科技部補助專題研究計畫成果報告
期末報告

整合感性語意差異的顧客需求設計分析與理性圖像衍生的模式於產品造形之發展(I)

計 畫 類 別 ：個別型計畫
計 畫 編 號 ：NSC 102-2221-E-269-023-
執 行 期 間 ：102 年 08 月 01 日至 103 年 07 月 31 日
執 行 單 位 ：遠東科技大學創意商品設計與管理系

計 畫 主 持 人：林銘泉

計畫參與人員：碩士班研究生-兼任助理人員：黃建雄
碩士班研究生-兼任助理人員：范旭華
博士班研究生-兼任助理人員：洪煜清

報 告 附 件 ：出席國際會議研究心得報告及發表論文

處 理 方 式 ：
1.公開資訊：本計畫可公開查詢
2.「本研究」是否已有嚴重損及公共利益之發現：否
3.「本報告」是否建議提供政府單位施政參考：否

中 華 民 國 103 年 10 月 26 日

中 文 摘 要 ： 近年來，由於社會變遷與電子資訊快速流通，消費者對產品的需求變化很大，選購產品的偏好複雜而難以掌握，使產品設計的趨勢為強調滿足不同的顧客需求。因此，設計師在產品開發過程中，需結合電腦資料庫的應用，以便快速產生產品外形構想，同時能更貼近消費者的多元需求與偏好。感性工學係經由解析人類的感性，有效結合商品化技術於商品特性中。基本上，感性工學以工學的手法，將人的各種感性定量化，再找出感性量與工學所使用的各種物理量間之高元函數關係，作為工程發展時的基礎。基於感性工學與工程設計間之鏈結與協調，尚在磨合時期，本研究計畫之重心為感性語意差異的顧客需求設計分析，其發展係運用心理圖析量表、因素分析、聯合分析與品質機能展開等方法於感性語意差異及對應之產品造形特徵間之鏈結模式建構。本研究所建立之整合感性工學與產品造形衍生系統，將可降低使用者需求與設計師認知之差異，並鏈結使用者的需求與產品形態要素，以提升設計工作之效率與品質。

中文關鍵詞： 感性語意差異，因素分析，品質機能展開，仿生設計

英 文 摘 要 ： In recent years, social changes and rapid development of electronic information technology has made consumers become variable in product requirements. Product design needs to satisfy different types of consumers. As such, the designer must use computer database in the generation of product forms and at the same time meet consumer requirements and preferences. Kansei engineering can effectively analyze the human emotion and reflect it on product characteristics. In general, Kansei Engineering helps designers to quantify a variety of emotions and link with engineering aspects of design. However, the linkage between emotion and rationality in product design is still very weak and needs further exploration. The research project will integrate properties of emotion and rationality into the generation of product forms. During the development process, Kansei semantic differential approach, factor analysis, conjoint analysis and quality function deployment will be used in a sequential connection for the first stage of product design. It is expected that the development of the proposed approach will reduce the differential cognition

between consumers and designers and link customer requirements with product form elements to help improve efficiency of design activity and quality.

英文關鍵詞： Kansei Semantic Differential Approach, Factor Analysis, Quality Function Deployment, Synectics

科技部補助專題研究計畫成果報告

（□期中進度報告/ⓥ期末報告）

整合感性語意差異的顧客需求設計分析與理性圖像衍生的模式於產品造形之發展(I)

Integration of Kansei Semantic Differential Customer-Oriented Design Analysis and Rational Graphics Generation Model into the Development of Product Forms (I)

計畫類別：ⓥ個別型計畫　□整合型計畫

計畫編號：MOST－102－2221－E－269－23

執行期間：**102 年　8 月　1 日 至　103 年　7 月　31 日**

執行機構及系所：**遠東科技大學　創意產品設計與管理系**

計畫主持人：**林銘泉 教授**

共同主持人：

計畫參與人員：**洪煜清、黃建雄、范旭華**

本計畫除繳交成果報告外，另含下列出國報告，共 _1_ 份：

□執行國際合作與移地研究心得報告

ⓥ出席國際學術會議心得報告

期末報告處理方式：

1. 公開方式：

   ⓥ非列管計畫亦不具下列情形，立即公開查詢

   □涉及專利或其他智慧財產權，□一年□二年後可公開查詢

2.「本研究」是否已有嚴重損及公共利益之發現：ⓥ否 □是

3.「本報告」是否建議提供政府單位施政參考 ⓥ否 □是，（請列舉提供之單位；本部不經審議，依勾選逕予轉送）

中　華　民　國 103 年　7　月　31　日

科技部專題研究計畫成果報告

整合感性語意差異的顧客需求設計分析與理性圖像衍生的模式於產品造形之發展(I)

Integration of Kansei Semantic Differential Customer-Oriented Design Analysis and Rational Graphics Generation Model into the Development of Product Forms (I)

計畫編號：102-2221-E-269-23

執行期限：102 年 8 月 1 日 至 103 年 7 月 31 日

主 持 人：林銘泉 教授　遠東科技大學 創意商品設計與管理系

Email：minglin@mail.ncku.edu.tw

研究人員： 洪煜清、黃建雄、范旭華

中文摘要

近年來，由於社會變遷與電子資訊快速流通，消費者對產品的需求變化很大，選購產品的偏好複雜而難以掌握，使產品設計的趨勢為強調滿足不同的顧客需求。因此，設計師在產品開發過程中，需結合電腦資料庫的應用，以便快速產生產品外形構想，同時能更貼近消費者的多元需求與偏好。感性工學係經由解析人類的感性，有效結合商品化技術於商品特性中。基本上，感性工學以工學的手法，將人的各種感性定量化，再找出感性量與工學所使用的各種物理量間之高元函數關係，作為工程發展時的基礎。基於感性工學與工程設計間之鏈結與協調，尚在磨合時期，本研究計畫之重心為感性語意差異的顧客需求設計分析，其發展係運用心理圖析量表、因素分析、聯合分析與品質機能展開等方法於感性語意差異及對應之產品造形特徵間之鏈結模式建構。本研究所建立之整合感性工學與產品造形衍生系統，將可降低使用者需求與設計師認知之差異，並鏈結使用者的需求與產品形態要素，以提升設計工作之效率與品質。

關鍵詞：感性語意差異，因素分析，品質機能展開，仿生設計

Integration of Kansei Semantic Differential Customer-Oriented Design Analysis and Rational Graphics Generation Model into the Development of Product Forms (I)

英文摘要(Abstract)

In recent years, social changes and rapid development of electronic information technology has made consumers become variable in product requirements. Product design needs to satisfy different types of consumers. As such, the designer must use computer database in the generation of product forms and at the same time meet consumer requirements and preferences. Kansei engineering can effectively analyze the human emotion and reflect it on product characteristics. In general, Kansei Engineering helps designers to quantify a variety of emotions and link with engineering aspects of design. However, the linkage between emotion and rationality in product design is still very weak and needs further exploration. The research project will integrate properties of emotion and rationality into the generation of product forms. During the development process, Kansei semantic differential approach, factor analysis, conjoint analysis and quality function deployment will be used in a sequential connection for the first stage of product design. It is expected that the development of the proposed approach will reduce the differential cognition between consumers and designers and link customer requirements with product form elements to help improve efficiency of design activity and quality.

Keywords：Kansei Semantic Differential Approach, Factor Analysis, Quality Function Deployment, Synectics

目錄

圖目錄

表目錄

一、前言

面對競爭激烈的全球化市場，產品開發過程須透過市場調查的機制，來確認新產品能滿足顧客的需求。為使產品在開發過程中減少企業無謂的損失，設計師在產品開發階段，不只要掌握忠實顧客外，更要考量潛在顧客。但潛在顧客對產品外形的偏好，設計師較難掌握，尤其在產品外觀造形為主的設計上，缺乏具說服性的量化數據，更難符合顧客的需求。再者，隨著大量製造的工業化進程下，顧客對產品的自我意識逐漸提升，企業必須提供符合各種偏好的顧客族群，以增加企業本身的形象、品牌精神與獲利能力。預測目標顧客族群的偏好，已成為產品設計階段的重要依據。依此，如何在設計前期有效導入參與式設計，讓顧客參與產品開發的意見具有實質效用，存在二項問題待改善: (1) 產品開發初期、若要加入顧客對產品外形的喜好及購買因素(諸如產品是否符合他個人風格、與他的生活方式有所連結等)，使用問卷方式調查受測者之基本資料，性別、年齡、月收入等，將難以確認該受測者是否為目標銷售族群。因此，區別該受測者為產品的目標銷售群，必能使該產品符合潛在顧客之偏好。(2) 儘管以潛在顧客自行描繪之方式，能讓開發人員直接瞭解受測者的喜好，但會因受測者的表達能力及時間限制，而有不同的認知，故如何減少設計師與潛在顧客之產品外形認知之差異，將是值得探討的方向。

感性工學是一個在設計領域的科學，可有效地將人的感性及感受對應到顧客的需求，並能以數值及量化的形式來呈現，使所獲得的設計資訊更具參考價值。有鑑於顧客需求不易確認，而滿足顧客需求對產品成功銷售具重要性，本研究擬建立由使用者輸入感性語彙，與參數化之關連作導向來建立新產品之系統，降低使用者感性需求與設計師感性認知之差異，並且尋找影響感性之主要產品型態要素，以提升產品造形設計之效率與成效。

二、研究之目的

本研究將整合感性語意差異法來進行顧客需求分析，並透過生活型態分析、因素分析與聯合分析法來定義消費者及使用者族群，以確保這些顧客需求來自於該產品的消費族群或潛在消費族群。當顧客需求與產品設計特徵確認後，再以品質機能展開法來建立兩者的關聯性，使得顧客需求與產品設計特徵之間的轉換，可以更快速有效地進行，同時也提高此一程序系統化與自動化的可行性。

本研究選取智慧型行動裝置與滑鼠為案例進行初步之分析與探討。有關智慧型行動裝置與滑鼠設計案例之選取，除考量這兩種產品為時下之 3C 電子產品，分別具有平直與曲面特徵之代表性產品，非常適宜本研究之切入。未來將思考以有機幾何之理性造形進行產品之發展，以便進一步鏈結消費者之感性訴求。

三、文獻探討

本研究為有效整合感性語意差異的顧客需求設計之發展，其文獻探討將包含有顧客需求導向的設計、感性工學與語意差異等。

1.顧客需求導向的設計

近年來國內外學者強化顧客需求導向的設計，並且廣泛應用電腦輔助設計的功能，做為發展產品造形與顧客做互動性的交流。蔡明琦（1999）利用產品的 3D 模型來獲取顧客對產品的感覺意象，再以『類神經網路』軟體分析顧客對產品造形所對應的感覺意象，將評價結果轉化為量化的資料庫，以建構出一個電腦輔助產品造形設計模式。徐嘉鴻（1999）運用虛擬實境、電腦 3D 模擬的方式與網際網路的特性，完成以虛擬原型為基礎的設計資訊系統，藉車體模型與人體模擬的設計資訊，輔助設計師於自行車裝配與騎乘關係上，將既有之相關研究成果作一整合與應用，作為設計與決策的參考。陳勝忠（2000）藉由設計的概念評估階段導入顧客參與之理念，結合網際網路之特性，使概念評估能經由網路跨平台之團體參與方式，

以輔助設計師作概念評估之客觀決策依據。管倖生、林彥呈（2002），以感性工學的程序，建構網頁設計系統。導入使用者的感性概念，探討何種網頁型態要素及感性語彙會影響使用者操作上的認知，藉此提出網頁型態要素與感性語彙之間的關連性。曾惠民（2003）指出以感性工學建構的 Pixel Style 網站的風格對使用者意象有關鍵性的影響。魏巧晴（2003）以工具機車床設計為案例，結合 QFD、模糊理論、與 TOPSIS 分析，對於工業工程上，產品概念之初步之決策肯定其在產品決策上能夠維持客觀性。陳智宣(2004) 運用美度測量方法將使用者對畫面型使用者介面的意象量化，並透過倒傳遞類神經網路，尋找出美度要素與感性意象的關連，以建立一個評價操作介面，提供設計師能快速掌握使用者對美度要素的認知，進而增進電腦畫面的美感。陳冠傑(2004)以 TOPSIS 分析應用在數位相機外形與握持方式的矛盾選擇最佳解。黃涵貞（2006）透過語意差異法（Semantic Differential Method）依據專家所配出的 22 種不同的網頁色彩配色樣本，測試高齡者對其網頁色彩會有何種感覺意象，並對哪些類型的配色有高度的喜好，以及不同性別是否會有認知差異。

2.感性工學

1970 年代從日本開始發展，感性（Kansei）是來自日語，其主要意涵為當人見到一項產品時心中經由腦內經驗累積所反應的意象，而感性工學就是把這種感覺應用於產品設計上，意圖將此感覺傳遞給使用者的一種技術。一般而言，感性工學分成三個步驟:(1)討論產品所給使用者的感覺，這樣的感覺通常都是以形容詞語彙來呈現的，並且將這些來自生理與心理的綜合感覺分類。(2)感性工學通常都會利用電腦技術來進行應用，通常來說都會有以下的四個資料庫，感性語彙資料庫、意象資料庫、知識資料庫、設計資料庫等。而利用如專家系統或是類神經的運算法可以藉由以上的資料庫來使輸入的語彙轉換成為產品來表達。(3)利用邏輯性的數學程式模組來進行感性語彙的解讀,也就是說明了根據相同的法則可以得到相同的結果。

3.語意差異法(SD 法)

語意差異法(Semantic Differential Method，簡稱 SD 法)是由 Charles E. Osgood 等人於 1942 年提出，其目的在幫助研究人員了解意象感覺，通常被視為用來評估非計量性的資料，以特定項目在一定的評估尺度中作重要性的評量。SD 法是由被評估的事物、量尺、受測者等三個要素構成。第一個要素是選定被評估的對象。第二個要素是選擇適合的評價尺度，這些尺度是由成對的對立形容詞所構成的，數目大約以 10-30 個較合適，而評價的等級，一般常用的是五級和七級。第三個要素是受測者，也就是樣本，樣本數最少要 30 人，才能得到較穩定的資料。

4.聯合分析法

聯合分析法早期稱為聯合衡量法（Conjoint Measurement），是由 Luce 及 Tukey 於 1964 年提出。Green 及 Rao (1971)把聯合分析法應用於消費者研究。由於聯合分析法屬於多變量分析方法之一種，適用於進行消費者心理判斷和偏好的衡量，其後更有許多學者針對聯合分析的預測能力、有效性、可靠性、推估法及調查方法進一步深入研究，使得方法的功能及應用性更具延展，在商業已廣被應用，無論是消費產品、工業產品、金融服務等，或新產品的評估、定位、競爭分析、定價或市場區隔等方面皆成為不可或缺的分析工具，而本研究欲瞭解各種屬性在選購中整體考量是否具重要性。

聯合分析法可說是一種人因顧客導向科技(Ergonomic Customer-oriented Technology)與產品研發設計的系統性工程方法，能掌握市場趨勢(Market Trend)與顧客的需求，並確認哪些設計特徵是重點目標項目，以縮短產品開發週期、增加顧客的滿意程度。聯合分析的一項基本假設是：受測者是依據構成受測體的多個屬性(Attributes)來從事知覺和偏好的判斷。換言之，消費者面對不同屬性水準組合成的異質性產品時，其購買決策是一種多重屬性的購買決策行為 (Multi-attribute Purchase Decision)。這種多屬性購買決策背後的假設即在於：產品之所以帶給人們效用不是因為產品本身而是由於產品的屬性使然。因此從行銷研究的觀

點而言，將消費者的偏好認為是產品屬性的函數而非產品的函數。因此，產品的效用＝f（各產品的屬性）。

聯合分析法是一種利用函數測定的技巧，所有的假設基礎皆以整合資料為主所建立的模型，簡單表示如下 (Hair et al.，1995)：

$$Y1=X1+X2+X3+\cdots+Xn \qquad (1)$$

其中 Y1 為可衡量或不可衡量的變數；X1，… ，Xn 則為可衡量的變數。因聯合分析適合於用來瞭解消費者對潛在產品或服務預設屬性的聯合評估方法，提供研究者探索消費者對產品偏好的組合，其特性主要如下：

(1)允許可衡量或不可衡量的應變數

(2)可使用分類的預測變數

(3)自變數與應變數具一般化關係，因此在統計分析上更具彈性。

聯合分析法的應用牽涉到以下幾種步驟：(1)偏好模式的選擇(2)資料蒐集方法(3)建立整體輪廓法之受測體(4)呈現受測體(5)應變數的衡量尺度(5)估計方法。本研究採用成分效用值模式。公式為：

$$y_j = \sum_{p=1}^{P} f_p(x_{pj}) \qquad (2)$$

其中，$f_p(x_{pj})$ 為受測者對第 j 個受測體第 p 個屬性水準的成分效用函數，此模式中若有 P 個屬性，每個屬性皆有 Q 個水準，則此模式有 P(Q-1)個參數值需要估計。

5.形態分析法

形態分析法(Morphological Analysis) 是由瑞士天文學家 Zwicky 所創造的構想搜尋方法。用一種系統化的分析方法來分析產品所有可能達成的造形。其實施步驟及原則有 3 個步驟：(1)界定主要問題：將所需要解決的問題明確界定出來，並且為了讓主題明確，最好能加入輔助說明。(2)尋找獨立因素：針對上述要解決的問題，按照其相關功能或特徵，列舉出相關的獨立因素，最好以獨立的功能來表示。(3)列舉可行解答：針對各個獨立因素，詳細列出所有可行的解決方案，並盡量以圖形表示，以幫助瞭解。形態分析法必須注意要點為：(1)所選定的獨立因素，必須是在同一層面的特徵，並且互相獨立，沒有層屬關係。這些獨立因素的組合要能包含所提出的問題。(2)為避免解答數目過於龐大，獨立因素最好不要超過八個。除此之外，可以藉由限制條件的建立以縮減解答的數目。(3)各可行解答除了根據以往的經驗，也該有創新性的解答。(4)在組合解答時，每個獨立因素只能挑選一個可行的解答。形態分析法在造形的產生上，是快速而且經濟有效的系統化方法，但是有時在構想發散後，無法適時的收斂，而且方案選擇的質與量是否能達成特定的要求，則必須仰賴專業知識的協助，以便作構想有效的發散，並減少發散的時間。形態分析法是將目標事物的所有獨立要素都列出來，並定義每一個獨立要素的可變參數，列成形態分析表，研究所有獨立要素的組合。形態分析表可容易分解成子系統的目標，能研究多種變數的不同組合與組合方法，Zwicky(1969)指出形態分析法具有下列二項優點：(1)幾乎可以包涵全部可行的組合方式、(2)具有強制配對機制，產生出意想不到的創新組合。張愷臨(2007)應用形態分析法將滑鼠依功能分為三個模組，分別為結構模組、追蹤模組與滾輪模組。利用其分析結果，確立零件與顧客需求所對應的三維形態圖。Chang(2007)利用形態分析法對 3D 產品外形，先將其拆解成各別之構成特徵，並賦予每個特徵不同之參數值，再重新將各種不同參數之特徵，組合成各式不同之 3D 形體。

6.品質機能展開之產品特徵與顧客需求矩陣

產品特徵與顧客需求的關係矩陣主要是將一般顧客對於產品之用語轉換成為工程上的術語，如顧客對產品之需求用語為：放保養品的美麗收藏空間，設計師很難將其需求投射為具體的

設計或產品規格上，且如此之需求用語所牽涉到的有放保養品、美麗、收藏空間，換句話說便是多準則的需求，設計師在處理時所需考慮到的因素會增加，且造成設計結果與顧客需求不符合的機會提高。赤尾洋二(1991)於『新產品開發品質機能展開之實際應用』一書中認為將顧客需求項目與產品特徵項目整理出來後，利用兩者之關聯強度以相關性係數來評估，所得之矩陣即為產品特徵與顧客需求的關係矩陣，本研究便是針對品質機能展開的顧客需求與產品特徵矩陣來探討，將顧客需求進行數量化的動作。

表 1 為單一顧客之產品特徵與顧客需求關係表，其相關性係數採用 1、3、5、7、9，作為相關性強弱的表達。1 代表無（沒關係），3 代表弱（有點關係），5 代表中（有關係），7 代表次強（很有關係），9 代表強（絕對有關係），如表 2 所示。

表 1 單一顧客之產品特徵與顧客需求關係表

		產品特徵				
		PC1	PC2	PC3	PC4	PC5
顧客需求	CR1	5	3	1	5	5
	CR2	9	1	3	5	9
	CR3	7	5	7	3	3
	CR4	7	9	9	5	5

表 2 相關性係數之對應表

相關性係數	對應強度	對應解釋
1	無	沒關係
3	弱	有點關係
5	中	有關係
7	次強	很有關係
9	強	絕對有關係

例如 PC2 產品特徵和 CR3 顧客需求的相關性係數為 5（中），其對應關係為有關係；PC1 產品特徵和 CR4 顧客需求的關係強度為 7（次強），其對應關係為很有關係。將資料整理後便可以得到以下的矩陣：

$$\begin{bmatrix} & PC1 & PC2 & PC3 & PC4 & PC5 \\ CR1 & 5 & 3 & 1 & 5 & 5 \\ CR2 & 9 & 1 & 3 & 5 & 9 \\ CR3 & 7 & 5 & 7 & 3 & 3 \\ CR4 & 7 & 9 & 9 & 5 & 5 \end{bmatrix}$$

林銘泉（1986）認為要使用品質機能展開來反映真正產品特徵與顧客需求，須剔除有主觀成分的問題。因此，以大量顧客問卷調查佐以數量化統計方法來決定所需之產品特徵與顧客需求矩陣為較佳之解決方案。本研究以單一顧客的產品特徵與顧客需求矩陣為個體，整合成眾多顧客之意見來當作客製化系統中的顧客需求與產品特徵。

7.集群分析

集群分析之目的是在於將物件加以集結成群，使得在群體內的個體的同質性很高，而群體之間的異質性很高。本次研究主要用到的方法為集群分析中的非階層集群法，它能在分群的過程中，將原有的集群加以打散，並重新形成新的集群。非階層集群法也有幾種不同的計算方法，各種方法都是先選出某些種子點作為集群的中心。本次研究主要選用的 K 平均數法

(K-means method)即屬於此類分析法，其物件打散後重新形成新的集群之特性，能幫助本研究於眾多受測者所填寫之介面中歸納組合出具有代表性之群集介面樣本。K 平均數法的演算步驟為：(1)將各個事物點（個體）分割成 K 個原始集群。(2)計算某一個事物點到各集群的平均數(重心)的距離(距離的計算通常採用歐幾里得距離)，然後將一些事物點分派到距離最近的那個集群。重心計算後得到新事物點的那個集群的平均數，以及失去該事物點的那個集群的平均數。(3)重複步驟(2)，直到各事物點都不必重新分派到其它的集群為止。

四、研究方法

本研究之發展期初分別選取智慧型行動裝置、滑鼠、與熊貓仿生之咖啡機為案例進行初步之分析與探討。有關智慧型行動裝置與滑鼠設計案例之選取，除考量這兩種產品為時下之 3C 電子產品，分別具有平直與曲面特徵之代表性產品，非常適宜本研究之切入。圖 1 與圖 2 分別為智慧型行動裝置與滑鼠造形變動之主要參數特徵。

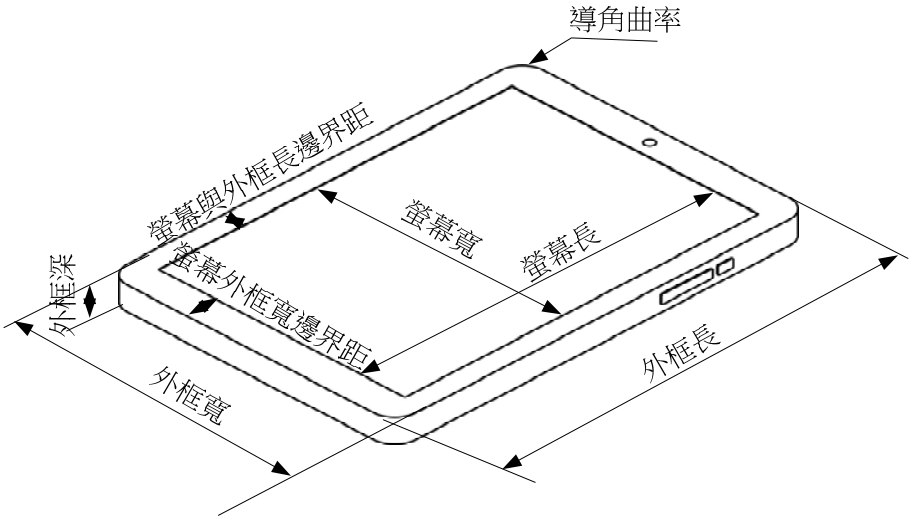
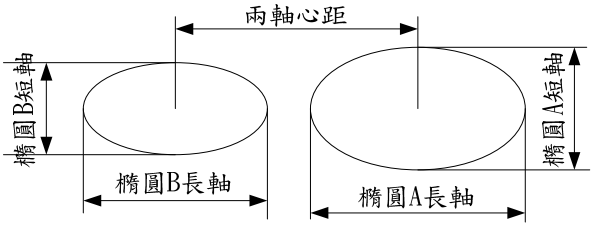
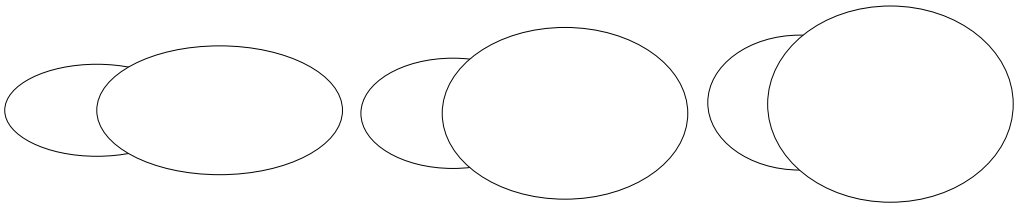


圖 1 智慧型行動裝置之有機參數界定



(a)利用有機幾何橢圓參數變動特質產生滑鼠外形之概念



(b)兩個橢圓長短軸不一及軸心距變動所產生之概念滑鼠外廓範例

圖 2 運用有機橢圓造形特徵之參數特徵界定及其變動於滑鼠之造形變化

為建立產品意象與產品設計要素之感性關聯模式，透過使用者生活型態調查分析與因素分析來確認使用者族群之分類，接著藉由聯合分析法來確認使用者族群的感性需求，並應用品質機能展開

法進一步完成感性語意差異的顧客需求設計分析。最終，將推論最佳設計方案之設計特徵組合。圖 3 為本研究設計流程圖。

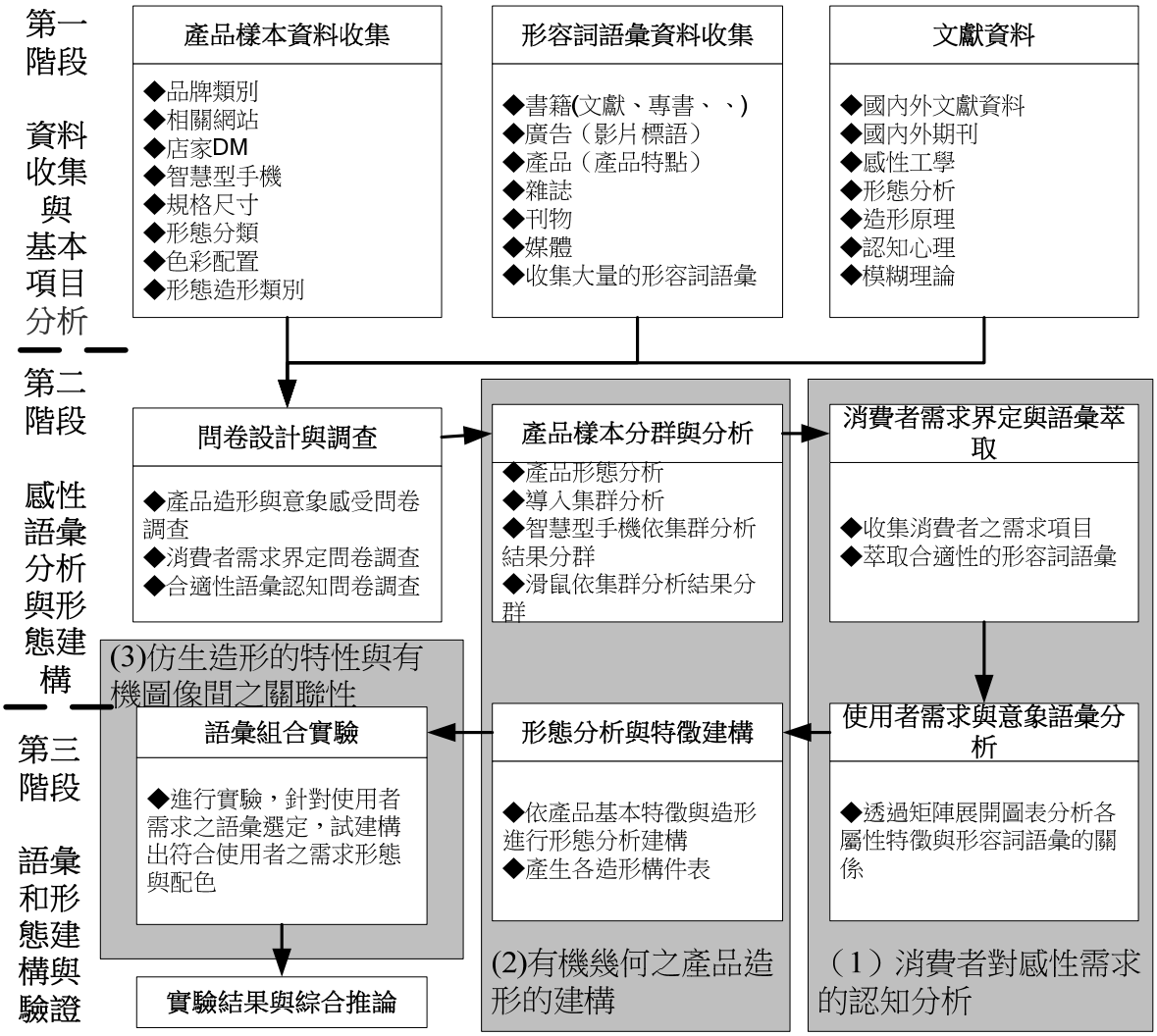


圖 3 研究設計流程圖

1. 確認形容詞語彙

由於使用者對產品意象的形容詞語彙眾多，本研究針對目標產品收集目前大眾流通的，或相關研究成果與文獻等形容詞語彙來收集。這些形容詞語彙，再經由實驗的方式讓受測者選出立刻理解的，或本身喜好偏好的形容詞，再透過實驗來篩選出適合該目標產品的意象語彙，以確認本研究目標產品的形容語彙。

本次收集總共有 216 組形容詞語彙，在這些為數眾多的形容詞語彙，經前測實驗讓受測者主觀選出立刻理解的形容詞進行篩選並剔除部份意思重疊與不易判斷之語彙後，所獲得語彙總計有 121 組，如表 3 所示。

2. 挑選設計要素

本研究針對產品的造形來進行研究，首先鎖定目標產品，透過產品型錄、網頁資料以及實體店面拍攝照片等途徑進行收集樣本圖片。再應用形態分析法將目標產品的外觀造形拆解成數個設計特徵，這些設計特徵定義為本研究重要之形態要素。這些產品形態要素進行數值化的程序，即使

表 3 形容詞語彙組合彙整表

1. 現代的←→傳統的	2. 美觀的←→不雅的	3. 穩重的←→輕佻的
4. 獨特的←→普通的	5. 迅速的←→緩慢的	6. 規矩的←→叛逆的
…	…	…
118. 設計感←→素雅的	119. 專業的←→輕便的	120. 新奇的←→清爽的
121. 質感的←→圓滑的		

用量化的參數來描述造形特徵，例如大小、角度、形式種類等，作為將來與形容詞語彙轉換的計算依據。最後應用群集分析的方法，將不同造形、形式的目標產品，依據型態要素加以群集分類。

本研究以智慧型行動裝置與滑鼠作為本研究測試案例，故在智慧型行動裝置上收集 SONY、SAMSUNG、APPLE、ASUS、HTC、NOKIA、LG 等數家知名品牌企業，進行其智慧型行動裝置之相關結構尺寸與數據進行收集與量測，並歸納彙整。在滑鼠部份，收集 Logitech 與 Microsoft 等知名品牌之不同類型滑鼠之相關結構尺寸與數據。其相關資料彙整對應方式如圖 4 與圖 5 所示。

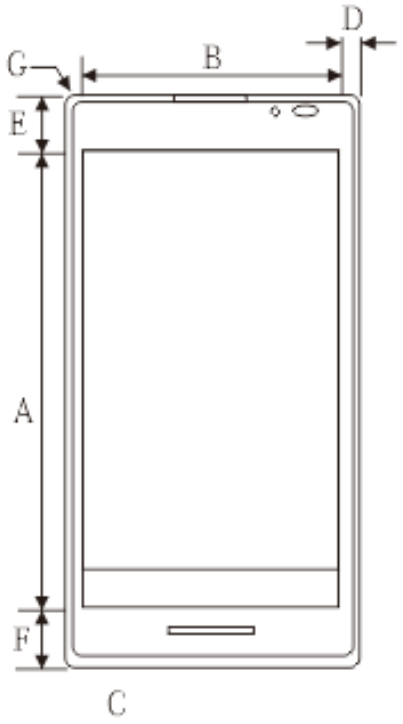


圖 4 智慧型行動裝置結構參數對照圖

A 表示為螢幕長度，單位公厘
B 表示為螢幕寬度，單位公厘
C 表示為手機厚度，單位公厘
D 表示為螢幕與左右外框間距，單位公厘
E 表示為螢幕與上外框間距，單位公厘
F 表示為螢幕與下外框間距，單位公厘
G 表示為圓角直徑，單位公厘

在整理數據的過程當中，台灣智慧型行動裝置之螢幕尺寸範圍為 3.2～7 吋。因考量台灣市場中，消費者主要購買智慧行動裝置多習慣以螢幕 5 吋的手機作為分界，故以 4～5 吋螢幕大小為主要參數資料，選出 4 組常見尺寸，並微調其參數為整數，使其後續研究之數值操作便於計算。其數據整理如表 4 所示。

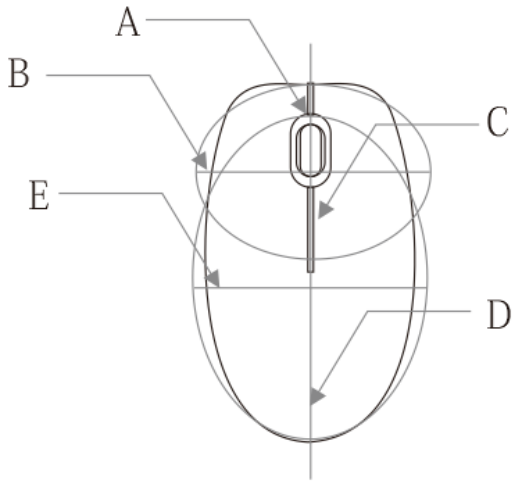


圖 5 滑鼠結構參數對照圖

A 表示為前圓縱軸長度，單位公厘
B 表示為前圓橫軸長度，單位公厘
C 表示為兩圓圓心距離，單位公厘
D 表示為後圓縱軸長度，單位公厘
E 表示為後圓橫軸長度，單位公厘

表 4 智慧型行動裝置之特徵參數表

	最小值～最大值	**常見的數值(mm)**	**1**	**2**	**3**	**4**
A	81.8～130	81.8，87.1，92.4，97.8，103.1，111.0，120.9	82	90	98	108
B	46～74	46，49，52，55，58，63，68	49	52	58	65
C	7.6～11.95	9.3，9.5，8.97，9.8，9.8，10.29，9，8.9	9	9.5	10	10.5
D	2～7	2，3，4，5，6，7	2	4	6	8
E	10～20	12，15，20	12	15	18	20
F	10～20	12，15，20	12	15	18	20
G	3～14	3，8，9，10，12，14	3	5	8	12

同理，在整理滑鼠數據的過程當中，以固定整數為主要參數資料，並選出 4 組常見尺寸，使其後續研究之數值操作便於計算。故將其數據進行整理如表 5 所示。

表 5 滑鼠之特徵參數表

	最小值～最大值	常見的數值 (mm)	1	2	3	4
A	25～60	40，45，50	40	45	50	55
B	20～50	35，40，45	35	38	42	45
C	10～75	10，15，20，25，30，35，40	10	20	30	40
D	25～80	50，55，60，70	50	55	60	70
E	20～70	30，35，40	35	40	45	50

3.建立語彙意象空間

所謂語彙意象即這些被定義的形容詞語彙，在消費者心目中的感受，但是這些內心的感覺並無法對應到具體的設計特徵，因此必須透過實驗或問卷的方法，將語彙意象對應到具體的設計特徵，這些形容詞語彙意象的強弱，對應到特定的數值化設計特徵，即本研究所謂的意象空間。本研究透過問卷調查來進行感性意象，以了解在消費者心目中主要是使用何種形容詞語彙去作為評估產品的喜好標準。

將所獲得 121 組形容詞語彙分製成問卷，調查消費者對智慧型行動裝置與滑鼠的形容詞語彙意象。在智慧型行動裝置部份收集 48 份問卷，將消費者所勾選之項目內容進行統計換算，以多數消費者所選定決定適用的形容詞語彙共有 11 組，如表 6 所示。透過消費者所挑選的語彙中發現，多數使用者對於某幾組特定形容詞較為集中與偏好，像是現代的與傳統的（81.3%）、創意的與模仿的（62.5%）、設計感與素雅的（93.8%）等三組，可以針對其語彙意象所表達之意義，深入探究消費者之語意對應於產品設計特徵為造形、比例、材質、色彩、功能、規格等何種項目，以利下一階段之研究進行探討。

表 6 適用於智慧型行動裝置之形容詞語彙

編號	形容詞語彙	次數	百分比
1	現代的←→傳統的	39	81.3
7	簡潔的←→複雜的	24	50.0
8	順暢的←→阻礙的	24	50.0
16	實用的←→裝飾的	24	50.0
22	流行的←→懷舊的	24	50.0
33	專業的←→業餘的	27	56.3
50	創意的←→模仿的	30	62.5
53	科技的←→復古的	27	56.3
62	耐用的←→脆弱的	27	56.3
118	設計感←→素雅的	45	93.8
119	專業的←→輕便的	27	56.3

在滑鼠部份收集 62 份問卷，將消費者所勾選之項目內容進行統計換算，以多數消費者所選定決定適用的形容詞語彙亦共有 11 組，如表 7 所示。再者，透過消費者所挑選的語彙中發現，多數使用者對於形容詞較為一般性，僅只有少數幾組形容詞語彙需求較為明顯，像是現代的與傳統的（64.5%）、順暢的與阻礙的（54.8%）、科技的與復古的（58.1%）、設計感與素雅的（54.8%）等四組，可針對其語彙意象所表達之意義，深入探究消費者之語意對應於產品設計特徵為造形、比例、材質、色彩、功能、規格等何種項目內容，以利下一階段之研究進行深入探討。後續

將該形容詞語會所選定之結果透過語意差異量表(SD)與多元尺度法進行問卷調查，進而建立形容詞語彙的意象空間。並結合後續的卡片並製作成形容詞語彙級距量表，如表 8 所示，以利後續結合消費者族群感性需求分析。

表 7 適用於滑鼠之形容詞語彙

編號	形容詞語彙	次數	百分比
1	現代的←→傳統的	40	64.5
4	獨特的←→普通的	28	45.2
5	迅速的←→緩慢的	28	45.2
8	順暢的←→阻礙的	34	54.8
15	輕巧的←→厚重的	30	48.4
33	專業的←→業餘的	28	45.2
47	好用的←→難用的	32	51.6
53	科技的←→復古的	36	58.1
118	設計感←→素雅的	34	54.8
119	專業的←→輕便的	30	48.4
121	質感的←→圓滑的	34	54.8

表 8 形容詞語彙級距量表

語彙	級距量表	語彙
現代的	←---------→	傳統的
	5 3 1 0 1 3 5	
獨特的	←---------→	普通的
	5 3 1 0 1 3 5	
…	…	…
專業的	←---------→	輕便的
	5 3 1 0 1 3 5	
質感的	←---------→	圓滑的
	5 3 1 0 1 3 5	

4.使用者族群感性需求彙整

使用者對於目標產品之需求分析係透過聯合分析法來進行。聯合分析所需受測體之產生，依產品設計特徵資料利用直交表產生最少之受測樣本，並以顧客需求屬性作為聯合分析受測樣本的評估指標。待完成聯合分析流程後，將可確認使用者族群之感性需求與產品設計特徵之間的權重值。

在智慧型行動裝置部份，依據產品特徵資料，透過田口直交表產生受測樣本數為 32 個（如表 9 所示）。然後透過電腦 3D 繪圖軟體 Solid Work，依其直交表所推算之特徵參數進行產品模型建製，如表 10 所示。

表 9 智慧型行動裝置之特徵屬性直交表

A	B	C	D	E	F	G	status	card
1	3	3	3	1	3	1	0	1
3	2	3	1	1	2	4	0	2
…	…	…	…	…	…	…	…	…
3	3	2	2	4	4	1	0	31
1	2	2	4	4	1	4	0	32

表 10 智慧行動裝置依直交表所產生之圖形（單位:mm）

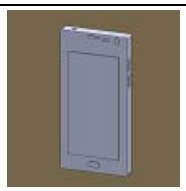
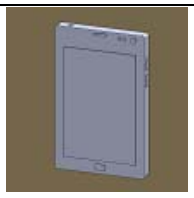
1 	螢幕長 :82 螢幕寬 :58 機身厚 :10 螢幕左右距離 :6 螢幕上邊框 :12 螢幕下邊框 :18 圓角直徑 :3	2 	螢幕長 :98 螢幕寬 :52 機身厚 :10 螢幕左右距離 :2 螢幕上邊框 :12 螢幕下邊框 :15 圓角直徑 :14
3 	螢幕長 :90 螢幕寬 :65 機身厚 :10 螢幕左右距離 :4 螢幕上邊框 :15 螢幕下邊框 :14 圓角直徑 :3	4 	螢幕長 :90 螢幕寬 :49 機身厚 :9.5 螢幕左右距離 :4 螢幕上邊框 :12 螢幕下邊框 :15 圓角直徑 :5
5 	螢幕長 :90 螢幕寬 :49 機身厚 :9.5 螢幕左右距離 :4 螢幕上邊框 :12 螢幕下邊框 :15 圓角直徑 :5	6 	螢幕長 :90 螢幕寬 :58 機身厚 :10.5 螢幕左右距離 :6 螢幕上邊框 :18 螢幕下邊框 :12 圓角直徑 :12
7 	螢幕長 :98 螢幕寬 :65 機身厚 :9 螢幕左右距離 :8 螢幕上邊框 :18 螢幕下邊框 :12 圓角直徑 :5	8 	螢幕長 :108 螢幕寬 :49 機身厚 :10 螢幕左右距離 :8 螢幕上邊框 :15 螢幕下邊框 :20 圓角直徑 :12
9 	螢幕長 :90 螢幕寬 :58 機身厚 :10.5 螢幕左右距離 :8 螢幕上邊框 :12 螢幕下邊框 :20 圓角直徑 :5	10 	螢幕長 :108 螢幕寬 :58 機身厚 :9 螢幕左右距離 :4 螢幕上邊框 :15 螢幕下邊框 :15 圓角直徑 :12
11 	螢幕長 :108 螢幕寬 :65 機身厚 :9.5 螢幕左右距離 :6 螢幕上邊框 :18 螢幕下邊框 :15 圓角直徑 :3	12 	螢幕長 :82 螢幕寬 :49 機身厚 :9 螢幕左右距離 :2 螢幕上邊框 :12 螢幕下邊框 :12 圓角直徑 :3
13 	螢幕長 :108 螢幕寬 :52 機身厚 :10.5 螢幕左右距離 :4 螢幕上邊框 :12 螢幕下邊框 :12 圓角直徑 :8	14 	螢幕長 :98 螢幕寬 :65 機身厚 :9 螢幕左右距離 :6 螢幕上邊框 :12 螢幕下邊框 :20 圓角直徑 :12
15 	螢幕長 :82 螢幕寬 :49 機身厚 :9 螢幕左右距離 :4 螢幕上邊框 :18 螢幕下邊框 :20 圓角直徑 :8	16 	螢幕長 :108 螢幕寬 :58 機身厚 :9 螢幕左右距離 :2 螢幕上邊框 :20 螢幕下邊框 :18 圓角直徑 :5

表 10(續)

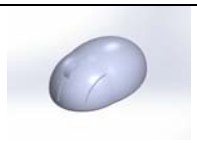
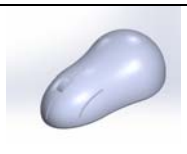
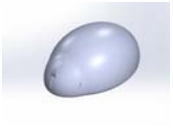
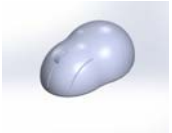
17 	螢幕長 :82 螢幕寬 :65 機身厚 :10.5 螢幕左右距離 :2 螢幕上邊框 :15 螢幕下邊框 :15 圓角直徑 :5	18 	螢幕長 :82 螢幕寬 :65 機身厚 :10.5 螢幕左右距離 :4 螢幕上邊框 :20 螢幕下邊框 :18 圓角直徑 :12
19 	螢幕長 :90 螢幕寬 :65 機身厚 :10 螢幕左右距離 :2 螢幕上邊框 :20 螢幕下邊框 :20 圓角直徑 :8	20 	螢幕長 :108 螢幕寬 :49 機身厚 :10 螢幕左右距離 :6 螢幕上邊框 :20 螢幕下邊框 :12 圓角直徑 :5
21 	螢幕長 :82 螢幕寬 :52 機身厚 :9.5 螢幕左右距離 :6 螢幕上邊框 :15 螢幕下邊框 :20 圓角直徑 :5	22 	螢幕長 :90 螢幕寬 :52 機身厚 :9 螢幕左右距離 :8 螢幕上邊框 :15 螢幕下邊框 :18 圓角直徑 :3
23 	螢幕長 :108 螢幕寬 :52 機身厚 :10.5 螢幕左右距離 :2 螢幕上邊框 :18 螢幕下邊框 :20 圓角直徑 :3	24 	螢幕長 :108 螢幕寬 :52 機身厚 :10.5 螢幕左右距離 :2 螢幕上邊框 :18 螢幕下邊框 :20 圓角直徑 :3
25 	螢幕長 :98 螢幕寬 :52 機身厚 :10 螢幕左右距離 :4 螢幕上邊框 :18 螢幕下邊框 :18 圓角直徑 :5	26 	螢幕長 :90 螢幕寬 :49 機身厚 :9.5 螢幕左右距離 :2 螢幕上邊框 :18 螢幕下邊框 :18 圓角直徑 :12
27 	螢幕長 :98 螢幕寬 :49 機身厚 :10.5 螢幕左右距離 :6 螢幕上邊框 :15 螢幕下邊框 :18 圓角直徑 :8	28 	螢幕長 :82 螢幕寬 :58 機身厚 :10 螢幕左右距離 :8 螢幕上邊框 :18 螢幕下邊框 :15 圓角直徑 :8
29 	螢幕長 :90 螢幕寬 :52 機身厚 :9 螢幕左右距離 :6 螢幕上邊框 :20 螢幕下邊框 :15 圓角直徑 :8	30 	螢幕長 :108 螢幕寬 :65 機身厚 :9.5 螢幕左右距離 :8 螢幕上邊框 :12 螢幕下邊框 :18 圓角直徑 :8
31 	螢幕長 :98 螢幕寬 :58 機身厚 :9.5 螢幕左右距離 :4 螢幕上邊框 :20 螢幕下邊框 :20 圓角直徑 :3	32 	螢幕長 :82 螢幕寬 :52 機身厚 :9.5 螢幕左右距離 :8 螢幕上邊框 :20 螢幕下邊框 :12 圓角直徑 :12

滑鼠部份依其產品特徵利用田口直交表產生最少受測樣本數 16 個（如表 11）。透過電腦 3D 繪圖軟體 Solid Work，依其直交表所推算之特徵參數進行產品模型建構，如表 12 所示。

表 11 滑鼠之特徵屬性直交表

A	*B*	*C*	*D*	*E*	*status*	*card*
2	2	2	2	1	0	1
2	4	3	1	3	0	2
…	…	…	…	…	…	…
4	4	4	4	1	0	15
4	2	1	3	3	0	16

表 12 滑鼠依直交表所產生之圖形

1 	前圓縱軸長度：45 前圓橫軸長度：38 兩圓圓心距離：10 後圓縱軸長度：55 後圓橫軸長度：40	2 	前圓縱軸長度：45 前圓橫軸長度：45 兩圓圓心距離：30 後圓縱軸長度：60 後圓橫軸長度：35
3 	前圓縱軸長度：40 前圓橫軸長度：38 兩圓圓心距離：20 後圓縱軸長度：60 後圓橫軸長度：50	4 	前圓縱軸長度：50 前圓橫軸長度：35 兩圓圓心距離：10 後圓縱軸長度：60 後圓橫軸長度：45
5 	前圓縱軸長度：40 前圓橫軸長度：35 兩圓圓心距離：10 後圓縱軸長度：50 後圓橫軸長度：35	6 	前圓縱軸長度：40 前圓橫軸長度：45 兩圓圓心距離：40 後圓縱軸長度：55 後圓橫軸長度：45
7 	前圓縱軸長度：50 前圓橫軸長度：35 兩圓圓心距離：30 後圓縱軸長度：55 後圓橫軸長度：50	8 	前圓縱軸長度：40 前圓橫軸長度：35 兩圓圓心距離：30 後圓縱軸長度：70 後圓橫軸長度：40
9 	前圓縱軸長度：55 前圓橫軸長度：35 兩圓圓心距離：20 後圓縱軸長度：55 後圓橫軸長度：35	10 	前圓縱軸長度：45 前圓橫軸長度：35 兩圓圓心距離：40 後圓縱軸長度：50 後圓橫軸長度：50
11 	前圓縱軸長度：50 前圓橫軸長度：45 兩圓圓心距離：40 後圓縱軸長度：50 後圓橫軸長度：50	12 	前圓縱軸長度：45 前圓橫軸長度：35 兩圓圓心距離：20 後圓縱軸長度：70 後圓橫軸長度：45
13 	前圓縱軸長度：55 前圓橫軸長度：35 兩圓圓心距離：40 後圓縱軸長度：60 後圓橫軸長度：40	14 	前圓縱軸長度：50 前圓橫軸長度：38 兩圓圓心距離：40 後圓縱軸長度：70 後圓橫軸長度：35
15 	前圓縱軸長度：55 前圓橫軸長度：45 兩圓圓心距離：10 後圓縱軸長度：70 後圓橫軸長度：50	16 	前圓縱軸長度：55 前圓橫軸長度：38 兩圓圓心距離：30 後圓縱軸長度：50 後圓橫軸長度：45

5.設計特徵資料庫

依據語彙意象空間調查分析結果，進一步建立目標產品感性語彙資料庫與意象資料庫，並且將產品意象與設計特徵之關連資料，建立一個知識庫，作為將來形容詞語彙轉換為產品設計特徵的推論依據。因此，為了後續研究之操作與實驗，智慧型行動裝置與滑鼠等產品特徵樣本透過電腦 3D 繪圖軟體 Solid Work 建置完成後，亦結合 Microsoft Visual Basic 程式編輯軟體協助建置可

互動式之操作界面，如圖 6 與圖 7 所示，以利後續其他資料之系統性彙整與實驗操作。

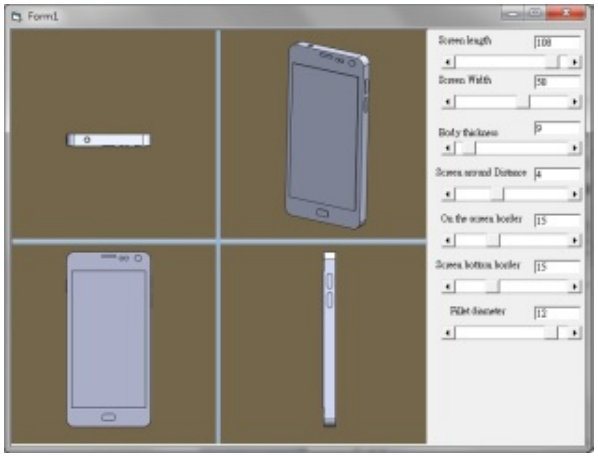


圖 6 智慧型行動裝置樣本（編號 10）之可互動界面設計示意

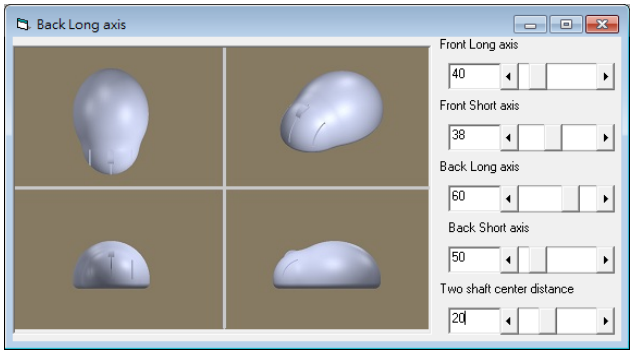


圖 7 滑鼠（編號 3）之可互動界面設計示意

五、結論與討論

本研究計畫之發展主要針對消費者對感性需求的認知、有機幾何之產品特徵造形的建構與對仿生造形的特性與有機圖像間的關聯性進行基本分析與相關資料建置。

依目前現階段成果顯示，可初步進行以下結論：

（1）在智慧型行動裝置之使用者形容詞語彙分析上，可看見使用者們對特定幾組形容詞語彙需求上有特殊偏好，可針對此細節深入分析，該語彙對應至產品特徵屬性為何，以了解使用者需求與產品特徵屬性之對應。

（2）在滑鼠部份，其使用者對形容詞語彙需求分析上，大多數形容詞語彙組別其顯著性不明顯，後續可增加使用者問卷調查數量，以提高分析之顯著性。再者，透過其使用者所選定之語彙來看，須針對其語彙意象所表達之意義，深入探究消費者之語意對應於產品設計特徵為造形、比例、材質、色彩、功能、規格等何種項目內容，以利下一階段之研究進行深入探討。

（3）依直交表所產生智慧型行動裝置之圖形來看，絕大多數產品特徵外型與市場上現有產品無太大差異，對後續的智慧型行動裝置之特徵屬性需求調查與對應可盡快進行。

（4）滑鼠部份，依直交表所產生之數據結果而製成之圖形上，有幾組外觀特徵與現有產品有些許差異，在數據彙整與關鍵特徵可能在進行修正與調整，以貼近現有產品之外形特徵。

現階段計畫執行選擇以智慧型行動裝置與滑鼠作為本研究之探討案例。在執行過程中，陸續完成其相關資產品特徵屬性相關資料建置、使用者族群感性需求語彙確立整合、可互動之樣本操作界面、、、等。後續將現階段成果逐步分項導入型態特徵建構分析和第二期計畫之工作內容。

參考文獻

中國生產力中心 QFD 研發小組編譯，赤尾洋二著，(1991)，*新產品開發品質機能展開之實際應用*。

中國生產力中心 QFD 研發小組編譯，赤尾洋二著，(1987)，*品質機能展開法 :如何有效掌握顧客需求*。

林銘泉，(1986)，*人機系統模式在產品設計與發展之應用*，正業書局。

林銘泉等，(2005)，運動休閒機能性織物品商業服務模式可行性研究，*紡織產業綜合研究所計畫總結報告*，國立成功大學工業設計學系。

施韋名 (1996)，眼鏡造形與感覺意象對應關係之研究，國立交通大學應用藝術研究碩士論文。

柯超茗 (1997)，材料視覺與觸覺質感意象的研究，國立雲林技術學院工業設計研究所，碩士論文。

高日菖 (1996)，產品意象及其表徵的研究-以收音機為例，國立雲林技術學院工業設計研究所碩士論文，1996。

張志三，(1996)，*漫談碎形 = A Talk About Fractals*，牛頓出版社。

張悟非，(2007)，*CATIA 與產品造形設計(5)-功能性模具元件設計 (Function Molded Part)*，全華出版社，台北。

許書瑋 (1997)，感性工學執行程序之建構，國立交通大學應用藝術研究所碩士論文。

曾文曲 編譯，Falconer, K. 著，(1991)，*分形幾何：數學基礎及其應用*，東北大學出版社。

黃俊英 (2004)，*多變量分析*，第七版，中國經濟企業研究所，台北。

管倖生、林彥呈，(2002)，以感性工學程序建構網頁設計系統之研究，*設計學報*，7(1)，59-73。

蔡子瑋 (1993)，產品意象語言研究—以本土性意象為例，國立成功大學工業設計研究所碩士論文。

簡禎富，(2011)，*決策分析與管理：全面決策品質提升之架構與方法*，雙葉書廊公司。

Afuah, A. (2003) . Innovation Management: Strategies, Implementation, and Profits, 2nd Edition, Oxford University Press, New York.

Aubert, H. and Jaggard, D.L. (2002). Wavelet analysis of transients in fractal superlattices, *Journal of Antennas and Propagation*, Vol.50, No.3, pp.338-345.

Baliarda, C.P., Romeu, J. and Cardama, A.(2000). The Koch monopole: a small fractal antenna, *Journal of Antennas and Propagation*, Vol.48, No.11, pp.1773-1781.

Betz, F. (2011), Managing Technological Innovation: Competitive Advantage from Chang, 3rd edn., John Wiley & Sons, Inc., New Jersey.

Betz, F. (2011). Managing Technological Innovation: Competitive advantage from Change, 3rd Edition, John Wiley & Sons, Inc., New Jersey.

Cross, N. (2000), Engineering Design Methods: Strategies for Product Design, 3rd edn, John Wiley & Sons, Inc., New Jersey.

Harada, A., Modeling the Evaluation Structure of Kansei Using Networked Robot, *International Conference on Advanced Intelligent Mechatronics '97* IEEE/ASME, pp.49-54.

Horiguchi, A., Suetomi, T. (1995). A Kansei Engineering Approach to a Drive/Vehicle, *International Journal of Industrial Ergonomics,* Vol.15, pp.25-37.

Hsu, S. H. and Chang, W. (2007). Effects of form feature structure on similarity identification, *Journal of the Chinese Institute of Industrial Engineers*, Vol.24, No.5, pp. 428-436.

Ishihara, S., Ishihara, K., Nagamachi, M., Matsubara, Y. (1995). An Automatic Builder for Kansei Engineering Expert System Using Self-Organizing Neural Networks, *Industrial Journal of Industrial Ergonomics*, Vol.15, pp.13-24.

Jack, B. R., John, W. M. and Charles A. C. (1998). The QFD Handbook, Wiley and Sons, New York.

Kigami, J. (2001). Analysis on Fractals, Cambridge University Press.

Kuo, C. F. and Chu, C. H. (2005). An online ergonomic evaluator for 3D product design, *Computers in Industry*, Vol.56, Issue 5, pp.479-492.

Nagamachi, M. (1995), "Kansei Engineering: A new ergonomic consumer-oriented technology for product development," *International Journal of Industrial Ergonomics*, Vol.15, pp.3-11.

Siah, E.S., Ooi, B.L., Kooi, P.S., and Xhou, X.D. (1999). Experimental investigation of several novel

fractal antennas-variants of the Sierpinski Gasket and introducing fractal FSS screens, *Proceedings, Microwave Conference, Asia Pacific*, Vol.1, pp.170-173.
Solomon, M.R. (2005), Consumer Behavior: Buying, Having, and Being, 6th Ed., Pearson Education, Inc., New Jersey.

附錄：本研究計畫之論文發表情形

A. 期刊論文

1. Chen, Min-Shi, Lin, Ming-Chyuan, Lin, Jenn-Yang and Wu, Yun-Yun, (2014/10). The Application of Bionic Concept in Product Form Design, The International Journal of Systematic Innovation (IJoSI), Vol.2 No.3, In Press, In Chinese (NSC-102-2221-E-269-023).
2. Lin, Ming-Chyuan*, Lin, Yi-Hsien, Lin, Chun-Chun and Chen, Min-Shi, (2014/9). An Integrated Neuro-Genetic Approach Incorporating the Taguchi Method for Product Design, Journal of Advanced Engineering Informatics, (NSC-102-2221-E-269-023), In Press, DOI: 10.1016/j.aei.2014.09.002, (SCI)(EI).

B. 研討會論文

1. Lin, Ming-Chyuan*, Lin, Yi-Hsien, Lin, Chun-Chun and Lin, Jenn-Yang (2014/6), "A Study on the Interface Design of a Functional Menu and Icons for In-Vehicle Navigation Systems," 16th International Conference on Human-Computer Interaction-HCI2014, Creta Maris, Heraklion, Crete, Greece, June 22-27, (NSC-102-2221-E-269-023) in Lecture Notes in Computer Science (LNCS), Human Interface and the Management of Information, Vol. 8522, Issue Part II, pp. 261-272, (EI).
2. 鄭怡靖、林銘泉*、林振成，(2014/5)，「應用網際網路於設計師與消費者互動平台建構之研究」，2014 中華民國設計學會設計學術研究成果研討會論文集，37:1-6，中華民國設計學會，NSC-102-2221-E-269-023，2014516。
3. 吳昀芸、林振陽、林銘泉*，(2014/1)，「應用仿生概念於產品之造形設計」，2014 大中華系統性創新研討會暨第六屆中華系統性創新學會年會論文集， SI2014-C- 48，1-9，遠東科技大學，NSC-102-2221-E-269-023，20140103。

國科會補助專題研究計畫項下出席國際學術會議心得報告

日期：103 年 7 月 7 日

計畫編號	NSC 102－2221－E－269－023－		
計畫名稱	整合感性語意差異的顧客需求設計分析與理性圖像衍生的模式於產品造形之發展(I)		
出國人員姓名	林銘泉	服務機構及職稱	遠東科技大學創意商品設計與管理系教授
會議時間	2014 年 6 月 22 日至 2014 年 6 月 27 日	會議地點	Creta Maris, Heraklion, Crete, Greece (希臘克里特島伊拉克里翁之克里特摩瑞斯)
會議名稱	(中文)第十六屆人機電腦界面國際研討會 (英文)16th International Conference on Human-Computer Interaction-HCI2014		
發表論文題目	(中文) 車用導航系統功能選單與圖像界面設計之研究 **(英文)** A Study on the Interface Design of a Functional Menu and Icons for In-Vehicle Navigation Systems		

一、參加會議經過

第十六屆人機電腦界面國際研討會(16th International Conference on Human-Computer Interaction-HCI2014)由原普渡大學(Purdue University, USA)教授 Gavriel Salvendy 與希臘克里特大學(University of Crete and Forth-ICS, Greece) 教授 Constantine Stephanidis 共同主辦，並由 Springer 出版社協辦，共整合十二個國際研討會成為 Human-Computer Interaction 國際研討會，設定的兩個主題分別為(1) Human-Computer Interaction System, 與(2) Human Interface and the Management of Information。上述兩個主題外，另衍生出數個領域主題如:Cross-cultural Design, Social Computing and Social Media, Augmented Cognition, Digital Human Modeling and Application in Health, safety, Ergonomics and Risk Management, Design, User Experience and Usability, Distributed, Ambient and Pervasive Interactions, Human Aspects of Information Security, Privacy and Trust, HCI in Business 與 Learning and Collaboration Technologies 。主辦本研討會的論文 800 字摘要或論文全文之投稿截止日為 2013 年 10 月 15 日(後延至 10 月 31 日)，本人於 10 月 13 日依研討會要求之格式，投出論文全文，題目為 A Study on the Interface Design of a Functional Menu and Icons for In-Vehicle Navigation Systems，編號 225，領域為(2) Human Interface and the Management

of Information。 2013 年 12 月 7 日接獲修正後通過之通知。完整可列印文件收稿截止日為 2014 年 2 月 7 日，本人於 2 月 6 日完成依特定格式與版面之完整論文（不超過十二頁）全文共十二頁的文稿上傳，並繳交註冊費（744.15 歐元）完成註冊程序，及上傳著作權聲明書、同意出版聲明書，完成所有程序。由於該研討會所有完成註冊之完整論文委由 Sringer 出版社發行，這些論文經過每位作者的校對後，分別印製紙本書共二十七冊於 Lecture Notes in Computer Science (LNCS),Lecture Notes in Artificial Intelligence (LNAI) 與 Communications in Computer and Information Science (CCIS)，均登錄於 EI Index。雖然研討會舉辦之期間為 6 月 22 日 6 月 27 日，但由於研討會期間適逢本校期末考週，為能順利完成學生課業之繳交與登錄學期成績，並配合華航班機，故訂於 6 月 23 日晚上出發。另為順道參觀臨近義大利之羅馬、佛羅倫斯、威尼斯與米蘭，特別自費多停留七天，於 7 月 6 日返國，以便收集一些與設計相關之資料。

二、與會心得

該研討會的日期為 2014 年 6 月 22 日至 6 月 27 日，地點在 Creta Maris, Heraklion, Crete, Greece (希臘克里特島伊拉克里翁之克里特摩瑞斯)。參與研討會的學者專家人數約一千五百多位，論文的場次共 244 場，每場有五至七篇論文發表，分三天在二十一個研討室舉行論文發表。另有廠商之展品陳列於會場內。至於論文發表，每個場次共 120 分鐘，每日上下午報告期間各休息三十分鐘，供下場次之論文發表者儲存簡報檔案於大會提供之電腦內。每場次設一主持人，論文發表時間約十五分鐘，並保留五分鐘提問。各個空間均備妥投影機與 15 吋筆記型電腦。

本人之論文發表安排在 ZEUS 之第 12 研討室，時間為六月二十六日上午 8:00-10:00，主持人為德國慕尼黑大學教授 Dr.Martina Ziefle，在本場次的學者專家約二十位，本人共被提問三個問題。整體的論文發表，嚴謹且具學術性，發表者均戰戰競競，而且都是教授親自發表，與會者亦非常認真聽講，並踴躍發言與討論。值得提起的是本場次原預定有七篇論文要發表，但有兩篇來至中國大陸的學者因故缺席。

整體而言，該研討會無論是接待或服務大致上良好。有此機會見識國外辦理這莫大型的研討會，算是難得的經驗。

三、考察參觀活動

本次出席研討會，利用空檔時間參觀希臘克里特島之考古博物館與克諾索斯皇宮舊址、聖托里尼島首邑費拉與伊亞鎮、羅馬(含梵諦岡美術館、聖彼得大教堂等)、佛羅倫斯、威尼斯、與米蘭等城市，並收集各成市博物館設計相關文物資訊，供未來教學之材料。整體而言，希臘與義大利在古蹟復原與維護方面，確實能力高強，值得國內相關領域學習。希臘因地處火山地帶，感覺上交通比較不方便，而義大利鐵路系統大致上完整，且與機場之銜接順暢，適合藉助鐵路進行遊覽。不過本次出席之研討會場址及參訪的城市，普遍出現兩個共同的缺點，分別為路

標非常不確實與不清楚，經常要找的地點近在附近，卻繞了非常大的圈子及沿途問路才找到，以及公共廁所標示不清，且不但高價收費還非常少。

四、建議

本次參與研討會前後大約十四天，行程大至緊湊合理。不過由於希臘與義大利為國際旅遊重要景點，且離台灣較遠，無論物價、住宿與機票都非常昂貴，再加上註冊費，確實花費龐大，貴會提供之費用若能由 65000 元提高至 85000 元，會比較貼近該地區之行情。

五、攜回資料名稱及內容

本次攜回之資料包括：(1)研討會完整議程表，(2)研討會論文集光碟片，(3)希臘克里特島相關資訊。其他資料則為有關其他相近之國際研討會資訊。值得提起的是本次研討會之論文集係委由 Springer 出版商分二十七大冊出書，每冊售價 80 至 90 歐元，頗具收藏價值。

六、其他

2015 年之 International Conference on Human-Computer Interaction-HCI2015 研討會將於 2015 年 8 月 2-7 日，在 Los Angeles, CA, USA 舉行。

HCI International 2014

22 - 27 June 2014, Creta Maris, Heraklion, Crete, Greece

Menu

- Home
- Submissions
- Proceedings
- Registration
- Best Paper Awards
- Exhibition
- Accommodation
- About Crete
- Travel to Crete
- Organized Tours
- Student Volunteers
- Sponsorship
- Contacts & Links

Call for Participation leaflet 4.3MB

Thematic Areas leaflets

Follow HCI International News:

Welcome to the 16th International Conference on Human-Computer Interaction

HCI International 2014, jointly with the affiliated Conferences, which are held under one management and one registration, invite you to Crete, Greece, to participate and contribute to the international forum for the dissemination and exchange of up-to-date scientific information on theoretical, generic and applied areas of HCI, through the following modes of communication: Plenary / Keynote Presentation, Parallel Sessions, Poster Sessions, Tutorials and Exhibition.

The Conference will start with three days of Tutorials (22-24 June). Parallel Sessions, Poster Sessions and the Exhibition will be held during the last three days of the Conference (25-27 June).

thematic areas:

- Human-Computer Interaction 42KB
- Human Interface and the Management of Information 520KB

affiliated conferences:

- 11th International Conference on Engineering Psychology and Cognitive Ergonomics 43KB
- 8th International Conference on Universal Access in Human-Computer Interaction 43KB
- 6th International Conference on Virtual, Augmented and Mixed Reality
- 6th International Conference on Cross-Cultural Design 40KB
- 6th International Conference on Social Computing and Social Media 43KB
  (formerly Online Communities and Social Computing)
- 8th International Conference on Augmented Cognition
- 5th International Conference on Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management
- 3rd International Conference on Design, User Experience and Usability
  Advert 90KB - DesignPoster 80KB
- 2nd International Conference on Distributed, Ambient and Pervasive Interactions 49KB
- 2nd International Conference on Human Aspects of Information Security, Privacy and Trust 51KB
- 1st International Conference on HCI in Business 42KB
- 1st International Conference on Learning and Collaboration Technologies 45KB

Creta Maris

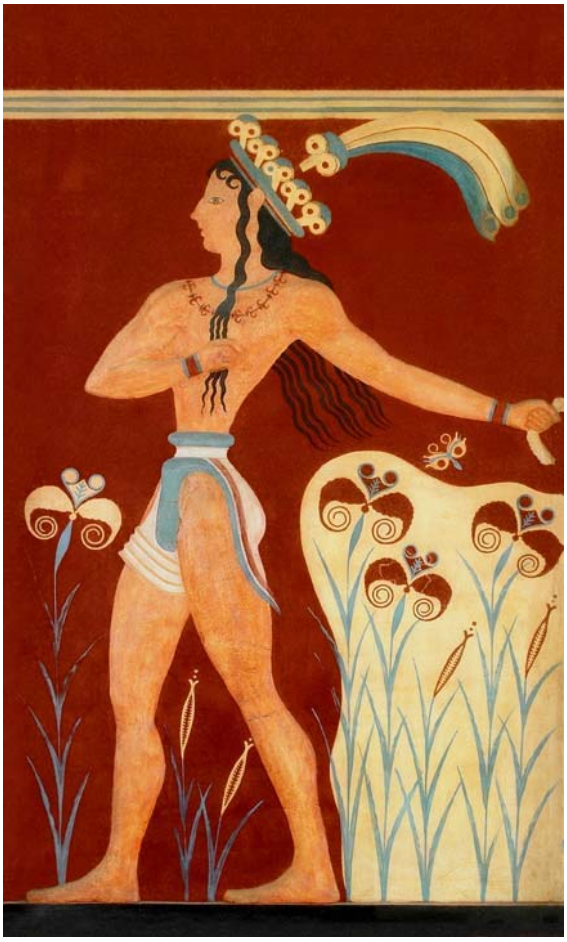
Highlights

- Keynote Speech by James Lewis
- Proposals submission is open
  - Posters: 7 February 2014
- Information about Registration

Proceedings by:

Springer

LNCS/LNAI/CCIS series Indexed by:
ISI Citation Index
EI Engineering Index
ACM Digital Library
etc.



Prince of the Lilies

Last revision date: December 7, 2013 by web@hcii2014.org

Privacy Policy

HCI 2014
International

16th International Conference on Human - Computer Interaction

thematic areas:

Human-Computer Interaction

Human Interface and the Management of Information

affiliated conferences:

11th International Conference on
Engineering Psychology and Cognitive Ergonomics

8th International Conference on
Universal Access in Human-Computer Interaction

6th International Conference on
Virtual, Augmented and Mixed Reality

6th International Conference on
Cross-Cultural Design

6th International Conference on
Social Computing and Social Media

8th International Conference on
Augmented Cognition

5th International Conference on
Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management

3rd International Conference on
Design, User Experience and Usability

2nd International Conference on
Distributed, Ambient and Pervasive Interactions

2nd International Conference on
Human Aspects of Information Security, Privacy and Trust

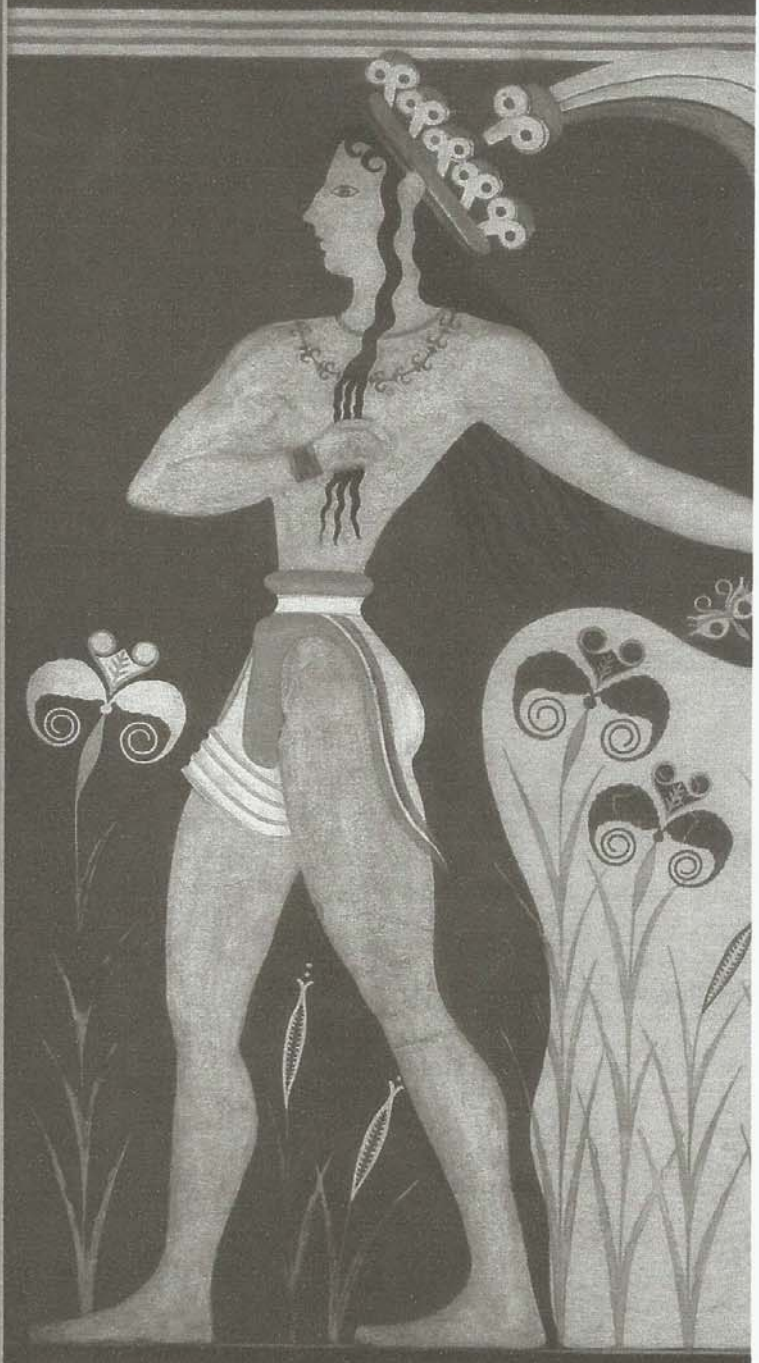
1st International Conference on
HCI in Business

1st International Conference on
Learning and Collaboration Technologies

22 - 27 June 2014

Creta Maris

Heraklion, Crete, Greece



Final Program

Under the auspicies of
14 distinguished international boards of
342 board members from 38 countries

www.hcii2014.org

Conference Founder, General Chair Emeritus and Scientific Advisor
Gavriel Salvendy
Purdue University, *USA*
and Tsinghua University, *P.R. China*

General Chair
Constantine Stephanidis
University of Crete and FORTH-ICS, *Greece*
Email: *cs@ics.forth.gr*

Conference Administration
Email: *administration@hcii2014.org*

Program Administration
Email: *program@hcii2014.org*

Registration Administration
Email: *registration@hcii2014.org*

Exhibition Administration
Email: *exhibition@hcii2014.org*

Student Volunteer Administration
Email: *sv@hcii2014.org*

Communications Chair, Exhibition Chair, HCI International News Editor
Abbas Moallem
Email: *news@hcii2014.org*

Conference at a Glance

Conference Registration – Secretariat

Conference Registration will take place at the Conference Secretariat, located at the Secretariat room next to ZEUS Hall, during the following hours:

Saturday, **21 June**	16:00 – 18:00
Sunday, **22 June**	08:00 – 17:30
Monday, **23 June**	08:00 – 17:30
Tuesday, **24 June**	08:00 – 17:30
Wednesday, **25 June**	07:30 – 18:00
Thursday, **26 June**	07:30 – 18:00
Friday, **27 June**	07:30 – 18:00

The Conference registration fee includes:

- participation in all open technical sessions (i.e. Parallel Paper Presentations)
- entrance to the Exhibition
- refreshment breaks between sessions (2 per day, mid morning and mid afternoon)
- Conference proceedings
- one ticket for the Conference Reception

Cancellation policy: Registration fee for any event is non-refundable.

Conference Evaluation

Your opinion and comments are very important for the improvement and future planning of the conference. We kindly ask you to spend a few minutes to fill-in the on-line anonymous survey through the link:

www.surveymonkey.com/s/HCII2014

or scan the QR-Code on the left

The survey will be available until **30 July 2014**

PROGRAM

Sunday 22 June 2014	**09:00 - 17:30**	Tutorials Day 1 - *page 13*
Monday 23 June 2014	**09:00 - 17:30**	Tutorials Day 2 - *page 13*
Tuesday 24 June 2014	**08:30 - 17:00**	Tutorials Day 3 - *page 13*
	18:00 - 19:30	Opening Plenary Session - Room: ZEUS Hall Keynote Speech - page 5 **Usability: Lessons Learned ... and Yet to Be Learned** *by:* **James R. (Jim) Lewis** Senior Human Factors Engineer IBM Software Group
	19:45	Conference Reception - *page 8*
Wednesday 25 June 2014	**08:00 - 18:00**	Parallel paper presentations, Day 1 - *page 20* Poster presentations, Day 1 - *page 84* Exhibition, Day 1 - *page 10*
Thursday 26 June 2014	**08:00 - 18:00**	Parallel paper presentations, Day 2 - *page 44* Poster presentations, Day 2 - *page 84* Exhibition, Day 2 - *page 10*
Friday 27 June 2014	**08:00 - 18:00**	Parallel paper presentations, Day 3 - *page 64* Poster presentations, Day 3 - *page 84* Exhibition, Day 3 - *page 10*

Thursday, 26 June 08:00 - 10:00

HIMI S089

Information in Transport

Room: 12

Chair(s): Martina Ziefle.

A Study on the Interface Design of a Functional Menu and Icons for In-Vehicle Navigation Systems
Ming-Chyuan Lin, Yi-Hsien Lin, Chun-Chun Lin, Jenn-Yang Lin.

Predictive Probability Model of Pilot Error based on CREAM
Xiaoyan Zhang, Hongjun Xue, Yingchun Chen, Lin Zhou, Gaohong Lu.

Advancement and Application of Unmanned Aerial System Human-Machine-Interface (HMI) Technology
Brent Terwilliger, David Ison, Dennis Vincenzi, Dahai Liu.

«A Careful Driver is One Who Looks in Both Directions when he Passes a Red Light» - Increased Demands in Urban Traffic
Martin Götze, Florian Bißbort, Ina Petermann-Stock, Klaus Bengler.

Neural Networks for Identifying Civil Pilot's Operation Sequences
Zhuoyuan Jiang, Qin Lu, Yuandong Liang, Chen Bin.

A Post-Simulation Assessment Tool for Training of Air Traffic Controllers
Aslak Wegner Eide, Stian Støer Ødegård, Amela Karahasanović.

Effect of Type and Strength of Force Feedback on the Path of Movement in a Target Selection Task
Martin T. Koltz, R. Conrad Rorie, Jose Robles, Kim-Phuong L. Vu, Panadda Marayong, Thomas Z. Strybel, Vernol Battiste.

EPCE S090

Engineering Psychology and Cognitive Ergonomics

Human Factors and Aviation Safety

Room: 10

Chair(s): Wen-Chin Li, Ruishan Sun.

Safety Culture Evaluation in China Airlines: A Preliminary Study
Chiou-Yueh (Judy) Tsay, Chien-chih Kuo, Chin-Jung Chao, Colin G. Drury, Yu-Lin Hsiao.

An Analysis of Hard Landing Incidents based on Flight QAR Data
Lei Wang, Changxu Wu, Ruishan Sun, Zhenxin Cui.

Study on a Model of Flight Fatigue Dynamic Risk Index
Ruishan Sun, Wenshan Song, Jingqiang Li, Wanli Tian.

The Evaluation Model of Psychological Quality for Civil Aviation Student Pilot Based on Fuzzy Comprehensive Evaluation
Shu Li, Yang You.

The Investigation of Pilots' Eye Scan Patterns on the Flight Deck during an Air-to-Surface Task
Wen-Chin Li, Graham Braithwaite, Chung-san Yu.

Analysis on Eye Movement Indexes Based on Simulated Flight Task
Chengjia Yang, Zhongqi Liu, Qianxiang Zhou, Fang Xie, Shihua Zhou.

A Theoretical Model of Mental Workload in Pilots Based on Multiple Experimental Measurements
Zongmin Wei, Damin Zhuang, Xiaoru Wanyan, Huan Zhang, Chen Liu.

UAHCI S091 S092

continues...

Universal Access in Human-Computer Interaction

HCI-based Affective/ Blended/Inclusive-Learning: Trends, Models and Applications

Room: ATHENA

Chair(s): Leontios J. Hadjileontiadis, João Barroso.

Multi-sensor Technology and Fuzzy Logic for Dancer's Motion Analysis and Performance Evaluation within a 3D Virtual Environment
Alexandros Kitsikidis, Erdal Yilmaz, Kosmas Dimitropoulos, Stella Douka, Nikos Grammalidis.

On Enhancing Disabled Students' Accessibility in Environmental Education Using ICT: The MusicPaint Case
Sofia Hadjileontiadou, Erasmia Plastra, Kostantinos Toumpas, Katerina Kyprioti, Dimitrios Mandiliotis, João Barroso, Leontios J. Hadjileontiadis.

Exploring B-Learning Scenarios using Fuzzy Logic-Based Modeling of Users' LMS Quality of Interaction in Ergonomics and Psychomotor Rehabilitation Academic Courses
Sofia Balula Dias, José Alves Diniz, Leontios J. Hadjileontiadis.

VIC – An Interactive Video System for Dynamic Visualization in Web and Mobile Platforms
Benjamim Fonseca, Hugo Paredes, Paulo Martins, André Alberto, José Rego, Leonel Morgado, Arnaldo Santos.

Integrating Computer Vision Object Recognition with Location Based Services for the Blind
Hugo Fernandes, Paulo Costa, Hugo Paredes, Vitor Filipe, João Barroso.

Evaluation of the Human Factor in the Scheduling of Smart Appliances in Smart Grids
Janio Monteiro, Pedro Cardoso, Rita Serra, Licínia Fernandes.

Ergonomics in Architecture - I

Room: ARTEMIS

Chair(s): Jerzy Charytonowicz, Agata Bonenberg.

Technical Progress And Ergonomics In Contemporary Domestic Kitchen
Jerzy Charytonowicz, Dzoana Latala-Matysiak.

Technical Progress in Housing Environment and its Influence on Performing Household Chores
Przemyslaw Nowakowski.

City – mass Communication Space. Access to Information in Relation to the Composition of the City
Agata Bonenberg.

The Evolution of Public Hygiene and Sanitary Facilities in the Context of Urbanization Processes and Social Conditions
Anna Jaglarz.

Ergonomics in the Practice of Project Architect on Selected Examples
Klaudiusz Fross.

Analysis of Natural Lighting with Regard to Design of Sustainable Office Buildings in Poland
Dariusz Masly, Michal Sitek.

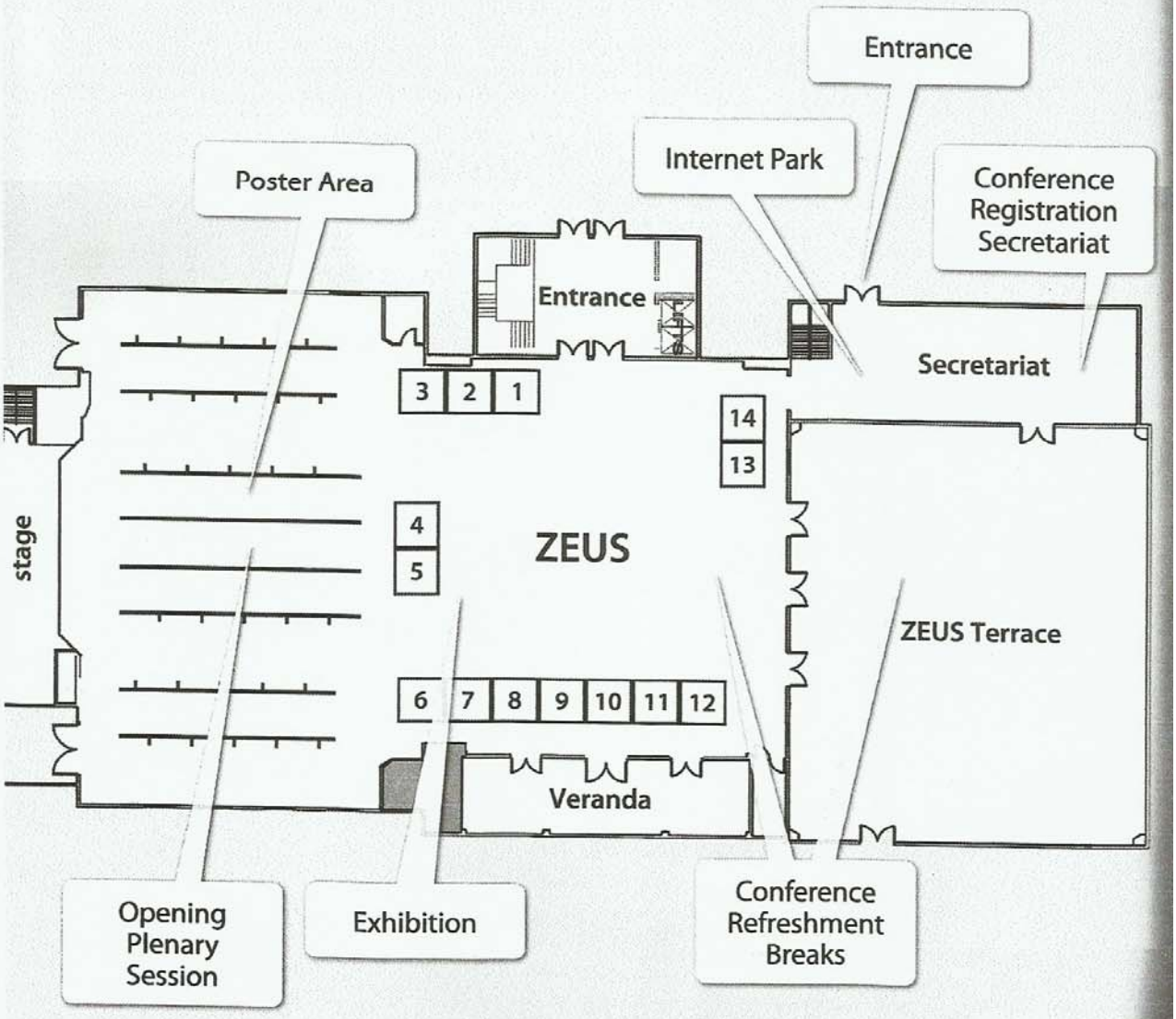
Brand Visual Identity in Architecture
Wojciech Bonenberg.

The Exhibition of HCI International 2014 is hosted in the **ZEUS Hall** of the Creta Maris Conference Center

Entrance to the Exhibition is free for all Conference participants

Timetable		
Display set–up	**Wednesday, 25 June**	07:00 - 10:00
Opening Hours	**Wednesday, 25 June**	10:00 - 17:00
	Thursday, 26 June	09:00 - 17:00
	Friday, 26 July	09:00 - 16:30
Display dismantle	**Friday, 27 June**	16:30 - 18:30

Creta Maris Conference Center



EXHIBITION

Registration ID: 2761

HCI International 2014

22-27 June 2014, Crete, Greece

CERTIFICATE OF PARTICIPATION

This is to certify that **Prof. Ming-Chyuan Lin, FAR EAST University, Taiwan**, has registered and participated in HCI International 2014, the 16th International Conference on Human-Computer Interaction, and the Affiliated Conferences, held in Heraklion, Crete, Greece from 22 to 27 June 2014.

25 June 2014

Heraklion, Crete, Greece

Constantine Stephanidis

General Chair, HCI International 2014

HCI International 2014
22-27 June 2014, Creta Maris, Heraklion, Crete, Greece

Απόδειξη Παροχής Υπηρεσιών / Receipt - Invoice

Προς/Bill to:
FAR EAST University
No.49, Zhong-Hua Road, Xinshi District
74448, Tainan City
Taiwan

Εκδότης/Issued by:
World Conference Services Inc.
37-14 Astoria Blvd, Astoria
NY 11103, USA
TIN: 26-2867593

ΑΦΜ/VAT Number: EL997247310
ΔΟΥ/VAT Office: Ηρακλείου / Heraklion
Αριθμός/Number: HCII2014-REC-424

Σύνεδρος/ Registrant: Ming-Chyuan Lin
Αρ. Εγγραφής/ Registration ID: 2761

Ημερομηνία/Date: 22 Ιουνίου / June 2014

Αντικείμενο / Item	Ποσότητα Quantity	Κόστος Είδους Item Cost	Σύνολο Total Amount	Ισοτιμία σε Ευρώ Euro Equivalent
Δικαίωμα πρόσβασης, με έκπτωση, στο επιστημονικό συνέδριο HCI International 2014 και στις παρεπόμενες υπηρεσίες του / Registration Discounted Fee	1	605.00$	605.00$	
		Υποσύνολο / Sub Total	**605.00$**	**€445.25**
		ΦΠΑ / VAT 23%	**139.15$**	**€102.41**
		Total Amount (US $)	**744.15$**	**€547.65**

Στοιχεία Πληρωμής / Payment Information

Αριθμός Συναλλαγής / Order Number: HCII2014-02761-01971
Μέθοδος πληρωμής / Payment method: Πιστωτική κάρτα / Credit Card $744.15
Συναλλαγματική ισοτιμία / Currency equivalence (Τράπεζα της Ελλάδος - ΕΚΤ / Bank of Greece - ECB, 20 Ιουνίου / June 2014): 1 (€) Ευρώ / Euro = 1.3588 ($) Δολάρια ΗΠΑ / US Dollars
Φορολογικός Αντιπρόσωπος / VAT Representative: Πηνελόπη Μαρταβαντζή / Penelope Martavantzi, ΑΦΜ / VAT#: EL034595877, ΔΟΥ Ηρακλείου / Heraklion Tax Office, Διεύθυνση / Address: Έβανς 44, Τ.Κ. 71201, Ηράκλειο Κρήτης / 44 Evans St., Heraklion, Crete, Greece

ΣΗΜΕΙΩΣΗ: Τόπος παροχής για τις ως άνω υπηρεσίες συνεδρίου θεωρείται η Ελλάδα, σύμφωνα με: α) το άρθρο 60 παράγραφοι 1 και 2 του νόμου 3842/2010, β) το άρθρο 53 της Οδηγίας 2008/8/ΕΚ του Συμβουλίου της 12ης Φεβρουαρίου 2008, και γ) το άρθρο 32 παράγραφος 2(γ) του εκτελεστικού κανονισμού (ΕΕ) αριθ. 282/2011 του Συμβουλίου της 15ης Μαρτίου 2011.
NOTE: Place of supply of the above described conference services is Greece, in accordance with: article 60 paragraphs 1 and 2 of the Greek law 3842/2010, b) Article 53 of the Council Directive 2008/8/EC of 12 February 2008 and c) Article 32, paragraph 2(c) of the Council Implementing Regulation (EU) No 282/2011 of 15 March 2011.

PAID


HCII 2014
22 - 27 June, Crete, Greece
www.hci-international.org
Ming-Chyuan
Lin
FAR EAST University
Taiwan
2761

HCI2014 16th International Conference on Human-Computer Interaction
In the Field of "Human Interface and the Management of Information"
6/26/2014

A Study on the Interface Design of a Functional Menu and Icons for In-Vehicle Navigation Systems

Ming-Chyuan Lin
Department of Creative Product Design and Management
Far East University, Taiwan

Outline

1. Introduction

Backgrounds

- The IVNS in 3C Electronic products becomes popular and involves daily information, leisure activity, entertainment guidance and communication
- Global positioning system of IVNS is an essential equipment in a vehicle
- Different menu functions and interface operation of an IVNS based on user preferences and requirements might affect the quality and safety of driving
- The number of functional items, layer arrangement of menu interface and visual icons still need further improvement

1. Introduction

Objective

Develop a systematic platform to design the framework of functional menu layers and the corresponding functional icons based on analyzing user requirements

2. Development Procedure

Three Development Stages

(1) Identification and Clustering Analysis of Functional Items
(2) Construction of an IVNS Interface System
(3) System Interface Experiment

3. Identification and Clustering Analysis of Functional Items

(1) Identification of the Functional Items
(2) Clustering Analysis of the Functional Items

Interface design factors for IVNSs

	Spec 1	Spec 2	Spec 3	Spec 4	Spec 5
Screen size	3.5 inch	4.3 inch	4.7 inch	5.2 inch	7 inch
Display aspect ratio	4 : 3	16 : 9			
Interface background	1 type	2 types	3 more types		
Main interface	single frame	upside: select area downside: search buttons	upside: power downside: select area	upside: power center: select area downside: search buttons	
Sub-interface	single frame	upside: select area downside: search buttons	upside: power downside: select area	upside: power center: select area downside: search buttons	
Main-interface icon size	same size	different sizes			
Information of main-interface icons	image	image and text	animation		
Number of icons in sub-interface	6	8			
Number of interface layers	2	3	4		
Display switch mode	click icon	click icon and switch the screen	click icon and confirm		
Icon frame	without borders	with borders			
Font	Times new roman	Arial	Arial bold		

Identification of the Functional Items

- Five brands: Garmin, Mio, Panasonic, TomTom and HOLUX
- 61 functional items were collected including 39 common functions and 22 special functions
- 44 functional items are identified based on 32 effective questionnaire results

List of collected and identified functional items

Common functions			Special functions		
	Title	Description	Title	Description
1	Road	Search a road	40 Picture	Search by coordinates of a picture
2	Intersection	Search an intersection	41 Color	Set colors of the map
3	Address	Search an address	42 Simulate	Route simulation
4	Parking lot	Parking lot nearby	43 Museum	Search a museum nearby
5	Highway ramp	Search a highway ramp nearby	44* Pre-crash system	An automobile safety system
6	Gas station	Search a gas station nearby	45 Plan a route	Plan a route next days
7	Detour	Made a detour	46* Brightness	Day or night Brightness
8	Organization	Search an organization	47* Auto Parking	An auto parking system
9	Attraction	Search an attraction	48* Phone	Connect to your phone
10	Volume	Adjust the volume	49* Current location	Show your current location
11	Restaurant	Search a restaurant	50* Voice	Introduce an attraction
12*	Home	Navigate to my home	51* Voice setting	Set the voice function
13	Hypermarket	Search a hypermarket nearby	52* Voice command	Controlled by means of voice
14	My routes	Saving a route	53 119	Call 119
15	Public transport	Search a public transport nearby	54* Game	Play a game
16	Roadside assistance	Roadside assistance information	55* Plug-in	A plug-in software
17	Language	Language setting	56* Calculator	A calculator
18	Screen Calibration	Calibrate the position of screen	57* E-book	Read an e-book
19	Planning a route	Planning a route	58* Layout	Set the layout of frames
20	Hospital	Search a hospital nearby	59* Following	Follow the car
21	Map view	Change the map view	60* Diary	Keep a diary
22	Types of route	Set the route type	61* Poetry	Play the poetry
23	Bank	Search a bank nearby		
24	Help	Help you get going with your device		
25	Entertainment	Search a public entertainment		
26	Brightness	Adjust the screen brightness		
27	History	Search Records		
28	Reset	Perform a full reset		
29	Phone number	Search by phone number		
30	Quick search	Set a quick search icon		
31	Time/Date	Set the time/date format		
32	Accommodation	Search for accommodations nearby		
33	Bluetooth	Connect to Bluetooth devices		
34	Coordinate	Planning a route using coordinates		
35	Radio	Listen to the radio		
36	Movie	Play video		
37	Photo	Photo browsing		
38	Music	Play music		
39	Save mode	Go to save mode		

Clustering Analysis of the Functional Items

- AIOs (A: activity; I: interest; O: opinion) type of questionnaire is used
- 10 types of activities, 7 types of interests and 8 types of opinions
- 106 effective questionnaire results
- SPSS Software for factor analysis
- 9 clusters of usability scenarios identified

Nine Clusters of Usability Scenarios

1. GPS system setup
2. Use of GPS while travelling
3. Travelling from one place to another place
4. Daily use of GPS on duty
5. Change destination while driving
6. Use of GPS for non-GPS activity
7. Use of GPS before driving
8. Personal Preference with GPS setup
9. Use of GPS for an emergency

Relational Evaluation Between Identified Functional Items and Usability Scenarios

- Conduct an interaction matrix
- 0 denotes no relation; 1 denotes with relation
- 10 GPS experienced subjects
- Ward's method in SPSS software is used to generate a hierarchical cluster of the system interface

Example showing an alternative cluster of an IVNS system interface

Main interface menu		Sub-interface menu Layer 1	Layer 2	Main interface menu	Sub-interface menu Layer 1	Layer 2
Cluster 1	Category Search	Attraction	Gas station	Cluster 4 Amusement	Movie	
		Accommodation	Public transport		Photo	
		Entertainment	My routes		Radio	
		Restaurant			Music	
		Hypermarket		Cluster 5 Planning a route	Simulate	
		Picture			Plan a route	
		Organization			Planning a route	
		Museum			Detour	
		Bank		Cluster 6 Setup	Help	Quick setup
		Parking lot			Reset	Volume
Cluster 2	Quick Search	Intersection			Save mode	
		Address			Time/Date	
		Road			Screen Calibration	
		Map view			Brightness	
		Phone number			Color	
		Highway ramp			Types of route	
		History			Bluetooth	
		Coordinate			Language	
Cluster 3	Emergency	Roadside assistance				
		119				
		Hospital				

4. Construction of an IVNS Interface System

(1) Determination of the Interface for Functional Menu Framework

(2) Icon Design for Functional Items

(3) Construction of an Interactive User Interface

Determination of the Interface for the Functional Menu Framework

- Current functional menu framework consists of one main interface and one sub-interface
- 3 types of main interfaces and 3 types of sub-interfaces identified in an individual display

Parameters and Levels of the Functional Menu Framework

Parameter		Level		
Main interface	Single frame	Top: selection area Bottom: browse area	Top: power area Bottom: selection area	Top: power area Center: selection area Bottom: browse area
Sub-interface	Single frame	Top: selection area Bottom: browse area	Top: power area Bottom: selection area	Top: power area Center: selection area Bottom: browse area
Maximum number of functional items	Main interface 4	5	6	
	Sub-interface 6	8	10	
Font	Times New Roman	Arial	Arial bold	

Characteristics of Recommended Parameter Levels

- Main interface with power area at top, selection area at bottom
- Sub-interface with power area at top, selection area at center and browse area at bottom
- 6 functional items in main interface
- 10 functional items in sub-interface
- Font with bold

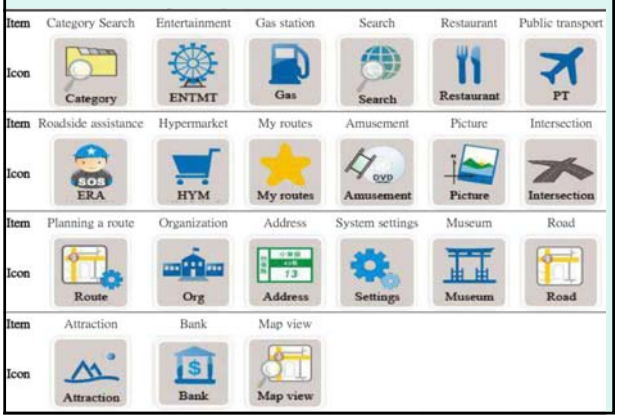
Icon Design for Functional Items

- Collect graphic icons from marketed functional items
- 50 graphic icons used and redrawn
- Adobe Flash CS3 is used
- Identify semantic image nouns for questionnaire design
- 32 effective subjects

Five Criteria for Icon Graphics Design

1. Limit an IVNS icon to 48x48 pixels with an area greater than 64 mm²
2. Use a single color as a background to obtain better tapping effect
3. Simplify the graphic image, color and shape to make it easy for users to understand
4. Unify the style of icons to be a family image
5. Allocate supplementary texts of functional items under the icons to enhance recognition

Partial Icon Designs for Specific Functions



Construction of an Interactive User Interface

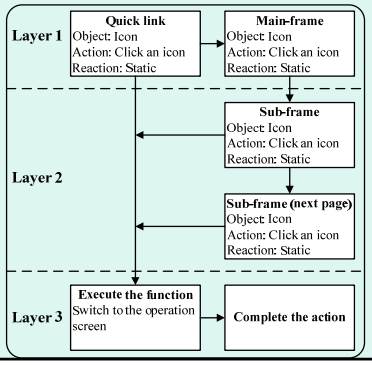
- Determination of the system panel
- Arrangement of the functional menu framework
- Retrieval and editorial process of the functional icon graphics
- Interactive connection of the interface

Simulation of the IVNS System Interface (HP iPAQ 212)

Representation of Main Interface

Representation of Partial Sub-Interface

Hierarchical Framework of the Interactive Interface



5. System Interface Experiment

(1) Experimental Planning of Proposed System Interface

(2) Conduction of System Interface Experiment

(3) Analysis of System Interface Experiment

Experimental Planning of Proposed System Interface

- one group using the developed in-vehicle navigation system; the other group using the Garmin Nuvi 1370T
- 10 types of tasks were designed for the experiment
- 20 tested subjects (13 experienced and 7 non-experienced)

Conduction of System Interface Experiment

- completion time (in seconds)
- number of times the user went back and forth between the layers
- number of mission errors

Analysis of System Interface Experiment

9 interface evaluation criteria:

(1) appropriate layout

(2) appropriate color

(3) easy to click

(4) easy to understand functional icons

(5) easy to understand texts

(6) avoid inappropriate touch

(7) easy to find functional items

(8) easy to learn the interface

(9) overall satisfaction

6. Conclusions

- The developed IVNS had a higher satisfaction than that of the comparison system
- A certain number of tested subjects and questionnaires is needed for modification and validation
- The proposed research will provide designers with information and process for an IVNS development

Acknowledgements

The authors are grateful to the National Science Council, Taiwan for supporting this research under the grant number NSC 102-2221-E-269-023

Co-Authors

- Yi-Hsien Lin, Ph.D., Assistant Professor
- Chun-Chun Lin, Ph.D., Associate Professor and Chairman
- Jenn-Yang Lin, Professor

Department of Creative Product Design and Management
Far East University, Taiwan

The End

Thank You

A Study on the Interface Design of a Functional Menu and Icons for In-vehicle Navigation Systems

Ming-Chyuan Lin*, Yi-Hsien Lin, Chun-Chun Lin, and Jenn-Yang Lin

Department of Creative Product Design and Management, Far East University, Tainan, Taiwan
{minglin,jylin}@mail.ncku.edu.tw, yisam0915@yahoo.com.tw,
purelin@ms17.hinet.net

Abstract. The progress in computer technology and information communication for consumer electronics and related intelligent products has greatly enhanced the usability of the global positioning system (GPS) of in-vehicle navigation systems (IVNSs). However, too many functions and information can be a burden to users while driving, which could include unsuitable icons, inappropriate framework configuration, redundant functional items and an unsuitable hierarchical configuration. The objective of this study is to develop a systematic platform to design the framework of functional menu layers and the corresponding functional icons based on analyzing user requirements. This research performed a three-stage assessment and an analysis on the graphical user interface, hierarchical layers of the functional menu such that the IVNS could be re-constructed based on the data collection and the analyzed marketed IVNS. IT is expected to provide reference information and a research process for designers to help create a more humanized, intelligent human-computer interaction.

Keywords: In-Vehicle Navigation System (IVNS), Menu Layer Configuration, Icon Design, Fuzzy Analytic Hierarchy Process (FAHP), Graphical User Interface.

1 Introduction

Due to the rapid progress in vehicle technology, many newly marketed products with intelligent functions are installed in vehicles to provide a more comfortable and convenient user environment for drivers. The global positioning system (GPS) of in-vehicle navigation systems (IVNSs) is one of the most common functions in a vehicle and is now considered essential equipment. With the assistance of an IVNS, the user can efficiently drive the vehicle to their desired destination without traditional guidebooks or maps. In general, there are two IVNS modes: (1) before driving and (2) while driving. The before-driving mode allows the user to set up the IVNS for the upcoming journey, whereas driving mode allows the user to readjust or modify the route while driving. The IVNS can also involve related communication, daily

* Corresponding author.

S. Yamamoto (Ed.): HIMI 2014, Part II, LNCS 8522, pp. 261–272, 2014.

information, leisure activity and entertainment guidance. Because an IVNS can integrate various functions into an intelligent system for driving, vehicle manufactures have tried to increase the number of functions in their IVNS to enhance the competition in global markets and satisfy user requirements. Several manufacturers have even designed particular functions or operational interfaces for their IVNSs to strengthen their respective technology. The functions and operational interfaces of an IVNS vary greatly and are based on the manufacturer' specifications and technological support. Most of the differences in the visual designs and functional segmentations appear in the menu functions and interface operation of the IVNS, which allow the user to operate the product based on their preferences and requirements. Despite these differences being the reasons why users choose a particular IVNS based on his or her preferences and use requirements, using intelligent products while driving will affect the quality and safety of driving. For example, inadequate interface information might make it difficult for the user to operate their IVNS, unsuitable icons and inappropriate configuration will confuse users, redundant functional items and an illogical hierarchical configuration will waste drivers' time when searching for functional items and increase the driver's mental workload. Furthermore, different IVNS brands have their own operational procedure and characteristics that will make the choice difficult. Green [1] suggested that an IVNS with redundant functions or an inappropriate icon design, interface framework and layer arrangement would confuse users during operation and cause users to spend more time searching for their desired function. PreiBner [2] recommended that the information interface design criteria of a vehicle should include the (1) use of a hierarchical structure in the multi-functional menu selection, (2) consider consistency and organization of related functions, (3) use simple images for functions and (4) consider the visual habits of users using the interface display. Amditis et al. [3] noted that a well-designed navigation system can enhance driving efficiency and reduce operational errors and accidents. Jung [4] introduced a context-sensitive visualization (CSV) method to incorporate users' internal contexts in the interactive product design by mapping out information onto the context models. Lin, et al. [5] considered that design a sub-window system in the IVNS to help reduce navigation errors. Cui, et al. [6] observed that the IVNS users tend to favor two-level hierarchies in grouping segments and use the similarity in content objects and applications. Cui, et al. also stressed that navigation history has to design in a content-centric way to organize and prioritize mobile interaction events and allow large individual differences. However, the usability of an IVNS based on the number of functional items, layer arrangement of the menu interface and visual icons may not satisfy users' requirements and still require further study and improvement. Therefore, the human-computer interaction interface in the IVNS should be designed and developed based on users' cognitive behavior to allow the contents to be displayed in the most comprehensible way. The objective of this research is to propose an appropriate interface design model for IVNSs; the analysis is followed by a validation experiment to recommend an optimum operation interface of an IVNS including a recommendation for a hierarchical layer configuration of functional items and icons that would help designers establish users' awareness on the graphical user interface and the information transmission mode of the electronic guide map.

2 Development Procedure

According to the research objective, there are three development stages for the proposed interface design model of an IVNS, which are the following: (1) identification and clustering analysis of functional items, (2) construction of an IVNS interface system and (3) system interface experiment. Stage 1 includes (1) identification of the functional items and the (2) clustering analysis of the functional items. In Stage 2, the construction procedure includes (1) determining the interface for the functional menu framework, (2) designing the icons for functional items and (3) constructing an interactive user interface. For Stage 3, the procedure includes (1) experimental planning of the proposed system interface, (2) performing the system interface experiment and (3) analyzing the experimental results. Note that the approach for the study (1) uses factor analysis [7] to obtain a clustering relation matrix of the functional items based on the usability scenario when using an in-vehicle navigation system, (2) conducts a hierarchical clustering analysis (HCA) [8] to categorize the functional items of an in-vehicle navigation system based on the clustering relation matrix, (3) applies a fuzzy analytic hierarchy process (FAHP) [9-10] to determine the optimum combination of functional items for the system interface design, (4) constructs a computer-aided system interface based on the identified functional items, layer arrangement and graphic icons and (5) uses a general human-machine interface measurement criteria to evaluate the usability of the developed system interface.

3 Identification and Clustering Analysis of Functional Items

The IVNS guides the user to the desired destination and prearranges routes for upcoming trips. Different manufacturers will have different support techniques that make functional items of IVNSs differ significantly. Note that different users (male or female) will also have different requirements for the functional items of an IVNS. Current interface operation of an IVNS includes external type and built-in type, and types of manual operation include push button plus touch-panel type and full touch-panel type. Most functional icons of a system interface of an IVNS appear in colors with a text explanation beneath the icons. The existing IVNS products have the following design factors: screen size, display aspect ratio, interface background, main-interface, sub-interface, main-interface icon size, information of main-interface icons, number of icons in the sub-interface, number of interface layers, display switch mode, icon frames and font, which are shown in Table 1. Based on the identified design factors for the interface design of IVNSs illustrated in Table 1, it is expected that this type of study would require customer opinions and preferences during the development process to ensure that the proposed model can satisfy a wide range of customer requirements. As such, identifying functional items will be the first step of this study followed by classifying the identified functional items to determine the number of interface layers.

Table 1. Interface design factors for IVNSs

	Spec 1	Spec 2	Spec 3	Spec 4	Spec 5
Screen size	3.5 inch	4.3 inch	4.7 inch	5.2 inch	7 inch
Display aspect ratio	4 : 3	16 : 9			
Interface background	1 type	2 types	3 more types		
Main interface	single frame	upside: select area downside: search buttons	upside: power downside: select area	upside: power center: select area downside: search buttons	
Sub-interface	single frame	upside: select area downside: search buttons	upside: power downside: select area	upside: power center: select area downside: search buttons	
Main-interface icon size	same size	different sizes			
Information of main-interface icons	image	image and text	animation		
Number of icons in sub-interface	6	8			
Number of interface layers	2	3	4		
Display switch mode	click icon	click icon and switch the screen	click icon and confirm		
Icon frame	without borders	with borders			
Font	Times new roman	Arial	Arial bold		

3.1 Identification of Functional Items

Because the currently marketed IVNS products have a variety of operating systems, display types, number of functional items, representation icons and interface layers, this study begins with a market survey that includes all the functional items and the design of a functional requirement questionnaire to help identify user requirements for functional IVNS items. The collection of functional items includes products from five brands: Garmin, Mio, Panasonic, TomTom and HOLUX. A total of 61 functional items, which includes 39 common functions and 22 special functions, was collected. These functions were then incorporated in a user experience questionnaire and forwarded to experienced users for evaluation. The questionnaire included (1) basic information of the test subjects (2) IVNS use experience and (3) a scale of 5 points (1, 2, 3, 4 and 5 points) to evaluate the functional items. Table 2 illustrates the collected 61 functional items and the identified 44 functional items based on 32 effective questionnaire results. Note that in Table 2, the number without "*" refers to the identified functional items and will be used in the classification and interface layer analysis.

Table 2. List of collected and identified functional items

Common functions			Special functions		
	Title	Description		Title	Description
1	Road	Search a road	40	Picture	Search by coordinates of a picture
2	Intersection	Search an intersection	41	Color	Set colors of the map
3	Address	Search an address	42	Simulate	Route simulation
4	Parking lot	Parking lot nearby	43	Museum	Search a museum nearby
5	Highway ramp	Search a highway ramp nearby	44*	Pre-crash system	An automobile safety system
6	Gas station	Search a gas station nearby	45	Plan a route	Plan a route next days
7	Detour	Made a detour	46*	Brightness	Day or night brightness
8	Organization	Search an organization	47*	Auto Parking	An auto parking system
9	Attraction	Search an attraction	48*	Phone	Connect to your phone
10	Volume	Adjust the volume	49*	Current location	Show your current location
11	Restaurant	Search a restaurant	50*	Voice	Introduce an attraction
12*	Home	Navigate to my home	51*	Voice setting	Set the voice function
13	Hypermarket	Search a hypermarket nearby	52*	Voice command	Controlled by means of voice
14	My routes	Saving a route	53	119	Call 119
15	Public transport	Search a public transport nearby	54*	Game	Play a game
16	Roadside assistance	Roadside assistance information	55*	Plug-in	A plug-in software
17	Language	Language setting	56*	Calculator	A calculator
18	Screen Calibration	Calibrate the position of screen	57*	E-book	Read an e-book
19	Planning a route	Planning a route	58*	Layout	Set the layout of frames
20	Hospital	Search a hospital nearby	59*	Following	Follow the car
21	Map view	Change the map view	60*	Diary	Keep a diary
22	Types of route	Set the route type	61*	Poetry	Play the poetry
23	Bank	Search a bank nearby			
24	Help	Help you get going with your device			
25	Entertainment	Search a public entertainment			
26	Brightness	Adjust the screen brightness			
27	History	Search Records			
28	Reset	Perform a full reset			
29	Phone number	Search by phone number			
30	Quick search	Set a quick search icon			
31	Time/Date	Set the time/date format			
32	Accommodation	Search for accommodations nearby			
33	Bluetooth	Connect to Bluetooth devices			
34	Coordinate	Planning a route using coordinates			
35	Radio	Listen to the radio			
36	Movie	Play video			
37	Photo	Photo browsing			
38	Music	Play music			
39	Save mode	Go to save mode			

3.2 Clustering Analysis of the Functional Items

To classify the identified 44 functional items, a usability scenario questionnaire was designed and distributed to the testers. The usability scenario questionnaire used AIO- (activities, interests and opinions) [11] type questions to perform a factor

analysis and analyze how the operation performance is affected by the key factors that transmit information during the process of human-computer interaction when using an IVNS. The research designed 25 AIO-type questions, which included 10 types of activities, 7 types of interests and 8 types of opinions. There were 106 effective questionnaire results. These results were forwarded to the statistical software SPSS for a factor analysis. This study defined 9 usability scenarios: (1) GPS system setup, (2) use of GPS while travelling, (3) travelling from one place to another place, (4) daily use of the GPS on duty, (5) change in the destination while driving, (6) use of GPS for none-GPS activities, (7) use of GPS before driving, (8) personal preference with the GPS setup and (9) use of GPS for an emergency. A relational evaluation between the identified functional items and the usability scenarios was then conducted with an interaction matrix. Points 0 and 1 were used to assess the relationships between the functional items and usability scenarios. These points correspond to no relation and with relation, respectively. 10 GPS-experienced subjects were asked to judge the items. The evaluation results were then used with Ward's method [7] in the SPSS software to generate a hierarchical structure for clustering groups. Table 3 illustrates one of the hierarchical clusters of the system interfaces. In Table 3, the main interface has 6 functional items; the sub-interface has a maximum of 10 functional items in the first layer.

Table 3. Example showing an alternative cluster of an IVNS system interface

Main interface menu		Sub-interface menu		Main interface menu		Sub-interface menu	
		Layer 1	Layer 2			Layer 1	Layer 2
Cluster 1	Category Search	Attraction	Gas station	Cluster 4	Amusement	Movie	
		Accommodation	Public transport			Photo	
		Entertainment	My routes			Radio	
		Restaurant				Music	
		Hypermarket		Cluster 5	Planning a route	Simulate	
		Picture				Plan a route	
		Organization				Planning a route	
		Museum				Detour	
		Bank		Cluster 6	Setup	Help	Quick setup
		Parking lot				Reset	Volume
Cluster 2	Quick Search	Intersection				Save mode	
		Address				Time/Date	
		Road				Screen Calibration	
		Map view				Brightness	
		Phone number				Color	
		Highway ramp				Types of route	
		History				Bluetooth	
		Coordinate				Language	
Cluster 3	Emergency	Roadside assistance					
		119					
		Hospital					

4 Construction of an IVNS Interface System

In constructing an IVNS interface system, there are two essential parts: (1) the functional menu framework evaluation and (2) functional icon design. The evaluation of the menu framework system is based on all the currently marketed IVNS interfaces and the result of the functional item clusters of the main interface and sub-interface. Determining the system interfaces is helpful in developing an IVNS interface system that will meet customer requirements. The framework specifications of the functional menu are considered as important parameters and will be evaluated with the FAHP approach. With regards to the functional icon design, this research uses a market survey, product catalogue collection and a questionnaire to identify higher cognition icons for design reference.

4.1 Determination of the Interface for the Functional Menu Framework

According to all the currently marketed IVNS interfaces, the functional menu framework consists of a main interface and a sub-interface. There are three types of main interfaces and three types of sub-interfaces based on the number of functional items in an individual display. Table 4 shows the parameters and levels of the functional menu framework. To select the most suitable system interface of the functional menu framework, the FAHP approach was applied in the evaluation process [9-10]. The evaluation criteria are based on human-machine interface measurement standards proposed by the International Standard Organization (ISO). Five measurement standards, which include fascination, tolerance, performance, efficiency, and ease of operation, were used. The five measurement standards were evaluated with fuzzy linguistic scales. The numbers, 1, 3, 5, 7 and 9, denote the least, less, medium, extremely and most important, respectively.

Table 4. Parameters and levels of the functional menu framework

Parameter		Level			
Main interface		Single frame	Top: selection area Bottom: browse area	Top: power area Bottom: selection area	Top: power area Center: selection area Bottom: browse area
Sub-interface		Single frame	Top: selection area Bottom: browse area	Top: power area Bottom: selection area	Top: power area Center: selection area Bottom: browse area
Maximum number of functional items	Main interface	4	5	6	
	Sub-interface	6	8	10	
Font		Times New Roman	Arial	Arial bold	

The parameters and levels incorporated with the five measurement standards form a matrix with parameters and levels assigned in rows and five measurement standards assigned in columns. A questionnaire was also designed and distributed to test

subjects via the internet. 30 test subjects evaluated each parameter level based on the five measurement standards on a fuzzy linguistic scale. The collected data were then pooled by the geometric average method. An alternative recommendation from the candidate system interfaces of the functional menu framework was selected to improve the system interface design. The characteristics of the recommended parameter levels are the following: main interface with power area at the top and selection area at the bottom, sub-interface with power area at the top, selection area at the center and browse area at the bottom, 6 functional items in the main interface, 10 functional items in the sub-interface and font with bold.

4.2 Icon Design for Functional Items

In designing icons for functional items, this study first collected graphic icons from the currently marketed functional items and identified semantic image nouns so the questionnaire could be distributed to determine a suitable connection between user requirements and functional icons. A total of 50 graphic icons, which included the main interface and sub-interface, was collected and redrawn [12]. The functional icons were designed using the computer software Adobe Flash CS3. The candidate icons for the functional items were designed as a questionnaire and distributed to the test subjects. The results indicated that users tended to accept daily or customary image graphics as icons. It appears that icon graphics with embodied characteristics are more recognized by users. Additionally, a simplified icon graphic will also provide a higher recognition. These suggestions lead directly to helping identify five icon graphics design criteria:

1. Limit the size of an IVNS icon to 48x48 pixels with an area greater than 64 mm^2.
2. Use a single color as a background to obtain better tapping effect.
3. Simplify the graphic image, color and shape to make it easy for the users to understand.
4. Unify the style of icons to be a family image.
5. Allocate supplementary texts of functional items under the icons to enhance recognition.

Based on the aforementioned graphics design criteria for icons, the research developed 50 graphic icons for the corresponding functional items. Table 5 shows the partial icons designed for specific functional items. An integrated system interface design criteria, which includes the functional menu framework, layers of functional items and functional icons, was then determined.

4.3 Construction of an Interactive User Interface

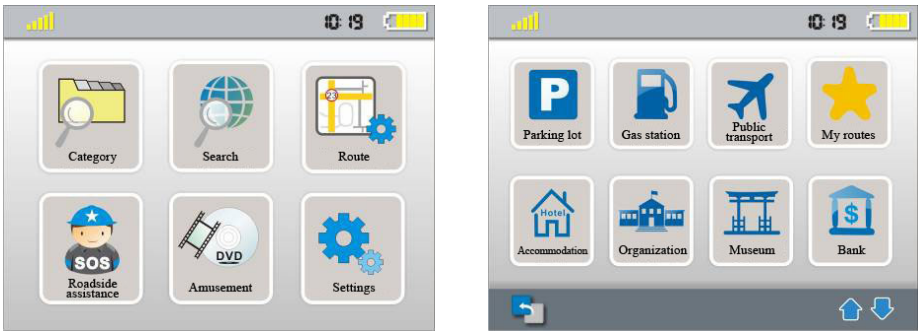
An IVNS was developed based on the high-demand functional items and clustering rules, the design factors of the interface and the features of the functional icons. Constructing a system interface includes the following: (1) determination of the system panel, (2) arrangement of the functional menu framework, (3) retrieval and editorial process of the functional icon graphics and (4) development of an interactive

Table 5. Partial icon designs for specific functions

Item	Category Search	Entertainment	Gas station	Search	Restaurant	Public transport
Icon						
Item	**Roadside assistance**	**Hypermarket**	**My routes**	**Amusement**	**Picture**	**Intersection**
Icon						
Item	**Planning a route**	**Organization**	**Address**	**System settings**	**Museum**	**Road**
Icon						
Item	**Attraction**	**Bank**	**Map view**			
Icon						

connection of the interface. To construct the system interface for this study, an HP iPAQ 212 Enterprise hand held display was used, as shown in Figure 1. The framework of the system interface, which includes 6 functional categories and 44 functional items, is illustrated in Figure 2. An interactive interface of the operational framework from this study is shown in Figure 3.

Fig. 1. Simulation of the IVNS system interface



(a) Representation of the main interface (b) Representation of the partial sub-interface

Fig. 2. Representation of the proposed IVNS system interface

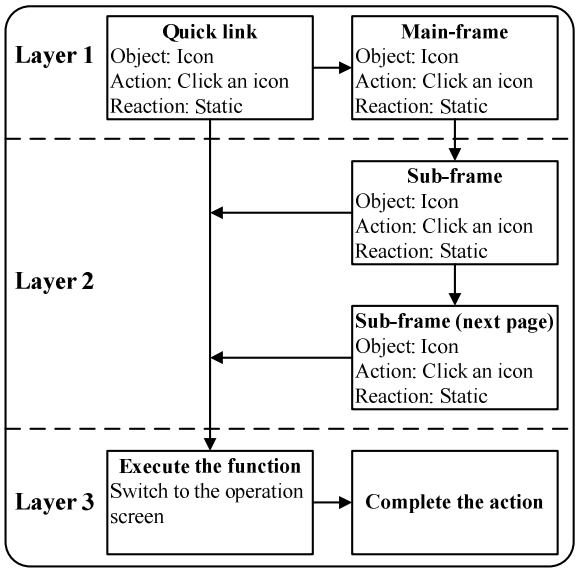


Fig. 3. Hierarchical framework of the interactive interface

5 System Interface Experiment

To evaluate the merits and faults of the developed IVNS, an experimental procedure was established for the system interface usability evaluation. The procedure included (1) experimental planning of the proposed system interface, (2) the system interface experiment and (3) analysis of the system interface experiment. In conducting the experiment, a comparison of two groups was conducted, with one group using the developed in-vehicle navigation system and the other group using the Garmin Nuvi 1370T. 10 types of tasks were designed for the experiment, and 20 test subjects who have design backgrounds were selected. Note that 13 of the test

subjects had experience using a GPS, whereas 7 test subjects did not have experience. The 10 types of tasks were (1) search for a gas station, (2) search for a roadside assistance, (3) adjust the screen brightness, (4) search for an address, (5) search for a culture center, (6) search for a crossroad, (7) search for a shopping center, (8) run the photo viewer, (9) search for a hospital and (10) search for an interchange. During the experiment, the completion time (in seconds), number of times the user went back and forth between the layers, and number of mission errors were recorded and analyzed.

After the experiment, the 20 test subjects were asked to fill out a questionnaire regarding the user interface evaluation criteria. The research defined 9 interface criteria for the evaluation, which are the following: (1) appropriate layout, (2) appropriate color, (3) easy to click, (4) easy to understand functional icons, (5) easy to understand texts, (6) avoid inappropriate touch, (7) easy to find functional items, (8) easy to learn the interface and (9) overall satisfaction. The evaluation is based on a 1-5 scale judgment with 1, 2, 3, 4 and 5 representing extremely low, low, medium, high and extremely high satisfaction, respectively. The results showed that the developed IVNS had a higher satisfaction than that of the comparison system. However, the developed in-vehicle navigation system still has several individual tasks that require further improvement.

6 Conclusions

IVNS products have become extremely popular, and many intelligent mobiles are even equipped with a built-in IVNS. The number of functional items in current IVNSs has increased gradually. Their differences have also become more apparent, which makes it difficult for the user to choose. Therefore, the designer is responsible for developing a friendly IVNS to meet user requirements. The research proposed a procedure to construct an IVNS interface that integrated several approaches, such as a usability scenario model, AIO scale, factor analysis, hierarchical clustering analysis, fuzzy analytic hierarchy process and graphics design. The hierarchical cluster analysis was used in the first stage to classify the hierarchical configuration of the functional items. Note that the fuzzy analytic hierarchy process was also used to evaluate the design factors of the framework configuration. In the second stage, the specifications of the system menu framework were determined using a fuzzy judgment matrix, and a design process of the functional icons was used. A system simulation for the experimental evaluation was also conducted in the third stage for further improvement. It was expected that through this research, the following results would be obtained: (1) a convenient connection between the graphical user interface in an IVNS and user cognition, (2) a friendly interface structure of the menu and digital content to enhance the operation performance, and (3) an appropriate mode of electronic information display on the vehicle windshield. In addition, this research provides reference information and a research process for designers to help establish users' awareness on the graphical user interface and the information transmission mode of an IVNS to make human-computer interaction more humanized and intelligent.

Acknowledgements. The authors are grateful to the National Science Council, Taiwan for supporting this research under the grant number NSC 102-2221-E-269-023.

References

1. Green, P.: In-Vehicle Information: Design of Driver Interfaces for Route Guidance. Transportation Research Board Meeting, Washington, D.C. Session 258B (1996)
2. PreiBner, O.: Design of Graphic Displays for Driver Information and Communication Systems. Computer Aided Animation. GmbH. AAAI Technical Report, SS-00-04 (2000)
3. Amditis, A., Pagle, K., Joshi, S., Bekiaris, E.: Driver–Vehicle–Environment Monitoring for On-board Driver Support Systems: Lessons Learned from Design and Implementation. Applied Ergonomics 41(2), 225–235 (2009)
4. Jung, E.C.: Methodology for Context-Sensitive System Design by Mapping Internal Contexts into Visualization Mechanisms. Design Studies 31, 26–45 (2010)
5. Lin, C.-T., Wu, H.-C., Chien, T.-Y.: Effects of E-Map Format and Sub-Windows on Driving Performance and Glance Behavior When Using an In-Vehicle Navigation System. I. J. Industrial Ergonomics 40, 330–336 (2010)
6. Cui, Y., Oulasvirta, A., Ma, L.: Event Perception in Mobile Interaction: Toward Better Navigation History Design on Mobile Devices. I. J. Human-Computer Interaction 27(5), 413–435 (2011)
7. Sharma, S.: Applied Multivariate Techniques. John Wiley & Sons, Inc., New York (1996)
8. Chen, M.-S., Lin, C.-C., Tai, Y.-Y., Lin, M.-C.: A Grey Relation Approach to the Integrated Process of QFD and QE. I. J. Concurrent Engineering: Research and Applications 19(1), 35–53 (2011)
9. Lee, W.B., Lau, H., Liu, Z.Z., Tam, S.: A Fuzzy Analytic Hierarchy Process Approach in Modular Product Design. Expert Systems 18(1), 32–42 (2001)
10. Li, T.S., Huang, H.H.: Applying TRIZ and Fuzzy AHP to Develop Innovative Design for Automated Manufacturing Systems. Expert Systems with Applications 36(4), 8302–8312 (2009)
11. Solomon, M.R.: Consumer Behavior: Buying, Having, and Being, 6th edn. Prentice-Hall, New Jersey (2004)
12. Lauer, D.A., Pentak, S.: Design Basics, 7th edn. The Cengage Learning Asia Pte, Ltd., Wadsworth (2008)

科技部補助計畫衍生研發成果推廣資料表

日期:2014/10/26

科技部補助計畫	計畫名稱: 整合感性語意差異的顧客需求設計分析與理性圖像衍生的模式於產品造形之發展(I)
	計畫主持人: 林銘泉
	計畫編號: 102-2221-E-269-023- 學門領域: 人因工程與工業設計

無研發成果推廣資料

102 年度專題研究計畫研究成果彙整表

計畫主持人：林銘泉	計畫編號：102-2221-E-269-023-
計畫名稱：整合感性語意差異的顧客需求設計分析與理性圖像衍生的模式於產品造形之發展(I)	

成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	1	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	2	3	100%		
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	2	2	100%	人次	
		博士生	1	1	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	3	4	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	1	0	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	無

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

科技部補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以 100 字為限）

□實驗失敗

□因故實驗中斷

□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：■已發表 □未發表之文稿 □撰寫中 □無

專利：□已獲得 □申請中 ■無

技轉：□已技轉 □洽談中 ■無

其他：(以 100 字為限)

先前部分相關研究以投稿國際期刊與國內外研討會，共計三篇國際期刊(含國際研討會論文轉期刊論文，國內外研討會三篇。最終之研究成果正在彙整與編輯，並準備投稿中。

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

本研究著重在消費者的感性認知鏈結設計師理性的造形建構，將提供設計師設計更為人性化的商品。