# Vehicle navigation systems: case studies from VDO Dayton

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## Abstract

This paper draws from the experiences of work for VDO Dayton MS5000 car navigation system, and describes from a design perspective some generic issues applicable in detailed interface design of car navigation systems.

## 1 Introduction

The paper is a presentation of work done for vehicle navigation systems, and conclusions drawn from it from a design perspective. It draws from the case study of the User Interface Design phase of the VDO Dayton MS5000 car navigation system. Design issues that apply to the design of all vehicle navigation systems are highlighted.

## 2 UI design and car navigation systems - VDO Dayton MS5000

The initial User Interface design phase of the VDO Dayton MS5000 car navigation system (image 1) took place in 1998. It can be considered one of the early examples of car navigation systems. The first generation of car navigation systems had constraints posed from the technical requirements (for example low screen resolution, memory, use of non proportional fonts etc), as is normal for a first generation of system platforms. Nevertheless some user interface issues that the design team has faced during the design of the VDO Dayton MS5000 apply more generally to the design of vehicle navigation systems.

The main task of a car navigation system is to help drivers getting from one point to another, which they have to define. Route instructions and orientation are given on a map as well as with generated speech. (In the map different scales of abstraction are possible). Other related content is locating petrol shops, restaurants, traffic-jam avoidance, find alternative routes, e.t.c. Two core prime actions in a car navigation system are

a) stating an address in the system, via a keyboard entry and
b) then, upon starting the journey the system directs the driver to the specified address.

In the User Interface Design of a car navigation system, a balance should be made between the interface and:

- the user
- the content

- the control device (the same interaction and interface may have to be designed open for very different input devices, according to the car-manufacturer it is addressed to.
- the environment (lighting conditions, sound level, e.t.c.)
- the technical possibilities and constraints of the platform
- other issues related to upgrades, (expandability to include more functions, different input devices e.t.c)
- branding image to be promoted.

The on-screen design for a car navigation system involves several design challenges (Mavrommati, 2001). The immediacy of the information presented and the time taken to understand it is very important as the users attention is shared between it and the driving task. The positioning of the display is a key factor here, as it is often in the driver's peripheral vision; the driver may need to move his eyes or even his head to read it properly. Another factor is the amount of attention the user can give to the display (and the system) at any one time. A car display should distract the users attention away from the road for an absolute maximum of a couple of seconds. These factors have consequences for the readability, colour, luminance, and contrast of the screen and information & graphics shown on it.


Image1: a sample screen of an interactive prototype based on the PC, and the VDO Dayton MS5000 system, as it was finally produced.

## 3 Design fine-tuning of the on-screen-user interface

Good user interface and interaction are essential since life and death circumstances are at stake. The driver's attention should remain at operating the vehicle, and not the car navigation system. Therefore immediacy and readability of the information are paramount in the design of the on-screen-information.

There are pragmatic considerations relating to the interface design of a car navigation system that influence the design, such as for example the lighting conditions. While driving, the environmental lighting conditions may change dramatically, ranging from very dark to very bright; this has an influence on reflections on the systems screen and makes it harder to read at times. To compensate for clarity and readability, the screen-brightness has to adapt (image 2), while on-screen graphics should be prepared to maintain their quality during these adaptations. Reflections off the screen can reduce the contrast of text and graphics making it more difficult to read and this can also happen if the graphics are 'too dark' for the environment. If however the screen and graphics are too bright for the environment then this 'glare' can make the screen uncomfortable to look at and will affect the ability of the viewer's eyes to be adjusted for the

lower ambient light level. This may be a problem in some situations, for example when using a car navigation system at night where the drivers ability to see outside clearly is vital.

To plan and conduct regular screen tests is crucial in the design process, in order to ensure the readability of the screen designs, under the various possible environmental conditions. Having frequent screen tests helps designers to build up an understanding about which fonts colours and graphics work best in a range of situations. Design awareness about the capabilities of the target screen and its viewing conditions is raised; this is important as the designed is mostly done on a computer screen (different viewing distance, resolution, colour quality than the target screen). A final decision on the screen design should not be reached until the interface is reviewed on the actual screen, as the design there may look different.

# 4 Visibility for all

In car navigation systems are designed for everybody including the mature and the colour-blind. Mature people need increased brightness and contrast within the screen in order to compensate for age related eyesight problems. Colour-blind people tend to describe red, dark yellow or green as brown and therefore highlighting of important screen elements in these colours or tints may go unnoticed. Adequate luminance contrast between screens, to ensure legibility by all should be catered by the design. A common trick is to test and fine-tune the design contrast by converting the design into greyscale. Yet, nothing compensates having a screen review with some people representing from these target groups, who can verify the overall readability.

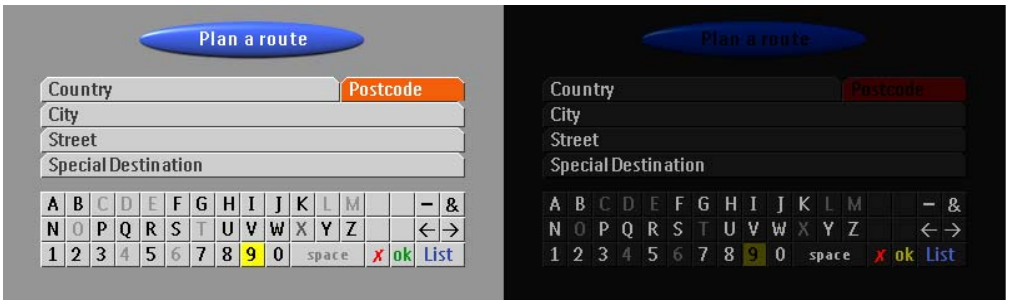


Image2: Screen designs for the keyboard entry.
The same screen is shown for the day and for the night situation. What seems to be completely dark, gives in fact exactly the same result regarding readability in a dark environment.

## *4.1.1 Detailing and explaining interaction*

While flowcharts or other diagrams are invaluable for making a map of navigation, they cannot express the dynamic aspects of how the user experience may be implemented (i.e. animation, sound, e.t.c.). Progressing from concept storyboards to interactive demos to perhaps a real system at the end are natural steps to take. Each time the fidelity is increasing, but the flexibility of it to be changed is decreasing. An interactive prototype is a tool for further development of the application or product. It is also often used as a communication tool for showing developers how certain aspects would work. Finally it can be used as an evaluation tool.

It's important to represent the whole interaction dynamically to give insight on aspects such as:

- The requirements on the user in terms of mental workload and attention.
- The system's readability in relation to interaction (i.e. clicking / touching / distance).
- The effect of sounds, animations and colours.
- The logical (or not) sequence of the screens;
- Other sensorial stimuli.

The experience as a whole is more than the sum of these separate parts, and in bringing the integrated experience to life the demo performs a complementary role to the flowcharts in the design process.

# 5 Conclusions

In the course of the User Interface Design work done for VDO Dayton, several variations of designs were created; mock-ups of the designs were taken further into creative interactive prototypes (these were done in Macromedia Director). Demo prototypes have not been evaluated with users in working prototypes of the system, (during car-testing sessions for example), during that project; nevertheless certain interaction elements of importance / frequent use, (such as alternative keyboard entry methods and layouts), were demonstrated as interactive prototypes giving a better feeling of the interaction involved to the project team. This process, together with benchmarking against the technological constraints of the system, had lead the selection of particular interaction design styles to be taken further. Screen designs have been reviewed in consultation with target users (color-blind), for ensuring appropriate legibility and clarity. The selected Screen-designs of the User Interface proposals (not in an interactive version) were tested in the final system and improvement actions were taken as a result.

# 6 References

Mavrommati. Chapter 6, Design of on-screen user interfaces. User interface design for electronic appliances, edited by K. Baumann and B. Thomas, Taylor and Francis, 2001