More and more comfort features and functions from outside the automotive industry are being put to use in cars. The number increases with each new model brought onto the market. The center console, as an interface between the human being and the machine – or between the driver and the vehicle – is becoming increasingly complex. Cockpit equipment is, however, also developing more and more into a vehicle for promoting the car manufacturer’s market image. In this context, car manufacturers work closely with their major suppliers to provide their end customers with optimum system solutions, as explained in this article by the automotive supplier Valeo.
1 Introduction

The increasing demand for safer and more comfortable cars poses a great challenge for suppliers of automotive applications. The question is how to enhance comfort for the car’s occupants (and provide the corresponding functions) without compromising driving safety. This is particularly true when the driver is alone in the car and wants or needs to use these functions while driving.

The design must be ergonomic and user-friendly. Drivers must be able to operate the electronics in their new car quickly and without a long learning period. Indicators and switches must be easy to use and must not distract the driver. In addition, the less time and attention drivers devote to their car, the more they can enjoy driving.

For the driver, operating comfort comprises the subjective experience of being able to cope with the systems and their operation. It should, however, be possible to confirm this subjective assessment using objective data that demonstrates to what extent the driver is distracted from driving by using the functions.

2 The Challenge of the Human-Machine Interface in the Car

Many of the new comfort functions that are now provided in cars originally came from non-automotive areas. The number and complexity of new functions seem to increase with each new car design. Every development and every inclusion of new systems into the interface between the human being and the machine must be planned around the driver. The new functions should improve comfort without posing a risk to driving safety.

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Car manufacturers know that cockpit design enhances their market image and allows a significant degree of differentiation. For that reason, they work closely with their major suppliers to ensure that new systems are developed in line with their strict specifications. One of the greatest difficulties in development is the objective and reproducible assessment of potential system solutions in the human-machine interface (HMI).

At its Research and Development Centre in La Verrière near Paris, Valeo has constructed a research laboratory (HMI laboratory) in which the ergonomics of the human-machine interface can be tested. The company aims to gain objective data to support the subjective experience of test drivers using comfort functions in the centre console. Valeo evaluates the system ergonomics in order to supply both customer and end user with system solutions that satisfy the most rigorous functionality and safety requirements.

The design of the centre console is extremely important. As part of the brand design, it must not only have an ergonomic design but must also satisfy the requirements of the car manufacturer. This is a particular challenge for developers, because they must combine optimum ergonomics with a design that reflects the customer’s image. Both the car manufacturer and the end customer as a car buyer have high expectations in this respect.

A team of specialists is responsible for the ergonomic integration of new systems into the vehicle. In addition to ergonomics experts, these include product designers working in the HMI lab with highly advanced technologies to integrate new HMI systems into the vehicle.

Valeo built its first simulator five years ago, Figure 1. Individual system components in the centre console were interchangeable, which allowed the development engineers to obtain feedback from car drivers as to which control mechanisms they found easiest to use for comfort functions, such as air conditioning, radio or navigation.

Various tests revealed, for example, that most drivers did not cope well with controlling systems that use one multifunctional switch; they simply felt overburdened. “Normal” drivers, i.e. those not particularly familiar with new technologies, prefer control systems with their own integrated control switches for each function area, such as air conditioning, navigation or sound systems, Figure 2.

3 Objective Analysis of the Human-Machine Interface - a New Approach

The experience gathered by Valeo with its first simulator was used in an important new development that allows highly realistic simulations to be performed. The technical highlight of the HMI laboratory is the new Driver Attention Simulator, on which systems are tested for their operating comfort.

The simulator has been available fully configured for projects since the end of 2002. “Fully configured” refers not only to the technical maturity of the hardware but also covers the necessary software, including the software that enables system adjustments and the individual calibration of its data capturing equipment to each driver and the recording and evaluation of the driver’s glances and movements.

3.1 Driver Attention Simulator

The Driver Attention Simulator has a flexible and modular design, with a re-configurable cabin geometry. With just a few adjustments, it can be adapted in size to suit various vehicle types, from small cars to luxury limousines or even vans, and supplied with the corresponding dashboard.

The simulator consists of half a vehicle front, with the front seats, centre console and dashboard together with the steering wheel, pedals and gear lever forming the vehicle interior. An interactive driving environment projected onto a screen in front of the vehicle simulates the journey to which the driver must react while simultaneously using various comfort functions in the vehicle.

The design of the simulator allows these to be repositioned easily, as components are held in place with simple but sturdy clips. The components used in the cabin are either prototypes or adapted from the production version of the vehicle. The components necessary for driving, such as the steering wheel, pedals, gear lever and brakes, are electrically linked to the simulator to allow interaction with the vehicle environment, which is computer-controlled and projected onto a screen in front of the driver’s cabin. The vehicle environment and characteristics of the vehicle’s behaviour can be selected from a list of standard routes and configurations of vehicle types, or, if desired, new configurations can be specially developed.

The route appears on the screen in front of the driver. Racetracks, city streets or country roads can be chosen as required. The drivers are given a stretch of road on which they must drive. The driving environment is interactive and reacts to steering commands from the driver as well as acceleration and braking. During the drive, which takes as much concentration and requires the same reactions as during real road use due to pedestrians and other vehicles, the drivers have to use the functions and comfort features available in the centre console. Detailed records are made showing what distracts their attention from the road and for how long. Data is collected for each test driver to document his or her behaviour during the drive. As the underlying environment for all consecutive system suggestions installed in the vehicle is identical, the results are comparable.

3.2 Data Capturing Systems

The test driver sits in the driver’s seat. A magnetic sensor on the right wrist records the movements of the hand as it travels between the steering wheel, gear lever and the switches operating the vehicle func-