

USING MULTIVARIATE ANALYSIS OF VARIANCE AND KANSEI ENGINEERING TO EXPLORE RESEARCH METHODS ON THE WEB PAGE LAYOUT

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ABSTRACT

Electronic commerce is an entry interface of hyperlinks for presenting a website's information to visitors, which is mostly concerned with human perception in terms of users' comprehension and mental demands. The visual effect of web banner and content advertisements are especially important in electronic commerce interface design and assume a marketing strategy. With the prosperous growth of electronic commerce, cascading style sheets framework supply designers the structure of website and modeling template, website towards cross-platform and be used extensively in other web devices. This paper aim to derive website page styles from design factors of essential web framework and accord with the demands of the market, and pursue to provide a model for web image design which meets customers' needs. First, semantic differential Technique is used to investigate the influence of visual elements on website banner and content framework and then we present kansei engineering analysis of visual components properties of cognitive. Finally, multivariate analysis of variance method is used to select an optimal design strategy. The research presents a visual interface design approach for web developers to reduce cost and proposes an optimal decision making deal with a website image design. The results of website page design model is applicable to other forms of cross-platform interface design contributes the electronic commerce website design.

Keywords: *Electronic commerce, Cascading Style Sheets, Multivariate analysis of variance (MANOVA), Kansei engineering, Web image design*

1. INTRODCUTION

Electronic commerce (E-commerce, EC) contributes not only great business opportunities to a variety of industry but also convenience to customers. The significant merits of electronic commerce are in the domain of communicating the information with services and merchandises, conveying complicated visual components for prompt psychological feeling. Therefore, the web page layout of design plays an important role in electronic commerce design. The visual design of web page affects consumer's emotion and stimulates the desire for purchase. Interpreting images or creating an atmosphere is predominant in a well web page design. With the explosive growth of the number of electronic

commerce, If the website interface design of image perception could be maintain with a standardized measurement, the results could be used to utilize the emotion web design. In communication design, more attention has been paid to the simulation of webpage circumstances. Hsiao (2005) addressed website design is the entry point to an enterprise website and critically influences a user's decision to explore or skip other pages, as it directly provides the first impression of the enterprise [17]. A website image design is composed of visual elements and information. Sechmen (2000) stated the visual image factors of interface design lead to web page image design and also affect user's evaluation [2]. Therefore, using appropriate graphic design elements attract customer attention and attain to the company's

image that customer expect. In addition, website design shows to create beliefs that influence users' attitudes and behavior towards the Website.

Liu and Tong (2009) pointed out the rapid competition in commercial markets and increasingly radical change of market demands, but both the profit of enterprises and marketing period for selling goods have been reduced. The problems have been reflected on the development process, the control of production and manufacturing cost [5]. With increasingly competitive market, many Internet industry enterprises have found that their production and manufacturing, marketing and market research reached the same level with their competitors and the only remaining competitive weapons were electronic commerce interface design innovation and the enhancement of design quality.

Consequently, a cascading style sheets framework was created to improve website efficiency and proposed designer website template to shorten the re-design process. Sohrabi (2012) pointed out cascading style sheets framework design offer flexible and accessible websites that facilitate the delivery of information and services has increased dramatically. Generally, Duckett (2011) indicated website template is divided into four part, header, banner, main content and footer [9]. Banner and content framework display the most important information and become the significant framework design influence user experience. Park(2003) proved advertisements in banner and content framework effectively increase the click-through rate and the key area impact user. Lohtia (2007) and Cebi (2013) evaluated the efficiency of banner components, the results showed that color variable affects the advertisement performance [13,15]. In order to meet customer needs, web design emphasizes the User-centered design (UCD), considering and solving the user problems, enhancing the user experience and pleasure. Norman (1986) indicated user-centered interface design, effectively enhance website usability, page views increased by user's satisfactory feedback [8]. Ngo and Byrne (2001) illustrated that when website functionality fulfill customer requirements, user turn attend to the aesthetic of interface design and website scenario [7]. Hsu (2011) studies showed that the web page situation relate to subjective awareness, consequently, designer's top priority is to explore the critical design factors impact website image design [3]. In Holtze (2008) and Lin (2013) paper, addressed graphics planning play an

important role in improving the user-centered web page design, colors and ratio of graphic design elements contribute to the users' feelings about a web page [19]. Bonnardel (2011) and LÁNYI (2012) realized that colors evoke distinct emotions and associated with planned website [4,11]. Considerations for today's interface design are to listen the voice of consumers' and improve aesthetic of websites.

However, by increasing the degree and sophistication of automation, Lau 2006 addressed electronic commerce will become much more dynamic, efficient, and hence more widely adopted by organizations. Intelligent software agents are promising to enhance the degree of automation and sophistication of electronic commerce [14].

As indicated by the studies cited above, the involvement of semantic words and visual design factors for measuring the images of home page design is vital. The aim of the research is to investigate and derive the sensibility from consumers and then establish an automatic model of electronic commerce web page layout design. This research specialized in visual interface components in banner and content cascading style sheets framework, and introducing the visual factors effect to website image design. The model of a framework visual design provide designers an optimal web style development and shorten the period of exploring interface design. This paper presents an interface design suggestion so as to meet customer expectations. By means of web module, the website image model design can easily apply to cross-platform and benefit to develop website image design on dynamic devices.

2. EXPERIMENTAL METHODOLOGY

The study approaches to the relationship between visual factors and image sensations of web page layout design. Figure 1 outlines the research procedure. The experiment choose a classical cascading style sheets framework car website as sample analysis. Next, defining visual principals for banner and content framework design components as independent variables, the image of website styles are the dependent variables in experiment design. To indicate the relevance between design factors and web page image design, multivariate analysis of variance analysis is used to discuss the relationship between design components and web page image design.

The conclusions promote to shorten the electronic commerce website design period and establish a web page image design optimal solution.

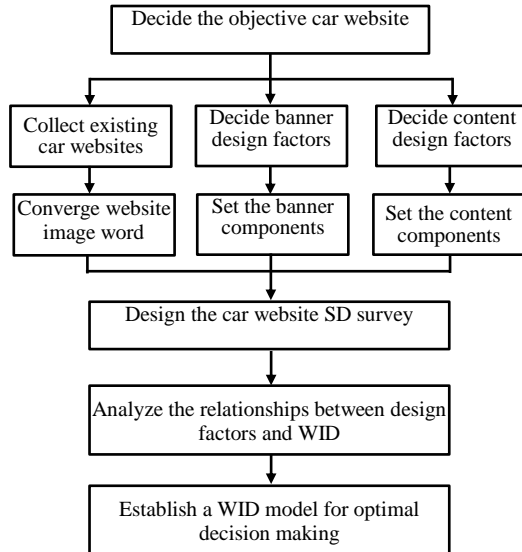


Figure 1. Flow chart of the research procedure

2.1 Determination of subject

Allowance must be made for website sample, the category of car website are first obtained by framework construction for the most classical cascading style sheets layout of sample analysis. Due to the various of web page layout, the research collected ten best-selling car cooperation official website in the world, ten cascading style sheets layout are enumerated for testing the influences between cascading style sheets layout and the degree of impact. Thirty subjects were conducted a closed survey to investigate which form of cascading style sheets layout affects user the most.

According to the mean average the sample of Volkswagen Aktiengesellschaft Canada official website was chosen from the car market’s top ten websites for the most influential and proper structure framework web design for the experiment sample. Principally, the selected subject of Volkswagen Aktiengesellschaft Canada official website layout contains Logo banner, navigation, content and footer four frameworks. Research designates Volkswagen Aktiengesellschaft Canada official website cascading style sheets layout of banner and content area for further experimental design.

2.2 Converge website image words

In order to select an initial set of car website sample, the concept of Kansei engineering theory (KET) was used for subsequent experiment, Nagamachi (1995), Liu and Tong (2009) advocated KET is a process of linking the users’ feeling using a survey or an experiment represented by image word pairs [5,10]. In this study, the open image is used to extract variety of car website images, thirty participants were asked to describe how will a car website influence user emotion. The research sort out eighty adjectives and summarize adjective words into an image scale of experimental website image words presents in Figure 2.

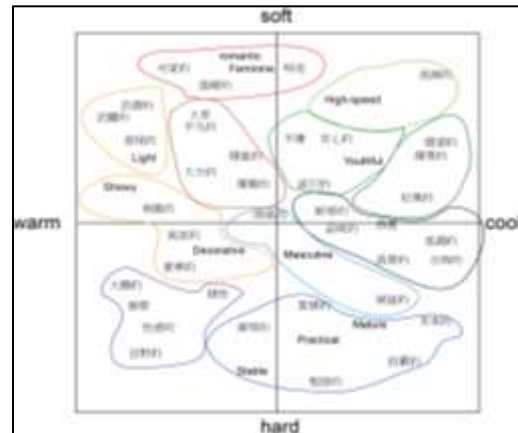


Figure 2. Image scale of website image words

After evaluating collected image words, based on evaluation, potency and activity policy, nine image adjectives were selected and then made into nine representative bipolar adjectives, which are considered as suitable for describing the image of a car website. Nine pairs of bipolar adjectives conduct to a seven point Likert type scale in the experimental design.

The selected image words are active and inflexible, luxurious and simple, wild and conservative, young and mature, steady and light, noble and vulgar, unique and popular, sweet and cool, male and female.

2.3 Define banner design factors

As the previously mentioned, the key design factors of influence banner design involved two independent variables, color and car size. In color system, Cochrane (2014) reported Munsell color system discovered and accurately mapped the peculiarities of

human color perception which is based on rigorous measurements of human subjects' visual responses to color. Due to the basis in human visual perception, Munsell color system space specifies colors based on three color dimensions. We selected five principal hues in horizontal circle of Munsell As the previously mentioned, the key design factors of influence banner design involved two independent variables, color and car size. In color system, Cochrane (2014) reported Munsell color system discovered and accurately mapped the peculiarities of human color perception is based on rigorous measurements of human subjects' visual responses to color. Due to the basis in human visual perception, Munsell color system space specifies colors based on three dimensions of colors. We selected five principal hues in horizontal circle of Munsell color system and controlled values of chroma and lightness, consisting of five major colors, refer to equation by the color set, see for Equation 1. below and Figure 4 illustrates the variables of color:

$$\delta = \{5R5/10, 5Y5/10, 5G5/10, 5B5/10, 5P5/10\} \quad (1)$$

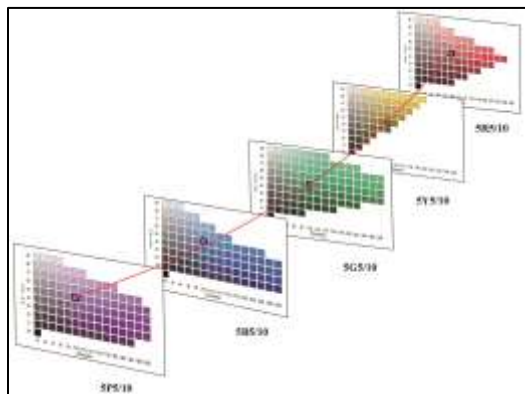


Figure 4. Munsell color system of the experiment

In terms of design factors of car sizes in banner, four ratio car size were defined by Fibonacci sequence in Table 1, web page layout was perceived as more beautiful, the following four ratio were used: 1:1, 2:1, 3:1 and 5:1. The above content is also a golden ratio design system.

Table 1. Four ratio size of content subjects





Four ratio	
1:1	2:1



2.4 Selection of content design components

Independent variables of colors and perspective of cars are determined on content design factors. The perspectives which are as followed: zero degrees front, forty-five degrees two-point perspective, ninety degrees side, turn one-eighty degrees to back. Four perspectives of car are featured in Table 2.

Table 2. Four perspectives of content subjects

Four perspectives	
zero degree	forty-five degrees
	
ninety degrees	one-eighty degrees
	

The selections of five color variables of content are as banner variables. For the content independent variables of four view angles of car were based on general car camera shooting angles, regarded as expedient perspectives presenting completeness and feature of a car.

2.5 Experimental evaluation of web page image design

Finally, the representative car website is rendered individually by five colors and four ratio size of object in banner framework, five colors and four car's view angles in content design as experimental samples. In order to ensure the clarity and consistency, the experiment showed on screen with

1024×768 pixels display resolution. In this step, each variable was designed for the car website sample questionnaire in closed survey. Regarding the concern of grasping consumer's psychological feelings, subjects were asked a series of eighteen website samples depended on nine bipolar adjectives criteria of website images created by Osgood's semantic differential questionnaire shows in Figure 4, questionnaire was written in Chinese.

Multivariate analysis of variance analysis is not only used to examine the changes in banner and content have significant impact on web page image design dependent variables, but also explore the relationship between banner and content visual design components. As the process of statistic analysis, the chi-square of Bartlett's test of sphericity, demonstrates the design factors effects on nine pairs of image words are significant $p > .05$. In addition, the Wilks' Lambda statistic is a probability distribution used in multivariate hypothesis testing to illustrate the calculation of within and between-groups sums of squares. The results imply the dependent variable of color elements affects the outcome of web page image design.

網頁介面設計因素與意象之關聯探討 No.

親愛的同學：

您好，我是國立雲林科技大學視覺傳達設計系所研究生，目前正在進行「網頁視覺介面設計與網頁意象關係」之相關研究，研究主要是針對網頁框架之圖樣內容給予網頁整體呈現之意象，本研究內容僅用於網頁視覺介面設計相關學術研究之參考，感謝您撥冗填寫，謝謝。

國立雲林科技大學 視覺傳達設計系所 LCV 數位設計實驗室

第一部分：請針對下列網頁設計所呈現意象，將您的感受與選偏向之形容語畫□中。

樣本	Banner Sample	語義差異量表
X10		活潑的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 呆板的 豪華的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 質樸的 狂野的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 拘謹的 穩重的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 輕巧的 年輕的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 成熟的 高貴的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 低俗的 獨特的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 大眾的 溫馨的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 冷酷的 男性化 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 女性化
X7		活潑的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 呆板的 豪華的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 質樸的 狂野的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 拘謹的 穩重的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 輕巧的 年輕的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 成熟的 高貴的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 低俗的 獨特的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 大眾的 溫馨的 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 冷酷的 男性化 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 女性化

Figure 4. Close survey of SD questionnaire

The research conducted 102 questionnaires in order to obtain the sample of experiment and acquires the assessment value for web page image design. A seven point Likert scale questionnaire is approach to scaling responses for positively correlated or no correlation with web page image design. In the pre-test stage participants consisted of seventy-nine participants, fifteen male and sixty-three female specialize in visual image design without experiences of website managing. The subjects of post-test are in the field of expertise with more than five years design management experiences, twenty-three website engineers, five male and eighteen female. In the study, 101 questionnaires were retrieved and the rate of valid questionnaire was ninety-nine percent. The survey aim to investigate user's attitude tendency and regarded as the criteria of web page image design.

2.6 MANOVA analysis results

The data support that the color of logo banner attributes the image of active and inflexible, luxurious and simple, wild and conservative, steady and light, noble and vulgar, unique and popular, sweet and cool web page design. Furthermore, the sizes of object in logo banner layout associates with impressions of young and mature, male and female website design. On the other hand, the data indicates that in content area the image of active and inflexible, luxurious and simple, young and mature, steady and light, noble and vulgar, unique and popular, sweet and cool were appeared to color factors. Perspectives of subject in content layout determined the web page style of young and mature, male and female. These findings suggest the optimal decision of web page design.

3. CONCLUSIONS

In this paper, we have examined some of the properties of website image design. The experiment was performed to establish the relationship between visual factors and website image design. We have presented a new approach for transforming users' perception into interface visual elements design. The concept of kansei- engineering was used to extract the representative experimental samples of car market websites database. The study conducted multivariate analysis of variance analysis to examine visual factors affect web visual image design. The result of analysis shows design factors have significant effects on website image design. It is evidently, the relation between design factors of colors in banner and content framework are more influential than car size variables. In addition, the result also indicates that nine pairs of image words can be divided into three groups. In the first group,

design factors composes of 5Y5/10, 5G5/10, 5P5/10 on banner framework and 5Y5/10, 5R5/10, 5G5/10, view of 45° two-point and 90° side perspective design factors of content framework are classified into the similar website image design. The second group of website image design suggests that the ratio of car sizes 1:1 and 2:1 on banner framework design factors are close to colors of 5B5/10 and 5P5/10 on content framework design. In third group of website image design shows the consistency of 5B5/10 color design factors and car size ratio of 3:1 and 5:1 on banner design.

The study develop a website image design model to explore the optimal combination of banner and content design on car website development for a given design concept represented by a car website image word pair. The results obtained from semantic words and visual design factors for measuring the images of home page design establish a web page layout design database for an automatic model of electronic commerce. In future research, the results is applicable to automatic electronic commerce website page design and facilitate the cross-platform, shorten the period of exploring electronic commerce website design.

The study have developed a web page image design model to explore the optimal combination of logo banner and content design on car website development for a given design concept represented by a car website image word pair. The results obtained from the statistic can be used to cross-platform design and evaluate user interface experiences.

1. Statistical analysis attributes significant relationship between web page image design and design components, especially the variables of color design in logo banner.
2. Research establishes a web image design model for web designers or web developers, advocates an optimal suggestions of developing web page design.
3. In this study, an innovative approach is proposed to find a model of image design applied to web page and also approved to mobile applications or other platform. In the future, the results provide designers with an effective design progress to web image design and utilize design factors to cross-platform.

4. Acknowledgements

The research was applied to industry-university cooperative research project in interface website design, and supported in part by the National Yunlin University of Science and Technology, LCY digital design lab, ROC under Grant No. 103-L01-3. The achievement of the project is practical. However, studies are insufficient for a variety of website design factors may also relates to human perception. The results provide designers with an effective design progress to web page image design and utilize design factors to cross-platform. The research is awarded by the National Library in gratitude and commendation for presentation of the dissertation under Grant No. 10403000920 and authorization to publicly disseminate this paper through the Library's theses and dissertations system.

The achievement of the project is practical. However, studies are insufficient for a variety of website design factors may also relates to human perception. The results provide digital interface designers with an effective design progress to website visual image layout and utilize design factors to cross-platform.

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