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Exploring the Minimalism in Product Design from Gestalt Visual Perception Perspective

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中文摘要

本研究提出一個解決產品設計決策問題之方法。研究目的主要以完形心理學與極簡主義觀點，進行產品造形設計之擇優評估。不同於傳統 AHP 方法，本研究所提出的決策評估模型，利用不同的數學工具，建立評判準則的優先順序，並作綜合評價以得到最終評判結果。為了驗證本決策評估模型之可行性與實用性，本研究進行案例說明，並獲相當可信之結果。除了產品造形之外，本決策評估模型亦可應用於平面設計、視覺設計等相關設計領域。

關鍵字：完形心理學、極簡主義、決策、評估、產品造形設計

Abstract

This paper provides a novel methodology for dealing with decision-making problems in product design fields. The purpose of this study is to evaluate product form design in terms of the perspectives of Gestalt psychology and Minimalist principles. Unlike traditional AHP methods, the proposed decision-making model uses distinct mathematical tools to establish priorities for the criteria and synthesize the evaluation results. A case study was conducted to illustrate the practicability of this proposed model. It has shown a credible result. In addition to product form design, this model can be applied to related design fields, such as plane design and other visual design.

Keywords: Gestalt psychology; Minimalism; Decision-making; Evaluation; Product form design

1. Introduction

There is a bivariate correlation between “structure” and “ornamentation” in product design. Structure refers to the essentials of creating product functions by means of science, technology, material, and engineering, while ornamentation refers to the measures to advance product value and to communicate product images to the users through cognitive, cultural, and aesthetic practices. With the incredibly fast paced advances being made in information technology, computers have emerged into the mainstream of present day society. Influenced by the concepts of structuralization and modularization in computer technologies, current product design has been trending toward singularized structure and integrated function. For example, there is no obvious structure difference among video recorders, VCD players, and DVD players. Also, current mobile phones integrate many functions into a telephone such as a digital camera, radio, MP3 player, PDA and GPS. The design trend of singularized structure and integrated function makes formal ornamentation more difficult and complicated, no matter what designers believe about the contention of “form follows function” or that of “form and function are one”. Product design must not only satisfy the physical rationality of the functions, but it must focus on consumers’ psychological needs toward product forms (Chuang et al., 2001; McDonagh et al., 2002; Chang et al., 2007; Chang and Wu, 2009). Crilly et al. (2004) proposed three dimensions of consumer responses to product forms: aesthetic impression, semantic interpretation, and symbolic association. Aesthetic impression is defined as the sensation that results from the perception of attractiveness in products. It is based on the well known “what is beautiful is good” phenomenon from social psychology and market research. Semantic interpretation is regarded as what a product is seen to say about its function, mode-of-use and qualities, implying forms independent of the aesthetic preferences of customers as well as those of their own. Symbolic association is the perception of what a product says about its owner or user, stressing the importance of personal and social significance attached to the design.

Nowadays product design involves a wide variety of high technology, extending the functional structure domains of products. In the ornamental aspects, there is an ever-increasing trend toward simplicity over complexity. Luxury but simplicity has gradually set the fashion for formal aesthetics of products. Minimalism describes a design style where the subject is reduced to its necessary elements. It is rooted in the reductive aspects of Modernism, and is often interpreted as a reaction against Abstract Expressionism and a bridge to post-modern art practices. Minimalist design places emphasis on using the basic geometric shapes as outlines, using only a single shape or a small number of like shapes as components for design unity, using tasteful non-fussy bright color combinations, natural textures and colors, and clean and fine finishes. Fischer (1989) indicated that the minimalist design is characterized by “aesthetic reductionism”, taking advantage of the geometric elements and advanced surfacing techniques to create product form aesthetics. It reasonably bridges the bivariate correlation between structure and ornamentation in product design, and also possesses the implication of “form explains function” in terms of product semantics. A product is regarded as a symbol underlying its own formal ornamentation,

and visually communicates its functional structure significance to the users through metaphor, analogy, simile, allegory, and interface design. In product design, geometric forms are one of the important styles, providing not only mathematical logicality and physical stability but also visual compatibility and cognitive acceptability. Minimalism is a neo-modern style, focusing on simple geometric appearance, quality material utilization, and pure integral performance. It faithfully reflects and communicates a “Zeitgeist” image without any reminiscence and illusion, interpreting modern fashion aesthetics as well as our lifestyle.

Design is the conscious and intuitive effort to impose meaningful order. Product form design is based on the creative processes of visual aesthetics. However, the visual modularity of the human brain is extremely complex and mysterious, containing not only the vision but also the comprehension. Livingstone (1988) indicated that the brain has at least three systems for interpreting signals coming from our eyes: one is concerned with colors, another distinguishes objects from each other by looking for variations in light intensity suggestive of shadows or contours, and a third is concerned with movement. There is a certain connection between aesthetic perception and the human brain (Zeki, 2000). Kant (1979) suggested that aesthetic perception can be considered as an experiential inquiry of psychological essence. Gestalt psychology, originating as a reaction to reductionistic schools of psychology, is a theory of mind and brain which proposes that the operational principle of the human brain is holistic, parallel, and analog with self-organizing tendencies. It refers to theories of visual perception developed by a group of German psychologists (e.g. Koffka, 1922; Köhler, 1959). These theories attempt to describe how people tend to organize visual elements into groups or unified wholes when certain principles such as proximity, similarity, continuity, symmetry, and closure are applied. The founders of Gestalt psychology believe that a perception cannot be meaningfully decomposed into its elementary components. They propose that the basic units of perception are themselves the perceptions—the “Gestalts” (or Gestalten) are the fundamental units (Goldstein, 2006). Gestalt principles describe the tendency to organize perceptual information into coherent patterns based on graphic properties (Murray et al., 1998). They emphasize the holistic nature where recognition is inferred more by the properties of an image as a whole rather than parts during visual perception. This is considered different from traditional pattern recognition where recognition is achieved by comparing image features of parts and their combinations (Jiang et al., 2006). Indeed, a gestalt is more than a pattern. It is regarded as the invariants of a collection of patterns that can mutually be transformed into each other through a class of transformations encoded by, or conversely, determining that gestalt. Geometric figures or shapes yield simple examples for the collection of patterns representing the gestalt since each pattern is transformed as a whole (Breidbach and Jost, 2006).

Minimalism in modern design is in vogue today, while Gestalt psychology is not just something of the past but, in fact, is a subject of renewed interest. Minimalist design uses simple geometric shapes as outlines to obviate the possible ideologies of specific images as well as reducing unnecessary formal processing to underline the material natures. Gestalt principle

attempts to understand psychological phenomena by viewing them as organized and structured wholes rather than the sum of their constituent parts. The Minimalist design highlights the essence of aesthetic reductionism, whereas Gestalt psychology emphasizes the grouping concept of visual perception. An interesting issue is how to achieve the requirements for aesthetic reductionism of the Minimalist design as well as conform to the holistic nature of the Gestalt perception when dealing with the visual elements. Motivated by the studies in Gestalt visual perception and Minimalism, this study proposes a novel decision-making model for evaluating product form design. In the literature, the analytic hierarchy process (AHP) proposed by Saaty (1980), is a system analysis technique for solving decision problems. It is a multiple criteria decision-making tool that has been used in almost all applications related to decision making (Vaidya and Kumar, 2006; Chen et al., 2009). A basic principle in the AHP is that valid results depend on establishing priorities for the criteria, priorities for the alternatives with respect to each criterion, and synthesizing the results by weighting and adding (Whitaker, 2007). The traditional AHP uses paired comparisons to weight the importance for attributes based on a hierarchical structure and requires that decision makers remain consistent in making pairwise comparisons among numerous decision criteria. However, accurate expression of relative preferences on the criteria is difficult for decision makers due to the limitations of Saaty's discrete 9-value scale (Lin et al., 2008). Hurley (2001) pointed out that it is frequently the case that decision makers are quite certain about the rank order of the objects for a particular pairwise comparison matrix but uncertain about the precise numerical weights that the AHP produces for that matrix. Accordingly, this decision-making model uses a new mathematical method combining the distance correlation analysis of similarity measure with the weighted generalized means. It can improve the weakness of AHP in assessing the relative importance weights of various criteria, taking advantage of eigenvalue algorithms to determine the weights of criteria as well as to accurately rank the decision alternatives.

2. Outline of the decision-making model

The gestalt effect refers to the form-forming capability of our senses, particularly with respect to the visual recognition of figures and whole forms instead of just a collection of simple lines and curves. Minimalism, on the other hand, is a trend in modern product design by which only the necessary elements are used. Based on the mathematical background of correlation-based similarity measure, eigenvalue and eigenvector, and weighted generalized means, the implementation methods are illustrated step by step as follows:

Step 1. Establish the criteria for the Gestalt-Minimalism-based decision making

$$C = (\text{Proximity}, \text{Similarity}, \text{Continuity}, \text{Symmetry}, \text{Closure}) \quad (1)$$

Step 2. Define the evaluation rules of the criteria in terms of the Gestalt-Minimalist perception

The main gestaltic grouping principle is that objects, colors, textures or patterns having one or several features in common are being grouped because they have this feature in common. Based

on the Gestalt laws of form perception and the Minimalist design principles, we define the evaluation rules as follows:

- Criterion 1: The law of proximity posits that when we perceive a collection of objects, we will see objects close to each other as forming a group. For a product form design, using only a single shape or a small number of like shapes for components tends to be perceived as a Gestalt-Minimalist perception.
- Criterion 2: The law of similarity captures the idea that elements will be grouped perceptually if they are similar to each other. In general, different perceptual fields are not advisable in a multiple-design style. For a product form design, using natural textures and colors can visually create similar clusters so that it tends to be perceived as forming a Gestalt-Minimalist perception.
- Criterion 3: The law of continuity refers to our tendency to see patterns and therefore perceive things as belonging together if they form some type of continuous pattern. For a product form design, the surface that uses tasteful non-fussy bright color combinations tends to be grouped as continuous patterns to form a Gestalt-Minimalist perception.
- Criterion 4: The law of symmetry captures the idea that priority in perceptual grouping is given to more natural, balanced, and symmetrical shapes over asymmetrical ones. Most geometric forms are symmetrical, and we intuitively integrate them into one coherent object (or percept). For a product form design, using the basic geometric shapes as outlines tends to be perceived as forming a Gestalt-Minimalist perception.
- Criterion 5: The law of closure posits that we perceptually close up, or complete, objects that are not, in fact, complete. Clean and fine finishes tend to be perceived as complete due to visual closure ability. Within a product form design, if the surface possesses clean and fine finishes, it appears to be grouped together to form a Gestalt-Minimalist perception.

Step 3. Determine the weights for the criteria

Given a set of representative products as samples, decision makers evaluate these sample products according to the evaluation rules of the Gestalt-Minimalist perception. The evaluation grades are 5-point linguistic scales ranging from “very good” (score=0.9) to “very poor” (score=0.1). The higher the score the closer the criterion is to the Gestalt-Minimalist perception. Substituting these scoring data into SPSS software to perform the Pearson distance correlation analysis, we can derive a proximity matrix. Taking advantage of the eigenvalue algorithms, a set of weights corresponding to the criteria can be determined as below:

$$W=(w_1, w_2, w_3, w_4, w_5); \sum_{i=1}^5 w_i=1 \tag{2}$$

Step 4. Evaluate the priorities for the alternatives with respect to each criterion

Select a set of products as decision alternatives, and then construct preference relations by

evaluating them in accordance with the evaluation rules of the criteria. The evaluations are also 5-point linguistic scales. They can be expressed as below:

$$A=(a_1, a_2, a_3, a_4, a_5); a_i \in [0,1], i=1,2,\dots,5 \quad (3)$$

Step 5. Synthesize the results by using the weighted generalized means

The aggregation function and the average h_α are expressed as follows:

$$h_\alpha^j = \left(\sum_{i=1}^5 w_i \cdot a_{j,i}^\alpha \right)^{1/\alpha}; \quad \bar{h}_\alpha^j = \frac{\int_a^b \left(\sum_{i=1}^5 w_i \cdot a_{j,i}^\alpha \right)^{1/\alpha} d\alpha}{b-a} \quad (4)$$

where a and b are the lower and upper limits of integration, respectively; i is the number of the criteria; j is the number of the decision alternatives.

Taking advantage of the numerical integration operations of the mean value theorem for integrals, we can rank the decision alternatives. The higher the average h_α value, the better the product alternative in terms of the Gestalt-Minimalist perception.

3. A case study

In order to illustrate the practicability of this proposed model, we implemented an empirical study in this section. The goal of this experiment is to evaluate the most desirable alternatives from a set of selected iPod speakers in terms of the Gestalt-Minimalist perception. The experiment consisted of two parts: (1) a pilot test to determine the importance (weights) of the criteria, and (2) the Gestalt-Minimalist perception evaluation for the selected iPod speakers.

3.1. Determining the weights of the criteria

The importance (weights) of the criteria is a critical factor in decision-making processes, and must be more objectively and equitably determined. As shown in Appendix A, six sets of iPod docks/speakers were selected as samples, which were manufactured by European loudspeaker companies and designed to blend elegant minimalism with aesthetic and acoustic technologies. Five product designers who had at least 5 years of personal work experience participated in the test to evaluate the selected samples according to the evaluation rules given above. The means of the quantitative judgments corresponding to each criterion were classified as shown in Table 1.

Substituting these rating data into SPSS software to perform the Pearson distance correlation operation, we obtained a proximity matrix as below:

$$R_{5 \times 5} = \begin{bmatrix} 1 & 0.985 & 0.851 & 0.762 & 0.881 \\ 0.985 & 1 & 0.756 & 0.719 & 0.798 \\ 0.851 & 0.756 & 1 & 0.610 & 0.926 \\ 0.762 & 0.719 & 0.610 & 1 & 0.782 \\ 0.881 & 0.798 & 0.926 & 0.782 & 1 \end{bmatrix} \quad (5)$$

Table 1. The means of the quantitative judgments corresponding to each criterion

	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5
Sample 1	0.82	0.82	0.86	0.86	0.78

Sample 2	0.62	0.66	0.62	0.34	0.54
Sample 3	0.58	0.62	0.54	0.62	0.58
Sample 4	0.54	0.54	0.62	0.58	0.58
Sample 5	0.74	0.78	0.62	0.82	0.62
Sample 6	0.82	0.82	0.82	0.82	0.82

Taking advantage of the eigenvalue algorithms, we found a set of eigenvalues: 4.239, 0.312, 0.408, 0, and 0.041. The eigenvectors corresponding to the maximum eigenvalue $\lambda_{\max}=4.239$ were 0.474, 0.451, 0.439, 0.406, and 0.463. Further normalizing these eigenvectors, the weights of the criteria were determined as follows:

$$W=(w_i)_{5 \times 1}=[0.21 \ 0.20 \ 0.20 \ 0.18 \ 0.21]^T \quad (6)$$

The result shows that Criterion 4 has the lowest importance and is given less weight in the evaluation. It is rational since the application of geometric and symmetric properties is essential and apparent in terms of the minimalist form design of such products.

3.2. Evaluating product form design by the Gestalt-Minimalist perception

In this part of the experiment, twelve products were selected as test cases on which to try out the proposed model for evaluating their form design in terms of the Gestalt-Minimalist perception. As shown in Appendix B, all the selected iPod speakers were popular and saleable at retail stores and on-line shopping websites in Taiwan. Thirty university students majoring in product design were selected as respondents to assess these product alternatives. As with the evaluating course of Part 1 of the experiment, the ratings of the criteria with each corresponding product were linguistically evaluated by the respondents. The means and standard deviations of the quantitative judgments were categorized and listed as shown in Table 2.

The mean scores for the product alternatives corresponding to the criteria were summarized in a matrix below:

$$A=(a_{ji})_{12 \times 5} = \begin{bmatrix} 0.79 & 0.77 & 0.79 & 0.79 & 0.77 \\ 0.57 & 0.59 & 0.53 & 0.50 & 0.55 \\ 0.69 & 0.77 & 0.69 & 0.68 & 0.71 \\ 0.77 & 0.79 & 0.75 & 0.75 & 0.77 \\ 0.70 & 0.66 & 0.61 & 0.63 & 0.61 \\ 0.75 & 0.75 & 0.77 & 0.75 & 0.75 \\ 0.80 & 0.78 & 0.79 & 0.79 & 0.79 \\ 0.59 & 0.61 & 0.57 & 0.58 & 0.56 \\ 0.65 & 0.63 & 0.65 & 0.69 & 0.60 \\ 0.67 & 0.69 & 0.72 & 0.69 & 0.67 \\ 0.49 & 0.51 & 0.49 & 0.47 & 0.51 \\ 0.62 & 0.59 & 0.61 & 0.63 & 0.61 \end{bmatrix} \quad (7)$$

Table 2. The means and standard deviations of the quantitative judgments

	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5
Alternative 1	0.79 (0.11)	0.77 (0.10)	0.79 (0.10)	0.79 (0.10)	0.77 (0.10)
Alternative 2	0.57 (0.15)	0.59 (0.12)	0.53 (0.16)	0.50 (0.10)	0.55 (0.15)
Alternative 3	0.69 (0.14)	0.77 (0.13)	0.69 (0.13)	0.68 (0.13)	0.71 (0.13)
Alternative 4	0.77 (0.10)	0.79 (0.10)	0.75 (0.14)	0.75 (0.13)	0.77 (0.12)
Alternative 5	0.70 (0.16)	0.66 (0.15)	0.61 (0.12)	0.63 (0.13)	0.61 (0.19)

Alternative 6	0.75 (0.12)	0.75 (0.14)	0.77 (0.12)	0.75 (0.13)	0.75 (0.13)
Alternative 7	0.80 (0.11)	0.78 (0.11)	0.79 (0.11)	0.79 (0.12)	0.79 (0.11)
Alternative 8	0.59 (0.19)	0.61 (0.15)	0.57 (0.14)	0.58 (0.13)	0.56 (0.14)
Alternative 9	0.65 (0.16)	0.63 (0.15)	0.65 (0.18)	0.69 (0.18)	0.60 (0.14)
Alternative 10	0.67 (0.17)	0.69 (0.13)	0.72 (0.14)	0.69 (0.16)	0.67 (0.15)
Alternative 11	0.49 (0.19)	0.51 (0.18)	0.49 (0.16)	0.47 (0.18)	0.51 (0.16)
Alternative 12	0.62 (0.17)	0.59 (0.15)	0.61 (0.17)	0.63 (0.14)	0.61 (0.17)

Let $a=-100$, $b=100$, substituting the data of matrixes (6) and (7) into Formula (4) to perform the weighted generalized means operation, we derived the evaluation results as shown in Table 3.

Table 3. The evaluation results for the decision alternatives

—	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
h_{α}^j	0.7815	0.5457	0.7175	0.7668	0.6483	0.7546
Rank	2	11	5	3	7	4
—	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11	Alternative 12
h_{α}^j	0.7901	0.5829	0.6429	0.6897	0.4931	0.6108
Rank	1	10	8	6	12	9

According to the evaluation results, we found that the most desirable products were Alternatives 7, 1, 4, 6, and 3 in order. Of the twelve decision alternatives, the best product form design was Alternative 7, whereas the worst was Alternative 11 in terms of the Gestalt-Minimalist perceptual measure. Further analyzing the products, the former is simply shaped like a tube and features a black body with metal grills covering its surface, while the latter possesses unnecessarily a specific image like its name—LuluCat. The results have shown that the proposed model is practical and dependable.

4. Discussions and conclusions

Gestalt and Minimalism are two important perspectives that can be used to assess product form design. In previous literature, however, few studies were conducted regarding the practical performance of using Gestalt theory associated with the minimalist design principles for assessing product design qualities. This study proposes a Gestalt-Minimalism-based decision-making model for evaluating product form design. The decision-making model uses a new mathematical method that combines the distance correlation analysis of similarity measure and eigenvalue algorithms with the weighted generalized means. Compared with the AHP method, this proposed method possesses the following advantages:

(1) Traditional AHP uses a discrete 9-value scale to capture ratio information by comparing relative preference of one alternative over another. However, accurate quantitative expression of relative preferences on the criteria is difficult for decision makers (Lin et al., 2008), particularly in such empirical study as using the perceptual evaluation rules for pairwise comparisons. As similar as the Likert scale that allows decision makers to rank the item order, the proposed method uses a 5-point linguistic scale to directly score alternatives without intricate pairwise comparisons. It makes the judgements easier and more intuitive and precise. However, there are some limitations as the commonly-used 5-point Likert scale suffered. The major limitation is that the linguistic scoring is a bipolar scaling method, measuring either positive or negative response to a preference. It may be subject to distortion from several causes like central tendency bias,

acquiescence bias, or social desirability bias. In spite of the limitation, the 5-point linguistic scoring is still valuable as compared with the 9-value pairwise comparing.

(2) Saaty advocated the use of the eigenvector technique for deriving the weights from a given pairwise comparison matrix. However, the lack of automatic mechanism for improving the consistency ratio (CR) can make the AHP impractical or impossible for the decision making when the time is crucial (Cao et al., 2008; Lin et al., 2008). The pairwise comparison matrix is a positive reciprocal matrix (Shiraishi et al., 1998). It must use redundant judgments for checking consistency, and this can exponentially increase the number of judgments to be elicited from decision makers. Some researchers even pointed out that this method can suffer from rank reversal (Belton and Gear, 1985; Dyer, 1990; Wang and Elhag, 2006). The proposed method uses a proximity matrix derived from the similarity measures of rating relations. It is a symmetric square matrix and we can use the eigenvalue algorithms to derive the weights of criteria. These weights corresponding to the criteria are sound as they are based on the principal diagonal elements within the proximity matrix. They can reasonably reflect the respective criterion's unique positive contribution to the whole preference relations. Ribeiro and Marques Pereira (2003) indicated that a limitation in determining weights is that weights should sometimes depend on the corresponding attribute satisfaction values. They argued that the determined weight should be modified when considering one attribute with a high relative importance w_i , which has a low satisfaction value a_i . However, this is not the case we explored, since the underlying assumption here is that the contribution of an individual attribute to the total rating of any alternative is independent of other attribute values.

(3) The use of weighting functions depending continuously on attribute satisfaction values produces aggregation operators with complex numerical behavior. The monotonicity of the aggregation operator is a crucial issue which involves constraints on the derivative of the weighted aggregation operator with respect to the various attribute satisfaction values. In decision-making processes, the technique of weighted means is commonly used to aggregate preference information as well as to rank the order of the decision alternatives. It assumes that weights are proportional to the relative value of a unit change in each attribute (Hobbs, 1980). However, different weighted versions (e.g. weighted arithmetic mean, weighted geometric mean, and weighted harmonic mean) may produce different results. To overcome this problem, the proposed method uses the weighted generalized means to synthesize evaluation results. The major difference between the weighted generalized means and the conventional weighted means is the involvement of α parameter. By varying the α parameter within the interval of $(-\infty, \infty)$, we can derive a homologous aggregation value based on a multiple criteria analysis. Taking advantage of the numerical integration technique, we can harmoniously rank the decision alternatives as well as accurately identify the most desirable alternatives.

In conclusion, this study contributes to our knowledge by using Gestalt theory associated with the minimalist principles in design areas. It also provides a novel methodology for dealing with decision-making problems in product design fields. The Gestalt-Minimalist perception refers to

the perceptual dimensions regarding minimum ornamentation of design features and maximum resistance to perceptual separation. Minimalist design is one of the product design styles that comprises unique form features. However, consumer preferences concerning product design are often affected by a large variety of form features. Further research could focus on evaluating consumer preferences in other perspectives of perceptual dimensions such as aesthetic impression, semantic interpretation, or symbolic association.

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Self-evaluation of the work

Product form design is a creative process that involves complex visual perceptions. It is very important to develop a novel decision support system for designers to deal with problems concerning the consumers' psychological preferences toward product forms. As Gestalt psychology and Minimalist principles provide an important perspective on visual perception, it is appropriate to apply these principles in assessing the quality of product form design.

Gestalt and Minimalism are two important perspectives that can be used to assess product form design. In previous literature, however, few studies were conducted regarding the practical performance of using Gestalt theory associated with the minimalist design principles for assessing product design qualities. This study has contributed to our knowledge by using Gestalt theory associated with the minimalist principles in product design areas, providing a novel methodology for dealing with decision-making problems.

This study has completed a research paper entitled “**A Gestalt-Minimalism-based decision-making model for evaluating product form design**”. It has been submitted to **International Journal of Industrial Ergonomics**.

Appendix A. List of the 6 selected samples for determining the weights of the criteria

Sample 1. Bowers & Wilkins "Zeppelin"	Sample 2. Etón "Porsche Design P'9120"	Sample 3. Jean-Michel Jarre "Aerosystem"
		
http://www.bowers-wilkins.com/	http://www.etoncorp.com/PorscheDesign	http://jeanmicheljarre.dk/tag/aerosystem/
640 mm (W)*173 mm (H)*208 mm (D)*7.5 kg	130 mm (W)*141 mm (H)*229 mm (D)*2.8 kg	120 mm-250 mm (Diameter)*1080 mm (H)*10 kg
Sample 4. Branex Design "iTamTam"	Sample 5. Scandyna "Micropod SE"	Sample 6. Bang and Olufsen "BeoLab 4"
		
http://www.itamtam.com/	http://www.podspeakers.com/	http://www.bang-olufsen.com/
300 mm (Diameter)*450 mm (H)*4.86 kg	125 mm (W)*195 mm (H, with spikes)*114 mm (D)*0.95 kg (without spikes) (for each speaker)	205 mm (W)*215 mm (H)*197 mm (D)*1.7 kg (for each speaker)

Appendix B. List of the 12 product alternatives for the Gestalt-Minimalist perception evaluation

Alternative 1. Thomson	Alternative 2. Sanwa	Alternative 3. Harman Kardon	Alternative 4. JBL
			
262x327x302 (mm) – 5.8 kg	190x56x220 (mm) – 0.91 kg	50.8x254 (mm) – 0.67 kg * 2 ; 232x258 (mm) – 2.9 kg * 1	76.2x76.2x76.2 (mm) * 2; 229x229x229 (mm) * 1 – 5.1 kg
Alternative 5. OZAKI	Alternative 6. Edifier	Alternative 7. Altec Lansing	Alternative 8. Kinyo ArtDio
			
113x110x115 (mm) – 0.5 kg	57x63x57 (mm) * 2; 260x84x59 (mm) * 1 – 0.7 kg	482x265x208 (mm) – 4 kg	60x83x119 (mm) * 2; 180x190x180 (mm) * 1 – 3.7 kg
Alternative 9. boynq Sabre	Alternative 10. Logitech	Alternative 11. LuluCat	Alternative 12. iHOME
			
200x100x150 (mm) – 1.5 kg	356x102x140 (mm) – 1.6 kg	250x129x123 (mm) – 1.2 kg	230x90x108 (mm) – 2.6 kg

出席國際學術會議心得報告

計畫編號	NSC 98-2221-E-343-010
計畫名稱	從完形視覺感知觀點探討產品設計之極簡風格
出國人員姓名	周志榮
服務機關及職稱	南華大學應用藝術與設計學系副教授兼校務發展組組長
會議時間地點	2009/8/19-2009/8/21；大陸西安
會議名稱	2009 International Conference on Industrial globalization and Technology Innovation
發表論文題目	The impact of asynchronous web-based learning on unemployed adult novices

一、參加會議經過

由國際組織創新協會(International Association of Organizational Innovation, IAOI)主辦之 2009 International Conference on Industrial globalization and Technology Innovation 2009 年 8 月 19 日至 8 月 21 日於大陸西安舉行。本次研討會計有來自 20 餘國學者，發表一百餘篇研究論文。會中除探討產業國際化與技術創新議題外，並對全球金融風暴後之組織創新交換心得。本研討會已舉辦三屆，參與學者遍及亞洲及美洲各國，在全球有關創新議題之國際研討會中，有相當之重要性與影響力。

本次會議會議議程三天，2009 年 8 月 13 日搭乘港龍航空由高雄飛抵香港，轉國泰航空班機抵達泰國曼谷機場，8 月 14 日拜訪暹羅大學 Siam University 校長 President Pornchai Mongkhonvanit，討論 2010 International Conference of Organizational Innovation 之舉辦事宜。8 月 15 日搭乘國泰航空由曼谷飛抵香港，再轉搭東方航空抵達西安，8 月 19 日至 8 月 21 日參加研討會議程，並發表研究論文。2009 年 8 月 22 日搭機經香港返回高雄小港機場。



拜訪 President Pornchai Mongkhonvanit of Siam University



參加 2009 International Conference on Industrial globalization and Technology Innovation

二、與會心得

產業全球化與技術創新為國際間熱門的研究主題，橫跨眾多學術領域。本次參加研討會除發表 The impact of asynchronous web-based learning on unemployed adult novices 研究論文外，並參加五場次之 Parallel paper presentations 包含 E-Learning, Information Technology, Consumer Behavior, Knowledge Management 與 Creativity 等 title sections。其中，Knowledge Management 與 Creativity 兩議題與個人目前研究方向有關，藉由參加本次研討會，認識各國學者並了解目前國際間有關技術創新領域之發展動向與研究成果，對於後續研究方向擬訂，助益良多。

The Impact of Asynchronous Web-Based Learning on Unemployed Adult Novices

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Abstract

Web-based learning has recently become a promising alternative to the traditional classroom. It can be regarded as a way to bridge the digital gap among individuals. Understanding why users accept or reject information technology is an important issue. The purpose of this study was to investigate the impact of asynchronous web-based learning on unemployed adult novices in Taiwan. The experimental results indicated that the majority of unemployed adult novices believe that web-based learning is useful for enhancing their job performance. However, the use of web-based learning technology seems not to be effective to them.

With regard to individual differences in gender, age, education, and learning performance, education is the critical factor influencing unemployed adult novices' web-based learning. It was significantly and positively related to web-based learning performance, and also had a group impact on perceived ease of use in terms of the low-education and high-education subjects. The present study suggests that a novice's educational level should be taken into account when developing an asynchronous web-based learning system. Certain web-based learning characteristics of the specific user population were also discussed.

Keywords: Asynchronous web-based learning; Technology acceptance model (TAM); Unemployed adult novice; Individual difference

1. Introduction

Learning is the process whereby knowledge is created through the transformation of experience (Kolb, 1984). Adult learning theorists posit that adults tend to learn only what they have a desire to learn (Knowles, 1984). With respect to the asynchronous web-based learning performance, Bhowmick et al. (2007) found that user performance is dependent on the type of multimedia combination and the type of learning task in terms of complexity. Choi, Kim, and Kim (2007) presented an e-learning success model containing a flow construct and attitudes as its central features. They pointed out that the two mediating variables (flow experience and attitudes toward e-learning) have significant impact on learning outcomes in e-learning, and that the antecedent factors related to flow experience could be different from those related to attitudes. Although a great deal of research concerning the e-learning/on-line learning issues has been conducted during the recent decade, most studies focused on higher education students (e.g. Bhowmick et al., 2007; Rovai, 2003; Vuorela & Nummenmaa, 2004) or enterprise employees (e.g. Wang, 2003; Wang et al., 2007) who are competent in using computers. Web-based learning can be considered a way to bridge the digital gap among individuals, but it requires a certain degree of individual computer literacy. It is quite an interesting issue how a computer novice performs in such virtual and asynchronous learning environments. However, there was little research concerning computer novices' web-based learning behaviors in the literature.

Web-based learning can be regarded as a new learning-supported technology that provides unprecedented opportunities of conducting a virtual and asynchronous environment for learning and training purposes. Irani (2000) indicated that perceived usefulness is a significant predictor of users' intentions to adopt the technology. The technology acceptance model (TAM) developed by Davis (1989) is a widely-used method to explain user acceptance and usage behavior of a new technology. Saadé and Bahli (2005) used an extended version of the TAM to provide insight for improving the assessment of web-based learning systems and enhancing the underlying system itself. The TAM identifies the relationships between perceived ease of use, perceived usefulness, attitudes, and behavioral intentions toward a target system (Davis, Bagozzi, & Warshaw, 1989). Perceived usefulness is defined as the degree to which an individual believes that using a particular system could enhance his/her job performance, while perceived ease of use is described as the degree to which an individual believes that using the system is free of effort. It is well known from the social psychology literature that joblessness may affect physical and psychological health as well as learning behavior. However, research on unemployed adult novices' user acceptance and usage behavior of web-based learning is still in the infant stage. It should be explored in order to understand how user characteristics influence the potential efficiency of this novel learning mode in terms of the specific user population.

2. Research model and experimental hypotheses

Web-based learning has recently become a promising alternative to the traditional classroom, supporting our society to achieve the goals of lifelong learning and on-demand learning. According to the technology acceptance model (TAM), the antecedents to actual use of technology are to be sought in the attitudes toward technology which in turn is determined by perceived usefulness, perceived ease of use, and a set of external variables such as socio-structural, cognitive, and behavioral characteristics.

Based on the concept of the TAM, the author used a technology acceptance inquiry to assess the impact of web-based learning on unemployed adult novices. The purpose of the technology acceptance inquiry was to understand the perceived usefulness (PU) and perceived ease of use (PEU) involved with the asynchronous web-based learning technology. The experimental hypotheses are as follows:

H1a: Gender difference in web-based learning performance was not significant.

H1b: Age range difference in web-based learning performance was not significant.

H1c: Education difference in web-based learning performance was not significant.

H2a: The correlation of perceived usefulness between gender groups was not significant.

H2b: The correlation of perceived usefulness between age groups was not significant.

H2c: The correlation of perceived usefulness between education groups was not significant.

H2d: The correlation of perceived usefulness between learning performance groups was not significant.

H3a: The correlation of perceived ease of use between gender groups was not significant.

H3b: The correlation of perceived ease of use between age groups was not significant.

H3c: The correlation of perceived ease of use between education groups was not significant.

H3d: The correlation of perceived ease of use between learning performance groups was not significant.

3. Methodology

3.1. Subjects

A total of 183 subjects were selected from the trainees of a web-based computer-training program in which they participated in the experimental study voluntarily. The participants were qualified unemployed adults who involuntarily left their jobs. The demographic data of this experiment were classified as shown in Table 1.

3.2. Experimental design and materials

3.2.1. The elementary computer-training program and web-based learning system

In order to conduct this experimental research, an asynchronous learning course was provided for the subjects who learned elementary computer skills. There were three major

units contained in the web-based learning program: (1) fundamental computer operation (300 minutes), (2) word processing (180 minutes), and (3) Internet application (300 minutes). The asynchronous web-based learning system was constructed in an interactive multimedia environment including text, graphics, animation, audio, and video elements. It mainly consisted of three functions: (1) learning information, (2) starting animation, and (3) on-line instruction and case practice. The learning information briefly introduced the course subject, learning goals, and other basic knowledge concerning the presented course. The starting animation described the learning context with a short narrative animation. The on-line instruction function provided context description, content lecture, operational guidance, and case practice.

Table 1. Demographic data of the experiment

		Number	Percentage
Gender	Male	45	24.6%
	Female	138	75.4%
Age range	Under 44 years old	85	46.5%
	45-54 years old	74	40.4%
	Over 55 years old	24	13.1%
Educational level	Low education level (Junior high school or below the level)	31	16.9%
	Middle education level (Senior high school)	105	57.4%
	High education level (Junior college or above the level)	47	25.7 %

This asynchronous learning course was held at the Extension Education Center, Fortune Institute of Technology (FIT). The training classroom was equipped with 15 Pentium personal computers and a network system. Each computer contained a standard mouse and keyboard for input devices, and a set of headphones and a 17" LCD monitor for output devices. The training classroom was available in office hours from 10:00 a.m. to 9:00 p.m. When connecting to the web-based learning system, participants had to login to the Website through the FIT's network server by entering their own identification code (i.e. user name and password). The overall learning time and process were controlled and recorded by the system automatically.

3.2.2. On-line tests

The tests corresponding to the three main units were followed in the web-based learning system. After finishing each course unit, participants must be examined through the web-based testing system. Twenty items of closed-ended questions were given in each unit test, and each question contained five alternatives with one only correct answer. Each correct response scored 5 points with the full score being 100 points. Participants were required to respond to the questions within the time allotted. The passing mark was 60 points and the

testing time was restricted to 10 minutes for each unit test. All the three unit test results were concurrently scored and recorded by the system.

3.2.3. Technology acceptance inquiry of the web-based learning

User analysis requires researchers to identify the characteristics of user population that are likely to influence their acceptance and effective use of the system. The users' perceptions of web-based learning are considered by applying the technology acceptance model (TAM). TAM has been widely used to predict the acceptance of a new technology. It postulates that the two variables, perceived usefulness and perceived ease of use, have great relevance to a user's technology acceptance behavior. According to the concept of the TAM, the author developed a technology acceptance inquiry to analyze the unemployed adult novices' web-based learning characteristics. The inquiry consisted of two parts: perceived usefulness (PU) and perceived ease of use (PEU). Each part comprised five closed-ended questions, and each question contained three options with one only choice.

3.3. Procedure

The empirical study used a post-test design. Participants learned elementary computer skills in their own rates of progress through the asynchronous web-based learning system. An assistant was available in the classroom, whose major assignment was not to teach the courses but to assist participants in dealing with the hardware and software problems. Three on-line tests were given in order after they had finished the corresponding three course units. All test results were scored and recorded by the system, which were used for analyzing the subjects' web-based learning achievements in this study. Having completed the overall learning courses and the corresponding tests, a paper-version questionnaire was provided to the subjects. Each subject responded the questions according to his/her own learning experience and knowledge.

4. Results

4.1. Web-based learning achievements

The mean score of the overall responses was 71.05 (S.D.=7.05). According to the score ranges, we divided the subjects into three groups: high performance (scored more than 80), medium performance (scored between 70 and 79), and low performance (scored less than 69). The mean scores of the on-line tests were 83.02 (N=27, S.D.=3.55) for the high-performance group, 73.96 (N=69, S.D.=2.82) for the medium-performance group, and 65.02 (N=87, S.D.=2.55) for the low-performance group. Out of the 183 subjects, nearly half did not perform well in the on-line tests.

With respect to individual differences in learning achievements, the mean scores of the on-line tests were 70.18 (S.D.=6.97) for the male subjects and 71.33 (S.D.=7.08) for the female subjects. Females were better than males in terms of the mean score results. The mean scores of the on-line tests were 72.14 (S.D.=6.63) for the young adult subjects aged under 44,

70.13 (S.D.=7.55) for the middle-aged subjects aged between 45 and 54, and 70.00 (S.D.=6.59) for the elderly subjects aged over 55. There was little difference between middle-aged and elderly subjects. The young adult subjects had better learning achievements than the other two age groups in terms of the mean score results. Of the three different education groups, the mean scores of the on-line tests were 67.58 (S.D.=5.69) for the low-education subjects, 71.57 (S.D.=7.04) for the middle-education subjects, and 72.16 (S.D.=7.31) for the high-education subjects. It appears the computer novices that have higher education had better web-based learning achievements. The descriptive statistics also showed that the unemployed adult novices, especially the elderly novices and the low-education novices, had the worst web-based learning achievements in the word processing unit as compared with the other two course units.

The first null hypothesis was tested by using independent-t and one-way ANOVA tests. The results report that gender difference ($F=0.051$, $P=0.822>0.05$, confirming the null hypothesis *H1a*) and age range difference ($F=1.919$, $P=0.15>0.05$, confirming the null hypothesis *H1b*) in web-based learning performance were not significant, whereas education difference in web-based learning performance was significant ($F=4.821$, $P=0.009<0.05$, rejecting the null hypothesis *H1c*). A Tukey post hoc comparison confirmed significant difference among the three education groups. The test results also indicated that education difference in word processing (Unit 2) and Internet application (Unit 3) was significant in terms of the subjects' web-based learning achievements.

4.2. Technology acceptance inquiry of the web-based learning

The statistics of the technology acceptance inquiry results were classified according to subjects' individual differences in gender, age range, education, and learning performance. As shown in Table 2, the percentages of responses within each question demonstrate the correlative intensities of the accessible conditions toward web-based learning. The greater the percentage of response the closer the accessible condition was perceived to the subject group's preference. We used the correlative intensities to identify certain web-based learning characteristics among the different classified groups. If the correlation of the subjects' preferences is significant, then the group effect on the perceived situation is regarded as insignificant. There is a group impact on the perceived situation if the correlation of the subjects' preferences is not significant.

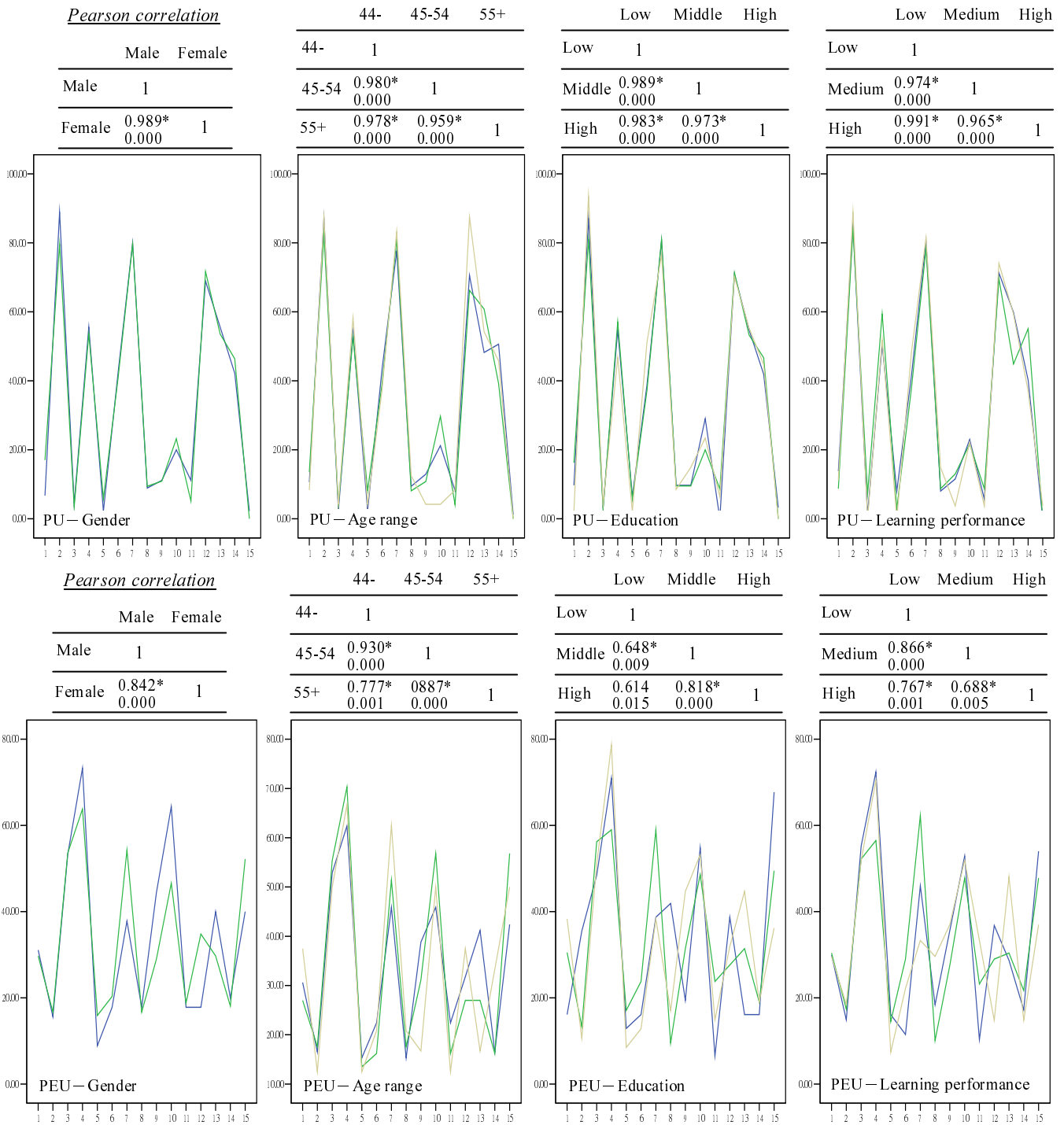
The Cronbach's alpha coefficient for internal consistency reliability was assessed. The alpha coefficients were 0.998 for the perceived usefulness, and 0.981 for the perceived ease of use. The high alpha reliability gives a support for the questionnaire content reliability. As shown in Figure 1, the line charts of the percentage distributions illustrate the perceptive correlations between subject groups' accessible conditions toward web-based learning. The correlation of perceived usefulness was more similar than that of perceived ease of use. It means that the acceptable condition in perceived usefulness was more consistent than that in

perceived ease of use in terms of the unemployed adult novices' web-based learning behavior.

Table 2. Responses to the technology acceptance inquiry of web-based learning

	Option	PU-1	PU-2	PU-3	PU-4	PU-5	PEU-1	PEU-2	PEU-3	PEU-4	PEU-5
Whole	a	21(11.5%)	99(54.1%)	146(79.8%)	41(22.4%)	99(54.1%)	55(30.1%)	121(66.1%)	92(50.3%)	93(50.8%)	59(32.2%)
	b	156(85.2%)	9(4.9%)	17(9.3%)	12(6.6%)	83(45.4%)	30(16.4%)	26(14.2%)	31(16.9%)	34(18.6%)	34(18.6%)
	c	6(3.3%)	75(41.0%)	20(10.9%)	130(71.0%)	1(0.5%)	98(53.6%)	36(19.7%)	60(32.8%)	56(30.6%)	90(49.2%)
Male	a	3(6.7%)	25(55.6%)	36(80.0%)	9(20.0%)	25(55.6%)	14(31.1%)	33(73.3%)	17(37.8%)	29(64.4%)	18(40.0%)
	b	40(88.9%)	1(2.2%)	4(8.9%)	5(11.1%)	19(42.2%)	7(15.6%)	4(8.9%)	8(17.8%)	8(17.8%)	9(20.0%)
	c	2(4.4%)	19(42.2%)	5(11.1%)	31(68.9%)	1(2.2%)	24(53.3%)	8(17.8%)	20(44.4%)	8(17.8%)	18(40.0%)
Female	a	18(17.0%)	74(53.6%)	110(79.7%)	32(23.2%)	74(53.6%)	41(29.7%)	88(63.8%)	75(54.3%)	64(46.6%)	41(29.7%)
	b	116(79.6%)	8(5.8%)	13(9.4%)	7(5.1%)	64(46.4%)	23(16.7%)	22(15.9%)	23(16.7%)	26(18.8%)	25(18.1%)
	c	4(3.4%)	56(40.6%)	15(10.9%)	99(71.7%)	0(0%)	74(53.6%)	28(20.3%)	40(29.0%)	48(34.8%)	72(52.2%)
Under 44 years old	a	9(10.6%)	46(54.1%)	66(77.6%)	18(21.2%)	41(48.2%)	26(30.6%)	53(62.4%)	39(45.9%)	39(45.9%)	35(41.2%)
	b	74(87.1%)	2(2.4%)	8(9.4%)	7(8.2%)	43(50.6%)	14(16.5%)	13(15.3%)	13(15.3%)	19(22.4%)	14(16.5%)
	c	2(2.4%)	37(43.5%)	11(12.9%)	60(70.6%)	1(1.2%)	45(52.9%)	19(22.4%)	33(38.8%)	27(31.8%)	36(42.4%)
45-54 years old	a	10(13.5%)	39(52.7%)	60(81.1%)	22(29.7%)	45(60.8%)	20(27.0%)	52(70.3%)	38(51.4%)	42(56.8%)	20(27.0%)
	b	61(82.4%)	6(8.1%)	6(8.1%)	3(4.1%)	29(39.2%)	13(17.6%)	10(13.5%)	13(17.6%)	12(16.2%)	12(16.2%)
	c	3(4.1%)	29(39.2%)	8(10.8%)	49(66.2%)	0(0%)	41(55.4%)	12(16.2%)	23(31.1%)	20(27.0%)	42(56.8%)
Over 55 years old	a	2(8.3%)	14(58.3%)	20(83.3%)	1(4.2%)	13(54.2%)	9(37.5%)	16(66.7%)	15(62.5%)	12(50.0%)	4(16.7%)
	b	21(87.5%)	1(4.2%)	3(12.5%)	2(8.3%)	11(45.8%)	3(12.5%)	3(12.5%)	5(20.8%)	3(12.5%)	8(33.3%)
	c	1(4.2%)	9(37.5%)	1(4.2%)	21(87.5%)	0(0%)	12(50.0%)	5(20.8%)	4(16.7%)	9(37.5%)	12(50.0%)
Low education	a	3(9.7%)	17(54.8%)	25(80.6%)	9(29.0%)	17(54.8%)	5(16.1%)	22(71.0%)	12(38.7%)	17(54.8%)	5(16.1%)
	b	27(87.1%)	2(6.5%)	3(9.7%)	0(0%)	13(41.9%)	11(35.5%)	4(12.9%)	13(41.9%)	2(6.5%)	5(16.1%)
	c	1(3.2%)	12(38.7%)	3(9.7%)	22(71.0%)	1(3.2%)	15(48.4%)	5(16.1%)	6(19.4%)	12(38.7%)	21(67.7%)
Middle education	a	17(16.2%)	60(57.1%)	85(81.0%)	21(20.0%)	56(53.3%)	32(30.5%)	62(59.0%)	62(59.0%)	51(48.6%)	33(31.4%)
	b	85(81.0%)	6(5.7%)	10(9.5%)	9(8.6%)	49(46.7%)	14(13.3%)	18(17.1%)	10(9.5%)	25(23.8%)	20(19.0%)
	c	3(2.9%)	39(37.1%)	10(9.5%)	75(71.4%)	0(0%)	59(56.2%)	25(23.8%)	33(31.4%)	29(27.6%)	52(49.5%)
High education	a	1(2.1%)	22(46.8%)	36(76.6%)	11(23.4%)	26(55.3%)	18(38.3%)	37(78.7%)	18(38.3%)	25(53.2%)	21(44.7%)
	b	44(93.6%)	1(2.1%)	4(8.5%)	3(6.4%)	21(44.7%)	5(10.6%)	4(8.5%)	8(17.0%)	7(14.9%)	9(19.1%)
	c	2(4.3%)	24(51.1%)	7(14.9%)	33(70.2%)	0(0%)	24(51.1%)	6(12.8%)	21(44.7%)	15(31.9%)	17(36.2%)
Less than 69 points	a	12(13.8%)	44(50.6%)	70(80.5%)	20(23.0%)	52(59.8%)	26(29.9%)	63(72.4%)	40(46.0%)	46(52.9%)	25(28.7%)
	b	74(85.1%)	7(8.0%)	7(8.0%)	5(5.7%)	35(40.2%)	13(14.9%)	14(16.1%)	16(18.4%)	9(10.3%)	15(17.2%)
	c	1(1.1%)	36(41.4%)	10(11.5%)	62(71.3%)	0(0%)	48(55.2%)	10(11.5%)	31(35.6%)	32(36.8%)	47(54.0%)
70-79 points	a	6(8.7%)	41(59.4%)	54(78.3%)	15(21.7%)	31(44.9%)	21(30.4%)	39(56.5%)	43(62.3%)	33(47.8%)	21(30.4%)
	b	58(84.1%)	2(2.9%)	6(8.7%)	6(8.7%)	38(55.1%)	12(17.4%)	10(14.5%)	7(10.1%)	16(23.2%)	15(21.7%)
	c	5(7.2%)	26(37.7%)	9(13.0%)	48(69.6%)	0(0%)	36(52.2%)	20(29.0%)	19(27.5%)	20(29.0%)	33(47.8%)
More than 80 points	a	3(11.1%)	14(51.9%)	22(81.5%)	6(22.2%)	16(59.3%)	8(29.6%)	19(70.4%)	9(33.3%)	14(51.9%)	13(48.1%)
	b	24(88.9%)	0(0%)	4(14.8%)	1(3.7%)	10(37.0%)	5(18.5%)	2(7.4%)	8(29.6%)	9(33.3%)	4(14.8%)
	c	0(0%)	13(48.1%)	1(3.7%)	20(74.1%)	1(3.7%)	14(51.9%)	6(22.2%)	10(37.0%)	4(14.8%)	10(37.0%)

Taking advantage of the percentages of responses as variables to perform the correlation analysis, we found that the correlation of perceived usefulness between gender, age, education, and learning performance groups was significant at the 0.01 level ($P < 0.01$, rejecting the null hypotheses $H2a—H2d$) according to the Pearson correlation analysis results. With respect to the perceived ease of use, the correlation between gender, age, and learning performance groups was significant ($P < 0.01$, rejecting the null hypotheses $H3a$, $H3b$, and $H3d$), while that between low-education and high-education groups was not significant at the 0.01 level ($P = 0.015 > 0.01$, confirming the null hypothesis). The results indicate that gender, age range, and learning performance effects on both perceived usefulness and perceived ease of use were insignificant. Education effect on perceived usefulness was insignificant; however, there was a group impact on perceived ease of use, particularly in terms of the low-education and high-education subjects.



*.Correlation is significant at the 0.01 level (2-tailed)

Figure 1. Perceptive correlations between subject groups' accessible conditions toward web-based learning

5. Discussions

According to the experimental results, nearly half of the trainees did not perform well in the on-line tests. The unemployed adult novices seem to be incompetent at web-based learning. In the perceived usefulness inquiry, 85.2% of the respondents initially considered the web-based learning as an applied tool that people have to possess the skills; 54.1% of the respondents expressed that the web-based learning is a tendency toward present day society. Although 79.8% of the respondents perceived that web-based learning is advantageous since it is flexible and allows learners to progress at their own speed and time, 71% of the respondents required more user-friendly interfaces and learning guidelines of the web-based learning system. 54.1% of the respondents expressed that they got a measure of achievement and developed a high interest in learning computer skills, while 45.4% of the respondents considered that they got a limited achievement but did not refuse learning more computer skills after they had completed the asynchronous web-based learning program.

With respect to the perceived ease of use, 66.1% of the respondents considered the web-based learning as a good way for learning, and 53.6% of the respondents immediately had a shot at using the system without any hesitation when using the web-based learning system for the first time. However, 50.8% of the respondents indicated that it is difficult to familiarize themselves with the usage of the operating interfaces. 50.3% of the respondents perceived web-based learning to be disadvantageous due to the lack of timely help by a teacher, and 49.2% of the respondents would like to request experienced help when an error message appears on the system. As a whole, the use of web-based learning technology seems to be ineffective to unemployed adult novices even though most of them believe that the learning mode is useful for enhancing their job performance.

5.1. Gender difference

Gender difference in web-based learning performance was not significant in terms of the unemployed adult novices. Gender effect on both perceived usefulness and perceived ease of use was insignificant. 44.4% of the male respondents expressed that the uniform learning mode cannot meet their individual requirements, whereas 54.3% of the female respondents perceived web-based learning to be disadvantageous due to the lack of timely help by a teacher. When an error message appears on the system, 40% of the male respondents would like to read the content of the message as well as to try to solve the problem by themselves, whereas 52.2% of the female respondents would like to request experienced help.

5.2 Age range difference

According to the test results, the elderly novices aged over 55 had the worst web-based learning achievements, particularly in the word processing unit. However, there was no significant difference in web-based learning performance among the three age groups. In the technology acceptance inquiry of web-based learning, age group effect on both perceived usefulness and perceived ease of use was insignificant. When using the asynchronous

web-based learning system for the first time, 37.5% of the elderly respondents felt amazing, yet 52.9% of the young adult respondents and 55.4% of the middle-aged respondents immediately had a shot at using the system without any hesitation. When an error message appears on the system, 41.2% of the young adult respondents would like to read the content of the message as well as to try to solve the problem by themselves; 56.8% of the middle-aged respondents would like to request experienced help; 33.3% of the elderly respondents would like to reboot the system.

5.3 Education difference

Education difference in web-based learning performance was significant, with the higher the educational level the higher the web-based learning achievement. It is worthy to remark that education difference in word processing and Internet application was significant in terms of the subjects' web-based learning achievements. Education effect on perceived usefulness was insignificant; however, there was a group impact on perceived ease of use in terms of the low-education and high-education subjects. 54.8% of the low-education respondents and 57.1% of the middle-education respondents considered the web-based learning a tendency toward present day society, while 51.1% of the high-education respondents thought it an ideal solution to the digital divide problems. 59% of the middle-education respondents considered web-based learning to be disadvantageous due to the lack of timely help by a teacher; 41.9% of the low-education respondents indicated that the web-based learning system is too complicated for them to understand; 44.7% of the high-education respondents thought the uniform learning mode cannot meet their individual requirements. When appearing an error message, 67.7% of the low-education respondents would like to request experienced help, yet 44.7% of the high-education respondents would like to read the content of the message carefully as well as to try to solve the problem by themselves.

5.4 Learning performance difference

Learning performance effect on both perceived usefulness and perceived ease of use was insignificant. 59.8% of the low-performance and 59.3% of the high-performance respondents expressed that they got a measure of achievement and developed a high interest in learning computer skills; 55.1% of the medium-performance respondents considered that they got a limited achievement but did not refuse learning more computer skills after they had completed the asynchronous web-based learning program. 72.4% of the low-performance and 70.4% of the high-performance respondents considered web-based learning as a good way for learning, yet 29% of the medium-performance respondents worried that the web-based learning process and outcome were difficult to be controlled. 37% of the high-performance and 35.6% of the low-performance respondents expressed that web-based learning cannot meet their individual requirements due to its uniform learning mode, while 62.3% of the medium-performance respondents feared that they could not solve the problems timely with the help of a teacher when using the asynchronous web-based learning system.

6. Concluding remarks

Web-based learning is a novel technology that provides people with unprecedented opportunities to learn anytime and anywhere in their own environment using information and communication technology (ICT). It can be regarded as a way to bridge the digital gap among individuals. Understanding what user characteristics computer novices are likely to influence their acceptance and effective use of such virtual and asynchronous learning-supported technology is an interesting issue. This study focuses on a specific user population to assess the impact of asynchronous web-based learning on unemployed adult novices.

In the experimental findings, gender difference and age range difference in web-based learning performance were not significant. Gender, age range, and learning performance effects on both perceived usefulness and perceived ease of use were insignificant in terms of the technology acceptance of web-based learning. Education is a critical factor influencing unemployed adult novices' web-based learning behaviors. It was significantly and positively related to web-based learning performance. Education had a group impact on perceived ease of use in terms of the low-education and high-education subjects' web-based learning. As a whole, the majority of unemployed adult novices believe that web-based learning is useful for enhancing their job performance; nevertheless, the use of asynchronous web-based learning technology seems not to be effective to them.

The findings of this study must be considered in light of its limitations. First, the study's results were obtained within the context of a short-term computer-training program and would need further validation across other web-based learning systems. In addition, the subjects were restricted to unemployed adult novices who have had no computer experience before participating in the elementary computer-training program. The possible influence of the inexperienced learners' self-efficacy on web-based learning might be a limitation. Secondly, the technology acceptance inquiry results were used to analyze users' accessible conditions toward web-based learning. Since these accessible conditions were limited to the question statements, it did not reflect a comprehensive explanation apart from these statements in terms of the respondents' web-based learning characteristics.

According to the experimental findings, education has a great impact on unemployed adult novices' web-based learning behaviors. This study suggests that a novice's educational level should be taken into account when developing an asynchronous web-based learning system. Further research should focus on how to improve the potential efficiency of web-based learning technology to the specific user population. Further research should focus on how to improve the potential efficiency of asynchronous web-based learning technology to the specific user population.

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產品造形設計是一項創意過程，牽涉複雜的視覺感知。對設計師而言，發展一套決策支援系統，以協助處理有關顧客對產品造形之心理喜好評測是一項重要的議題。由於完形心理學與極簡設計原理提供一項重要的視覺感知觀點，非常適合運用此原理以評估產品造形設計品質。

雖然完形視覺感知與極簡主義是產品設計的兩項重要觀點，可用於協助評估產品造形設計，但文獻上有關完形理論與極簡設計之整合應用研究，卻極度缺乏。本研究主要貢獻在於將完形視覺感知理論結合極簡設計原理，提出一套“完形—極簡決策評估模式”，本決策評估模式可用於協助設計師進行產品造形設計評估，處理複雜的造形視覺感知等決策評估問題。

本計畫研究成果已完成論文"A Gestalt-Minimalism-based decision-making model for evaluating product form design"投稿於 International Journal of Industrial Ergonomics, 目前正接受審查中。

