-of-use and distraction potential in a reliable,

reproducible and economical manner. The setup consists of a PC monitor, a steering wheel, and a set of pedals. The probands see a three-lane road stretching out before them (see Figure 11). Signs on the left and right sides of the road indicate the lane they should be driving in.

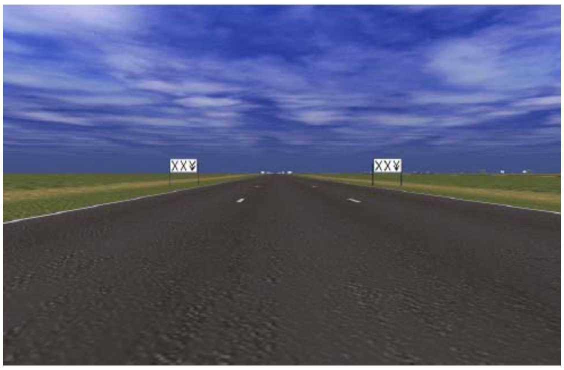

Figure 11 The Lane Change Task

With a special software tool the lane deviation from the ideal course as a measure for distraction and the duration of tasks can be calculated afterwards (see Figure 12).

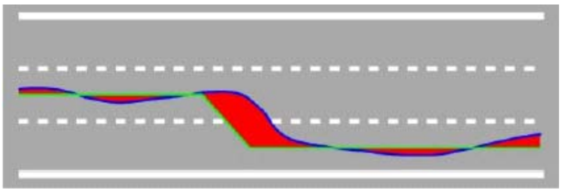

Figure 12 Lane deviation from the set course

The target application has been an infotainment, communication and navigation system, consisting of a radio, CD-player, television, telephone and navigation simulation. As tactile modality, the user was provided with a central controller integrated in the armrest mockup.

For the expert test, 12 persons were invited. They already had experiences with conventional hierarchical menu concepts and had an average age of 34 years.

The test persons had to try the new functions successively while driving: the bookmark function, the navigable status string, and the context-sensitive option button have been tested comparing to using the conventional structure. For each task sequence, they had to proceed one ride by using the new function and one ride by using the ordinary hierarchical menu style.

Afterwards, the persons were interviewed with a questionnaire about handling, acceptance, benefit, and distraction effects.

5. RESULTS

Regarding time data, it shows that through any newly introduced network dialogue function, significant time savings have been reached (see Figure 13): the option button meets an average time saving of 26.5%, the bookmark function reached 35.8% and the status string 35.1%.

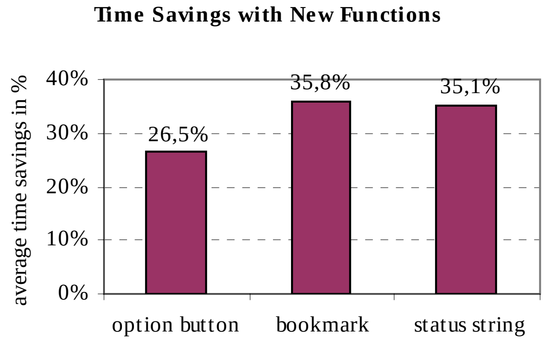

Figure 13 Time savings with new functions

The deeper the menu points are located in the hierarchy, the higher time savings resulted.

With regard to the average track deviation, the new functions evoked no verifiable irregularity. The average relative lane deviation by using the status string, the option-button, or the bookmark function has been 9 % higher compared to the use of the conventional hierarchical menu (see Figure 14). This very small irregularity can be traced back to the test persons being less trained with the new functions.

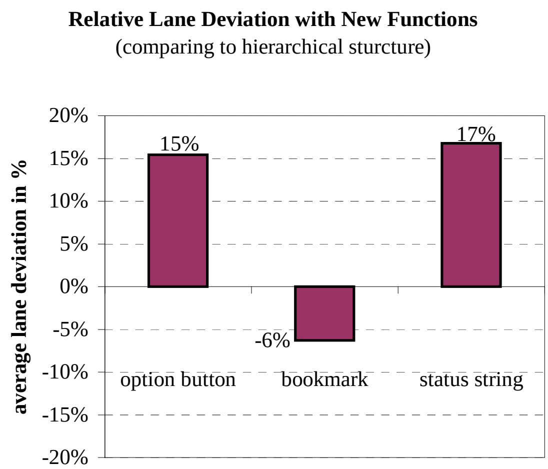

Figure 14 Average relative lane deviation

In the subjective rating, a high agreement of the test persons with the new network functions has been resulted: To the statement “This function makes sense”, the option button has reached an average rating of 4.00, the status line 4.58 and the bookmark function has reached the highest score with 4.82 (1- I disagree; 5 - I agree, see Figure 15).

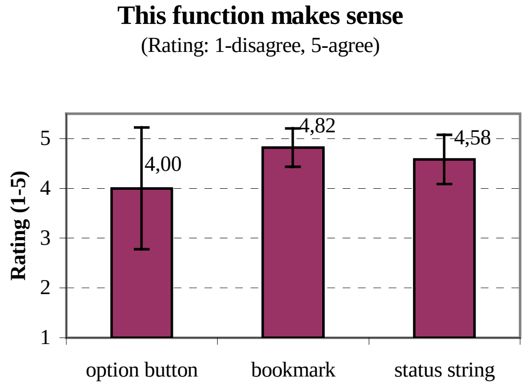

Figure 15 Statement: This function makes sense

Summarizing, the new functions have reached a very high subjective acceptance by the probands and the objective data has proofed great acceleration in handling.

6. CONCLUSIONS AND OUTLOOK

The main aspect of these studies had been to primarily improve the traffic safety and to accelerate the intuitive retrieval of information and functions in vehicles. The results of the usability study has shown that through network dialogue structures, time savings of about 32.5% can be reached. According to experience, the effect might even be higher with more training of the user.

As there has been no evident influence on the drivers’ attention to driving, the main goal of more safety and user-friendliness for handling is achieved. Consequently, the drivers’ sovereignty is increased.

To meet the drivers’ intention, further research should be focused on which and how many links should be offered to the driver according to the context.

REFERENCES

[1] Niedermaier, B.: Development and evaluation of a rapid-prototyping approach for multimodal human-machine-interaction in automobiles. Munich, Technical University of Munich, Institute for Human-Machine Communication, Dissertation, 2002.

[2] Project FERMUS (Error-Robust Multimodal Speech Dialogs), in: www.fermus.de, 2003.

[3] Norm ISO9241 part 14: Menu Dialogues. In: Ergonomic requirements for officework with visual display terminals (VDT-s), 1996.

[4] Mulzer, W.; Zhang, S.: The Little History of The World Wide Web, FU Berlin, Department of Informatics, 2001. URL: http://www.inf.fuberlin.de/lehre/SS01/hc/www, 2003-08-12.

[5] Gloor, P.: Elements of Hypermedia Design: Techniques for Navigation and Visualization in Cyberspace. Zürich: BirkhäuserBosten, 1996. URL: http://www.ickn.org/elements, 2003-08-12.

[6] Human-Computer Interaction Lab., University of Maryland: Homepage. URL: http://www.cs.umd.edu/hcil/, 2003-08-12.

[7] Ahlberg, C.; Shneiderman, B.: The Alphaslider: A Compact and Rapid Selector. Institute for Systems Research, University of Maryland, 1993.

[8] Bederson, B.: Fisheye Menus. Institute for Advanced Computer Studies, University of Maryland, 2000.

[9] Shneiderman, Ben: Designing the user interface: strategies for effective human-computer interaction. 3. ed., Mass. [u.a.]: Addison-Wesley, 1998.

[10] Norm ISO9241 part 10: Dialog Principles. In: Ergonomic requirements for officework with visual display terminals (VDT-s), 1996.

[11] Norm ISO/DIS15005: Road vehicles In: Ergonomic aspects of transport information and control systems - Dialogue management principles and compliance procedures, 2002.

[12] Mattes, S.: The Lane-Change-Task as a Tool for Driver Distraction Evaluation. In: Strasser, H.; Kluth, K.; Rausch, H.; Bubb, H. (Eds.): Quality of Work and Products in Enterprises of the Future (pp. 57-60). Stuttgart: ergonomia Verlag, 2003.