THE PILOT STUDY ON THE LEGIBILITY FACTORS OF LED DISPLAY ON PUBLIC BUS

[1]CHO, WEI-JEN, [2]LEE, FANG-YI, [3]WU, CHIH-FU, [4]XU, CONG

[1]The Graduate Institute of Design Science, Tatung University, Taipei, Taiwan
[2,3]Department of Industrial Design, Tatung University, Taipei, Taiwan
[4]School of Media and Arts, Chongqing University of Posts and Telecommunications, P.R. China
E-mail: [1]choweijen@gmail.com, [2]angela.fangyilee@gmail.com, [3]wcf@ttu.edu.tw, [4]xucong@cqupt.edu.cn

Abstract- The purpose of this study is to summarize the existing visual design specifications of the legibility of front LED display on the bus, and then find out the design elements of visual recognition. The Arabic numerals on the bus front LED display show the route number of the bus, and the researches of visual design elements on visual recognition indicate that the key visual design elements are 1.Colors - the three colors are red（R255, G0, B0）, yellow（R238, G232, B56）and green（R0, G255, B0）, 2. Fonts（Times New Roman, Arial and New Johnston Medium）, and 3. Display locations (middle, left). The results of this study provide valuable basics for the further analysis on key elements affecting visual recognition of front LED display on the bus and for the design references to increase level of visual recognition.

Keywords- LED, color, fonts, legibility

I. INTRODUCTION

Due to the needs and changes of life style in Modern society, the energy saving, high efficiency and long life LED products have been widely used in human life. Such as the use of LED bulbs to replace the traditional light bulbs, car lights, outdoor billboards and traffic sign facilities. Governments around the world have been vigorously promoting the energy saving and carbon reduction policies. Therefore, LED has been widely used in road lighting and transportation facilities. In addition, LED traffic information display can also provide the public with clear information. It is learned that LED has evolved from decorative function to a new field of all general lightings. The text and number are important visual communication elements in the visual design and a more functional, higher performance, better identification text and number can be created through designing, dressing, choreography compiling and editing. Under the influence of busy traffic and dullish ambient lighting, passengers may not be able to identify the correct bus route in short time. Especially at night time, the change of ambient lighting condition will increase the difficulty of identification and thus miss or misuse the buses. Therefore, it is necessary to find out the design elements of the bus front LED display and carry out further researches on the factors that affecting the identification/recognition design. This study focused on the bus front LED display to explore the current Arabic digital LED variable visual information design status, and concluded that the font, color and Arabic numerals are the key design elements. The purposes of this study are as followings: 1) To explore related literatures on Arabic numerals of LED display on the Bus. 2) To explore the current design application status of Arabic digital LED display. 3) To explore the design elements of bus front Arabic numerals LED display.

II. LITERATURE REVIEW

2.1. LED

Light Emitting Diode (Light Emitting Diode); referred to as LED, it is a light emitting device which converts electrical energy into light energy. Its initial application was mainly in indicator lightings and display panels. With the appearance of white LED, it is now widely used in general lightings and has replaced the traditional lightings. The advantages of LED are longer lifetime, not easy to be damaged and better lighting performance (Ma Xiaokang, 2008).

2.2. Color

The formation of color is because the visible light energy transmitted into the eye can stimulate the eye cells and the formation of color, the general visible light wavelength range from 380nm to 780nm (Chen Junyan, 1997). In addition, the conical cells on the retina sensed the light and then create the formation of color visual experience of human beings. The path of the formation is to upload the image to the neural network, then the color vision system will classify the color image signal and the color vision nerve system of retina will transmits the image to visual system in human brain (Zhang Yin, 2000). Xu Shengxiong and other researchers have mentioned in their "human engineering" book: in the visible light spectrum, different bandwidth will produce a variety of different color perceptions, in which purple (about 400 nm wavelength), blue (about 450 nm wavelength), green (wavelength 500 nm), yellow orange light (about 600 nm wavelength), and red light (wavelength above 700 nm). In the case of adequate lighting levels, the rod-shaped cells and the cone-shaped cells of eyes can both be functioning properly, it is known as “photonic vision”, and the

eyes have the most sensitive response to the green light (550nm). When in case of poor lighting level, the cone cells could not function properly; rod-shaped cells will determine the visual ability of human, in this case, the eyes most sensitive to blue-green light (500nm). Chen Mingde found out in 1995 that the larger of the color difference in color combinations have better identification results. In a study from Yu wan-lai, Tsai Chuan-den and Cheng rui-hung in 1997 related to the text / background legibility/recognisability, in total 30 combinations of six colors - red, yellow, green, blue, black and white, were studied. The results showed: the combination of white / yellow, yellow / white and green / blue have the highest error rate of visual legibility/recognisability, and then the combination of black / blue, red / green, blue / green, blue / black and green / red. The color combination red / white, Yellow / black is regarded as the combinations with the lowest error rate of visual legibility/recognisability. Based on the data survey from current bus front LED display in Taipei area, it showed that the red and yellow colors are more used for numerals and more green color is used for routes indication, mainly to differentiate with the red color, while orange color is used in the Chinese fonts display only.

2.3. Fonts

A study from Chinese scholar Wang Ming Xian related to the text used in traffic signs has proposed：" the similarity in fonts of Arabic numerals can create difficulty of recognition and easily cause wrong recognition, such as 1 and 4, 3 and 8, 5 and 6, 6, and 8, 6 and 0, 8 and 9 and 0 and 8 (Wang Mingxian, 1984). According to the researches of David Kingery and Richard Furuta, the study on visual legibility/recognisability of best font type and font size for reading the electronic media news newspaper shows that the Arial and Times New Roman are the two best English alphanumeric fonts for legibility/recognisability. In addition, designated in the current Buses signage and display guideline issue (02) of U.K., the English alphanumeric font used for traffic signs is the New Johnston Medium. Based on literatures and the results of current status survey, three kinds of fonts (Arial, Times New Roman and New Johnston Medium) are included into the design sample in this study（Fig.1, 2, 3）. Because of this study does not do research on the Chinese font, the Jinmei bold body Chinese font used by the current Ministry of Transportation in road signs will be directly adapted as design sample. A study by Garvey, Zineddin and Pietrucha (2001) on width and height ratio of font characters concluded that the narrow fonts have better legibility/recognisability than the wider fonts.

1234567890

Fig. 1. Times New Roman font

1234567890

Fig. 2 Arial font

1234567890

Fig.3. New Johnston Medium font

2.4. Legibility

Visual recognition refers to the scope of human visual ability, how to correctly identify the interpretation of signs displayed in the shortest possible time (Wang Mingxiong, 1983). The indicators for legibility assessment are font design, brightness, contrast and visual visibility, and these indicators have influences on the visual search and identification (Easterby, 1978). Xu Shengxiong (1991) pointed out that there are three calibration standards in human factors engineering for the design or assessment of alphanumeric display:

(1) Visibility： detectability, meaning that you can identify the text attributes and symbol attributes from the background

(2) Legibility： discriminability, Means that you can identify the attributes in the text, such as stroke thickness, font style and contrast

(3) Readability: meaningfulness, the forms of presentation of the text are single word, sentence or article with the ability to interpret or make the contents of the information understandable; and the recognition factors affecting the meaningfulness are the text interval distance, paragraph spacing and so on. Scholar Easterby (1978) has pointed out that the three factors that affect the correct identification of information are readability, visibility, attention ability, and their contents are as follows: 1) Readability: the use of words and grammar.2)Visualization: assessment indicators such as font design, signs & symbols and visibility will affect the visual search.3)Attention ability: including assessment index such as graphic design, time and space coding, shape and color coding and others.Through the user's psychological and perceptional conversion process, the messages are easier to be understood.

III. RESEARCH APPROACHES

Based on the current development of bus front LED display design in Taipei, this study carried out:

(1) "Literature review and investigation": data collection and analysis based on visual human factors, psychology of completion and visual recognition three aspects. Currently the government does not have unified specification for the bus front LED display, so this study refers to and adapts the design specification from "Guidelines Manual for the Designation of the Road signs Indicator year 2011" and the "Regulation for the Administration of Motor Transport".

(2) "Investigation of problems found in observations and interviews ": in the investigation of existing visual information design and related applications of the current bus front LED display, some of the bus companies do not take into consideration of the needs of visual human factors and legibility principles in setting up the alphanumeric display panel on the buses. As a result of that, many people cannot clearly identify the bus numbers in a short time. In order to achieve a better visual communication information system design purposes, we must consider the overall needs of users, improve the weak points and utilize the human factors engineering and visual communication concept to meet the needs of users. At present, the bus routes in the Taipei area are numbered with the Arabic numerals and each company uses different font type. The fonts are colored with red, yellow and green. Now, some buses use indicating boards hanging inside of windshield to distinguish the sub-lines, an interval route and the express bus. The red font and green font are also commonly used to differentiate the different routes. Due to this disorganized system of information display, the passengers can not clearly identify the bus route in a short time. As of today, there is no unified or consistent specification of the LED display in front of the bus in Taipei. （See Fig.4）



Fig.4. Messy information display

(3) Most of the bus companies equipped their buses primitively, manufactured by the company itself or obtained from outsourced jobs. Found out from the survey interview that the buses users are used to firstly look at the Arabic numerals are displayed, and then to identify the routes. Therefore this study focused on the Arabic numerals at bus front display. After on site observing and interviewing survey, we have concluded the current status and identify the problems of the bus front display of the bus in Taipei.

IV. DESIGN VERIFICATION

This study is divided into two parts. The first part is of the "literature analysis" to explore the relevant literature to generalize the design elements that affecting visual identification. The second part is of the "on site observing and interviewing survey", after survey we have concluded the current status and identify the problems of the bus front display of the bus in Taipei city that the bus companies' digital font and color combinations are not the same and there is no standards. In addition, different outsourced repairing workshop uses different fonts and light color combinations. Even within one company there could be more than two types of fonts and light color combination on the buses. Through literature review and field study, this study found that the numeral part of the lamp colors are red（R255, G0, B0）, yellow（R238, G232, B56） and Green (R0, G255, B0), the Chinese texts are of the orange color. The main subject of this study focused on Arabic numerals on bus front LED display, therefore the Chinese text part is not included in the scope of the study.

CONCLUSIONS

In this study, the main subject is the current visual design specifications of LED display in front of the bus, and based on "literature study and inquiry" and "observation and current status survey" to generalize and summarize the design elements are font types of Arabic numerals（Times New Roman, Arial, New Johnston Medium）, LED lights colors (red, yellow, green) and display locations (middle, left) for the experimental sample design, experimental planning and data analysis of future further study. The results of this study provide design reference to factors affecting visual identification elements on bus front LED display for future further study.

REFERENCES

[1] Ma Xiaokang (2008), LED lighting photoelectric technology development status, Taipei.
[2] Chen Junyan (1997), Color and Vision, Optical Engineering, No. 57.
[3] Zhang Yin (2000), the visual vision of color vision (applied psychology research), five books published in Taipei.
[4] Xu Shengxiong, Peng You, Wu Shui Pi (1991), Human Factors Engineering, Yangzhi Culture, Taipei.
[5] Chen Mingde (1995), the screen text / background color combinations and related operating characteristics of the visual performance and visual fatigue of the study, the National Taiwan University of Science and Technology Institute of Management Technology, doctoral dissertations.
[6] Xiao Wan-lai, Cai Deng-hong, Zheng Rui-hong (1997), Chinese text and background factors on the impact of reading recognition, the National Science Research Report, the National Yunlin University of Science and Technology.
[7] Wang Mingxian (1984), visual response to road traffic signs (below), Industrial Design, 45, p.39-43
[8] Transportation Institute of Transportation (2010), 100th Edition of the Road Indicator Signing Reference Manual.
[9] Transportation Institute of Transportation (2010), the study of visual human factors in road traffic engineering facilities.
[10] Ministry of Communications (2013), Rules for the Administration of Motor Transport.
[11] Easterby, R. S., Tasks, “processes and display design, in: Information Design: the Design and Evaluation of Signs and

Printed Material (eds)", by Easterby, R. and Zwaga, H. J. G., Wiley, New York.（1978）.

[12] Garvey, P. M.; Zineddin, A, Z. & Pietrucha, M. T.. "Letter legibility for signs and other large-format applications, Proceeding of the Human Factors and Ergonomics Society Annual 2001,Vol.2".（2001）.

[13] Kingery, David; Furuta, Richard, "Skimming electronic newspaper headlines: a study of typeface, point size, screen resolution, and monitor size", Information Processing & Management Volume: 33, Issue: 5, September, 685-696 (1997).

★★★