Display formats for the evaluation of automotive dashboards

Daniel R. Mestre *, David Blumenthal **, Ludivine Boivin **, Jean-Marie Pergandi *

* Institute of Movement Sciences/ Mediterranean Virtual Reality Center, Marseilles, France
** Perception and Sensory Science Team, Renault, Guyancourt, France

Objectives

Virtual Reality prototyping can be used early in the design process, to question future customers about the aesthetics of future vehicles, without the need for physical mock-ups.
Nonetheless, it is questionable whether numerical solutions and display formats are adequate as concerns the observer's capacity to appreciate the physical dimensions of virtual objects. Most importantly, are the conclusions of a study conducted on a virtual mock-up transferable to the final product?

In the present experimental study, we evaluated the ability of naïve observers to perceive the physical dimensions of a vehicle's dashboard, using a number of digital display formats.

Methods

Products

9 dashboards were constructed using a numerical parametric model (Catia ® software) [1]. They were exported to 3DS Max ® (for light and texture processing) and finally 3DVia Virtools ® software (for rendering).
A Taguchi factionary orthogonal experimental design was used to define the dashboards, varying along four dimensions: vertical concavity, horizontal concavity, depth and height (figure 1). Each dimension had only two values (+/-), which defined 8 dashboards (figure 2). One additional dashboard was used as a reference (average value of all dimensions).

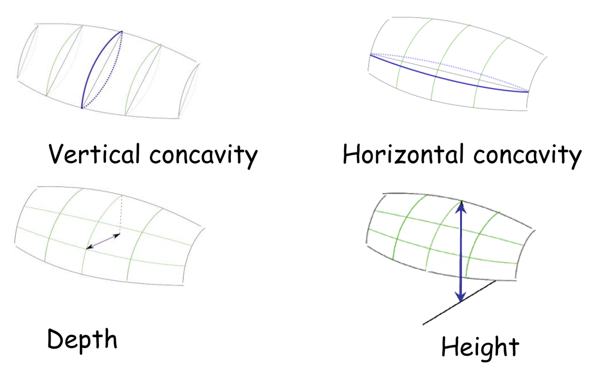

Figure 1. Physical dimensions of the parametric model

	Horizontal Concavity	Vertical Concavity	Height	Depth
A	+	+	+	+
B	+	+	-	-
C	+	-	+	-
D	+	-	-	+
E	-	+	+	-
F	-	+	-	+
G	-	-	+	+
H	-	-	-	-

Figure 2. Experimental design

Displays

We tested four display formats. First, with reference to "classical" solutions used in automotive magazines, we used a "view-from-the-backseat" format (figure 3a), displayed on a regular computer terminal. In a second condition, we used the same viewpoint, but the scenery was projected on a large frontal screen, on a 1:1 scale. In a third condition, we used a "QuicktimeVR-like" format presented on a terminal (figure 3b). The viewpoint was set to the driver's seat and the observer was allowed to look around (using mouse control). This condition was used to test the hypothesis that first-person active viewing might be beneficial to the evaluation process, notably by allowing the observer to choose an optimal point of view. Finally, an immersive 4-sided cave-like system was used (figure 3c). The observer was seated in the device (on a real car seat). He/she had an optically-correct 1:1 scale view of the car interior. Stereoscopic glasses were used to enable depth-from-stereopsis perception and the subject's head was optically tracked, in order to deliver real-time motion parallax information.

Figure 3a. static view

Figure 3b. interactive view

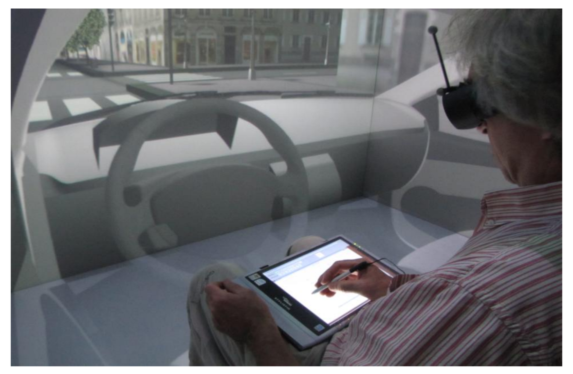

Figure 3c. immersive system

Methods

Task

We asked observers to compare the 9 dashboards according to the four dimensions of variation: vertical concavity, horizontal concavity, depth and height.

The methodology was adapted from a well-known technique of sensory science [2]: the sensory profile. Using a PC tablet and software (right), naïve observers moved through the different dashboards at will and were asked to score (figure 4) them along one of the above 4 dimensions (one at a time). Three observers were tested in each of the four display conditions.

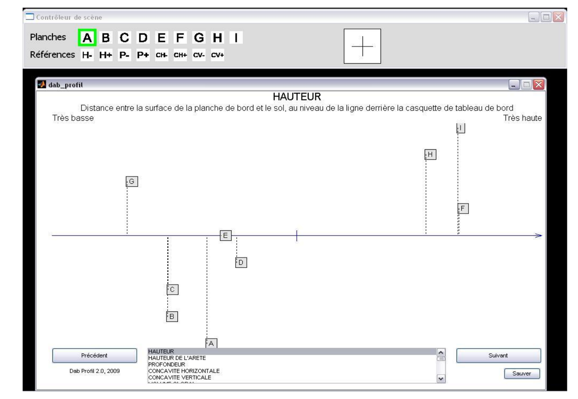

Figure 4. The observer's interface

Results

The sensory scores for each sensory term were analyzed using one-way analysis of variance (the factor was the dashboards) and using Least Significant Distance (Fisher test) to compare the average scores of the dashboards (figure 5).

The immersive condition (figure 3c) led to a more precise classification of the dashboards. By more precise we mean that different characteristics of the dashboards led to different sensory groups. The "Quicktime" interactive format (figure 3b) was second best, while the other conditions (static photo from the back seat (figure 3a)), on either a small or large screen (1:1 scale) led to mixed classifications. However, even for the immersive format, the depth dimension was poorly evaluated (on the right, statistical representation of the ranking performance of 12 observers)

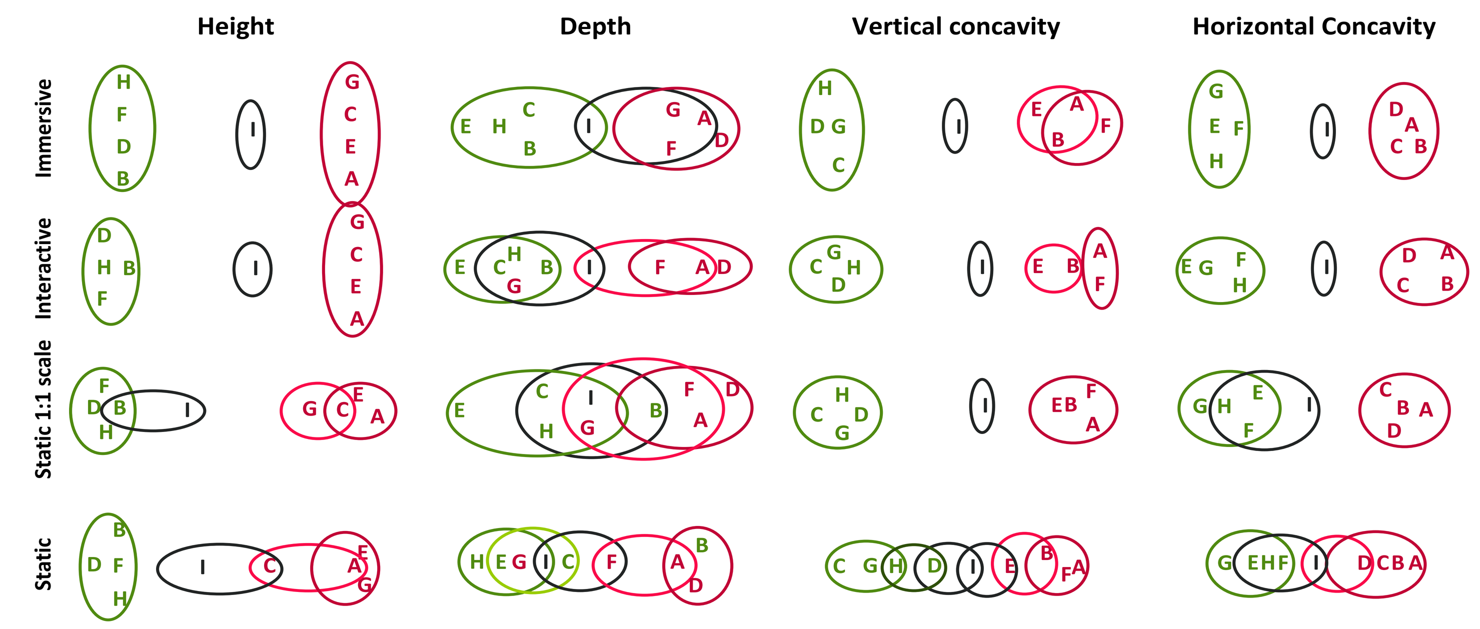

Figure 5. A dashboard is represented by a letter. Its color indicates its physical value in the experimental design (figure 2). The distance between dashboards is proportional to their statistical perceptual distance. The dashboards linked by a circle are not significantly different.

Conclusion and perspectives

As suspected, interactive, 1:1 scale, immersive visualization inside a "cave-like" device enables the observer to accurately perceive the physical dimensions of a digital mock-up. However, some caveats are in order and underline the need for further research. First, depth is not easily perceived, even when the observer is immersed inside a virtual environment. Spatial resolution, realistic textures and illumination might be involved in this matter. Secondly, a first-person view and a mobile viewpoint (as in our interactive condition) appear important. Future work will deal with a comparison between the relative importance of first-person and 1:1 scale views of a digital object. Finally, we are dealing here with physical dimensions. Further steps will address the evaluation of aesthetical and hedonic dimensions in consumers' studies.

[1] Poirson E., Petiot J-F. , Aliouat E. , Blumenthal D. and Boivin L. (2010) *Interactive User Tests to enhance innovation – Application to car dashboard design*. International Conference on Kansei Engineering and Emotion Research, Arts et Métiers ParisTech, Paris, France, 2nd-4th March 2010.

[2] Stone H., Sidel J., Oliver S. Woosley A., Singleton R.C. (1974). Sensory evaluation by Quantitative Descriptive Analysis. *Food Technology*, 28(11), 24-34.