

# Global versus Regional User Requirements for the Vehicle HMI

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## Abstract

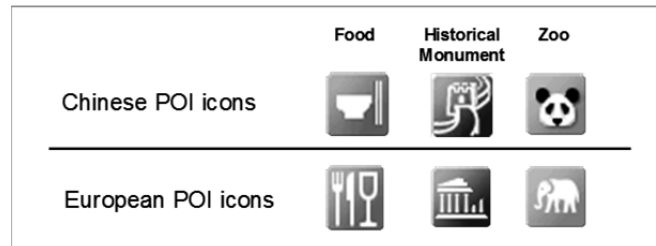
Based on global product development, unification of HMI concepts in the automotive sector plays an important role. To understand the scope of the HMI globalization or the need for regional adaptations, several investigations with participants from China, North America and Europe have been carried out. Different display aspects like color and labels were tested with the help of flash animations, computer simulations and prototype components. The results show that for color a global HMI solution can be found, whereas for item labels regional differences do exist.

## 1 Introduction

Nowadays, most automotive manufacturers offer their customers a broad range of electronic functions and systems. These are for example radios, navigation systems or driver information- and driver assistance systems. The Vehicle Human Machine Interface (HMI) is designed to make those functions easy to use. The more important the HMI becomes the more the question arises whether one HMI will be accepted by users around the world or not. And, if not, which regional requirements do exist and should be implemented into these concepts. Therefore, questions about different display contents, different grades of information density, colors, graphic styles and the use of icons as well as language specific problems play an important role in the development of new HMI variants in the vehicle.

North American and Chinese customers for example prefer more input devices like touch screen displays in the vehicle, whereas European (German) customers prefer more controller based concepts (Bloch 2007). Generally, such different preferences between users worldwide can have several possible causes. Different meanings e.g. for colors and symbols in several cultures can lead to such regional preferences. According to Bourges-Waldegg and Scrivener (1998), problems of the usability of products arising from different cultural backgrounds of users, can be traced back to a different understanding of the meaning of representations of e.g. colors, symbols and shapes. Whereas in Western countries like Europe and North Amer-

ica the color “red” represents the meaning “alarm”, in Eastern countries like China and Taiwan the same color stands for “luck”. Chinese’s brides for example wear red dresses instead of white dresses because the color white means “death” in most Eastern countries (ZiBler-Gürtler 2002). Cultural differences can also be found in the meaning of different symbols. Figure 1 shows examples of different signs in China and Europe.



*Fig. 1: Examples of different signs in China and in Europe*

In summary, different cultural backgrounds of the users worldwide lead to different preferences for symbols, images and input devices. To understand what a customer really needs and wants, it is important to investigate cultural characteristics in a highly manner (Choong & Salvendy 1998). Therefore we need to find out more about the expectations users from different regions have of a future vehicle HMI.

## 1.1 Aim of the Studies

Discussions about how a future vehicle HMI concept has to look like, deliberations that there are some cultural differences that have to be addressed in a next generation of HMI, are brought up again and again. Some research teams recommend the importance of understanding cultural differences in color appreciation and color response to enable an effective usage of colors when designing interfaces (Noiwan & Norcio 2006). In particular against the background that color is a very important, sophisticated and complex component of screen design (Lee & Bolin 1999). Maybe the most favorite color of customers can influence their color preference for display icons. A Study with 120 American and Thai participants showed that participants of both cultural groups rated the color blue as their favorite color from the six colors red, blue, orange, yellow, violet, and green. Cultural differences are shown for the second favorite color which was red for American and yellow for Thai participants. Otherwise, the least preferred color also fits well in both cultures and was violet (Noiwan & Norcio 2006). Results of a study which deals with color appeal of websites in three different cultural groups (Canada, Germany, Japan), showed for three different color schemes (blue, grey, yellow) that participants of all three cultural groups tend to dislike the yellow website color scheme, while the blue color scheme seemed to be fine for all three cultural groups (Cyr et al. 2010). Another interesting topic is the use of icons, text or a combination of both to label buttons and/or other items on a display. Icons are often used in human-machine-interaction to support the use of the interface and to make it more intuitive and international. Even the use of icons alone can be less space consuming than text labels or a combination of

both (Wiedenbeck 1999). Results from computer interfaces show that for users with low experience, especially during the initial learning phase, text labels and combinations of icons and text are more informative, easier to interpret and learn as icons alone. Regardless of whether it matched with the real performance, the perceived ease of use was higher for icon labeled computer interfaces than for both other variants. Also, text labels seemed to be very important in the early learning phase but lost their importance after the participants have learned how to interpret them (Wiedenbeck 1999).

The aim of the present studies was to give an initial response on the very important question, whether it makes sense for an automotive manufacturer to pursue one global HMI strategy or if HMI concepts have to be regionalized.

## 2 Method

Two different studies were carried out to test the hypotheses stated above. For this paper it was decided to explain one main study in more detail and an additional study in an abbreviated version to validate the results of the main study.

### 2.1 Study 1

Study 1 was set in the three HMI laboratories of the Ford global HMI team. All three HMI laboratories in China, Europe and North America do have similar testing conditions. All laboratories are windowless rooms with artificial light coming from above. As test material two Dell notebooks (model "Latitude 6400") were used in Europe and China and an identical Dell monitor (model "1908FPt") was used in North America. All monitors have had the same fixed angle and color, contrast and brightness configurations. The participants were sitting in one of the three HMI laboratories at a desk with the monitor in front of them. The light above the monitor was dimmed down.

#### 2.1.1 Sample

In total, data from 90 participants were incorporated in the study. All participants were employees of the Ford Motor Company or from suppliers of the Ford Motor Company. The sample was balanced concerning region and gender. Therefore, 30 Chinese, 30 European and 30 North American participants attended the experiment. Each cultural group consisted of 15 female and 15 male participants which results in a total of 45 female and 45 male participants. Overall, the participants were between 20 and 60 (and above) years old. 61 of the participants had corrected vision (short & farsightedness). Two participants of the American sample had astigmatism. Detailed information on sociodemographic data of the sample can be seen in Table 1.

Variable	Total	China	Europe	North America
Gender	45 f, 45 m	15 f, 15 m	15 f, 15 m	15 f, 15 m
Age	20-60+	20-39	20-59	20-60+
Visual aid	N = 61	n =27	n = 18	n = 16

Table 1: Sociodemographic characteristics of the total sample and for each of the three different regions

### 2.1.2 Materials and test procedure

For the stimulus material, five different flash animations were programmed with the software Adobe Flash Player Version 10. The basic screen which was used as basis for all five flash animations showed a typical radio screen of a multimedia display in the vehicle. The radio screen which was used in the study is not related to any specific brand or carline and should only be seen as an experimental framework (see figure 2).



Fig. 2: Radio screen - experimental framework used in all five flash animations

The participants had the task to modify different aspects of the display in order to what they like best and what they like least in a vehicle display. The independent variables are color, shape, gloss, labels and information density. This paper focuses only on two of these aspects, namely color and labels, for more details of the variables shape, gloss and information density see Becker et al. (2011).

For the adjustment of their most favorite and least favorite color, the participants had to use two sliders to change the hue and the saturation of the color of the items in the display. The color coding in the flash animation is based on the HSL color space model, with the parameters hue, saturation and luminance (Silvestrini 1994). Luminance was used as a fixed parameter. For the assessment of the color preference in the experiment, the values for hue and saturation were registered for each participant.

For the second independent variable “label”, participants had to choose between different labels of a display: text only, icons only and the combination of text and icons. With the help

of a second animation, participants had to set a ranking of the three possibilities with the help of a visual analogue scale.

A short questionnaire comprised the sociodemographic data and different questions addressing subjective assessments (5-stage rating scales and items based on semantic differentials), that the participants had to answer for each part of the experiment.

### 2.1.3 Results

#### Color

Figure 3 shows the results of the most favorite colors for display items. Comparing the mean values of the different regions, it can be said that there is a tendency towards a blue shade as most preferred in all cultural groups (Mean global value: hue = 200°,  $SD = 71.2$ ). For the saturation value, a trend towards a saturation of around 80% can be shown.

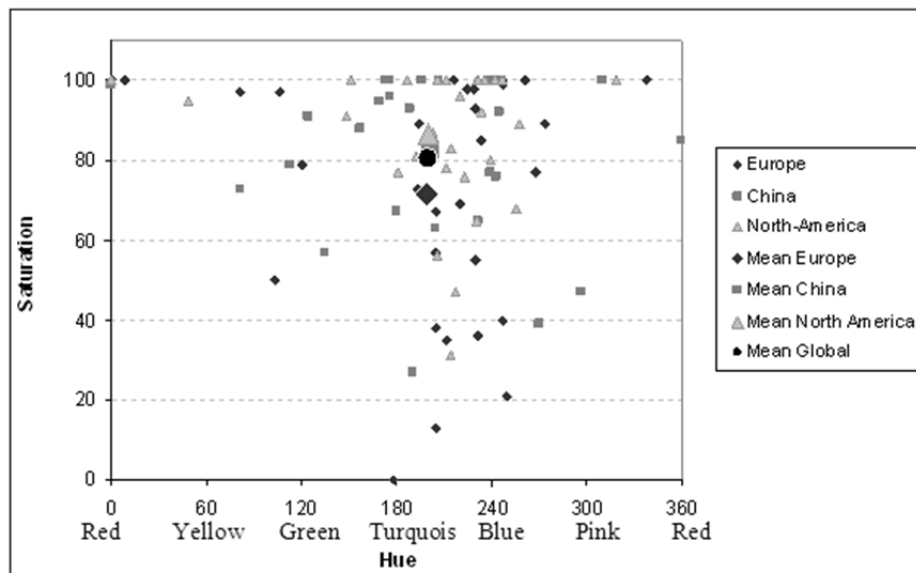


Fig. 3: Most favorite colors for display items

For the least favorite colors, there is not such a clear trend as shown for the most favorite colors. Nevertheless, the results show two tendencies towards the colors greenish yellow (hue value around 60°) and magenta (hue value around 305°) in all three regions (see figure 4).

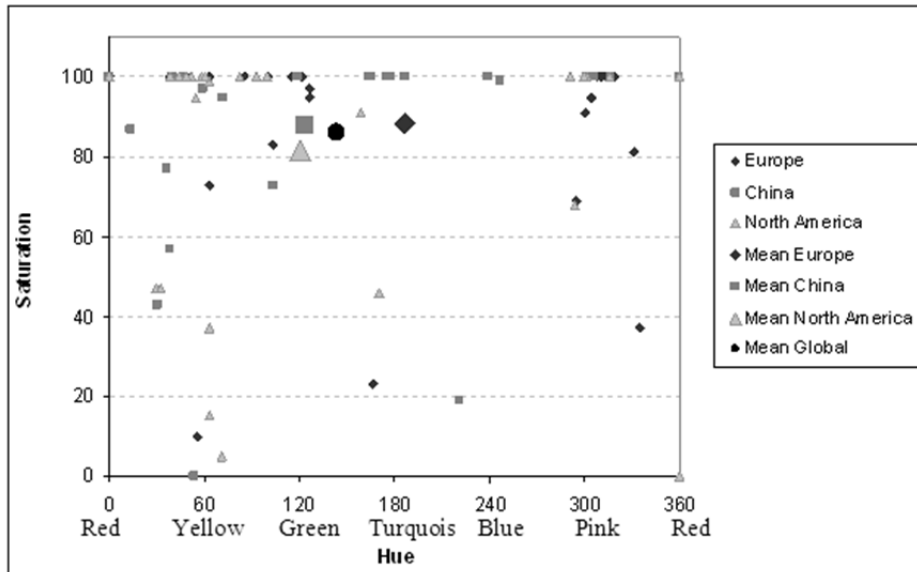


Fig. 4: Least favorite colors for display items

**Ways to label items on a display**

Results of an analysis of variance with repeated measures show, that there is no significant main effects of regions,  $F(2, 87) = .34, ns$ , but a significant main effect for "label",  $F(2, 87) = 57.71, p < .0001$ . The post hoc test (Sidak,  $p < .05$ ) shows that the combination of icons with text and text only, are significantly better assessed than the variant icon only (see figure 5).

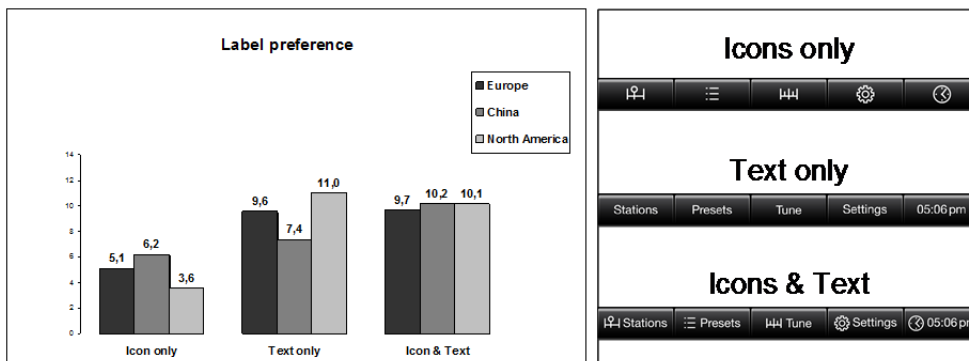


Fig. 5: Preference for display labels (mean values with 0 = negative to 14 = positive)

## 2.2 Study 2

For study 2 another laboratory experiment with a real cluster prototype component was carried out in the three regions China, Europe and North America. The aim of the study was the validation of usability and appearance of a new cluster. One of the main questions was whether participants prefer information displayed with or without icons. Therefore, different versions, for example, of a trip computer were provided: a version without any icons or additional text, one with additional icons (such as a clock for trip distance or a gas pump for average fuel consumption), and one with additional icons and text (e.g. a clock and the text “trip timer”).

### 2.2.1 Sample

From the total sample of  $N = 60$  participants,  $n = 20$  were participants from China,  $n = 20$  from Europe and  $n = 20$  from North America. All participants were employees of the Ford Motor Company or from suppliers of the Ford Motor Company. Overall, the participants were between 21 and 59 years old.

### 2.2.2 Results

The participants were asked to rank three different versions of the trip computer screen (icons only, text and icons and neither text nor icons (values only)). The results show that 79% European and 70% Chinese participants prefer the version with icons only the most. For the North American participants no clear preference was found for the first preference (40% icons with text, 35% icons only and 25% neither text nor icons). Comments from European and Chinese participants on their first choice were for example that “icons are helpful for the understanding” and “icons are very comprehensible” and “you don’t have to read a lot”. Comments from North American participants on the other side were that “icons are visually distracting” and “a version without icons is clean and simple”. Furthermore “a version with icons and text is as detailed as possible and it could also work without symbols, but text is important”.

## 3 Discussion

The different studies on display perception give answers to the question whether the implementation of a global HMI concept is possible or if local HMI variants are needed. First, the results of study 1 show for color preference, that participants from Europe, China and North America do have similar color likings in terms of display items. Concerning this experimental investigation, participants prefer a blue shade the most. This finding is in line with other studies, as for example found for websites by Cyr et al. (2010). Also the study shows which colors should not be implemented in vehicle displays: the colors magenta and a greenish yellow were not preferred by the participants.

The results for item labels look different. In study 1 no significant cultural differences are found, but the variant “icons only” is not desired in all three regions. On the opposite, the

results of study 2 show cultural differences between North America and China/Europe: participants from Europe and China prefer variants with icons more often. Therefore, if a global solution is desired, it is recommended to use a combination of icons and text.

These initial studies show that investigations on global and regional user requirements are very important for the development of the vehicle human machine interface and should be further pursued. Moreover, other important markets such as South America, Russia and India have to be included into this process.

### Acknowledgement

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