

# Forecast on Automobile User Interface in Ubiquitous Environment

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**Abstract:** This research is to suggest the future user interface appearing in automobile interior in ubiquitous environments by analyzing changing aspects of user interface in design areas followed by digital convergence. With the application of up-to-date technologies automobile interior space is regarded as a space of living, but without appropriate application of the devices inside the automobile, the technologies will not be easily utilized. Therefore, this research is to analyze design aspects appearing in automobile interior space with the technological changes, and to prepare the foundation for forecasting future automobile user interface. Specific models from each automobile manufacturer applying up-to-date technologies will be analyzed and while analyzing intuitive elements on user interface, this research will confirm that user behaviors in a automobile interior space is also becoming intuitive. By analyzing changing aspects appearing in different types of automobiles, it will suggest the basis for forecasting the spatial changes in each type of automobiles.

**Key words:** *Automobile, User Interface, Digital Convergence, Ubiquitous*

## 1. Introduction

Today we are living in the era of convergence. The boundaries between each domain are diminishing and they are changing and revolving. Each sphere of science is converging and creating new forms of consequences. The subjects which used to steadily perform the unique function are changing into multi-functional aspects, and it is not only limited on digital appliances, but also appears in other boundaries. However, in the driving situations, even though an automobile has the most up-to-date technology, if the drivers can not properly manipulate devices, its up-to-date technology can not be easily utilized.

In this research I study the evolution of the appearances in convergence aspects within automobile interior space. The process on the theoretical considerations on interface and digital convergence is also covered. And while observing the changes of interface which have occurred in automobile interior space of the past, I forecast the interface for near future automobile interior design within the environment of “ubiquitous”. For the boundaries of the automobile types, this study focuses on passenger cars. And the analysis of high-technology elements of automobile designs is searched in the boundary of luxury cars as far as the most up-to-date technologies are applied on the highest class cars from each automobile manufacturer. Also the forecast are based on human factors, human-centered design, and intuitive interface design while considering the meaning and the way of application in ergonomics.

I investigate the appearances of convergence in various design areas which has been improving and changing until now. The analysis on the changes of the interface in the automobile interior employed in the past and present is performed to forecast the future automobile designs. While analyzing the historical changes in technologies and formations of the automobile interior space, I will investigate the problems occurring from those situations. And by analyzing the aspects of convergence which are now appearing in the automobile interior space and by researching the converging aspects of other areas, I will forecast the future interface of automobile interior space maximizing its usability under the situations of “driving.”

## **2. Automobile user interface in the age of digital convergence**

### **2.1 Intuitive interface in automobile interior design**

With the improvement on digital technologies, the entire living instruments are synthesized into the one big network. And what is so called “full service network” is about to emerge.<sup>1</sup> As digital devices are absorbed into automobile interior environments, the automobile is not regarded as the transportation device, but as living environments. The convergence of controlling the electric appliances like browsing in internet with the cellular phone, watching TV, listening to radio, and doing the video communications by using the personal computer is happening. Boundaries of each product are reduced, and the characteristics appearing in each product are altering as well.

Interfaces in automobiles have experienced lots of changes. Since Benz patents car in 1886, user interface in automobile interior had lots of changes. When a shape of each interface was not formed, shapes of handles and other control sections were similar to those of bicycles'. The controlling devices were totally mechanical, and most functions were closely related to user's driving activities.

Intuitive interface means the action for controlling devices according to one's intuitive sensibility. With intuition one can instantly grasp holistic ideas, instantly narrow or broaden the focus of attention, instantly change viewpoint or the way of looking at something, and make judgments on higher-order structures.<sup>2</sup> Without additional educations on operating products, while depending on human behaviors, a user is about to intuitively achieve product's operation methods. When users need immediate manipulation on devices while driving, rather than achieving manipulating methods by learning, it is necessary to intuitively perform its operation based on human's behavioral intention. And this means a user needs to have an intuitive interface which requires no manuals or educations.

#### **(1) A visible interface**

When the functions of interface, through human's sensing organ, are approached or sensed not long ago and are not removed from human's short term memory, this function of interface can be “visible”. And in other cases, this can be “invisible”. For users to correctly activate the interface, appropriate elements should become visible in the first place. With visibility, it should show the confronting relations between actual operations and user's behaviors. If the interface intentionally tries to remind a user of the existence of certain functions, this activity already becomes invisible. When users luckily found how to operate the functions after going through lots of steps by searching for its interface, this is not regarded as visible interface. When you are in the situation of

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<sup>1</sup> The Meaning on Convergence and Decentralization, Choi, Hwan Jin.

<sup>2</sup> The Dagstuhl Workshop on Intuitive Human Interface for Organizing and Accessing Intellectual Assets

using help options for operating methods, the interface becomes invisible. When analyzing interface, designers always have to sufficiently investigate on how users perceive the functions which certain products have, and they also have to arrange the each visible function to contain sufficient affordance.<sup>3</sup>



Figure. 1 Different types of buttons and knobs<sup>4</sup>

### (2) The principle of mapping<sup>5</sup>

Mapping is a technical term meaning the relationship between two things, in this case between the controls and their movements, and the results in the world. Consider the mapping relationships involved in steering a car. To turn the car to the right, one turns the steering wheel clockwise (so that its top moves to the right). Natural mapping, by which it means taking advantage of physical analogies and cultural standards, leads to immediate understanding.



Figure. 2 Seat adjustment control and window switch from a Mercedes-Benz<sup>6</sup>

### (3) The principle of feedback<sup>7</sup>

Feedback-sending back to the user information about what action has actually been done, what result has been accomplished-is a well-known concept in the science of control and information theory. Imagine trying to talk to someone when you cannot even hear your own voice, or trying to draw a picture with a pencil that leaves no mark: there would be no feedback.

<sup>3</sup> The Humane Interface, Raskin Jef, 2003, P, 81-82.

<sup>4</sup> The visible interface- when users are facing the operation methods for certain devices, users need to see the way to operate these elements. And this can be learned once they are looking at buttons and knobs of the device. Users can imagine whether to push the button or to turn the knob around from the look of these elements.

<sup>5</sup> The design of everyday things, Donald Norman, P23:7-28.

<sup>6</sup> This is an excellent example of natural mapping. The control is in the shape of the seat itself: the mapping is straightforward. To move the front edge of the seat higher, lift up on the front part of the button. To make the seat back recline, move the button back. Mercedes-Benz automobiles are obviously not everyday things for most people, but the principle doesn't require great expense or wealth. The same principle could be applied to much more common objects, The design of everyday things, Donald Norman, P24

<sup>7</sup> The design of everyday things, Donald Norman, P27:7-28

## 2.2 Intuitive interface within the automobile interior space

With an appearance of digital convergence today, when electric devices in automobiles are more complicated and various, intuitive interface plays a main role to let users freely and correctly operate the devices. Accordingly, drivers can intuitively access the devices and this behavior eventually keeps it safe to manipulate devices in driving situation.

In driving situations, a driver's intuitive decisions are absolutely needed. In the past, when functions were to determine forms, functions of each element apparently were visible, and users did not have many problems using those functions. However, with the development of micro-processor chips, these multiple functions were absorbed into one button, and naturally one button began to perform multiple tasks.

When a majority of automobile companies adapted a digital instrument board instead of an analog panel, it was comparably harder for a driver to intuitively perceive the speed with digital speedometer. Eventually automobile manufactures adapted analog panels again. Even though speed on a digital instrument panel can be instantly perceived by the driver, speed ranges can not easily be sensed. However, it is easier for a driver to perceive the speed ranges in analog instrument panel since a driver can compare the proportions on an instrument panel, and intuitively perceive the speed.

## 3. Analysis on the interface of today's automobile interior space

### 3.1 Driver-centered interior

In the past, the automobile interior was created only for driving behaviors, and main compositions were needed only for driving conditions. However, as the area of product design and others are converged, converging aspects in automobile design becomes more active. But as convergence aspects produced more complicated user interface, it made users learn a lot more complicated information for operation.

In the past, dashboard design of automobiles was focused on driver's preferences. However, with higher importance on leisure and sports, its location and shapes also changed. Center console shapes of sedans in the past mostly were inclined toward a driver's seat. And those let drivers have easy access to devices located in center consoles. However, passengers sitting behind and next to a driver were not easily able to access the devices.



Figure. 3 BMW's interior design in the past<sup>8</sup>

### 3.2 Driver and passenger-centered interior (sharable design)

It can be found from the most recently designed SUVs or RVs, and it is designed for sharing their devices for

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<sup>8</sup> As it shows, the center consoles of BMWs in the past were inclining toward driver's seat. And this is showing that the devices were mainly focused on driver's preferences, on the other side it is harder for passengers to reach the devices located on center console. In other words, the design looked closed from the viewpoints of passengers.

passengers. With increased demands on leisure life, users are seeking for more convenient life for operating devices within their living environments. TV, DVD, CD, and computers are converged into automobiles, and this eventually let a driver share the space with other passengers.



Figure. 4 Center fascia designs for RV & SUV

### 3.3 Changes in automobile interior design

#### 3.3.1 Historical changes of interior design in specific models

Selection standards for analysis are high-end models from each automobile manufacturer since those are adopting new technologies. In order to analyze changes, I selected models with considerable and consistent histories. Target models are BMW 7 series, Mercedes Benz's S class, and Nissan Maxima. These are regarded as the highest-end from each automobile manufacturer. Time sphere can be from the beginning of 1980s' to the present (2008), since convergence aspects were mostly active in 1980s'.

Generally, mechanical and complicated buttons in 1980s' gradually became simpler and buttons became more electric. Center fascia shapes became complicated until the mid 1990s', while adopting LCD screen in mid 1990s' numbers of buttons were decreased and buttons moved towards the upper part of a dashboard which was closer from a driver's field of vision. Center fascia shapes became more complicated until mid 1990s'. However, it became simpler with LCD screen as functions of each button were absorbed into a screen. A LCD screen was located in the center of a center fascia, but with provided multimedia, GPS, and other contents it became larger. Finally the location of LCD screen moved closer to the upper part of a dashboard for drivers to easily look at in driving position.

#### 3.3.2 Analysis on interior changes in current models

Explorations on changed aspects of automobile interior can be demonstrated as following. For easier illustration, I divided the center fascia into two different areas of a control area and a display area. When convergence aspects were not rapidly developed, a display and control area in the past was located in the middle of a center fascia, and they were mechanical. However, as it becomes more converged, a control area becomes more electronic and gradually become separated from a display area. With the emergence of LCD touch screens, electric buttons were absorbed into LCD. A LCD screen was located in the middle part of center fascia, but as the new automobile models were manufactured, it moved toward the upper part of dashboard. This display area gradually moved towards a windshield, and it became closer to the driver's range of vision. And a control area which used to be located in the middle part of center fascia was also separated from a display area, and moved toward the bottom part of a center fascia.

However, with the emergence of new concept of controlling systems, the location of a control area became higher and closer to the location of driver's arms. Even the height of a center console became higher, and finally a center console moved to the height of driver's armrests. It clearly shows that automobile interior is gradually developed as "living space", and it becomes more user-centered. Rear passenger seats tend to be separated, and even control devices are dispersed to rear sections. This eventually provides opportunities to entire passengers to share one vehicle. Additionally the fact that a display area moving closer to the driver's field of vision and the control area moving towards the location of arm apparently shows that user interface in automobiles becomes more intuitive.

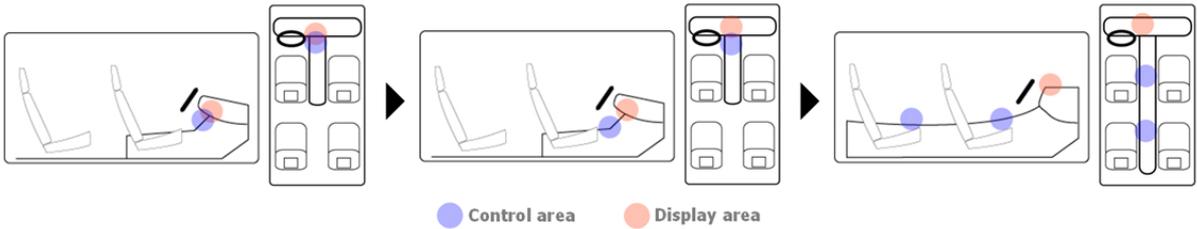


Figure. 5 Interior changes in current models

**4. Future automobile user interface within ubiquitous environment**

**4.1 Future automobile interior design in concept models**

**4.1.1 Analysis on interior design of concept models appearing in motor shows**

To understand current status and trends on automobile interior, concept cars from each year from 2000 to 2008 were analyzed. Samples are extracted and researched from international auto shows such as Paris Motor Show, Turin Motor Show, Geneva Motor Show, Detroit Auto Show, Tokyo Motor Show, and Frankfurt Motor Show. For analyzing concept cars from motor shows, I classified various interior aspects in concept models into four different categories. Interior styles in concept models are largely divided into four types as A, B, C, and D.

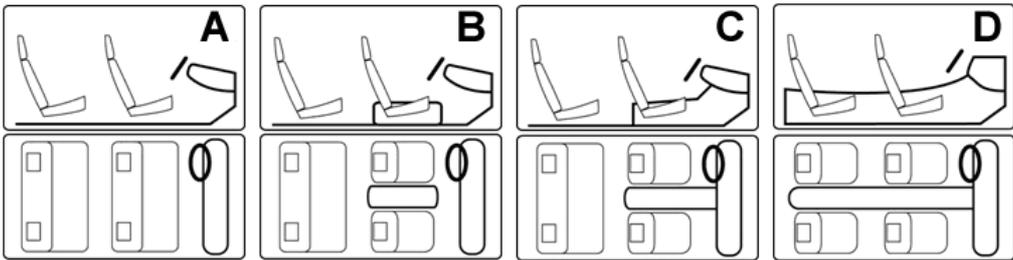


Figure. 6 Different types of automobile interior appearing in motor shows

A-types shows that interior areas excluding dashboard are opened, in other words, boundaries between a driver's seat, a passenger's seat, and a rear passenger's seat are not apparently separated. For types of B and C, it shows a driver's seat and a passenger's seat are separated. Also rear passenger seats are integrated into one area. Finally D-type, while the heightened center console is expanded to rear seats, shows the area is totally separated into individual areas as driver's seat, passenger's seat, and rear passenger's seats. A-type mainly appears in SUVs or

minivans corresponding to trends which are becoming more leisure and family-oriented. This illustrates that automobile interior is not designed for only drivers but created for entire passengers.

#### **4.1.2 Concept of the future automobile interior**

Eventually future automobile interior from concept models are largely inclining toward following two types. One (A-type) is mainly appearing in minivan and SUV designs, and the other (D-type) is mostly appearing in sedans and sports coupes.

A-type emphasizes its center fascia and dashboard design. Passengers will share one large center fascia and dashboard. And this implies the meaning of "sharing one space." Front seats and rear seats are respectively connected and visualizing integrated aspects illustrating each passenger shares one big space of an automobile. D-type mostly appearing in sedans illustrates that each passenger is sharing one machine of an automobile. A control area is dispersed to a rear seating area and each passenger area is divided for each passenger's own propensity. And a controlling device is individually located at each passenger's section as well. In this separated space even temperature can be individually controlled by each passenger's preference. And this describes that the concept of automobile interior becomes more like a living space and more user-centered while making users be more comfortable and convenient.

### **4.2 Forecast on future automobile user interface in ubiquitous environment**

#### **4.2.1 Intuitive interface in future automobiles**

In order to control various types of electric devices in automobile, what kind of methods should be applied and what will be the best solution to realize? Intuitive interface can be one of the best methods for easily and safely performing complexity appearing in digital convergence era. And designs should be connected to a driver's experience. Even though generations and environments change, design systems which a driver was experiencing and contacting until now should be applied to newer automobiles. And while user experience design is connected to intuitive elements, it will create safer and more correct usability.

With the influence of digital convergence and ubiquitous, GUI becomes more important than PUI. With the enlarged LCD screen, physical user interface in the past will exist as one of the contents controlling the device of automobiles. Also it will perform tasks as one of the elements while putting more importance on GUI.

#### **4.2.2 The totally separated user interfaces**

With the introduction of Drive-by-Wire technology and a fuel cell engine an automobile will be utilized in to more various ways. Recent concept models from various motor shows around the world apparently show separated spaces in limited space of automobile.

With the rise of newly created social groups, automobiles are morphing into a space satisfying users' need. New generations appeal to the concept of sharing, but still want to be separated from other individuals. Eventually they seek for design with not only individual characteristics but also the concept of sharing. From this point of view future automobiles should apply individual sections of space, and let each passenger share devices implanted in automobiles.

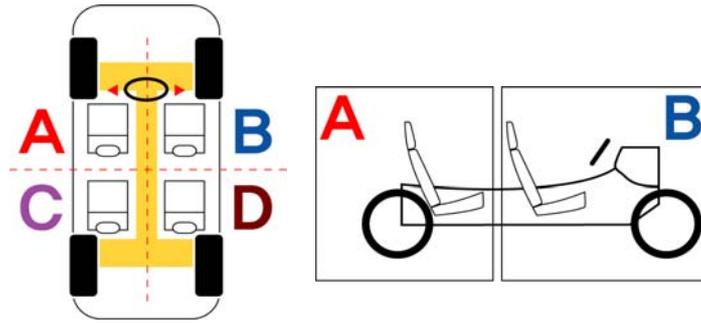


Figure. 7 Future automobile interior design with totally separated interface

#### 4.2.3 The relations to ubiquitous environments

Automobile networks with mobile services are accelerating with the start of Telematics services. With the influence of mobile networks and digital convergence, more complicated and more diverse automobile interior gradually begins to communicate with other objects located in the other areas. Ubiquitous network represents the next-generation IT paradigm characterized by the ability of various portable devices and information appliances used anytime and anywhere. Though the shifts of technology best described by the expressions “embedded in the real world” and “ownership to applications,” ubiquitous networks continue to evolve from “ownership-focused ubiquity,” where users depend on the mobile environment they own, to “application-focused ubiquity” in which the universal availability of devices enables users to concentrate on applications.<sup>9</sup>

In ubiquitous era, while automobiles are manufactured into an intelligent electric energy vehicle, with a consumer’s cooperation, various Telematics services will be introduced. Especially within automobile interior space, a vehicle will be able to perform automatic recognition of the owner, and key and door open. And it will provide not only requested information related to user’s driving behaviors realized from various devices and displays installed in driver’s and passenger’s seats, but also will supply entertainment/game contents, and digital broadcasting. In the future consumers will use automatic recognitions on forward objects for automobile’s driving control, braking and automatic recognition on traffic lights and speed limits, the confirmation on the location maps for acquiring traffic information, GPS reception maps, recharging stations for cellular phones, and receptions on DMB signals.<sup>10</sup>

<sup>9</sup> A development scenario for ubiquitous networks: viewed from the evolution of IT paradigms, Hiroyuki Nomura, P, 1.

<sup>10</sup> User scenario of ubiquitous IT in 2030(I), Electric Parts Researching Electric Information Center ([www.eic.re.kr](http://www.eic.re.kr)) p.5

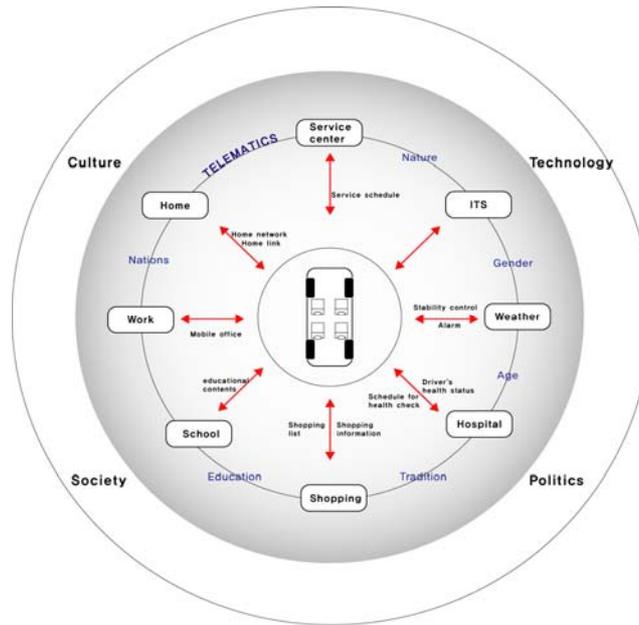


Figure. 8 Future automobile in ubiquitous environments

Future automobiles in ubiquitous environment will be based upon more advanced Telematics technologies. An automobile is capable of being connected to the number of social facilities, and sends/receives the various information-related services. An automobile itself will be put in to the biggest category of politics, economy, society, culture, and technology. And within those areas, it will be communicating with other social facilities. As for the smaller categories, the environment will include education, tradition, age, nations, and gender. Also these environmental elements will be based upon ubiquitous society.

## 5. Conclusion

With the integration on digital convergence, shapes of modern society become more complicated. And we will be able to find the behavior of users who always have to consider and learn manuals before manipulating certain devices from the viewpoint of user's usability. It is not easy to forecast how the future will look like, as today's technologies have incredibly fast progresses. Forecasts will always have to consider other environmental elements such as politics, economy, culture, society, and technology. And from that basis, the correct forecast and the plans will be made. In the digital society, human beings and the objects around them will be all connected and communicating each other. Moreover, in the ubiquitous society, these trends will accelerate and most objects will be tied into several networks. And also the automobile will apparently be the part of these networked societies. Hopefully the automobile will act as an access point between each network and will perform the tasks from a driver and passengers while being connected to other environments. And the role of the automobile in the future will be the important element for the future society.

The directions which automobile design will seek for are totally unlimited. However, even with this unlimited potential which automobile eventually has, its roles in the future will be much more various. And the way to realize its roles and the future will be entirely based upon the social trends and technologies, which will embrace the environment of automobile interior space. And automobiles will exist as one of the most necessary tool in the human life.

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