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理事長序

2014 年 12 月 16 日由環球科技大學文創學院、多媒體動畫設計系承辦的「第八屆台灣數位媒體設計學會國際研討會」於該校隆重展開。本次大會議題主軸為「文化創意產業運用視覺傳播於行銷推廣之研究與應用」，共同研討文化創意產業領域中最新的創見與成果應用。大會活動提供產業實務分享、最新國際動向專題演講、產學面對面交流討論平台，以及 15 篇學術論文宣讀。與會貴賓涵蓋國內著名文創產業經營者、加拿大與日本專家蒞臨，並有國內各數位媒體設計相關科系學者共襄盛舉，除了促進本次研討會國際學術交流外，亦指引文創產業最新發展與未來展望，足見承辦單位用心與文創能量之展現。

自 2014 年 IJDMD 國際數位媒體設計學刊改為一年發行兩期，本期為今年發行之第六卷第二期期刊，共收錄兩篇英文論文及四篇中文論文。探討內容包括有(1)英文論文「New Thoughts on Cultural Creative Product Design: A Case Study on the Transformation of Architectural Elements of a Taiwanese Temple」，該研究係以台灣龍山寺為研究標的，從建築元素的轉換探討其台灣文化的本質與新思維；(2)英文論文「Design Education Research on Creative-Oriented and Skill-Based Teachings - A Case Study of Computer Graphics Course」，針對電腦繪圖課程教學中如何融入創意與技術，以實驗教學法發現創意導向與技能本位的教學活動，並比較兩者間的優勢與劣勢，及其差異性；(3)中文論文「理感性語意應用對影音學習之成效」，對生態影音影片透過理性與感性的附加語意，以實驗研究法分組測試學生學習理性與感性及認知學習成效；(4)中文論文「3D 動畫師心智地圖描繪與核心技能推導」，利用描繪業界 3D 動畫師的外顯知識呈現-心智地圖，以質化訪談、編碼與發展範疇歸納專業動畫師的核心能力；(5) 中文論文「數位雲端資料庫 BIG DATA 提升傳統產業之創新應用－以鞋類設計開發業為例」，以近年熱門的雲端科技結合巨量資料庫，讓企業搶先求得優勢發展的契機，並透過數位化方式，將珍貴的技術有效保留，實際應用於鞋類設計之開發；(6) 中文論文「動畫中的陰影及其特性對深度知覺之影響」，討論動畫中的陰影特性對受測者在深度知覺判斷上的影響加以分析，以實驗法量測陰影邊緣模糊、光源調整對動畫場景的渲染影響觀眾知覺判斷。

感謝各方學術先進賜稿，擴展本刊研究範疇，以及協助審查的委員們給予學術專業協助，深化本刊學術深度及內容專業，讓 IJDMD 國際數位媒體設計學刊一路走來，不斷地向上提升。

理事長 王年燦

Foreword by Chair

On December 16th 2014, the Department of Multimedia and Animation from TransWorld University's College of Design proudly presented "The 8th Taiwan Digital Media Design Association International Conference". This session's topic will be focused on "The Application and Research of Using Visual Communication for Marketing in the Creative Cultures Industry". Many of the newest innovations and achievements in the creative cultures industry will be discussed. The conference will play host to the sharing of real industry matters, speeches on the newest international trends, industry-university face-to-face discussion platforms, and 15 readings of academic theses. Participating guests include famous domestic industry managers as well as experts from Canada and Japan. Also several domestic scholars from digital media design related departments will also be visiting. Aside from motivating the international academic exchange of this conference, this also will guide the creative cultures industry to the newest developments and expectations. One can very clearly see just how much devotion and cultural energy is being shown from the event organizers.

Starting 2014, the IJDMD International Journal of Digital Media Design will be changed to publish two issues in a year. The current issue is the second issue of sixth volume journal published this year. It compiles two English papers and four Chinese papers. The content in question includes: (1) "New Thoughts on Cultural Creative Product Design: A Case Study on the Transformation of Architectural Elements of a Taiwanese Temple". This study uses the Taiwan Lung-Shan Temple as a study subject to discuss Taiwan's culture and new ways of thinking through the structure's aspects; (2) "Design Education Research on Creative-Oriented and Skill-Based Teachings - A Case Study of Computer Graphics Course". This study focuses on how to integrate creativity and skills into computer graphics courses. Experimental teaching is used to discover creative-oriented and skill-based educational activities. Pros and cons between the two are compared; (3) "The effect on rationality and emotion with additional semantic to video learning". This study uses environmental videos along with rationality and emotion with additional semantics. Through experimental group research students are tested in their effectiveness in rational, emotional, and cognitive learning; (4) "Depiction for 3D Animators' Mental Models and the Core Capabilities Derivation". This study draws out the mental model of a professional 3D animator's external knowledge. Through qualitative interviews, coding and development categorization, the core skills of a professional animator are inducted; (5) "Innovation Application of Cloud Big Data of Traditional Industry Improvement– A case study of the design and

development of shoe industry". In recent years combining cloud technology and large databases is getting more and more popular. This allows companies to get the first advantage in their development. Additionally valuable skills can be preserved efficiently through digital means. This is employed in practice in shoe design development; (6) "The Influence of Shadow and Characteristics in Animation on Perceived Depth" This study discusses, and analyzes the influence of shadow characteristics in animation on perceived depth on test subjects. Through experimental means the influence of a shadow's penumbra, and light adjustments on an animation scene's conscious effect on a viewer are measured.

Thank you to all the academics who have submitted drafts in advance which has expanded the research range of this journal, and assisted examination committee members in giving academic professional assistance which increases the academic depth of this journal and its content's professionalism. This has allowed the IJDMD International Journal of Digital Media Design to continuously rise to greater heights.

Nien-Tsan Wang
2014.12.15

New Thoughts on Cultural Creative Product Design: A Case Study on the Transformation of Architectural Elements of a Taiwanese Temple

Chia-Wei Kuo[1], Fu-Yuan Li[2]
1 PhD Candidate, The Graduate Institute of Design Science, Tatung University, Taiwan, wnkuo@hotmail.com
2 Associate Professor, Department of Industrial Design, Tatung University, Taiwan, fuyuan62@hotmail.com

ABSRTACT

The recent trend of economics in Asia has seen a transition from high tech industries to the emphasis on the diversity of cultural creative industry. No latter than Korea, Japan, Hong Kong, Thailand, and Singapore, Taiwan has also raised the priority degree of strategic development of cultural and creative sector, so as to improve national competiveness via the integration of creativity, local culture and comprehensive marketing strategies.

Nevertheless, despite the abundance of approaches toward cultural creative design, most designs were based on brief transformation of form. No cultural creative designs were accomplished via expert analysis and systematic construction of ideology, leaving an integral design model with flexibility unfortunately unavailable. To address this issue, an Integrated Design Scheme is proposed as a design approach based on metaphysical analysis with the aid of formal transformation and user feedback. This research targeted at Taipei Lungshan Temple by conducting detailed analysis on its architectural elements to investigate the essence of Taiwanese culture. Experts were invited to construct a set of practical design criteria, so as to define the application of metaphysical analysis and the approaches to incorporate multiple cultural concepts.

To access the feasibility of this approach, we joined in hand with Lungshan Temple Foundation in the development of a public bench for use inside the Lungshan Temple, and the design accomplished was named the Sea-of-Cloud Bench. The work now serves in Lungshan Temple and is greatly appreciated by both local Taiwanese and international tourists. In reflection to the tolerant and harmonious world view of Chinese Confucianism, they also manifested the delicacy of dougong carving in the temple and the aesthetics of Chinese architecture. It is expected that the combination of metaphysical study and cultural element transformation proposed in this research would shed new insights upon cultural creative design.

Keywords: cultural creative design, metaphysics, integrated design scheme of cultural concepts

1. Introduction

1.1 Research Background

As Taiwan's technology and information industries have stepped into a rather stable and mature stage, the focus of economy development has gradually shifted towards cultural and creative industries. In light of this, the Small and Medium Enterprise Administration of the Ministry of Economic Affairs embarked on the One Town One Product (OTOP) campaign. Taiwan OTOP is the guide string for the promotion and development of local cultural industries. Products with unique, historic and cultural values are promoted towards the world under professional marketing scheme, so as to open new horizons for the future of Taiwan's economy.

Thanks to the integration framework of marketing strategies and culture creativity, distinctive local products now flourish in many areas of Taiwan. The ceramic craftwork in Yingge, wooden sculptures in Sanyi, and the Bopilao Historic Block in Mengjia are all success stories to support the OTOP campaign. The challenge to come, however, is to make sure that the same model works for all the 22 cities and townships of Taiwan. It is a consensus among local designers to nourish Taiwan's local economy and extend Taiwan's market share in global terms with the aide of government subsidiaries.

All cities in Taiwan feature diversity and characteristics. Taipei as the capital is considered the centre of cultural and economic developments. Mengjia Lungshan Temple, the emblem of Taiwanese architecture, is therefore

selected in this research for cultural exploration and design application. Wanhua District, where Mengjia Lungshan Temple is located, was once the commercial, political, cultural and educational hub of northern Taiwan. Nourished by Wanhua's richness in cultural heritage and geographical distinctiveness, Lungshan Temple is a symbolic witness of Taipei's change and growth in history.

With concerns about the potential decline of Taiwan's traditional craftsmanship and spiritual essences, we attempted to explore the historical and architectural elements of Mengjia Lungshan Temple, as well as to extract design elements that can be applied to practical product design.

1.2 Research Objectives

A general definition of cultural creative products covers the transformation and conservation of existing cultural elements into modern commodities with higher value. In the mean time, the original remains and renews against the tide of time.

In order to propose a practical model for the design of cultural creative products, we accessed the essence and contents of cultural characteristics of Mengjia Lungshan Temple via in-site field survey, literature review, and expert interviews. A set of design criteria was applied in the development of a practical product, so as to access the feasibility of this study. It is expected that this research should meet the following objectives:

(1) Propose an integrated design scheme of cultural concepts with expert design criteria from the extraction and transformation of Lungshan Temple's architectural elements.

(2) Combine traditional craftsmanship and modern product design in the development of Lungshan Temple's public chair, as well as a reminder of the merit of humanism and cultural heritage.

2. Design criteria based on expert opinions

2.1 Pre-design questionnaire survey

Two groups of interviewees were invited in our open-ended questionnaire survey. The first group was composed of 40 male and 40 female local residents of Taipei city with an average age of 35; the other group has 40 male and 40 female participants who resided outside the realm Taipei city with an average age of 38. The questionnaire survey revealed the following:

(1) It is a consensus among the participants that Mengjia Lungshan Temple explicitly embodies the spirit of Southern Fujian architecture with elaborated ornamentation and curve variation of the roof ridge.

(2) The fusion of both native and Japanese cultures creates a blend of cultures that also affected local architecture.

(3) As the heart of Taipei's cultural and economic development all the way through the Qing Dynasty and the Japanese Occupation, Mengjia Lungshan Temple boasts in its profound historical meanings. The deity worshipped in this temple is Guanyin and the number of worshippers makes it an important tourist attraction. Designated as a Grade 2 Historic Monument in Taiwan, this temple has gone through 4 major renovations and reconstructions. With invaluable artistic significance, Lungshan Temple is indeed the most symbolic temple in Taipei City.

2.2 Establishment of design criteria

Professionals from various sectors were consulted to review the results of the field survey and expert interview, so as to establish practical design standards. Four experts, including a architect: Prof. Chian-Lang Lee, who specializes in the architecture of Lungshan Temple, Taiwanese artist: Zhi-Cheng Xie, product designer: Jun-Hao Chen , and Chun-Liang Chen, a master of oriental aesthetic design gathered for three discussions. They examined the cultural elements of Mengjia Lungshan Temple and concluded with a set of design criteria for product design:

(1) Emphasis on the local features of Lungshan Temple architecture (Spiritual – application of abstract concepts): Lungshan Temple is symbolic in the subtleness and aesthetics of traditional Fujianese architecture, further enhanced by poems, couplets and building materials offered by local aristocrats, merchants and commercial firms since the Qing Dynasty. It is estimated that the characteristics drawn from these artistic and architectural elements can be applied to magnify the distinctiveness of our design.

(2) Honoring the humane spirit of Confucianism (Spiritual – application of abstract concepts): Humanistic thinking in Confucianism is the core of Taiwanese tradition and doctrine, suggesting that the progress of harmony should begin with

establishing orders and achieving peace for individual mind, then for the nation, and finally for the universe. Humanism not only defines personal conducts but also reflects in the tolerance toward foreign subjects. Hence, the exploration of Lungshan Temple's humane spirit should resort to the Doctrine of the Mean in Confucianism, which can be extended as the philosophy of integration, universal kindness and humanity.

(3) **Flexibility in the application of architectural elements (Institutional – transformation of system):** Unlike general approaches, it is suggested in the expert interview that the exploration of the architectural elements of Mengjia Lungshan Temple should focus first on details (patterns and carvings) before extending to the structural and spatial arrangement. Despite of minor diversities in Taiwan's temple architectures, commonness and similarities prevail. To stress the idiosyncrasy of Lungshan Temple, the emphasis should be put on dougong (the corbel wood brackets), a structural element between the interior of the roof and the columns. The correspondence between the structural arrangement and the paintings, colors and structure of dougong may shed new light upon the design targeted at Lungshan Temple.

(4) **Limitations on the application of abstraction (Instrumental – transformation of physical objects):** First and second degree abstraction, rather than third degree abstraction, should be more feasible in the transformation of architectural elements in that the originality of the target object can be better preserved. Meanwhile, the designed product can better serve as a reminder of the memories and impressions of Lungshan Temple's cultural spirits.

(5) **Combination of fashion, craftsmanship and aesthetics (Instrumental – transformation of physical objects):** To connect with international market, cultural creative design in Taiwan should incorporate global trend and local craftsmanship and materials. This approach will also enhance the product in terms of both cultural value and competiveness, as well as the sustainability of local industries. It is expected that interdisciplinary collaboration and the use of diverse mediums may bring new life to traditional culture and shorten its distance from life experiences of nowadays.

3. Application of Metaphysical Analysis

Although we have established a set of rigorous design criteria in the expert interview, the practical design process deals with sophisticated concepts through the expression of creativity and form, hence it involves the plural, humane, and spiritual aspect. To further clarify the evolvement of our design model, metaphysics oriented design model is applied to guide and construct the designer's emotional and spiritual response to a cultural object.

Figure 1 illustrates the application of metaphysical analysis in product design. In general, cultural product design usually defines the spiritual and substantial existences of cultural elements from the three perspectives of metaphysics. In summary, cultural elements can be considered from the three dimensions of instrumental, institutional and spiritual dimensions, as shown in the following figure.

In the instrumental level, all the tangible objects derived in the collective life experience of an ethnic group can be considered in the practical design. The transformation of an instrumental object or element may remind the viewer of memories about the past and historical values. With reference to Dr. F. Y. Li's study (2006) on cultural abstraction of the Chinese people, this research employs the innovative quantitative analysis and assessment to validate the feasibility of third degree abstraction.

By definition, first degree abstraction conserves 80%~90% similarity to the target object referred in the design process; second degree abstraction retains 65%~75% of the formal elements of the object; and the third degree abstraction contains only 30%~40% similarities of the original object. These three abstraction approaches can be employed when appropriate in the transformation of cultural creative design.

The institutional level touches upon the universal design, regional design, and cultural-distinctive characteristics derived from the regulations and agreements formed under collective behavior codes of human society.

The spiritual level covers the spiritual and abstract aspects. While the instrumental domain touches upon touchable objects and the institutional domain focuses on behavioral requirements, the spiritual level emphasizes

more on personal feelings and sensations. The expression of a spiritual element is very often intuitional and may be reflected in designer's response to the touch, color, structure, and spatial arrangement of a certain cultural object of the instrumental level.

The trinity of the three levels of the metaphysical approach is fundamental in that spiritual, physical, and behavioral elements coexist in an inseparable and indispensible wholeness. The metaphysical design approach encompasses formal outlook (appearance of the mind), collective thoughts (utilization of the mind), and individual feelings (embodiment of the mind). The proprioception of the designer can be connected with tangible object and the universality of the institutional system, so as to grasp a comprehensive understanding of the abstract wholeness. The incorporation of metaphysical analysis in the process of cultural creative design can map appropriately the formal elements of an object with authentic historical meanings, as well as empower the designer with sensibility to cultural essences.

4. Literature Review

process of creative thinking and proposed that "*Thinking is an object-oriented psychological activity that achieves the converting of creativity and problem-solving by means of observation, memorization, doubting, imagination, questioning, and evaluation* (Chen, 2008)." This is an intensive cognition processes. Cheng (2004) suggested that the exposure to external events and objects contributes to the accumulation of experiences in the designer's memory; in time the designer may present a product that features elements that are identical to the original and recognizable for the viewer (Cheng, 2004). Therefore, it can be assumed that that transformation of cultural creative design is a process in which the designer who works with memory and sensational experiences to translate the design elements and communicate with the ultimate user.

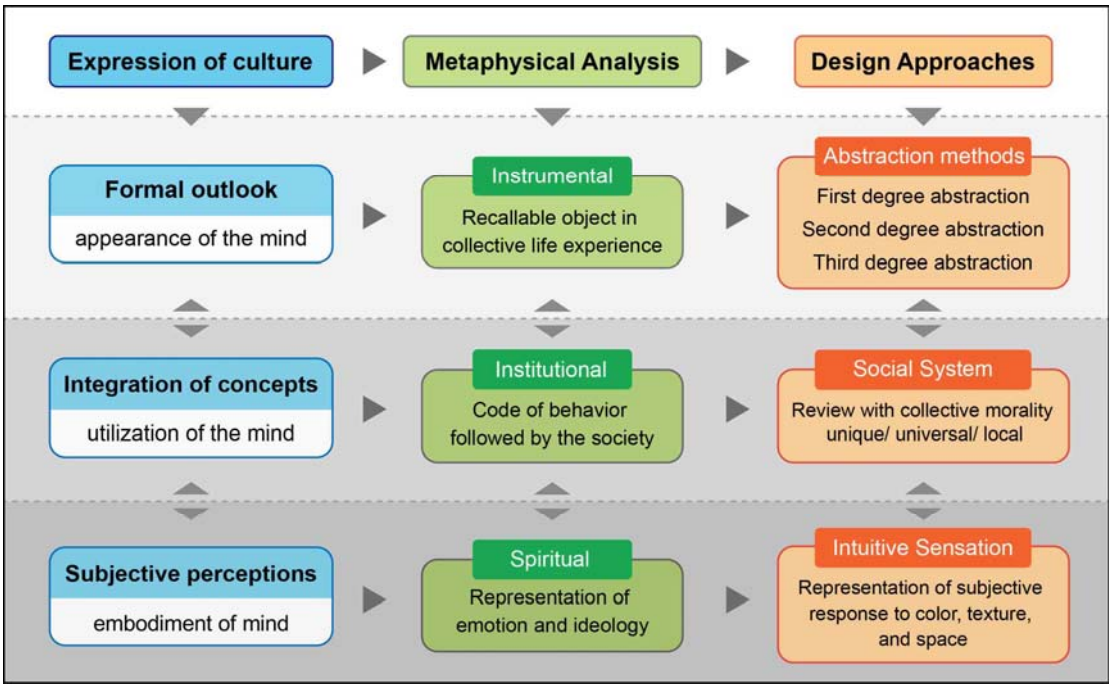

Figure 1. Metaphysics in the design process

4.1 Reviews of Theories and Practice of Transformation in Cultural Creative Design

Generally speaking, cultural creative design involves more than often the designer's intuition and instinctive response to a cultural object to exercise the transformation and application of forms. We have noticed in the cultural creative design practice of this study that the success of a creative expression depends on the ability to handle the plural nature of the transformation and to integrate a multitude of concepts. If the designer can fully access the feasibility and transformation approaches of an element, both the flexibility and comprehensiveness of expression can be better ensured.

Chen (2008) pondered upon the transformation

In addition to the transformation of form,

however, other researchers further proposed practical approaches to access the spiritual essences of the design object. Leong (2003) illustrated the three levels of culture object; the internal level covers unique background story and cultural empathy, the middle level features operational, structural, and functional traits, and the external level emphasizes color, form, and texture. Also, Dr. Yang proposed a three-layer structure of culture with spiritual, institutional, and instrumental dimensions (Yang, 1998).

Lin (2005) proposed a model of product design with cultural transformation. The development of cultural product should not only cover all the three dimensions of cultural elements but also address to issues related to tangible features like color, form, and details. Furthermore, operation and functionality design should also resort to the user's ideology in terms of cultural characteristics and values.

In light of the above, we can conclude that the three dimensions of cultural element serve as an internal guideline on the metaphysical construct that correspond with the aesthetic value of the object and the sum of collective user experience. This approach enhances the intuitiveness in the establishment of concept, enables the designer to determine form and functionality of the product, and directly correspond to the characteristics of the targeted cultural essence. The drawback of this approach, however, is that it does not specify measurements for the transformation of forms and parameters to satisfy requirements in practical use. Complete literature review and user feedback are also in lack. Therefore we proposed an integrated design scheme of cultural concepts that incorporates the three metaphysical dimensions of cultural elements as the groundwork to develop methods for the application of the first, second and third degree abstraction, as well as the transformation of cultural elements. It is also highlighted that firsthand expert interview and literature review should be employed to collect background knowledge. Last but not lease, user feedback should be appreciated and accessed to enhance the essence of the design. Now we can move on to look into details of this innovative and integrated scheme for cultural creative design.

4.2 The Architectural Elements for Cultural Creative Design Processes

In order to obtain better understanding of the history of Mengjia Lungshan Temple as a symbol of traditional southern Fujian architecture, our literature review covered publications, records, and archives of historical buildings in Taiwan. Photographs were taken to analyze the value and element of the special arrangement and dougong carving.

4.2.1 History of Mengjia Lungshan Temple

Worshiping Guanyin as the main deity, also known as the Goddess of Mercy, Mengjia Lungshan Temple in Wanhua District has been designated as a Grade 2 National Historic Monument (Figure 2). Many scholars and experts have contributed to the documentation of this temple's historical and architectural background. Among them, architectural historian Lee's monograph of 1992, *Research and Study on Mengjia Lungshan Temple*, has been deemed as the most detailed yet comprehensive account of the temple. The main idea can be summarized as follows.

Mengjia was the junction of transportation and economic activities during the Qing Dynasty and Japanese Occupation. Consequently, Mengjia Lungshan Temple served as both the heart of religion and the gathering place of artistic and business exchanges. This temple has a pivotal position in terms of cultural, political and commercial senses.

Tamsui County Gazette edited by Chen (2006) during the reign of Tongzhi Emperor in the Qing Dynasty is the earliest official record on Lungshan Temple's renovations. It was stated that *"Located on Menjia Street, Lungshan Temple was built in Quanzhou Anhai Style in the year of 1738. Only the stand for the statutes survived the 1815 earthquake. With donations from Shih-Chao Yang, Chao-Yang Huang, and the descendants of Shih-Chao Yang, the temple was renovated in 1867* (Chen, 2006)*."* Renovation of the whole temple took place in 1920 and reconstruction of the main hall occurred in 1955. In sum, this temple had gone through many difficulties and cultural changes.

Figure 2. Lungshan Temple of today

4.2.2 Renovation of Mengjia Lungshan Temple

Lungshan Temple had gone through four rebuilds and other minor renovations. The

outlook we see today is the result of the temple-wide renovation in 1920 and renovation of the main hall in 1955. Lee (1989) described the work of 1920 that "*This renovation recruited many outstanding craftsmen and utilized innovative techniques, making it a significant event in the history of Taiwanese temple, which expands over one hundred years*" (Lee, 1989, pp. 16). It was also noted in this book that a crew of first-string craftsmen with I-Shun Wang, master of Quanzhou Xidi Style architecture, as the project leader. Mavens of the time, such as wood carver Hsiu-Hsing Yang, ceramic artists Kun-Fu Hung and Ping Lin, as well as masonries His-Lai Chiang and A-Chiu Hsin were all seen in the name list. Therefore, the ensemble of craftsmanship and skill accounts for this temple's inimitable status as a Taiwanese temple.

4.2.3 Spatial and Structural Arrangement of Mengjia Lungshan Temple:

With over 270 years of history, Mengjia Lungshan Temple went through numerous architectural modifications and thus becomes very complex in layout. *Mengjia Lungshan Temple Gazette* mentioned that "*Lungshan Temple was rebuilt on the same site, yet the scale upgrades. Also, the original structure was of ordinary temple style, yet the additions were of palatial style*. (Liu, 1951)" The reconstruction of the Lungshan Temple has not only produced a larger scale of palatial-style structural arrangement, but also prospered the local craftsmanship. Hsu (2010) further illustrated the idea of "palatial style" in *The Illustrated Guide of Mengjia Lungshan Temple* that "*This layout places the main hall in the centre and surrounds it with the front hall, rear hall, the east and west complexes and the cloisters. Therefore the building complex forms in a hollowed square setup* (Hsu, 2010, pp. 38-42)." The hollow square of palatial style inherits the wing layout and Minnan style courtyard house framework of traditional Chinese architecture. From this architecture, the central belief of Confucian ideology of self-cultivation, settling one's family, stabilizing a state, and bringing peace and harmony to the world by using regulation is fully expressed.

It can be summarized from the literature review that Mengjia Lungshan Temple is a temple built in palatial layout with eleven "kai-jian" in width and three halls on the vertical axis. Kai-jian refers to the standard width of a room in traditional Chinese architecture, and the floor plan shows a hollow square (see Figure 3). The main structures include the Front Hall, the Main Hall (Centre Hall), the Rear Hall and the Bell and Drum Towers on the left and right wings. With the framework in mind, we can proceed to look into the delicacy and details of these buildings.

4.2.3.1 The Front Hall

The Front Hall is a building complex with the Tri-River Hall in the middle and the Dragon and Tiger Halls on both ends. The frontispiece has five doors and is about 11 "kai-jian" in width.

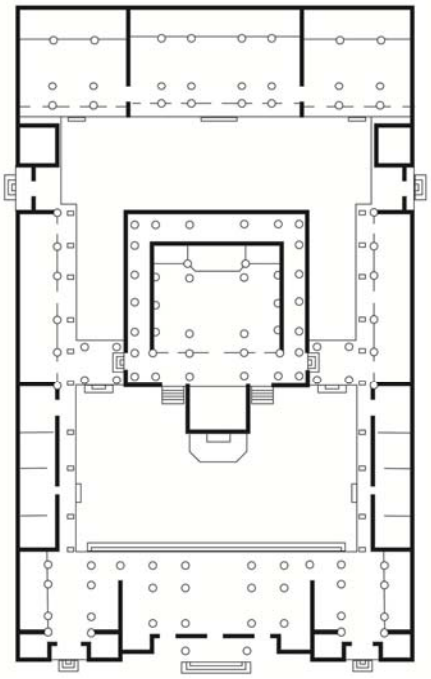

Figure 3. Layout of Lungshan Temple

Liu (1994) explained that Tri-River Hall is named by the its entrance, the Tri-River Gates, and is functioning in terms of reception, resting and worshipping. The three doors implemented in a row symbolize the image of followers coming like three rivers flowing in. In practice, ingress and egress of the public take place in the Dragon and Tiger Halls located on both ends of the Tri-River Hall. The left is called the Azure Dragon Hall while the right is the White Tiger Hall. The entrance gates to the two halls are therefore called the Dragon Gate and the Tiger Gate.

Investigation on the frame structure of the Front Hall involved a massive literature review, field survey, and on-site photographing. It was revealed that the roof structure of the Tri-River Hall is of Duan-Yan-Sheng-Jian style roof (with broken ridge and elevated centre eave as shown in Figure 4) while that of the Dragon and Tiger Halls was of Xieshan style roof (hipped roof with Dutch gables, with 9 ridges and 4 slopes as

shown in Figure 5). Supporting system for the roof of Tri-River Hall featured caisson ceiling (Figure 6) and flat ceiling (Figure 7), while that of the Dragon and Tiger Halls were of Che-Shang-Lou-Ming-Zao style (girder and beam structure with no ceiling under the roof as shown in Figure 8).

Figure 4. Duan-Yan-Sheng-Jian style roof on the Tri-River Hall

Figure 5. Xieshan style roof of the Dragon and Tiger **Gates**

Figure 6. A caisson ceiling

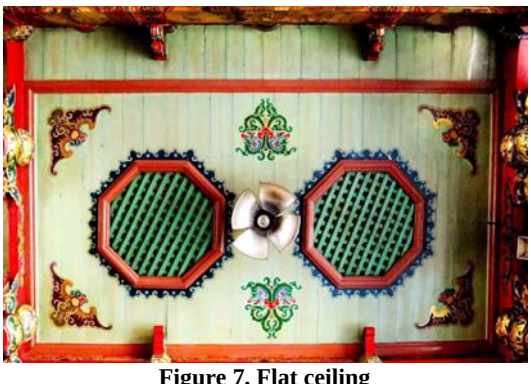

Figure 7. Flat ceiling

Figure 8. Exposed girder and beam structure

Decorative and structural elements, such as the caisson domed ceiling, flat ceiling, round-ridge roof and Che-Shang-Lou-Ming-Zao (exposed ceiling), are all intricately combined in the Front Hall. This not only embodied the skillfulness of master I-Shun Wang but also created a variety of depth perceptions inside the roof structure, which is very distinctive in the architecture of the Front Hall.

4.2.3.2 The Main Hall

The Main Hall sits in the centre of Lungshan Temple as the most solemn and majestic sanctuary of its building complex. It serves the statute of Guanyin, accompanied by Mañjuśrī (the bodhisattva of transcendent wisdom), Samantabhadra (the bodhisattva of universal worthy) and the 18 Arhats on both sides.

This hall stands independently from other buildings with a Xieshan style roof with double-tiered eaves (Figure 9). The hall is surrounded by cloisters on all sides (Figure 10). It was observed in our field survey that the design of the spiral caisson ceiling in this hall is based on the caisson domed ceiling of Tri-River Hall (Figure 11). With highly decorative dougong system inserted between the columns, a dynamic yet magnificent world of Buddhism becomes vivid to the viewer's eyes. As shown in Figure 11, this makes the Main Hall the most elaborate, sophisticate, yet delicate building inside Lungshan Temple.

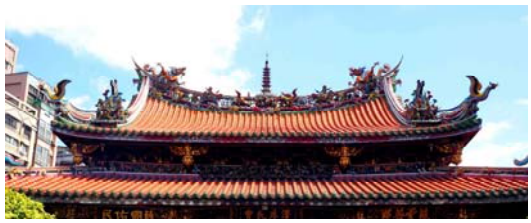

Figure 9. Xieshan style roof with double-tiered eaves on the Main Hall

Figure 10. The Cloister

Figure 11. Spiral caisson ceiling of the Main Hall

4.2.3.3 The Rear Hall

The Rear Hall of Lungshan Temple is composed of Matsu Hall in the middle and Wen-Chang and Guandi Halls on the east and west wings, serving deities in the traditional Taiwanese folk religion.

I. H. Li (2006) analyzed the structure of the Rear Hall. With a scale of 3 kai-jian in depth and 11 kai-jian in width, this hall has a roof divided into three portions by the gables. In the middle is a Xieshan style roof with double-tiered eaves, while the wings featuring Yingshan style roof (flush gable roof, with 5 ridges and double slopes) with single-tiered eave (Figure 12). Similar to the Dragon and Tiger Halls in the Font Hall, the frame structure is of Che-Shang-Lou-Ming-Zao with exposed ceiling (Figure 13).

Comparison with the Front Hall and the Main Hall reveals that the Rear Hall is of less importance in that carvings, paintings and other decorative elements are either absent or simplified here.

Figure 12. Yingshan style roof with single-tiered eave of the Rear Hall

Figure 13. Structural Arrangement of the Rear Hall

4.2.3.4 The Bell and Drum Towers

The Bell and Drum Towers are common in traditional Chinese temples. They are built to house large ceremonial bells and drums chanting for both religious assemblies and everyday timekeeping. The Bell and Drum Towers of Lungshan Temple are of two-story pavilion structures; the Bell Tower is on the east wing (Figure 14) and the Drum Tower is on the west wing (Figure 15). It is noticed in our survey that the hexagonal sedan chair roof (Figure 16) was the first of its kind in Taiwan. The downturn curvature of the roof ridge on top of the tower forms a spirited contrast to the upward ridge line of the roof on the lower tiers, adding more vitality and mobility to the outlook.

Figure 14. The Bell Tower

Figure 15. The Drum Tower

Figure 16. Sedan chair roof

4.2.4 Dougong System of Mengjia Lungshan Temple:

Dougong, corbel wood brackets, is the structural element between the interior of the roof and the columns. It is an eye-catching part among other architectural elements in traditional Taiwanese temples. "Dou" refers to the block as "gong" refers to the bracket arm. Both come in a variety of styles. *The Research and Study on Mengjia Lungshan Temple* (Lee, 1992) summarized 7 types of dougong, including Chu-Yen Dougong (bracket set supporting beams that project beyond the eaves), Wang-Mu Dougong (meshed bracket set), Pai-Lou Dougong (bracket set for the decorative archway), Tian-Hua Dougong (bracket sets arranged to embellish the ceiling), Kan-Jia Dougong (bracket sets to adorn the cornice), Dong-Jia Dougong (bracket sets under the truss) and Jie-Wang Dougong (bracket sets to form the caisson domed ceiling like a spider web).

Among the 7 sorts, "Wang-Mu Dougong" and "Jie-Wang Dougong" are the most decorative with highest complexity and requirement for superb craftsmanship. Therefore, they are worth of further investigation.

4.2.4.1 Wan-Mu Dougong

Repetition is an emphasis in the design of Wan-Mu dougong. As can be seen in the middle of Tri-River Hall's eaves gallery, Yun-Wen-Xie Gong (cloud-patterned diagonal bracket arms) and Li-Hu Gong (hornless dragon bracket arms) are jointed with Ba-Ge Dou (octagonal connection blocks) and three different types of Wan-Gong Dou (bowl-shaped connection blocks). Together they intricate into an elegant rhythm of Ruyi pattern (ceremonial jade scepter, as shown in Figure 17). On the other hand, outstanding on both ends of the Tri-River Hall, upright Guandau Gong (blade-shaped bracket arms), Li-Hu Gong, and Tsao-Juan Gong (rolled leave bracket arms) are in juncture with Ba-Ge Dou to construct another form of Wan-Mu (lattice) structure that is simplistic and yet powerful (Figure 18).

We have noticed an interesting contrast between humbleness and aggressiveness in the design of dougong for the Tri-River Hall. Architect I-Shun Wang deliberately combined the litterateur image of jade Ruyi scepter and the martial image of Guan Dao (the blade of a military general) in his design, signifying the merit of ancient scholars being well versed in both humanity and martial arts. Furthermore, the aesthetic value is enhanced as the rationality in structure and the sensibility in art merge in delicacy.

Figure 17. Meshed bracket set in the middle of the

Figure 18. Meshed bracket set in both sides of the Tri-River Hall

4.2.4.2 Jie-Wang dougong

Also referred as the caisson domed ceiling, Jie-Wang Dougong is a decorative part of the interior roof structure that comes most often in octagonal, round, or rectangular arrangement. It is the most splendid and skill intensive architectural element in Taiwanese temple.

A multitude of Wan-Mu Dougong complexes are intertwined into the octagonal caisson domed ceiling upon the Tri-River Hall in the Front Hall (Figure 19). A Ba gua (octagonal diagram) is placed on the top to ward off evil spirits and bad luck. Yun-Wen-Xie Gong (cloud-patterned diagonal bracket arms), Li-Hu Gong (hornless dragon bracket arms), and Tsao-Juan Gong (rolled leave bracket arms) are jointed in a cadenced order with Wan-Gong Dou (bowl-shaped connection blocks), Gua-Leng Dou (oval connection blocks) and Ba-Ge Dou (octagonal connection blocks). Wan-Gong Dou signifies the image of prosperity, while the Gua-Leng Dou is a symbol of fertility blessing. Layers of bracket set patterns represent the wish-fulfillment of the race to move onward and upward towards everlasting prosperity.

The spiral caisson ceiling (Figure 20) is composed of Li-Hu Gong and Fang Dou (square connection blocks). The bracket sets are arranged in a clockwise rotation and was the first of its kind in Taiwan by the time of completion. The Li-Hu Gong stands for the sublime position of Guanyin, and the Fang Dou is a metaphor of dignity and righteousness. The spiral pattern of the ceiling reflects the Buddhist philosophy of reincarnation and the eternally revolving Wheel of Dharma.

Figure 19. Octagonal caisson ceiling

Figure 20. Spiral caisson ceiling of the Main Hall

The dougong system is indeed the most distinctive feature of Lungshan Temple architecture. The Wan-Mu dougong is an embodiment of Chinese literate's righteousness and leniency in humanism, while the complexity and multiplicity in the spiral caisson ceiling reflects the importance of Buddhism in Taiwan. Dougong art in Lungshan Temple is invaluable to Taiwan in that they carry meanings in the senses of religion, culture, antiquity, architecture, and southern Fujian painting. In essence, they are a living legacy of Chinese culture.

It was observed in the architectural layout and frame structure of Mengjia Lungshan Temple that "representation of belief in form" is in the core of traditional Taiwanese architecture. The Front Hall, The Main Hall, The Rear Hall, and the Bell and Drum Halls on the east and west wings were arranged to form a foursquare landscape in the adoration of morality and righteousness in Confucianism. On the other hand, dougong and caisson ceiling were carefully installed under the roof of the halls as attribute to the glamour of harmonious heaven. Together they signify the value of cosmos consonance in Chinese tradition. Besides the splendor of Buddha's land and the combination strong-mindedness and soft-heartedness of Chinese scholar, Lungshan Temple architecture also embodies core concept of the eternal wheel of life in Chinese Buddhism. These architectural elements are in fact a priceless inventory of Chinese cultural legacy and craftsmanship, waiting for further exploration of designers, writers, artists, and researchers.

5. Integrated Design Scheme with the Construction of Cultural Concepts

We have selected the structural arrangement of dougong and beams in Mengjia Lungshan Temple as our design element, and the emphasis was put on the beauty of carving and wood framing in traditional Taiwanese architecture. In order to validate the feasibility of the cultural creative design approach proposed in this study, we cooperated with Lungshan Temple Foundation in the development of a public chair to be installed inside the Lungshan Temple. The project was based on the integration of cultural concepts, and the public chair produced now serving in Lungshan Temple is highly recognized by both local and international visitors.

Figure 21 illustrates the skeleton of the integrated design scheme of cultural concepts. This comprehensive design model incorporates design approach, transformation of cultural

elements, literature analysis, expert design criteria and user feedback.

In the stage of metaphysical analysis, we have taken 1538 photos of dougongs in Lungshan Temple. The dougongs were categorized before the application of abstraction, in which adjustments were made to meet specific requirements of the product interface. The result may constantly reflect in the expression of design from the perspective of all of the three metaphysical dimensions. Correspondence between the theme and the object is also repeatedly reconfirmed.

In cases of exceptional complexity in the transformation of cultural elements, we offer three options of corner feature extraction, microcosmic observation, and totem extraction. Corner feature extraction refers to the selection of a portion of the silhouetted cultural element and the transformation of the extracted segment. The microcosmic approach amplifies some features of the element to a degree of exaggeration. Also, the designer can simply borrow the entire target cultural element as a totem to be properly modified or polished. So far, functionality and usability are still to be considered to ensure the roundedness of the design.

Moreover, field survey and expert interview were performed to establish design criteria. By following the suggestions of the experts, we reviewed documentation related with Lungshan

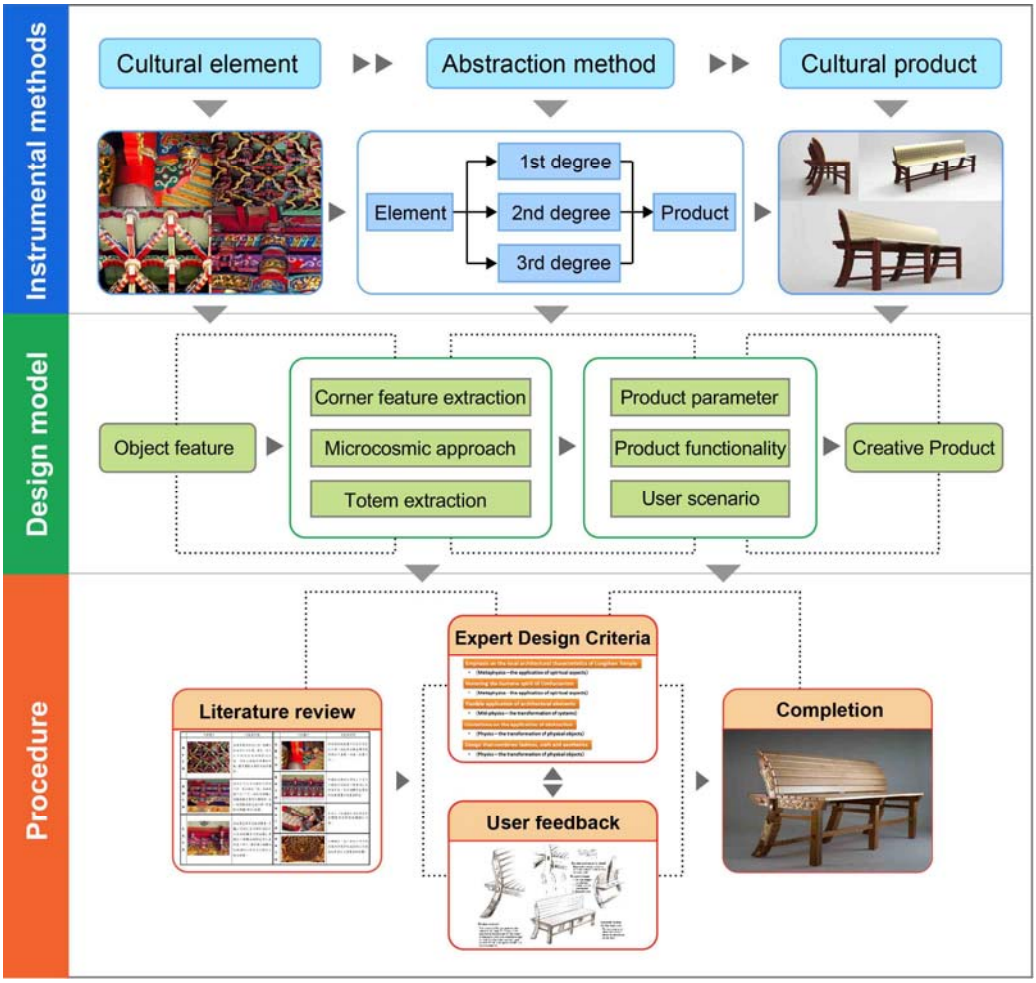

Figure 21. Integrated design scheme of cultural concepts

Temple and reached a proper understanding of the essence of cultural design. Eventually, specification about the form of the product was settled through the analysis on abstraction measures and transformation of elements. A massive multitude of design concepts and combination derived as we exercised the integrated design scheme of cultural concepts. Naturally enough, a series of product design proposals were produced through dynamic adjustment of applications.

6. Case Study

6.1 Practical Design Demonstration

A demonstration design of the public chair for Mengjia Lungshan Temple was accomplished under the proposed integrated design scheme of cultural concepts.

Figure 22 is a sketch of concept development for the design. The contour of dougong, the block set structure, and colors used in the decoration paintings of Lungshan Temple were selected as the basic design elements. Our analysis revealed that second degree abstraction (65%~75% similarity) is more acceptable and recognizable for users of Lungshan Temple, including local residents and worshippers. In light of this, microcosmic approach was adopted to capture characteristics of the Wan-Mu Dougong for the transformation of form in second degree abstraction. With reference to Taiwanese folktale of Lord Guan and life situation of local people, the designer presented the bench called *Sea-of-Cloud Bench* (Figure 23).

Guandau Gong (blade-shaped bracket arms) is a eye-catching feature of Xidi style architectures. Therefore this image was extracted from Lungshan Temple for the design of the side panels for the bench. Wooden carvings with cloud pattern, golden seat surface, and the exposed mortise and tenon joint (Figure 24) were incorporated to represent the splendor and delicacy of Lungshan Temple architecture. From the perspective of functionality and convenience, three holes were opened on the shelf attached to the back of the chair to serve as umbrella holders (Figure 25).

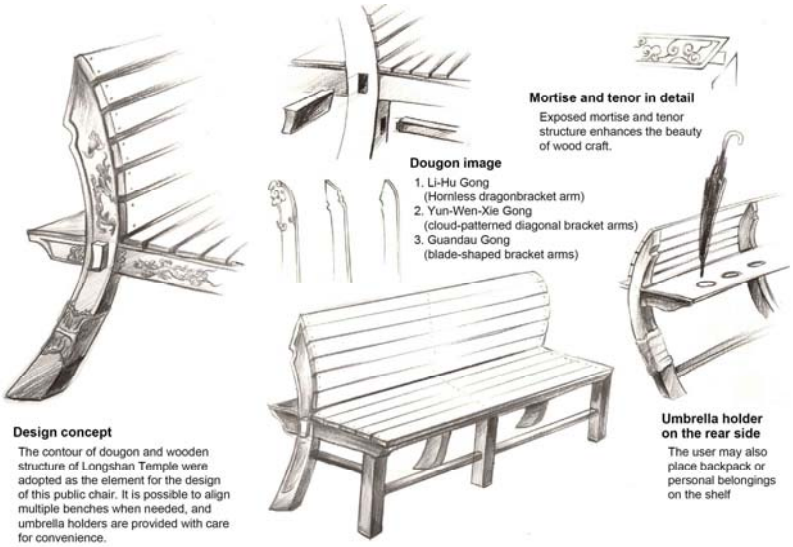

Figure 22. Concept development

Figure 23. Front view and scenario simulation

Figure 24. Cloud-patterned craving, golden chair seat and the tenon joint

Figure 25. Umbrella holders on the back of the chair

6.2 Design Evaluation Base on Expert Design Criteria

The design of the Sea-of-Cloud Bench was based on our expert design criteria with regard to the three metaphysical dimensions of cultural elements to accomplish the essence of the product. The process and measures are explained as shown in Table 1.

Table 1. The Content of Design Evaluation of the Sea-of-Cloud Bench Base on Expert Design Criteria

Expert Design Criteria	The Explanation of Design Evaluation of the Sea-of-Cloud Bench
(1) Emphasis on local features of Lungshan Temple architecture	A required in our expert design criteria, the product should be composed of locally obtained materials. Maple and hinoki cypress with Taiwan origin were used for the making of public chair for Lungshan Temple. Native Taiwanese cypress is distinctive with its scent and hardness and may recall memories of the Japanese occupation period when it is widely used in architecture and daily life. Through metaphysical analysis on the mentality under the colonial rule of Japan (spiritual dimension) was reflected upon the use of experienced object (instrumental dimension), that is, Taiwanese Hinoki cypress. By this we see the connection between exterior appearance and interior affection.
(2) Adoration of humane spirit in Confucianism	The exposed mortise and tenon joint is a unique carpentry technique. Cypress tenon was used in the cross halving joint. The mortise embracing the tenon signifies the idea of tolerance and inwardness in the Confucian Doctrine of the Mean. From the institutional perspective, Confucianism is in essence the code of behavior followed by all members of the race. This is an example of the intimacy between moral teaching on the spiritual level and moral code on the institutional level.
(3) Flexibility in the use of architectural elements	Inspired by the criterion of flexible use of architectural elements, we adopted the microcosmic approach to magnify a detail feature. The decorative carvings and dougong system were firstly addressed before we extend and integrate them into the structure of the chair. Intaglio was applied to the carvings; patterns were engraved in three different depths. A thick layer of hinoki cypress was used as the cornerstone for the cross halving joint. Here we see an ingenuous application of materials and a unique combination of structural elements. User-friendliness was also attended in that an extended portion was attached to the back of the chair to provide a space to place personal belonging and at the same time serve as umbrella holders.
(4) Limits on abstraction	Design of the Sea-of-Cloud Bench is based on second degree abstraction (65%~75% similarity) of the Wan-Mu dougong on the two ends of the Tri-River Hall (Figure 18). However, the original was constructed in a multi-layered structure. To make the design element more feasible in the product development, we extracted only a single unit of dougong for the design of the chair. It was realized in our analysis that second degree abstraction was the optimal option because the user may more likely to recall the image of the original. Furthermore, the extracted design element has more potential to cooperate with modern functionalities, so that the output may serve better than only an unpractical artistic item with traditional wood carvings.
(5) Fashion, craftsmanship, and aesthetics	The seat surface and back of the bench were painted with flaxseed oil into a modern and fashionable color of maple. The conjunction of maple (seat) and cypress (back) creates a strong sense of conflict, which is also an approach of material integration that now prevails in Europe. The tone of maple darkens in use and age, and the change was intended in our choice of material.

The above analysis on the integrated design scheme of cultural concepts of this research reveals that the Sea-of-Cloud Bench based on cultural dimensions is an optimal design that features flexibility, pluralism, and integrated application of cultural elements.

6.3 User Feedback and Analysis

The Sea-of-Cloud Bench designed via our integrated design scheme of cultural concepts has been installed in right-handed hallway of the Lungshan Temple for use of local residents and international visitors (Figure 26). According to the estimation of Lungshan Temple Foundation, visitor counts of the temple remain the highest among all temples in Taipei city, ranging between 3000 and 5000 per day. As the bench was installed inside the Lungshan Temple, the coloring and pattern of carving on both sides were in harmony with the wooden carvings of the whole building. To access user behavior, on-site observation and questionnaire survey were carried out, so as to validate the feasibility of this research. The results are as shown in Table 2:

Table 2. The Results of the User Feedback and Analysis

(1)	95% of the interviewees reported fondness of the design and comfort offered by the bench.
(2)	The dragon patterns on the carvings and the blade-shaped contour were metaphorically connected with Lord Guan's pole weapon, which is a token of the military general's mightiness and righteousness. The interviewees felt protected and bless when they sit on the Sea-of-Cloud Bench.
(3)	The overall design and color are in tune with carvings of the Lungshan Temple. Paintings and carvings on the original dougong were very distant from the visitor of the temple as they were untouchable monuments. Yet while the patterns on both sides of the Sea-of-Cloud Bench were inscribed on hard maple and cypress, the users may touch and feel the carpentry work directly.
(4)	The users appreciated the delicacy of the mortise and tenor structure of the Sea-of-Cloud Bench. While sitting on the chair, they took a close look at the beauty of the joint structure and felt safe with the sturdiness of the chair.
(5)	The enlarged umbrella holder is very user-friendly in that both backpacks and umbrellas can be placed handily behind the user.
(6)	The golden tone of the seat (maple) seems very natural and is in concordance with the carvings of the building. Meanwhile, the users also agree with the value of the product in terms of fashion and modern senses.
(7)	Foreign tourists were impressed by the unique design of Sea-of-Cloud Bench. Unlike common public chairs, delicate carvings were allocated on the sides around the tenon joint structure. This reflects the humbleness in Taiwanese tradition, as well as the tolerance in Confucianism.
(8)	The carpentry work and structuring technique of the Sea-of-Cloud Bench were highly valued by foreign visitors. By the brilliant hands of the designer, the intricacy of dougong was transformed and incorporated into the structure of the bench. Not only that the wood carvings can be examined in detail but the structure of the chair successfully represented the aesthetics in Chinese architecture.

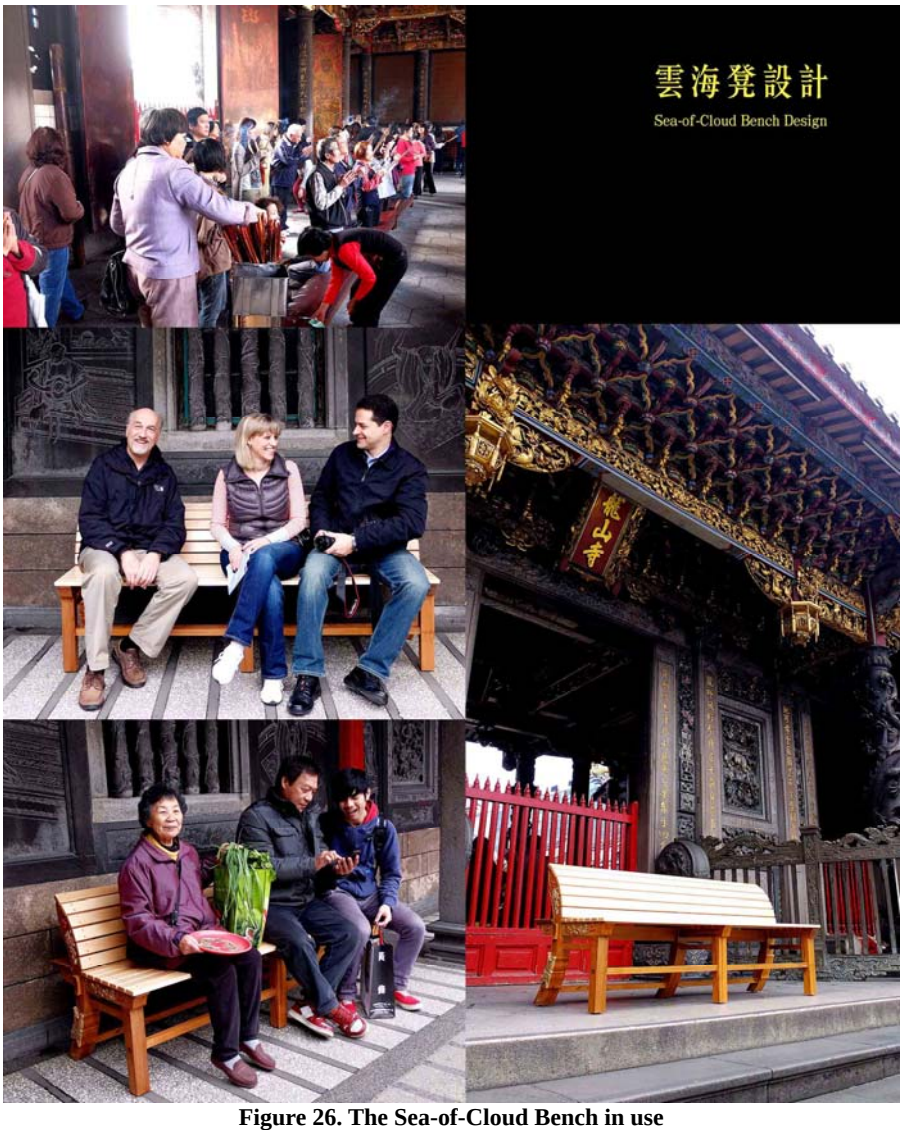

Figure 26. The Sea-of-Cloud Bench in use

7. Conclusions

In the application design based on Lungshan Temple's architecture elements, we demonstrated a practical process of cultural creative design. Through on-site investigation of the buildings, we touched upon the value and humanistic spirit underlying the architectural characteristics of Lungshan Temple. The results obtained in the field survey and expert interview further corroborated the vitality and distinctiveness of Taiwan's local culture.

The investigation with the proposed integrated design scheme of cultural concepts concludes as follows:

(1) Demolition of the myth about carving patterns as dominating totems: The multiplicity of carvings inside the Lungshan Temple was a challenge in the extraction of totem image. It is therefore suggested in the research that designers should first examine the cultural essence and symbolism underlying each carving pattern before engaging in the transformation and application of image. By this approach we can expect a reasonable match between the output and the targeted cultural essence.

(2) Less is not more: The idea of "form follow function" prevails the Western world and designers tend to minimize formal expression as they develop their design. Nevertheless, completeness of the carvings and patterns is essential in the design of the Sea-of-Cloud Bench; excessive reduction of formal elements may raise issues in the transformation of cultural elements and detach the user from previous experiences of the original cultural object.

(3) Marriage of traditional craft and modern technology: The Sea-of-Cloud Bench has been validated as the optimal design that combines both intricate woodcarving and the modern carpentry techniques. The conflicting yet attractive union of tradition and modern turns a new age of modern craftsmanship.

(4) Reflection upon traditional culture: The pursuit for innovative technology and streamlined design is the mainstream ideology in product design of today. The beauty of this study, on the other hand, ponders upon measures to access the ultimate essence of an object. Traditional culture is the most valuable assets of Taiwan because it stands for the collective life experience of local people and legacy from Chinese culture. The design demonstration in this study is an example of bringing sustainability to traditional culture.

(5) Comprehensive application of integrated design scheme of cultural concepts: The integration of concepts specifies the standards and requirements for the abstraction of form. Multiple options of transfomation approaches (corner feature extraction, microcosmic, and totem extraction) are provided to clarify the transformation process of cultural elements and satisfy user requirements and product functionality. This may avoid carelessness in the use of elements. In addition, expert interview and literature review helps with the establishment of a large-scaled expert knowledge databank, to which the designers may resort for pluralistic feedback analysis in cultural creative design.

(6) Dynamic correlation between metaphysical concepts and integrated design scheme of cultural concepts: The integrated approach proposed in this study is a feasible and also practical model for cultural creative design in the stage of concept development. However, in the establishment of expert knowledge database, the designer should still rely on literature review to conduct image and text analysis and access the spiritual and metaphysical essence of the content. The nature of the product and the underlying mentality are determined by how the designer makes use of the impressive power of the object. Brilliant combination of sensational experiences related to texture, color, and form is achieved to deliver professional design that is capable of reminding the user of the value and essence of the targeted cultural elements.

Acknowledgments

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Design Education Research on Creative-Oriented and Skill-Based Teachings - A Case Study of Computer Graphics Course

Yi-Chen Hsu
National Taipei University of Education, yichen@tea.ntue.edu.tw

ABSTRACT

This research aims to investigate how creation and skill are taught in design education, and how the ratio of both factors should be arranged in the teaching plan of a computer graphics course. It also asks how the creative-oriented and skill-based teachings influence students on design works. This research conducted two phases of experimental teachings (creative-oriented teaching and skill-based teaching) to investigate the differences of student learning performance and outcomes during these two phases. The creative-oriented teaching phase focused on design thinking and creation inspiring; the skill-based teaching phase focused on software function introduction and skill practice. Questionnaires of learning performance were collected from students after each teaching phase for result analysis. The expert interviews and group discussion were also conducted to collect data. The quantitative data from expert censorship of design works and learning performance questionnaire was computed using the SPSS for Windows. Additionally, information from expert interviews and group discussion was adopted as the qualitative data in this study.

Some suggestions are proposed from the research results, and these suggestions are offered for the design courses that were designed for the Science College students. Due to the college of science students being more familiar with computer techniques and software knowledge than the college of arts and design majors, the design course should be planned to be more concentrated on creative-oriented teaching, such as creation inspiring, design procedure teaching, and practical design knowledge guiding. Also, the design course should contain small parts of skill-based teaching, for example the introduction of basic tool and practice of frequent using tool of design software.

***Keywords*:** Design Education, Creative-Oriented Teaching, Skill-Based Teaching, Computer Graphics.

1. Introduction

It is always a tough situation for design teachers when planning the ratio of skill to creation in the design course. Goldschmidt (2003) stated the similar opinion that expert knowledge and creative spark are the predicaments in designing education. Hence, what kind of content of design course is able to assist students in learning more and learning better? Should the design course focus on the skill-based teaching of technique using or the creative- oriented teaching of idea inspiring? In the research of Goldschmidt (2003), students stated that some lecturers teach functions and others teach form, but they wanted to study form! As the development of technology and computers progresses, functions and techniques of computers change all along. Students believe that it is better for them to learn functions and techniques of computers by themselves during their own leisure time.

This research took a computer graphics course as a case study. Teng (1997) suggested that basic computer graphics courses should focus on the technique training; advanced computer graphics courses should focus on the creation inspiring. Nowadays, in the digital era, students deal with computers and digital devices all the time. Therefore, teachers do not need to spend lots of time on introducing the interface and function of software since students are already familiar with such technology. As a result, design courses should be designed with the current trend. Also, "As the tools of designing developed in parallel with technology, the core structure of the education is based on a model with creative and analytical aspect: *Designerly* way of thinking aims at originality and uniqueness (Orlandi, 2010)."

This research intends to find out the advantages and disadvantages of a creative-oriented teaching and a skill-based teaching. In addition, this study analyzed the influences of these two teachings on students' learning performance and design works. We state some ideas that are proposed as the reference for further experimental design course in the end of this research.

2. Reference Review

This study aims to provide some suggestions for the structure of design courses that are planned for the Science College students. We investigate the influences of the creative-oriented and skill-based teachings on student performances and design works. To do so, we took a look at the related reference such as design education, creation in design education and skill in design education.

2.1 Design Education

Design education generally refers to courses that are held in universities or schools in order to promote national aesthetic and train designers. Now the commonly accepted idea is that the formal instruction and periods of academic study for designers in educational intuitions (Lawson, 1997). Also, design education has shifted from the focus of training in traditional courses to an emphasis on research course (Yeo, 2014).

Artists and designers mostly learn design related skills and knowledge in design education. Kolb (1984) stated that learning is "the process whereby knowledge is created through the transformation of experience." Therefore, knowledge and practical experience are the two main factors in design education. A higher design education system is the place that is anticipated to be the locus of synthesis and integration of knowledge into practice (Goldschmidt, 2003). Students are expected to be trained how to design and introduced to a culture, various conception of design, likely to be a designer in design education (Eyikan, 1998). In addition, Bakarman (2005) proposed that there are three key elements of the new model design education: attitude, skill, and knowledge.

The development of technology over the years has taken place at a speedy pace. Design education has to keep up with the times. Nowadays, digital design education needs to promote not only simply knowledge of materials and mastery of special technical skills, but also techniques and accurate use of tools or instruments (Lewis, 2005).

2.2 Creation in Design Education

In design education, the teaching would be meaningless if the teaching only applies computer as the technique because of the modern trend. Roland (1990) mentioned that instructors have to teach students the proper ideas in the digital design teaching. Design majors should use their imagination and creation to create works, and apply various forms and methods to develop the aesthetic and creative works of digital arts. Therefore, creation is important in digital design education since the graphics designer wishes to advance in its career and to become popular (Cropley & Cropley, 2010; Efe Varol, 2012). Also, peer learning is integral to the creative practice of designers (Budge, Beale, & Lynas, 2013).

The professional knowledge is considered as the foundation for designers to make the professional design decisions (Lawson, 1997). Furthermore, designers should change the role to be less problem-focused and more socially engaged through the construction of design process (Lloyd, 2013).

2.3 Skill in Design Education

Skill teaching in design education refers to the hand-sketch and hand-painting practice mostly found in the old times. As the development of computers and technology continues to advance, the functions and techniques of computers become skills that designers and design majors must learn. Nowadays, skill training covers the hand-drawing methods and computer graphics techniques. Teng (1997) suggested that the basic computer graphics course should focus on the training of practical techniques, included understanding of the computer functions and compresence of the computer skills. Also, it is necessary for designers to follow the developments in technology and direct it towards practice in order to keep the graphics designers updated (Efe Varol, 2012).

3. Research Scope and Purpose

The target subjects of this study are the students of Science College, not the students of art and design related departments (art and design related departments such as design, media, art, illustration, graphic design departments and so on). Therefore, subjects of this research are more familiar with computer techniques and software knowledge than the art and design majors. However, Science College students not as acquainted with aesthetics theories and principles as the art and design majors.

We defined computer graphics courses in this study as courses that produced graphics by using computers and the represented image data through a computer. In this research, we choose Adobe Illustrator CS6 as the instruction software. The aim of this course is educating students to be able to design fine computer graphics independently. In addition, the creative-oriented teaching in this study refers to the teaching that focuses on design thinking and creation inspiring; the skill-based teaching refers to the teaching that focuses on software introduction and skill practice. The aims of this research are as follows:

- Executing both the creative-oriented and

skill-based teachings in a design course.

- Investigating the influences of the creative-oriented and skill-based teachings on student design works.
- Analyzing the effects of the creative-oriented and skill-based teachings on student learning performance and outcomes.
- Proposing the suggestions about planning the ratio of the creative-oriented and skill-based teachings in computer graphics course.

This research aims to investigate the influences of the creative-oriented and skill-based teachings in design education on student learning performance and design works. The results of this study are expected to provide suggestions to shorten the distance from idea inspiring to skill practice in digital design process. This research will also additionally propose the teaching guidelines of computer graphics for future design education. There were reference review, experimental teaching phases, expert interviews and data collecting in this research. The research procedure was planned as Figure 1.

4. Methodology

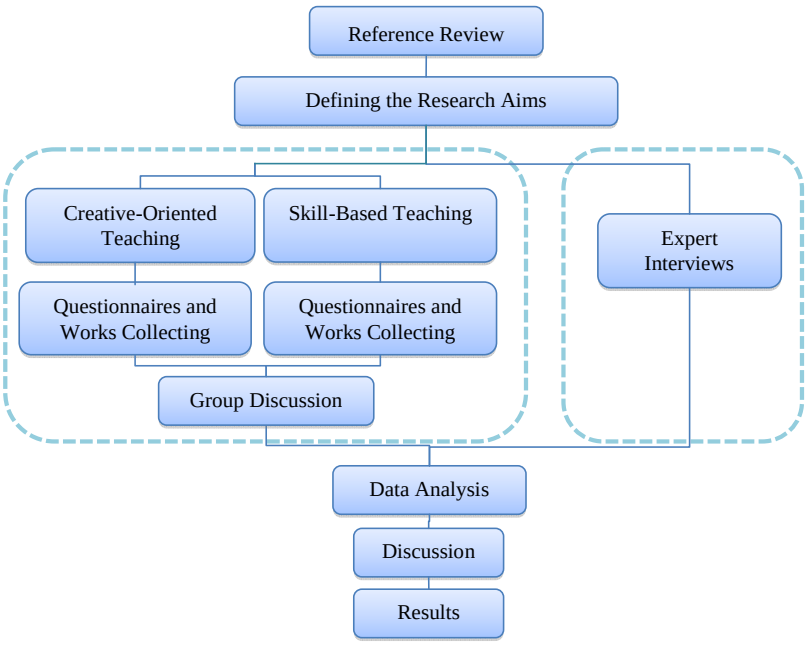

Figure 1. The Research Procedure

A one-factor-at-two-levels (creative-oriented teaching – skill-based teaching) counterbalanced within-subjects design was employed in this experiment. This experiment was conducted in a computer graphics course that has held for the sophomore students in the Department of Digital Technology Design in National Taipei University of Education. We collected questionnaires of learning performance, design drafts and completed works from the participated students after each teaching phase for data analysis.

4.1. Creative-Oriented Teaching

The creative-oriented teaching phase was conducted for four weeks. In this phase, we paid attention to the guidance and interaction of creative aspect, but only taught basic functions of Adobe Illustrator CS6. Students needed to design a computer graphic LOGO in this phase. This phase of teaching was arranged in steps, and there were a draft phase, a coloring layout phase, a computer practice phase and a final layout phase. In the draft phase and the coloring layout phase, we encouraged students to think and design widely, and we gave suggestions and instructions to students in their every draft. In the computer practice phase, we only gave basic instructions of Adobe Illustrator CS6 such as geometry design, coloring, and line drawing. Students were asked to submit a designed LOGO as the assignment in this teaching phase.

4.2. Skill-Based Teaching

The skill-based teaching phase was conducted for four weeks as well. We paid more attention to the comprehensive function instruction and practice in this phase, but only taught basic design standards for business cards. Students needed to

design a computer graphic business card in this phase. In the draft phase, we only gave the practical specifications about a business card design. In the computer practice phase, we spend more time on function instruction and practice of Adobe Illustrator CS6, and made sure all the students were able to use Bezier curves and gradient coloring. Students were asked to submit a double-side designed business card as the assignment in this teaching phase.

We collected the learning performance questionnaires, drafts, coloring layouts and completed works after each one teaching phase. The questionnaires collected from students and experts were analysed as the quantitative data in this research. On the other hand, the group discussion of six students and interviews of nine experts were considered as the qualitative data.

We invited nine experts who have been working more than ten years in design industry or design education to partake in this research, and five of them have even more than twenty years of working experience. During the interviews, experts had to examine students' drafts, coloring layouts and completed works in two teaching phases. We asked experts to evaluated students' works in two teaching phases from the skill aspect and creation aspect, and scored these works. Open interviews were followed by the evaluation phase, we questioned experts to give some suggestions about design education, such as students need to learn what kind of knowledge and ability in the computer graphics course, design industry need what kind of talented people, the ratio of skill training and creation inspiring to divide in design education, and so on.

5. Research Analyses

There were quantitative and qualitative analyses in this research. Quantitative data contains questionnaires of student learning performance and expert feedback forms of student work examinations. In addition, qualitative data contains a group discussion and expert interviews.

5.1. Quantitative Analysis of Learning Performance

One-factor-at-two-levels (creative-oriented teaching phase – skill-based teaching phase) counterbalancing within-subjects design was employed in this experimental teaching. The target focus group centred on the students of Science College who participated in computer graphics course. 49 subjects partook in the actual experiment, of which 7 subjects failed to complete the experiment procedure (did not complete all the course assignments, withdrew the course in the mid-term, or invalid questionnaires), and their responses were discarded from the analysis, which was performed on the remaining 42 cases. Questionnaires were measured by a single item on the five-point Likert scale, and was analysed by means of a Paired-Samples T Test via SPSS Statistics v17. There were 12 questions that grouped into three aspects (skill aspect, creation aspect, and learning performance aspect) in the questionnaire. The T tests of these three aspects are shown as Table 1, 2 and 3.

Table 1: The T Test of the skill aspect.

	The creative-oriented teaching	The skill-based teaching
	Mean [SD]	Mean [SD]
Knowledge learning	4.63 [0.536]	4.28 [0.630]
	T=2.630, P=0.012<0.05	
Knowledge applying	4.42 [0.663]	4.30 [0.599]
	T=0.777, P=0.441>0.05	
Skill learning	4.42 [0.626]	4.30 [0.558]
	T=0.819, P=0.418>0.05	
Skill applying	4.12 [0.697]	4.02 [0.636]
	T=0.585, P=0.562>0.05	
Skill aspect	17.44 [2.108]	16.86 [2.007]
	T=1.250, P=0.218>0.05	

Table 2: The T Test of the creation aspect.

	The creative-oriented teaching	The skill-based teaching
	Mean [SD]	Mean [SD]
Design thinking	4.40 [0.695]	3.93 [0.704]
	T=2.892, P=0.006<0.05	
Solutionizing	4.05 [0.722]	3.91 [0.684]
	T=0.948, P=0.349>0.05	
Creative performance	3.91 [0.971]	3.93 [0.704]
	T=-0.116, P=0.908>0.05	
Integration	3.88 [0.662]	4.02 [0.707]
	T=-0.903, P=0.372>0.05	
Creation aspect	16.21 [2.615]	16.33 [2.388]
	T=-0.193, P=0.848>0.05	

Table 3: The T Test of the learning performance aspect.

	The creative-oriented teaching	The skill-based teaching
	Mean [SD]	Mean [SD]
Self-review	3.84 [0.721]	3.84 [0.721]
	T=0.000, P=1.000>0.05	
Peer learning	4.00 [0.655]	3.88 [0.662]
	T=0.842, P=0.404>0.05	
Knowledge enhancement	4.26 [0.759]	4.30 [0.674]
	T=-0.264, P=0.793>0.05	
Target achievement	3.79 [0.888]	3.77 [0.649]
	T=0.125, P=0.901>0.05	
Learning performance aspect	15.88 [2.373]	15.98 [2.283]
	T=-0.156, P=0.877>0.05	

Among three aspects that there were only two items exhibited significant differences, both of them indicated that the creative-oriented teaching phase gained higher scores than the skill-based teaching phase: ‘Knowledge learning’ (T=2.630, P<.05) in the skill aspect and ‘Design thinking’ (T=2.892, p<.05) in the creation aspect. Both of them demonstrated that the student learning performance in the creative-oriented teaching phase was better than the performance in the skill-based teaching phase. This demonstrates that subjects experienced better knowledge learning and well-design thinking in the creative-oriented teaching phase. No significant differences were determined between ‘knowledge applying’, ‘skill learning’ and ‘skill applying’ in the skill aspect, ‘solutionizing’, ‘creative performance’ and ‘integrating’ in the creation aspect, as well as ‘self-review‘, ‘peer learning’, ‘knowledge enhancement’ and ‘target achievement’ in the learning performance. This indicates that the subjects experienced a similar level of these items during these two teaching phases.

5.2. Qualitative Analysis of Learning Performance

After two teaching phases, we invited six students who performed outstanding and learned well during these two phases to participate in the group discussion. There were four open topics considered in this discussion.

Firstly, we asked whether they felt the difference between two teaching phases or not. Most students replied that they did not notice the difference between these two teaching phases. It was the beginning of the new semester, and most of them noticed only the difference of assignments. The LOGO design was the first assignment, and the personal business card design was the second one. However, one student indicated that he felt frustrated when teachers made the comments on his draft in the creative-oriented teaching phase. He observed that he needed to study harder and spend more time to complete the design work well. Therefore, when he submitted the first design work which he designed from draft to completion on his own, he felt very proud of himself.

Secondly, we enquired students about which phase they learned more in. Most students answered that they all learned something during these two phases, but they learned differently between the two. In the creative-oriented teaching phase, students learned more design knowledge such as art theory and creative thinking. On the other hand, in the skill-based teaching phase, students learned more about

software technique and material information. One student responded that he spent lots of time on draft sketches in the creative-oriented teaching phase, and then he self-learned some computer technique with his spare time in order to complete his design well. On the other hand, in the skill-based phase, instructors did not give many suggestions to his draft, but introduced lots of software knowledge in this phase. Compared to the LOGO assignment, the personal business card assignment seemed easier and with sufficient technical source to complete. In this way, he did not need to self-learn anything in this stage. Nevertheless, the self-learning in the creative-oriented teaching phase responded to the opinion of Schunk (1984) – arousing the learning interest of students are able to improve self-efficacy and learning motivation.

Thirdly, we queried students about which teaching method they preferred. Most students replied that they enjoyed both teaching methods. Hence, we changed the question so that only one teaching method could be chosen. Few students answered that they would take the creative-oriented teaching method if they have to pick one. Seeing that they are students of Science College, they could improve computer technique with self-learning. In addition, subjects have a few courses related to design and art currently; they need the teaching of creative-oriented more than the skill-based teaching.

Finally, we asked students to give some further suggestions to future design courses. Since subjects have few design related courses, they all advised that more design related teachings should be scheduled in the future, such as art and design theory, recommendations about design works, and suggestions about improvements. They also suggested that computer techniques should not be omitted. There should be basic tools and frequently used functions of computer technique explained in the design courses.

5.3. Quantitative Analysis of Expert Interviews

After two phases of experimental teachings, we collected all the design drafts and works that students designed during both phases. Then, we invited experts from design education and industry to examine design drafts and works of students, as well as play a part in expert interviews. Experts were asked to give suggestions and examinations on these works from creative and technical aspects. Nine experts participated in this research, and they all scored these works from two teaching phases. The highest score was 5, and the lowest score was 1. The means of the feedback forms that we collected from experts are showed as Table 4.

Table 4: The means of the feedback forms that filled by nine experts.

	The creative-oriented teaching	The skill-based teaching
Professional technique	3.67	3.78
Professional knowledge	3.22	3.67
Analyze	3.44	3.56
Creative thinking	3.67	3.44
Creative performance	3.22	3.44
Integration	3.44	3.56

Among six items, ‘Creative Thinking’ is the only item which shows that design works in the creative-oriented teaching perform better than the works in the skill-based teaching, and other five items exhibit that design works in the skill-based teaching gain higher scores than the creative-oriented teaching. However, only nine experts took part in this survey, so it is hard to distinguish the advantages and disadvantages among two teachings from nine experts’ examination. Therefore, we can take a look at the preference of nine experts about these two teaching styles. Four of nine experts gave higher scores to the creative-oriented teaching, other four experts gave higher scores to the skill-based teaching, and the other one took a neutral stance.

5.4. Qualitative Analysis of Expert Interviews

Four of nine experts appreciated the creative-oriented teaching. They indicated that the LOGO works designed during the creative-oriented teaching phase were more diversified and original than those ones during the skill-based teaching phase. Even some LOGO works show the high level of techniques in computer graphics. However, the level of LOGO works was ranged in huge difference. Experts believed that the design process arranged in steps is able to inspire students with more creative ideas and help develop the self-solve ability of students. The design steps include discussions in the draft stage,

introductions in the coloring layout and suggestions in the final layout. On the other hand, experts indicated that works designed during the skill-based teaching phase were limited by the computer skills easily. Although those works had consistent levels of quality, there were few excellent works.

Four other experts appreciated the works of the skill-based teaching. They pointed out that the business cards designed in this phase exhibited details on materials, fonts and shapes. These works demonstrated the practiced computer skills, even the well performance in creative concepts. Furthermore, experts indicated that the creation in card works might have been influenced by the previous teaching. Therefore, the business cards were designed with the advantages of both creative and skill based techniques. On the other hand, the LOGO works needed more training and practice in regards to design skills and graphic design principles.

In addition, three of nine experts specified that it was hard and unjust to evaluate the different teachings with different design outcomes. Furthermore, the works designed in the skill-based teaching were affected by the previous creative-oriented teaching. Experts struggled to give the fair evaluations to those works of two phases. In the end, experts provided some suggestions to the design courses for the college of science. They advised to increase the creative-oriented and design process teachings for the students of the college of science.

6. Research Results and Suggestions

This research aims to investigate how creation and skill are taught in design education, and how the ratio of both factors should be considered in the teaching plan of a computer graphics course. It was hard to evaluate the design outcomes through quantitative data in the previous research. Therefore, this research adopted two experimental teachings and invited nine design related experts to estimate the works of two teaching phases. The results of this research have led to the proposal of the below suggestions for design courses that are designed for the Science College majors.

Firstly, only ‘knowledge learning’ and ‘design thinking’ showed the significant differences between the two teachings in the questionnaire analysis. Moreover, both items showed that the creative-oriented teaching gained higher scores than the skill-based teaching, even the ‘knowledge learning.’ Therefore, the results of students’ self-evaluation showed that ‘knowledge learning’ and ‘creating thinking’ in the creative-oriented teaching were better than the skill-based teaching in learning performance.

Secondly, regarding the feedback forms from the experts, only ‘creative thinking’ presented that the creative-oriented teaching was better than the skill-based teaching. Other items (professional technique, professional knowledge, analyze, creative performance, and integration) indicated that the skill-based teaching performed well than the creative-oriented teaching. Referring to the appreciation of these two teachings, four of nine experts gave higher scores to the creative-oriented teaching. Four other experts gave higher scores to the skill-based teaching, and the other one stood a neutral stance.

Thirdly, we invited six students to join our group discussion to review the teachings. Most students provided higher evaluation to the creative-oriented teaching. Even they felt frustrated when they were asked to create lots of drafts. However, they were inspired to produce tons of creative ideas at the same time. Furthermore, following the design process that was arranged in steps from the draft, coloring layout to the final layout, students felt more confident when they actually executed the design. Also, students tried to self-learn when students had some problems to complete their design. Students asked classmates and tutors, searched online, and looked for the solutions in the books. The creative-oriented teaching motivated them to treasure their design, and do their best to make the design perfect. Subjects were the students of Science College. Students were acquainted with computer related knowledge, and therefore would like to have more art and design courses about design principles, design process and creative thinking.

Finally, the nine experts gave some suggestions to the design courses that are designed for the Science College students. They recommended designing more creation guiding in the design courses. As they evaluated the works of two teaching phases, the works of the skill-based teaching belonged to the similar level but no excellent ones. That’s the reason that students were taught tons of functions and skills of computer graphics, but little creative thinking. However, students were led to follow the design process from the draft making, layout coloring, and final layout confirmation in the creative-oriented teaching phase. Although the works of this phase were leveled distinguishing, works should be more creative and excellent if under proper tutoring of instructors.

7. Conclusions

Some suggestions are proposed from the research results, and these suggestions are offered for the design courses that were designed for the Science

College students. This research executed two styles of design teachings: the creative-oriented teaching and the skill-based teaching. Students learned lots of knowledge about the design theory and creative thinking in the creative-oriented teaching, and they were educated sufficiently about the graphic skills and computer functions in the skill-based teaching. Subjects of this study were the Science College students. Therefore, we suggest the design courses for the Science College students should focus on creation inspiring, design process and design principle teaching, as well as a side with basic functions and frequent used skills of computer techniques.

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理感性語意應用對影音學習之成效

施竣彥 [1]，賴淑玲 [2]，張榮吉 [3]
亞洲大學數位媒體設計學系，maxshih.tw@gmail.com [1]
僑光科技大學多媒體與遊戲設計系，sllai0809@gmail.com [2]
亞洲大學數位媒體設計學系，roger@asia.edu.tw [3]

摘要

身處於知識爆炸的時代，每個人的資訊需求與喜好程度皆不相同，市場上多樣化的數位媒體教材開發琳瑯滿目，但大多缺乏良好設計，導致無法滿足閱聽大眾的需求。臺灣擁有豐富多元的生態之美，更蘊藏著豐饒的人文情感，闡述知識資訊的同時，若能夠帶有情感的描述，適切運用雙碼理論，增添理性與感性的附加語意，將使生態知識的呈現更具厚度。本研究配合教育部「高級中學課綱」之設計，應用於生態教育課程中。精緻的生態影音拍攝讓學生學習更加徐徐如生，學生在觀看影片的同時，透過理性與感性的附加語意，期能與知識以及情感產生更多連結。研究結果發現，不同的數位影音實驗設計，觀看理性組與感性組的學生，其認知學習評鑑成效都較控制組優異；觀看感性組之學生，其情感態度提升成效最優異；針對男女學生不同性別分析，男生觀看理性組學習成效較佳，女生則是觀看感性組的學習成效較佳；男生與女生觀看感性組的情感態度相較於控制組與理性組有明顯成效。

關鍵詞：雙碼理論、附加語意、理性、感性。

The effect on rationality and emotion with additional semantic to video learning

Jyun-Yan Shih [1], Shu-Ling Lai [2], Rong-Chi Chang [3]
Department of Digital Media Design, Asia University, maxshih.tw@gmail.com [1]
Department of Multimedia and Game Design, Overseas Chinese University, sllai0809@gmail.com [2]
Department of Digital Media Design, Asia University, roger@asia.edu.tw [3]

ABSTRACT

People's information needs and preferences vary in the knowledge explosion era. A wide variety of diversified digital-media tutorials has been vigorously developed. However, most materials are poorly designed that they fail to satisfy the needs of readers. Taiwan possesses a great variety of ecological beauties and is abundant in humanistic affections. When elaborating knowledge information, ecological knowledge can be substantially enhanced through emotional descriptions, the appropriate application of dual-coding theory, and the addition of both rational and sensible semantics. This study applied the Ministry of Education high school curriculum design to ecological education courses. Sophisticated ecological videos enable students to experience authentic learning. While the students watched the videos, adding rational and sensible semantics in the videos assisted students in connecting with knowledge and emotions. The results indicated that students who watched videos containing rational or sensible semantics had stronger performance in cognitive learning evaluations than the students in the control group did. Those who viewed the video containing sensible semantics (sensible group) had the highest level of improvement in their emotional attitude. Among the male students, those who watched the video that was integrated with rational semantics (rational group) had higher learning effectiveness, whereas female students in the sensible group exhibited higher learning effectiveness. The emotional

attitudes of the male and female students in the sensible group were significantly improved compared with those in the control group and the rational group.

***Keywords*:** Dual Coding Theory, Additional Semantic, Rationality, Emotion.

1 緒論

腳本及文案企畫是整個數位影音製作的靈魂，市面上有著多元的數位媒體教材開發，但是腳本文案始終缺乏良好設計，在內容知識呈現的質與量缺乏設計與考量，導致閱聽眾的學習產生困難，學習過程也索然無味。本研究由理性與感性的附加語意出發，透過闡述(elaboration) 讓學習者在學習量上得到充分的認知，在情感上，觸發更多的感動與聯想。理性附加語意在本研究之生態影音中提供重要的知識重點解析及數據輔助，以強化資訊內容；感性附加語意則是在生態影音中提供重要的文學詩詞補充與情感描述，期望可深化其思考與學習連結。

1.1 背景與動機

本研究配合國科會「探索數位的福爾摩莎—HD高畫質節目製作與跨媒體播放平台加值應用計畫」執行，結合數位影音、教育、視覺設計，針對台灣特有動物的相關生態議題，製作生動有趣的多媒體教材，期許能提升台灣生態科學教育的廣度與深度。影片從環境與生態在人類生活上的角色，探討環境變化及生物行為與人們生活之關係，藉使學生能正確瞭解生態知識，也讓生態保育普及深入生活中，並且提升生態知識及學習吸收效率，讓閱聽眾輕鬆躍入知識瀚海，領略生態的奧妙。

本研究希望藉由理性與感性附加語意的輔助以增加影音內涵，並希望能夠了解理性與感性附加語意是否能提升學生的學習認知與情感態度。

1.2 目的與假設

本研究以 HD 高畫質生態影片為基底，特別選擇臺灣特有鳥類環頸雉為主角，根據雙碼理論的闡述(elaboration)需求，製作三個實驗組別教材，以了解理性與感性附加語意與視覺影像結合，對於高中生數位影音學習影響；本研究提出五個主要的研究假設：

一、理性與感性附加語意不會影響高中生之認知學習。

二、理性與感性附加語意不會影響高中生之情感態度。

三、不同性別不會影響學生之認知學習。

四、不同性別不會影響學生之情感態度。

五、理性感性附加語意及性別對認知學習與情感態度沒有交互作用。

1.3 研究限制

本研究的影片實驗教學融入自然科學的課程，係採隨機分派的分組實驗方式，以班級為單位分派學生作為研究對象，將受測的男女人數依校方隨機分配組成、年級統一等限制，來排除各組別學生性別與學習能力差距問題。

2 文獻探討

2.1 訊息接收認知

人們對於外來環境的刺激，如認為是重要訊息則會透過感官收錄、採納、吸收、組織、儲存於短期記憶、工作記憶，隨後轉換為語意或心像的形式與舊有知識連結，然而不需要的訊息會在此階段遺忘，符合所需的訊息會進入長期記憶，成不易遺忘的知識。

Seels 和 Richey 認為，訊息的設計包含了注意、知覺和記憶保持的原則(Seels & Richey, 1994)。透過有系統性的規劃，可有效將新的知識經驗與舊有知識經驗相互連結，產生認知理解並獲得概念的建立與認同。將有目的、有意義的訊息經由文字、圖像、聲音等物質形態來傳遞，使人們認知、吸收，進行學習。

知識訊息輸入的品質很重要，Rosenshine 提到教師應該提供學生廣泛的閱讀（影像和文字）機會，幫助學生發展知識(Rosenshine, 1995)。由於人們學習與認知經驗皆不相同，因此具備基模的程度也有所差異，若能有效提取學習者的先備知識與經驗，配合學生的吸收能力與基模，就會有效內化成為自我的知識，促進理解記憶，縮短學習時間提高成效，產生意義學習(Ausubel, 1968)。此外，Clark 及 Lyons 進一步指出，利用數位影音來教導知識內容，

呈現其因果關係有助於深入學習，另再增添文字解說的輔助，將促進學習者對內容的反思(Clark & Lyons, 2004)。

2.2 雙碼理論與數位學習

人類有兩套彼此互動又獨立運作訊息的系統，分別是語文與非語文兩大類。文字類的記憶若以心像方式來解讀，則記憶的效果遠優於採取文字方式解讀的結果(Paivio, 1971)。因此，利用數位影音媒體的整合特性，可將文字與影像雙重形態的內容相互連結；由感官系統吸收、編碼管理，將訊息具像化，儲存於記憶區中，使人們在內容認知、回想與記憶檢索有正面的幫助(Clark & Paivio, 1991; Mayer & Anderson, 1991;莊雅茹，1996)。圖文並用的方式比僅有文字呈現的效果好，能將無法陳述的抽象概念具體表達(Najjar, 1996)，影音與文字同時呈現，內容將更清楚真實，更容易理解，然而，數位影音能夠呈現人、事、物和情景，使閱聽眾融入其中，獲得感染薰陶，並且兼顧知識學習和娛樂效果，引起興趣 (Allan, 1985)。Mayer 與 Sims 也認為文字訊息與視覺訊息同時呈現會比先後呈現更有效幫助建立連結，以提升學習效果(Mayer & Sims, 1994)。

使用數位影音的教學比傳統的教學更能讓學習者高出十五倍的理解程度，記憶維持的時間也達到五倍以上的持久（張正宙，1994）。數位影音具備整合龐大的知識內容的優勢，使教學精緻、個別化，可根據學習者認知能力、學習經驗差異，選取適合程度的教材內容。

2.3 數位影音與附加語意的重要性

好的多媒體內容能夠協助建立三種訊息處理的認知過程，分別為選擇、組織、整合(Mayer, 1997)。媒體中訊息設計的策略會直接對閱聽眾有所影響（楊家興，1995），Hartman 與 Sticht 認為，越抽象、複雜的內容，越適合用附加語意來輔助；適量且必要的字詞註釋有助於認知理解，反之，添加非必要及過多訊息會產生干擾。使用綱要式的附加語意內容比全文式的文字內容有更好的學習成效（陳定邦，1995）。進而應用腳本概念整合資訊，能促使閱聽眾對內容記憶更深刻，並提升資訊回憶的貫串力(Singer et al., 2013)。具故事腳本設計的語意重點，有助於喚醒記憶與進行深度思考(Ivala et al., 2013)，成串的訊息經自我的解讀組織判斷，有邏輯的歸納內容，可建立通盤的理解(Bower, Black & Turner, 1979)。

然而，數位影音與附加語意的組合呈現，可產生互補作用，影像的直觀效果，提供閱聽眾最直接的視覺刺激，但表象所能感知的固然有限，若是同時搭配文字資訊，觀看到呼應、提點重要訊息，就會有強而有力的連結，獲得完整的理解記憶，達到提綱挈領的功能（范懿文、陳彙芳，2000、陳定邦，1995），因此，由理性與感性的附加語意資訊與數位影音的結合，以強化知識資訊及情感體會的連結。

2.4 理性與感性的重要性

John Dewey 曾說：「想要改變一個人，必須先改變他的環境，環境改變了，他就被改變了」(John Dewey, 1969)。藉由情境的感染牽引，可以促進閱聽眾更投入。求知的過程，閱聽眾是處於情境建構的脈絡中(Brown, Collins & Duguid, 1989)；而人們的性情、成長背景、認知的差異，改變了思考時理性與感性比重(Ryle, 1949)。單純理性闡述是有限的，若要獲得充分的知識，也必須透過感性的情緒、情感和審美經驗，讓認知更為完整(Dewey, 1916)。有系統邏輯架構下，將感性語詞轉化為理性邏輯的思維導向，於學術研究具有意義與重要性（葉茉俐，2014），當感性被萃取時，吸收以及邏輯會有良好提升；理感性相輔助，形成理智與情感的溝通平衡，幫助閱聽眾融會貫通學習領域之間的關係(Eisner, 1993)。

閱聽眾是主動的知識建構者，知識則是閱聽眾與情境互動的產物(Anderson, Simon & Reder, 1996)。情境的體驗中，使得閱聽眾與知識內容的關係不再抽象遙遠。然而，教學亦強調學習者與情境的交互，教育情境之陶冶成為教育中根本的意義。並藉以感性文學對應其關鍵意涵詮釋與知識性內容之結合，使得精神美感轉化到視覺美感的表現（楊凱全，2013）。

學習者自我內心與情境的交流，留下深刻體會，其教學情境有助於組織聯想。在情境的催化引導中，能夠激發創造嶄新的思路(Beatty, 2011)。情境的感染薰陶是重要催化劑，牽動學習的感受。

3 研究方法

本研究依據研究目的及文獻探討後，參照教育部訂定的高中課綱，設計三款影音教材（理性、感性、對照控制組）與問卷設計（態度評量及學習成效測驗），以李克尺度評量受測者的情感滿意度、學習興趣、知識充足性，並製作評量測驗，瞭解受測者對認知理解能力與情感態度回饋效果，進而請教育學者、生態內容專家們對實驗影片、問卷內容之設計進行

審核、建議與修訂，建構符合課程與認知理解力的內容，達到最佳專家內容效度。

本研究內容設計開發，是經由與鳥類生態專家學者研討，針對鳥類的生態規劃五個重要階段(孵化、抵禦天敵、育雛、破殼、離巢)，進一步整合生態學者與相關單位對於各種階段的精闢解析，以強化理性知識；另一方面，經由與文學專家研討，將生態專家規劃的重要階段轉化呼應於人類情感，融合人文詩詞著作，發展出各種階段的感性詞彙，以轉化感性情境。設計過程中皆結合影視多媒體專家的審視指導，使得實驗內容的腳本設計及解析語意符合適切設計。

本研究設計的實驗教材，提供高中教師結合生態教學課程應用，當學生觀賞完畢，透過態度問卷調查以及測驗評量，作為數位影音教材改進之分析。研究者運用 SPSS 統計軟體，實施數據統計與分析，檢定研究假設。本研究理性附加語意與生態影片的結合應用，其設計發展架構如下圖 1 所示：

圖 1. 理性附加語意與生態影片之設計發展架構圖

本研究感性附加語意與生態影片的結合應用，其設計發展架構如下圖 2 所示：

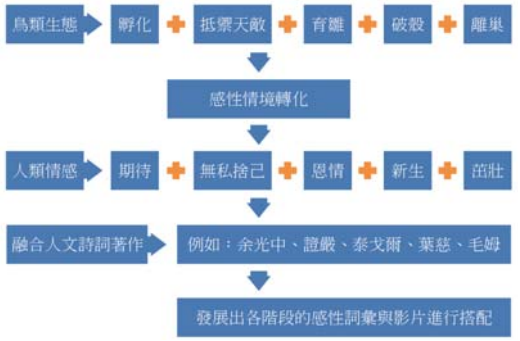

圖 2. 感性附加語意與生態影片之設計發展架構圖

經由國內外論文、期刊、專書與網路資訊等文獻，分析研究對象的學習特性，並與專家學者們訪談，挑選出符合需求且適合的內容。將知識內容、故事劇情腳本、影音視聽效果等設計完成後，再次經專家學者們討論、測試、調整到定案，隨後再進行施測。

本研究問卷設計經由先備知識測驗以及經驗問卷填答，瞭解受測學生對生態的接觸與認識程度、瞭解文學認知程度與自我情緒發展取向；以李克尺度進行態度評量，統計受測者在實驗過程中，其所獲得的情感態度滿意度、學習興趣與知識內容的充足性、喜好程度給予評量，設計測驗學習試題，所有問卷題目皆以影片內容作為出題依據，於正式研究實驗前，針對欲實驗研究的知識內容進行文字內容蒐集、篩選與設計，撰寫完成題目之後，皆經由教育學者、國語文學者與生態專家對問卷、試題、實驗影片內容等進行討論與審查，並給予指導建議、測試及調整，對於研究目的、實驗影片內容與測驗題的適切性、關連性與填答的難易度進行修正，若內容超出學習者經驗範圍或者教學內容之用字遣詞不合適即修訂，確保教學內容完整度，達到最佳的專家內容效度。

3.1 研究對象

本研究以高中學生為研究對象，選擇台中某一高中一年級隨機選取三個班級學生（共計 121 名）作為研究樣本，採用 3（控制組、理性、感性）× 2（男性、女性）分組實驗設計，實驗分組如表 1 所示：

表1. 實驗分組表

組別/性別	媒體呈現內容	媒體解說內容
控制組/男女學生	生態影音	單純旁白之輔助
實驗組/男女學生	生態影音	旁白及理性附加語意之輔助
實驗組/男女學生	生態影音	旁白及感性附加語意之輔助

由於參與實驗的男女學生人數是採班級為統一單位，依照原先校方的班級人數分配來進行實驗，實驗組別的總人數與男女學生人數統計如下表 2 所示：

表2. 實驗組別人數分配表

組別	實驗總人數	男學生	女學生
控制組	40	20	20
實驗組-理性	40	21	19
實驗組-感性	41	28	13

3.2 研究實施

將受測學生隨機分派至對照控制組、理性附加語意組及感性附加語意組，於自然科教室分別進行實驗教學。本研究與自然科教師合

作，課程開始前，教師先將實驗影音中的生態物種進行簡短說明，讓受測者獲得基本認識，引導受測者進入學習狀態，隨後運用投影方式播映教材。為了降低受測者之間的干擾，維持良好獨立性，教師會要求受測者在觀看影片與填答問卷過程中皆不得交談。

而測驗資料與問卷回饋內容分析，為確保品質與效度，本研究將獲得的數據資料，進行 Cronbach's Alpha(α)信度係數來檢驗內部的一致性，把驗證數據與文獻、專家訪談、問卷等內容歸納，實施研究分析。

3.3 設計影音學習內容

本研究設計製作出三種影音設計，除對照控制組是採用市售影音教材之設計方式(單純旁白) 呈現，畫面並未添加任何輔助內容；理性與感性的影音設計則是分別添加所屬類型的輔助內容。

理性附加語意組的設計，是將環頸雉生長過程中孵化、抵禦天敵、破殼、育雛、離巢的重要階段，搭配理性輔助內容，以強化知識，其畫面如下圖 3 所示（範例：破殼-卵為淺橄欖色，雛鳥為早熟性幼鳥）：

圖3. 結合理性附加語意之影音畫面

感性附加語意組的設計，是將環頸雉生長過程中孵化、抵禦天敵、破殼、育雛、離巢的重要階段，搭配感性輔助內容，對應於人類之期待、新生、恩情、無私、茁壯的情感，並且融合人文著作，其畫面如下圖 4 所示（範例：育雛-天塌下來有媽媽，用脊椎來頂住；地翻過來有媽媽用胸脯來護住）：

圖 4. 結合感性附加語意之影音畫面

4 數據分析與討論

4.1 研究假說檢定

假說 1：理性與感性附加語意不會影響高中生之認知學習。

統計分析：先利用一般線性模式的敘述統計與 ANOVA 再用 Post Hoc 檢定的 Tukey HSD 多重比較，分析控制組、理性組及感性組認知學習是否有顯著差異，如表 3、4、5：

表 3. 組別之認知學習成效檢定

依變數	組別	平均數	標準離差	個數
認知評量測驗	控制組	6.70	1.181	40
	理性	7.72	.599	40
	感性	7.66	.575	41

表 4. 組別之認知學習顯著性分析

來源	依變數	型 III 平方和	df	平均平方和	F	顯著性
截距	認知評量測驗	6251.668	1	6251.668	9117.126	.000
組別	認知評量測驗	26.581	2	13.290	19.382	.000

表 5. 組別之認知學習成效多重比較

依變數	(I)組別	(J)組別	平均差異 (I-J)	標準誤差	顯著性	95% 信賴區間 下界	95% 信賴區間 上界
認知評量測驗	控制組	理性	-1.02*	.185	.000	-1.46	-.59
		感性	-.96*	.184	.000	-1.40	-.52
	理性	控制組	1.02*	.185	.000	.59	1.46
		感性	.07	.184	.931	-.37	.50
	感性	控制組	.96*	.184	.000	.52	1.40
		理性	-.07	.184	.931	-.50	.37

假說驗證：由 F 檢定發現控制組、理性組及感性組均達顯著差異 F(2,119)=19.382, *p=.000(p<0.05)*，在學習成效之認知學習比較，理性組(mean=7.72)及感性組(mean=7.66)皆優於控制組(mean=6.70)，對認知學習都有提升，達顯著水準，與控制組相比較，理性組與感性組 p 值皆為*.000*；不過，理性組與感性組彼此則未達到顯著差異。

假說 2：理性與感性附加語意不會影響高中生之情感態度。

統計分析：先利用一般線性模式的敘述統計、交叉表與 ANOVA 再用 Post Hoc 檢定的

Tukey HSD 進行多重比較，分析控制組、理性組以及感性組情感態度是否有顯著差異，如表 6、7、8、9：

表 6. 組別之情感態度成效檢定

依變數	組別	平均數	標準離差	個數
態度平均	控制組	3.22	.429	40
	理性	3.56	.393	40
	感性	3.84	.286	41

表 7. 組別之情感態度交叉表

組別	影片觀後感				總和
	體會情感	資訊清楚	兩者皆有	皆不明顯	
控制組	3	16	3	18	40
理性	3	30	7		40
感性	13	6	22		41

表 8. 組別之情感態度顯著性分析

來源	依變數	型 III 平方和	df	平均平方和	F	顯著性
截距	態度平均	1445.077	1	1445.077	11377.924	.000
組別	態度平均	7.457	2	3.729	29.358	.000

表 9. 組別之情感態度多重比較

依變數	(I)組別	(J)組別	平均差異 (I-J)	標準誤差	顯著性	95% 信賴區間	
						下界	上界
態度平均	控制組	理性	-.34*	.080	.000	-.53	-.15
		感性	-.62*	.079	.000	-.81	-.43
	理性	控制組	.34*	.080	.000	.15	.53
		感性	-.28*	.079	.001	-.47	-.10
	感性	控制組	.62*	.079	.000	.43	.81
		理性	.28*	.079	.001	.10	.47

假說驗證：各組別間的情感態度成效均達顯著差異 F(2,119)=29.358, *p=.000(p<0.05)*，情感態度的表現，理性組(mean=3.56)與感性組(mean=3.84)皆顯著優於控制組(mean=3.22)，感性組則又顯著優於理性組(感性組 *p=.001*、理性組 *p=.001*。

假說 3：不同性別不會影響學生之認知學習。

統計分析：利用一般線性模式的敘述統計與 ANOVA 的性別變項比較男女學生的認知學習成效，如表 10、11：

表 10. 不同性別之認知學習成效檢定

依變數	性別	平均數	標準離差	個數
認知評量測驗	女	7.44	.873	52
	男	7.30	1.004	69

表 11. 不同性別之認知學習顯著性分析

來源	依變數	型 III 平方和	df	平均平方和	F	顯著性
截距	認知評量測驗	6251.668	1	6251.668	9117.126	.000
性別	認知評量測驗	1.498	1	1.498	2.185	.142

假說驗證：男女學生的學習成效未達顯著差異，不同性別不會影響學生之學習成效 F(1,120)=2.185, *p=.142*。

假說 4：不同性別不會影響學生之情感態度。

統計分析：先利用一般線性模式的敘述統計、交叉表與 ANOVA 的性別變項比較男女學生的情感態度成效，如表 12、13、14：

表 12. 不同性別之情感態度檢定

依變數	性別	平均數	標準離差	個數
態度平均	女	3.62	.417	52
	男	3.48	.467	69

表 13. 不同性別之情感態度交叉表

性別	影片觀後感				總和
	體會情感	資訊清楚	兩者皆有	皆不明顯	
女	9	25	12	6	52
男	10	27	20	12	69

表 14. 不同性別之情感態度顯著性分析

來源	型 III 平方和	df	平均平方和	F	顯著性
截距	662.668	1	662.668	902.271	.000
性別	1.976	1	1.976	2.691	.104

假說驗證：男女學生的情感態度成效未達顯著差異，不同性別不會影響學生之情感態度成效，F(1,120)=2.691, *p=.104*。

假說 5：理性感性附加語意及性別對認知學習與情感態度沒有交互作用。

統計分析：利用一般線性模式的敘述統計與 ANOVA 再用 Post Hoc 檢定的 Tukey HSD 多重比較，交互分析各組間男女生的認知學習與情感態度成效，如表 15、16、17、18、19：

表 15. 組別與性別之認知學習成效檢定

依變數	組別	性別	平均數	標準離差	個數
認知評量測驗	控制組	女	6.95	.999	20
		男	6.45	1.317	20
	理性	女	7.74	.653	19
		男	7.71	.561	21
	感性	女	7.77	.599	13
		男	7.61	.567	28

表 16. 組別與性別之認知學習顯著性分析

來源	依變數	型 III 平方和	df	平均平方和	F	顯著性
截距	認知評量測驗	6251.668	1	6251.668	9117.126	.000
組別* 性別	認知評量測驗	1.199	2	.600	.874	.420

表 17. 組別與性別之情感態度檢定

依變數	組別	性別	平均數	標準離差	個數
態度平均	控制組	女	3.38	.355	20
		男	3.07	.448	20
	理性	女	3.72	.432	19
		男	3.41	.297	21
	感性	女	3.86	.287	13
		男	3.83	.291	28

表 18. 組別與性別之情感態度交叉表

組別	性別	影片觀後感				總和
		體會情感	資訊清楚	兩者皆有	皆不明顯	
控制組	女	2	10	2	6	20
	男	1	6	1	12	20
理性	女	2	14	3		19
	男	1	16	4		21
感性	女	5	1	7		13
	男	8	5	15		28

表 19. 組別與性別之情感態度顯著性分析

來源	依變數	型 III 平方和	df	平均平方和	F	顯著性
截距	態度平均	662.668	1	662.668	902.271	.000
組別 * 性別	態度平均	1.680	2	.840	1.143	.322

假說驗證：組別與性別間的認知學習成效未達顯著差異 F(2,115)=0.874, *p=.420*，但本研究發現，男生觀看理性組有較佳的學習成效(mean=7.71)，女生則是觀看感性組有較佳的學習成效(mean=7.77)；接著，組別與性別間的情感態度成效未達顯著差異，但是本研究也發現，男生觀看感性組(mean=3.83)的情感態度相較於控制組(mean=3.07)與理性組(mean=3.41)有明顯成效，女生也是觀看感性組(mean=3.86)的情感態度相較控制組(mean=3.38)與理性組(mean=3.72)有明顯成效。

5 結論

本研究結果證實，相較傳統無附加語意之影片，將有目的、意義的訊息經由文字、圖像、聲音等物質形態來傳遞，使人們認知、吸收，進行學習，透過理性與感性附加語意應用於影像結合的方式，增添文字解說輔助，促進學生對內容的反思(Clark & Lyons, 2004)，確實能提高學生的專注力與聯想記憶力，且多數受測學生能夠正確吸收知識，達到良好學習成效；而採用感性附加語意與影像結合，藉由情境的感染牽引，確實能促進學生更投入(Beatty, 2011)，引發學生知識學習興趣，同時傳達正向思維。應用腳本概念整合資訊，能促使閱聽眾對內容記憶更深刻，並提升資訊回憶的貫串力(Singer et al., 2013)。具故事腳本設計的語意重點，有助於喚醒記憶與進行深度思考(Ivala et al., 2013)，成串的訊息經自我的解讀組織判斷，有邏輯的歸納內容，可建立通盤的理解(Bower, Black & Turner, 1979)，理性形成知識連結，感性促使情感態度連結，互相的輔助，產生理智與情感的溝通平衡，幫助閱聽眾融會貫通學習領域之間的關係(Eisner, 1993)。然而性別的部分未達顯著效益，可能是由於觀看內容為生態影片，男女生的基礎認識程度接近；研究也發現結果與常理之男性較理性，女性較感性一致，男學生接收訊息與反應時的情緒態度屬冷靜、沈著反應，多以邏輯推理的思考過程來解讀，因此可以提供更多理性面向資料，並適度補充感性資訊。而女學生接收訊息與反應時的情緒態度是澎派、細膩、由內心深處激發出感觸，思考過程充滿豐富的情感，因此對女性宜提供更多感性面向資料，並適度補充理性資訊。研究結果對未來文字腳本及影音設計製作有很大意義，以結合理感性的附加語意設計與教育的課綱方針開發輔助教材，提供適切屬性選擇，達到因材施教的教學目標，有利於教師教學品質以及學生學習成效的提升。期待藉由本研究未來能延伸針對不同年齡族群，不同的知識內容做進一步研究，為影音製作提供更為完整的設計指引。

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3D動畫師心智地圖描繪與核心技能推導

張裕幸 [1]，**溫羿真** [2]
1 世新大學數位多媒體設計學系, yhchang@cc.shu.edu.tw
2 聯合信用卡中心資訊服務部，apearl@mail.nccc.com.tw

摘要

近年來，3D 動畫的藝術表現相當受到歡迎並被公認為主流娛樂，而「原創」與「美學」更是其核心價值。為配合動畫電影新興產業的需求，以及培育本地動畫專業創作人才，自 2001 年起，台灣大專校院陸續設立動畫相關科系，至今已超過 50 餘個系所。然而動畫教學目標應與貼近企業用人需求，以提昇其專業能力，方能支撐動畫產業成長。有鑑於此，本研究認為了解業界 3D 動畫師的外顯知識有助於學界人才培育接軌業界需求。外顯知識的描繪係經由訪談國內業界 3D 動畫師的學習歷程進行構面抽取產生心智地圖，經受訪者確認後再推導共同的核心能力。研究方法包括質化訪談、編碼與發展範疇，描繪心智地圖並歸納其核心能力。研究結果顯示，電腦動畫師其專業能力必需包含三個面向，即創意設計能力、電腦技術能力與職業性向能力。創意設計能力係指美學素養、手繪技藝與創意表達等 27 項能力組合；電腦技術能力則有對電腦技術的應用與整合能力等 8 項能力；職業性向能力則有商業化能力與國際化的視野等 16 能力。

關鍵詞：電腦動畫、心智地圖、核心技能、3D 動畫師。

Depiction for 3D Animators' Mental Models and the Core Capabilities Derivation

Yuh-Shihng Chang [1], **Yi Zhen Wen** [2]
1 Department of Digital Multimedia Arts, Shih Hsin University, yhchang@cc.shu.edu.tw
2 National Credit Card Center of R.O.C，apearl@mail.nccc.com.tw

ABSTRACT

The art and esthetics of 3D animation are so popular, it had be regarded as the main entertainment recently. Specially, the original and the esthetics are the core value of animation. In order to coordinate the flourish of animation movie industrial, the universities founded the animation relative departments, and have more than 50 departments until now. However, the most graduates' qualifies would not meet the requirements of the employers. Based on above observations, this research tried to depict the dominant knowledge of 3D animators of Taiwan. To establish their mental models and the core capabilities, which are the representation of 3D animators' dominant knowledge. The research method including interviewing the professionals of the 3D animators and sketch the tacit knowledge of their interview manuscripts, to draw the individual mental models and obtain the core capabilities. The result of our research is that the 3D animation professional capabilities include tree categories, i.e. the planning design, computer technologies and the career development dimensions. The planning design category contains the aesthetic, sketch and creative and so on 27 abilities. The computer technologies category contains the integration, application capabilities and so on 8 abilities. The career development category contains the commercialization, the global view and so on 16 capabilities.

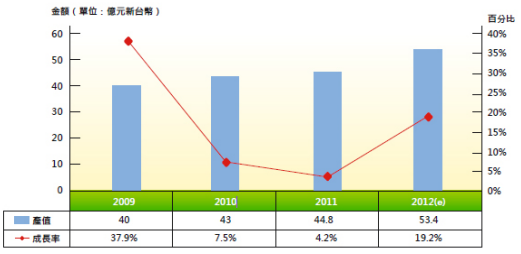
***Keywords*:** Computer Animation, Mental Model, Core Capability, 3D Animator.

1 導論

世人真正見識到 3D 電腦動畫的魅力在於 1993 年美國大導演史蒂芬史匹柏所拍的《侏羅紀公園》(Jurassic Park)，當喬治・魯卡斯的動畫技術讓遠古時代的恐龍再現在全球觀眾的眼前時，很多觀眾如同電影主角山姆尼爾無法相信眼前的事實而大聲驚呼。就在當下，3D 電腦動畫的力量不僅讓恐龍復活，它進一步改變整個電影產製模式以至人類的娛樂方式。到 1995 年，電影史上第一部全 3D 電腦動畫的《玩具總動員》(Toy)推出後，創造了 3 億 5 千 4 百萬票房加上 1 億美元的錄影帶出售成績，讓傳統 2D 動畫的市場佔有率漸漸勢微；知名的 3D 動畫電影如 2001 年的《怪獸電力公司》(Monsters, Inc.)、《史瑞克》(Shrek)，輕易突破 4 億 7 千 8 百萬美元的票房(Ian, 2005)、到最近 2013 年 3D 動畫片大作《冰雪奇緣》(Flozen)襲捲全球票房達 12.75 億，這些電影皆利用大量的 3D 電腦動畫製作技術，豎立娛樂產業的里程碑，屢創電影票房新高記錄。於是，全世界動畫產業的典範漸漸由 2D 手繪卡通轉移至 3D 電腦動畫，以 2010 年至 2014 年全球票房為例，能創造上億美元營收的票房均為 3D 動畫(Box Office Mojo, 2014)。

至於，反觀台灣電腦動畫產業產值依據經濟部工業局統計 2012 年約 53.4 億元新台幣，較 2011 年成長約 19.2%。仍以動畫電影的海外代工為主，產值成長主要來自於肖像授權及新媒體動畫(體感遊戲機上的動畫內容)，而真正能開拓市場產值的原創型動畫電影 2013 年之後仍有待觀察(經濟部工業局，2012)。

表 1. 2009~2012 年台灣電腦動畫產業產值



(資料來源：經濟部工業局，2012)

3D 動畫是需要美學素養再加上電腦技術的文化創意產業，台灣過去從事動畫代工培養了許多優秀的動畫製作與技術人才。但動畫的核心價值是故事創意與想像力；相對地，台灣動畫在開發全球性作品所需要的「原創型」動畫人才相對貧乏。美國知名電腦動畫公司藍天工作室技術指導賴聿倫先生認為，對於從事電腦動畫業界來說，個人的才華是相當重要的天分；不論是在藝術領域或是電腦技術領域，都需要數年的時間培養其專業的技能。一個剛出道的動畫師就需要 3 年至 5 年的訓練時間，而美學的素養則更不可能在數個月內得到提升，需更長的時間累積經驗與能力(呂敦偉，2005)。

產業要發展成功，重要的關鍵就是要有優秀人力投入。韓國自 1999 年時該國只有 12 個動畫相關科系；到 2003 年則超過 1500 個系所(張純嫻，2003)。國內大學校院於 2001 年起陸續開授動畫製作課程或成立相關科系，至 2014 年與動畫相關的數位媒體設計科系則超過 50 餘所。但由於台灣 3D 電腦動畫創作環境缺乏大型的電影工業作為後盾，經濟規模小，無法以現有產製模式培養大量所需專業人才。在產業合作方面亦無法比照好萊塢與美國西岸大學的合作模式下建立起關鍵知識的轉移。因此相對上，台灣 3D 電腦動畫師養成的環境更形困頓。新成立的科系缺乏專業實作技能與業界最新技術水平間有極大的斷裂，為此西基動畫公司董事長施文祥表示：「許多大學在學期間做了很多作品，但這些作品對業界來說，都是未達標準的。目前大學畢業生的動畫製作能力只有 30-40 分，必須加強到 50-60 分，才是業界可以接受的(陳恆光，2013)」。雖台灣動畫公司目前與國內部分大學嘗試開設產學合作的訓練課程，包含教材分享與師資訓練。惟業界在分工上是相當細緻，在選用人才上要求的是學生否具備 3D 動畫某項特定技術的專才？業界需要什麼樣的人才?業界需要的動畫人才是否有共同的特質或類型？上述提問若回歸其業界目前專業動畫師的核心能力是什麼？可以達到符合職場核心能力的部分面向。然而這只是動畫師外顯的能力，至於有關於原創才華這部分，如創意、發想、觀點與敘事能力等等內隱的特質呢? 就必藉由了解 3D 動畫業師的內在心智模型與外顯技能間的轉換過程的了解，方能培養真正的動畫人才，解決需求與供給落差的問題。

大學價值在於其可提供卓越教育，讓學生得以經由高等教育成為社會的菁英，個人能力得以充分發展，經濟可以良性進步及整體產業亦蒙其利(黃政傑，2007) 。惟當今 21 世紀，大學角色除了需重視人文涵養與通才教育之外，亦要透過卓越教學發揮最後一哩(the last mile)的效益 ─ 「輔導學生至就業之路，訓練學生職能直接與企業需求接軌。」時代的變遷下，大學教育應強調提升大學生就業力(employability)，所以大學生就業力是衡量大學績效的一項新指標。在第 15 期評鑑雙月刊中一文「評鑑大學績效的新指標—就業力」就

指出：「一般而言，就業關注的通常是大學畢業生在一特定短期內 3 至 6 個月能否找到工作，進入職場服務；相對地，就業力所關注的是在一專業領域的長期生涯發展，甚至可轉換至不同專業領域的工作能力之培養。因此，並不應狹隘地只注重大學畢業生的就業而已，而是重視大學畢業生的競爭力…」。在美國，有一些大學引進的「關鍵技能」（critical skills）或核心能力，在加拿大將核心能力視為是高級人力在生涯發展中所必要的能力(王如哲，2008)。

站在教育立場，本研究認為提昇國內動畫人才的品質是改變台灣現有產業環境的重要因素之一。好的人才是動畫產業生產鏈的核心，能促進產業成長的良性循環。進一步帶動相關週邊事業的蓬勃發長，形成動畫產業的價值鏈體系，如圖 1(張裕幸，2007)。

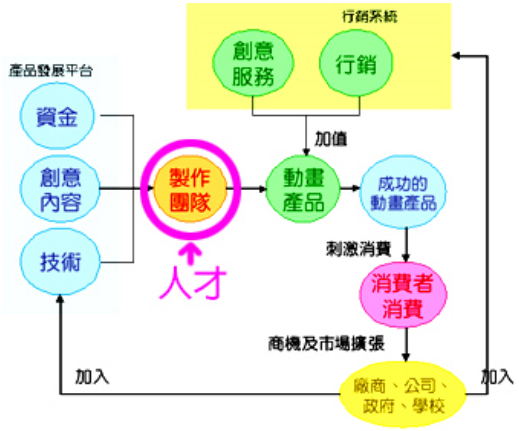


圖 1. 動畫產業的價值鏈

資料來源：(張裕幸，2007)

專家知識包括「默會知識」與「外顯知識」。由於默會知識僅能轉移無法描繪，僅可意會無法言傳(賴鼎銘、葉乃靜，2007)，但從外顯知識中得知其核心技能。惟，專家的外顯知識可從描繪 3D 動畫師個人內在心智地圖，進一步歸納 3D 動畫師的外顯核心能力。承此，研究目的條列綜述如下：(一)描繪 3D 動畫創作人才的內隱心智地圖，了解業界 3D 動畫師外顯的核心技能為何。(二)以三多原則分析個別心智地圖的構念，以超過構念涵蓋率 50%為準則歸納出 3D 動畫師的核心能力。本研究對 3D 動畫師外顯知識描繪流程如下：質化訪談→訪談內容質化編碼與歸納→描繪個別心智地圖→歸納外顯核心能力。

2 文獻探討

2.1 3D 動畫

3D 動畫包括：電影或劇場版動畫、電視動畫、遊戲動畫、廣告動畫、網路動畫以及後製特效動畫等；對電影(劇場版)動畫或電視動畫而言，主要的關鍵在於有好的故事劇本、製作技術及視覺特效，透過全球性的發行通路，就可以行銷全世界。進入數位的新時代，3D 電腦動畫技術的成熟，讓動畫的視覺特效越來越擬真與華麗。除了高科技電腦所創造的逼真特效外，最重要的因素就是動畫角色在表演上與實拍影片(live action)的戲劇敍式形式上不同，3D 動畫表演生動活潑，它以動畫的方式敍事，不著痕跡地結合現實與非現實的環境、場景(scene)、情境(scenario)、內心狀態、夢境、記憶與幻想，形成超現實的類像，獲得觀眾的認同，並回饋高品質、引人入勝的畫面與豐富感人等情節。

早在 1978 年科幻故事電影「星際大戰」(Star Wars)，導演喬治盧卡斯(George Lucas)就運用了動畫的概念於影片中絕地武士手持的「光劍」，而成為科幻片的經典名作。到了 1989 年，迪士尼的《小美人魚》(The Little Mermaid)開始採用電腦繪製背景，並加上結合流行音樂的歌舞劇風格，推出後在市場上大受歡迎。在《小美人魚》動畫電影中，美人魚的童話故事並非原創，但在電腦技術與歌舞劇的表現手法下重獲新生，以新的手法來創新與表現創意，呈現給觀眾耳目一新的體驗(陳昭義，2005)。1990 年代，喬治盧卡斯成立的 ILM 公司負責好萊塢五成以上電影特效。其中最為知名的是《侏儸紀公園》中栩栩如生的各式恐龍。從 1990 年代至今，拜電腦高科技之賜，動畫電影也開始給人不同的風貌和感覺，在好萊塢電影工業大力推波助瀾之下，而 3D 電腦動畫應用於電影製作與特效已趨成熟，並且 3D 動畫已漸漸成為一般大眾所喜愛的主流電影之一。1995 年則是電影史上的里程埤，由迪士尼發行，皮克斯製作的全世界第一部全 3D 動畫電影《玩具總動員》，其整部片子充滿了令人激賞的創意與靈感，全世界創造了 3 億 5,400 萬美元的票房收入，是當年影史以來第 14 部賣座電影。引起全球觀眾對 3D 動畫影片的興趣，也帶動 3D 動畫電影的快速成長與流行，隨後多部影片如《蟲蟲危機》(A Bug's Life)、《史瑞克》、《怪獸電力公司》、《超人特攻隊》(The Incredible)證明 3D 動畫的潛力與受觀迎的程度，好萊塢電腦動畫技術也邁向新的里程埤(李娟萍，2005)，並掌控了全球商業動畫電影的消費趨勢。從 2010 年至 2014 年好萊塢動畫影片中累積票房票房上億美元的影片皆為 3D 動畫電影，不僅在題材腳本的再創新、有趣溫馨的故事情節、老少皆宜的幽默感、及對角色人物真誠而深刻的描繪、精心

動畫製作與唯妙唯肖的視覺特效等等因素，3D 動畫電影始終佔有一席之地與具有重要性的指標與影史意義，更是全球票房賣座的最佳保證(如表 2)。

表 2. 2010 年～2014 年全球賣座 3D 動畫電影

NO	好萊塢 3D 動畫電影	美加票房	發行年/月
1	樂高玩電影 (The LEGO Movie)	**$257**	2014/2
2	馴龍高手 2 (How to Train Your Dragon 2)	**$174**	2014/6
3	里約大冒險 2(Rio 2)	**$131**	2014/4
4	冰雪奇緣(Frozen)	**$400**	2013/11
5	神偷奶爸 2 (Despicable Me 2)	**$368**	2013/7
6	怪獸大學 (Monsters University)	**$268**	2013/6
7	古魯家族(The Croods)	**$187**	2013/3
8	無敵破壞王 (Wreck-It Ralph)	**$189**	2012/11
9	冰原歷險記 4 (Ice Age: Continental Drift)	**$161**	2012/7
10	勇敢傳說(Brave)	**$237**	2012/6
11	馬達加斯加 3 (Europe's Most Wanted)	**$216**	2012/6
12	汽車總動員 2 (Cars 2)	**$191**	2011/6
13	功夫熊貓 2 (Kung Fu Panda 2)	**$165**	2011/5
14	玩具總動員 3 (Toy Story 3)	**$415**	2010/6
15	史瑞克 4 (Shrek Forever After)	**$238**	2010/5
16	魔髮奇緣(Tangled)	**$200**	2010/11

註：本表為彙整美加地區上映票房(單位百萬美元)，以魔髮奇緣(Tangled)為例，美加票房 2 億美元，全球票房 5 億為 9 千萬美元。

(資料來源：Box Office Mojo, 2014)

儘管科技能替動畫影片達到加分的效果，但是流行性娛樂市場的高報酬與高風險特質依舊未變，以 2010 年迪士尼發行第 50 部電影魔髮奇緣(Tangled)為例，其影像視覺風格同時融合了 3D 電腦科技及傳統手繪，以 2 億 6 千萬美元的影片製作成本，全球電影票房就達 5 億 9 千萬美元的收入，投資報酬率為 226%躋身於全球賣座影片。尤其值得一提是 2013 年 3D 動畫片《冰雪奇緣》這部連續贏得第 71 屆金球獎最佳動畫片、第 41 屆安妮獎最佳動畫電影、第 67 屆英國電影學院獎最佳動畫電影，以及第 86 屆奧斯卡金像獎最佳動畫長片。全球 12.75 億美元票房，是有史以來最高票房的動畫片(Box Office Mojo, 2014)。所以利用 3D 動畫數位科技加值的文化創意產業，已成為產業獲利新主流。當台灣硬體代工走向「微利」時代，本土原創勢力也朝向依循「皮克斯經驗」摸索上路。如西基動畫、首映創意、大腕、ODD incredible、太極影音、頑石創意、甲馬創意、滾石移動、電視豆等從事動畫創作的公司，正著手佈局著如何透過原創動畫，推產品推向國際舞台，獲取數億商機。台灣身為華人文化樞紐，如何利用這方面的優勢，配合產業政策或教育方式擴大動畫產業規模，建立良性循環的產業供應鏈以搶攻廣大的華人市場，為當務之急的議題。另，台灣高等教育單位陸續成立 50 多所數位媒體設計科系，其課程規劃設計均與培養動畫人才有關。如何建置符合業界需求的 3D 動畫師核心能力以及有系統化的學習機制。本研究認為可藉由了解動畫業界動畫師內隱的心智地圖描繪，再推導外顯的核心能力定訂，再以其核心能力規劃相應的課程做為學習指引，讓訓練出來的學生發揮長才為企業所用，才能提昇當前高等教育培訓動畫人才的品質。

2.2 心智模型

人類的腦部記憶結構基本上是由無數的網狀神經元節點(Nodes)與節點間的神經元傳導連結(Link)所構成(Jonassen,2000)。英國頭腦基金會總裁東尼・博仁(Buzan,1993)提出一種以圖像表達人腦結構的方法稱為心智圖。Buzan 在 1991 年針對一位十三歲小孩進行研究中，由學童實際學習的觀點描繪「心智地圖」，其中繪製圖像或文字於紙中央：表示主觀點。再繪出支線，用關鍵字或圖表示相關主題或要點。由相關主題或要點，繪出次連結線，用關鍵字或圖表示次相關主題或次要點。由次主題或要點，繪出連結線，表示詳細之狀況，由支節點擴展表示更細之相關知識資訊。密西根大學學者 Kieras and Bovair 認為心智圖涉及複雜的心理系統，反映放射式思考概念，以一個知識中心點向外擴展，它是知識聯想的過程，透過心智地圖可以有系統地了解專家在其專業領域所擁有的關鍵知識(Kieras & Bovair, 1984)。Buzan 並指出心智圖可以配合其他策略或工具，如集體研討技巧、潛力開發、腦力激盪、文字、圖形刺激、顏色應用技巧…等等，可作為開發潛意識或創新思考等訓練。顯然，心智圖是由節點和表達節點之間關聯的鏈接所構成，它與人類心智思考及神經突觸(synapse)相似，可以將人腦內的思維以一種較容易理解的方式表達出來，亦可以代表個人的知識與行為的心智模式(Zaltman & Schuck, 1998)。Johnson-Laird 在知名的《Cognitive Science》期刊中發表了「認知科學中的心智模型(Mental Models in Cognitive Science)」論

文中指出：心智模型的理論有效說明了孩童在學習過程中如何進行問題的推導，以及建構其內在思考過程的推理法則。因此，在國外大多數研究認知科學的學者們均接受以心智圖的表現形式以凸顯學習的實證結果(Johnson-Laird, 1980)。如今利用心智圖表達潛意識或感官思維已被廣泛地應用於教育學、心理學或社會科學各領域(Brinkmann,2003; Good,2002; Israel & Buzan,1991; Steyn & Boer,1998)，可見心智圖可以有效地組織大量的非結構性資訊和知識，將內隱知識或構想予以概念化表現或系統化整合(連啟瑞、盧玉玲，2005)，Kieras and Bovair 認為心智模型對學習的認知階段有重要的實證性。在學習過程中對專業知識的建構，日本學者野中(Nonaka)與竹內(Takeuchi)呼認為知識創造的兩個構面即認知與技能，認知層面可以由心智地圖予以呈現檢視，而技能部分則是因應特定情境下之不斷練習而獲取的純熟技藝，由「做中學」而習得，由認知至技能展現即內隱至外顯轉化的過程(野中郁次郎、竹內弘高，1997)。研究社會科會學者 Carley & Palmquist (1992) 指出透過語言表達可以把觀念與語意結構轉化成具相關性的網路拓樸結構，形成心智模式，它可以有效呈現知識歷程而形成自我內在知識，心智模型廣泛應用於認知科學中描繪個人的概念性邏輯模型。承上述文獻回顧，本研究將將設定訪談國內 3D 動畫師的主題為(1) 以說故事方式陳述個人的學習心路歷程。

2.3 職能導向的核心能力

所謂核心能力係指個人在職場上或公司相較於競爭對手擁有其競爭優勢，；對公司而言，核心能力能讓公司產品產生效益、而且能擴展其市占率以及讓競爭對手無法超越。核心能力需要時間的積累和長年累月地學習以有效地組織能力和佈署資源：例如管理能力、行銷經驗、製造效能、運輸與流通、資訊系統處理效率以及研發能量等(維基百科，2014)。所以，核心能力應是學生畢業後所能展現出來的能力，而不是教師在校內所教授的能力(劉維琪，2010)。判斷是否具備核心能力的標準在於該能力是否能創造出競爭優勢。Hanson, et al.(2008)提出滿足四種競爭優勢的標準：

(1)有利的：核心能力讓企業或公司得以創造機會或化解存在或未來的威脅。

(2)稀有的：核心能力是相對稀少的或需要大量的時間資源投入得以累積。

(3)難以仿效：個體或企業不容易發展該能力。值得注意的是，它不僅意味著要仿效需要昂貴的代價，更重要是仿效它相當困難。

(4)不可替代：核心能力沒有等價的替代物，例如研發能力(R&D)，它需要相當的關鍵技術或關鍵知識。

歐洲先進國家的雇主們相當重視職能導向的核心能力，特別在職業學校的人才培育教育的具體落實。以德國為例，為了提升學校人才核心領域的專業能力，特別重視實務能力、產業核心知識(know-how)的養成、職場態度和職業倫理等(Walter, 2001)。對多數產業雇主而言，關注的是學校所培育出來的人力素質，能否符合階段性產業競爭環境對人才能力的需求。此人才能力的表現，直接影響企業能否在不景氣的逆境中繼續生存與發展的關鍵。於是儘管學校在培育人才上，台灣面臨長期產業不景氣態勢下，各級學校必須省思企業雇主對學校培育人才的期望(周談輝，2001)。以 3D 動畫產業為例，整個產製過程從故事企劃、分鏡腳本、角色道具場景塑模、動畫肢體表演、貼圖(材質)、到燈光效果、攝影機運動以至後製剪輯幾乎都是長時間腦力密集工作。在台灣積極發展文化創意產業的趨勢下，設計學群動畫相關科系成為志願填選的大熱門(臧聲遠，2013)，故對目前以 3D 動畫產業培訓人才的相關科系，應認知其畢業生應具備有 3D 動畫核心能力的專業，才為目前動畫業界所想要的人才。在高等教育評鑑中心基金會所發行的《評鑑雙月刊》中陳恆光先生亦提到：「為證明學生所學達到教育目標，應聆聽企業僱主、學生家長與畢業校友的意見，並注意教學成果，應是先達到教學成果，再證明能達到教學目標。」其中，持續課程改革與建立核心能力檢核系統，是系所應進行的重要教學改進措施。藉由校友就業調查、了解業界人才需求與政府產業規劃方向，可以設定符合業界職能所需的核心能力 (陳恆光，2013)。承上述文獻回顧，本研究將將設定訪談國內 3D 動畫師的主題為(2)您個人認為您具備哪些能力是符合 3D 動畫業界需求？及(3)業界如何評估這些能力？至於可否(4)對目前學界 3D 動畫課程的建議。

3 研究方法

3.1 研究設計

為能有效描繪 3D 動畫師的心智模型，本研究採質化半結構式專家訪談，於進行深度訪談前先讓受訪者清楚了解訪談的主題，並依據真實訪談的情境及受訪者的反應來適時調整問題之順序，讓受訪者表達出個人本身的學習經驗、觀念感受、態度、專業能力等，期使本研究能更了解受訪者對問題的想法與態度。以建構 3D 動畫師外顯的專業核心能力，本研究所設定訪談對象包含 3D 動畫的企業僱主、學界具有業界經驗的 3D 動畫教師或畢業校友，

並需符合下列幾項原則：

(1)受訪者所任職之單位為從事 3D 動畫製作並有持續性作品產出。
(2)受訪者有動畫師資歷超過二年以上，目前為資深動畫師或以上職位。
(3)受訪者為動畫相關之教育訓練單位，負責動畫人才培育之業務。
(4)受訪者參與之公司 3D 動畫專案作品曾獲國際級動畫獎之記錄。

目前符合上述原則且完成深度訪談之受訪者資料如下(表 3)：

表 3. 受訪者背景資料(業界)

編號	現職	背景敘述與經歷
A	黃先生	曾任西基電腦動畫、東森電視台、台灣夢工場、尚風科技、森林創意公司總監，專長 3D 電腦動畫專案規劃擁有多年產業及國際合作經驗，業界年資超過十年。符合受訪條件 1、2、3、4。
B	陳小姐	為西基電腦動畫 3D 動畫模型師，業界資歷滿八年。符合受訪條件 1、2、4。
C	呂先生	專長為 3D 動畫、虛擬實境、電腦動畫概論、後製特效剪接、曾任鴻友科技工業設計師…等豐富之經歷，本身更是資深 3D 設計工作者、3D 動畫教師。業界年資則超過十年。符合受訪條件 2、3。
D	吳小姐	作品入選 2007 教育影展動畫片，目前為西基電腦動畫 3D 動畫模型師，業界資歷滿八年。符合受訪條件 1、2、4。
E	賈先生	動畫製作人，有著基層歷練的功夫與專案之統籌能力，現行主要督導整個專案動畫的製作與創作開發，業界年資十年。符合受訪條件 1、2。
F	王先生	動畫公司創辦人、影音內容需求規劃、製作執行與影音動畫技術及內容開發與動畫影音製作(如相關軟體、書籍、資料…等)，並負責培育公司新人，以製作更精緻的動畫作品為主，業界年資超過十年。符合受訪條件 1、2、3。
G	吳先生	動畫製作人，從大學時接電腦動畫的設計案，從一開始的繪圖設計到現在。並也曾擔任新藝術遊戲學苑的顧問，協助課程設計的安排，業界年資超過十年。符合受訪條件 1、2、3。
H	楊先生	太極影音股份有限公司從事動畫製作總監，帶領過動畫專案曾獲得許多國際大獎並得到同業界肯定。符合受訪條件 2、4。

在訪談對象的時間許可下，研究者徵求受訪者同意現場錄音並將訪談內容轉成逐字稿，找出相關的重要概念與構念，進行概念化編碼，依據編碼原則依順序為構念(Dimensions)、範疇(Categories)及核心範疇(Core category)，描繪出 3D 動畫師個人心智地圖。完成上述個人心智地圖的描繪後經由受訪者確認無誤後，再以三多原則進行比較分析及整合、建立所有受訪者共同的「核心能力」。三多原則源自於學者 Christensen & Olsnon (2002) 及 Zaltman & Coulter (1995)提出將共同構念及相關構念納入共識地圖(Consensus Map)的兩個準則，即(1)共同構念為提及某構念的受訪者人數達受訪者總數的 1/3；(2)相關構念則為提及相對關係的受訪者人數達受訪者總數的 1/4。

3.2 訪談設計與資料信度

本研究以半結構式深度訪談來進行訪談，半結構式訪談為事先提供初步訪談主題或大綱，以方便研究者進行一系列跟研究主題相關之問答，它包含一種引導性的對話，比傳統結構訪談的方法更為有效(劉明德等，2007)。本研究訪談設計包含以下四個主題：

(1)、受訪者以說故事方式陳述個人的學習心路歷程。
(2)、您個人認為您具備哪些能力是符合 3D 動畫業界需求？
(3)、業界如何評估這些能力？
(4)、對目前學界 3D 動畫課程的建議。

上述訪談大綱所設定四大主題的原因分別為：第(一)問項希望受訪者不管是否科班出身，了解其學習路徑為何，與如何建立其個人的專業領域知識，訪問完第一題會進行訪談內容質化編碼與歸納並描繪個別心智地圖；(二)問項希望能了解受訪者具備哪些能力是業界認定 3D 動畫的核心能力(質化編碼所需)；第(三)係對照第一題、第二題希望能更具體地以業界的語言描述這些核心能力(統整同意不同詞的用語)；第(四)則為開放式問項，以業界觀點進行課程規劃的建言，希望業界提供個人的業界經驗如何讓學界訓練人才與業界需求接軌。透過質化方法中概念編輯進行開放式譯碼(徐宗國，2004)描繪受訪者的心智地圖，再進一步推導其核心能力。

在資料的信度上，本研究於資料蒐集過程中，運用三種方法來確保資料蒐集的可靠度，以提升本研究的內在信度，第一：盡量完全保留研究對象的原始陳述詞彙，第二：研究對象之相關背景資料確認與專業代表性，第三：在訪談過程中，要求受訪者確認所抽取之構念及所描繪的心智圖是否符合其學習行為特徵。本研究資料分析步驟如下：

(1)、謄錄逐字稿：為了分析的方便，將訪談的資料逐字翻成文件，並打字編排，以做

為資料分析的基礎。

(2)、閱讀本文：反覆閱讀訪談記錄是否為本研究最重要的資料分析基礎。

(3)、依主題編碼：對本文資料適度解讀後，由文本涵義及文獻的觀點中發展一些主題，做為編碼的類別。

(4)、資料呈現：把資料予以概念化編碼依照逐字稿之頁次及行次標明，再一一分類於主題編碼類別之下，以抽取構念與相關概念。

(5)、構念確認：描繪出構念及構念間相關路徑，經由受訪者確認後定稿。

(6)、定義範疇：由研究者發展範疇並為範疇定義名稱，以整合不同受訪者對相同概念不同詞彙名稱的差異，並可以對不同的構念做系統化分類。基本上範疇名稱需要拉高其抽象層次並涵蓋所涉及的概念(徐宗國，2004) 。

(7)、描繪個人心智地圖：一旦完成了範疇命名後，並決定其核心範疇，即可描繪受訪者之心智地圖。為確保編碼後資料的效度與內在一致性，本研究除了請受訪者確認訪談後所萃取出的構念與構念間的關連性外，亦協助受訪者依據上述構念與關連性描繪出個別心智地圖(Kassarjian, 1977)。

(8)、抽取共同構念：以心智圖所呈現的構念依三多原則彙整出共同構念與構念間之關係。

(9)、外顯核心能力推導：依步驟(8)結果進行歸納專家的外顯核心能力。

4 研究結果與分析

4.1 構念與個人心智地圖

本研究針對表 3 符合篩選原則的八位 3D 動畫師(以 A、B、…、H 表示)進行上述六項步驟操作後，取得每位受訪者的個人構念，依編碼原則將其構念分別納入三大範疇；分別為「創意設計能力」、「電腦技術能力」以及「職業性向能力」，並描繪出個人的心智地圖，惟限於篇幅考量本文僅呈現受訪者 B 西基動畫師陳小姐的個人心智地圖(如圖 2)及西基動畫師吳小姐的個人心智地圖(如圖 3)。圖 1、2 中白色圈圈為個人心智地圖中所提到的構念，本研究彙集八位動畫師的個別構念，以三多原則共抽取出 165 個共同構念。圖 2、3 構念與構念間關係為雙向關連，白色圓滿代表受訪者在訪談中所提及的原始構念，紅色圓圈代表使用開放性譯碼過程，比較不同構念間若指涉同一現象時，就可以把這些概念聚攏為同一組構念，並指定一個層次較高也較抽象的構念統攝，即圖中紅色圓圈。個別心智地圖間的關連為階層式由下而上聚合關連。因為特定個人之訪談結果，在訪談中彼此間相互指涉關連較少。

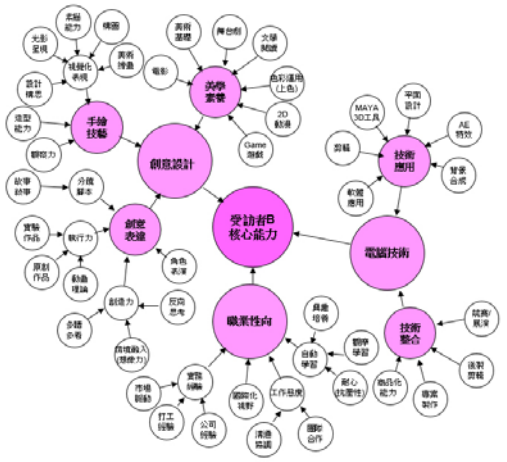


圖 2. 受訪者 B 的心智地圖

(註：經受訪者 B 確認)

範疇的推論以受訪者 B 為例，動畫師陳小姐為西基 3D 模型師，她認為平時她會閱讀文學作品、觀看舞台劇，休閒活動有看電影及玩時下流行的 online Game，及漫畫。從這些媒體或文本中可以增進她對美感的素養及色彩的感知。她亦認為自己的美術基礎訓練也是她從事這行業的基本功。故在進行構念推導時，本研究將「電影」、「美術基礎」、「舞台劇」、「文學閱讀」、「色彩運用」、「2D 動漫」及「Game 遊戲」視為原始構念，由下而上彙集子範疇為「美學素養」。

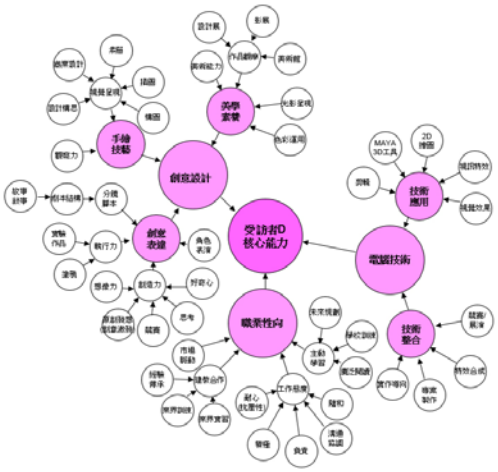


圖 3. 受訪者 D 的心智地圖

(註：經受訪者 D 確認)

4.2 抽取共同構念

經由三多原則彙整歸納出 51 個共同構念總表如表 4 所示。三多原則源自於學者 Christensen & Olsnon(2002)、Zaltman &

Coulter(1995)提出將共同構念及相關構念納入共識地圖(Consensus Map)的兩個準則，即(1)共同構念為提及某構念被受訪者提出的人數達受訪者總數的 1/3，則該構念納入共同構念；(2)相關構念為構念與構念間的相對關係被受訪者提到的人數達受訪者總數的 1/4。本研究採用之三多原則與受訪者取樣無關，它是編碼後之模型化原則。在共識地圖中可以發現80%以上的共有構念會於每位個別受訪的構念中被提及。以本研究為例，若有超過 3 位受訪者(3 位受訪者>=8 位受訪者/3)提及「創造力」，則該構面會納入共同構念與共同心智地圖之中；再者若受訪者超過 2 人(2 位受訪者>=8 位受訪者/4)提及創造力與想像力有關連，該相對關係亦進入共同心智地圖之中(如圖 4)。共同心智地圖中，白色構念間的關連均標示著經三多原則統計出，8 位受訪者針對構念間相互指涉的次數，該次數數據表示 8 月受訪者間共同看法的重疊次數。

表 4 是經由三多原則操作後，整理出 8 位受訪者的共同構念。從心智模型到共同概念圖的轉化以構念 3「工作態度」為例，提到動畫產業職場上直接指明「工作態度」相當重視有 A、B、C、D、E、F、H 共計 7 位。但受訪者有人(B、D、H)認為「執行力」為工作態度的面向之一；受訪者(B、C、E、F)認為「團隊合作」是工作態度的面向之一。以此類推由表 4 中共同概念如「執行力」、「積極進取」、「團隊合作」、「溝通協調」彙集成「工作態度」構念予以概括，在訪談稿中有直接提及「執行力」與「工作態度」者經統計有 3 位受訪者(B、D、H)、明確提及「積極進取」與「工作態度」者有 4 位受訪者(D、E、F、H)，如圖 4 所示。

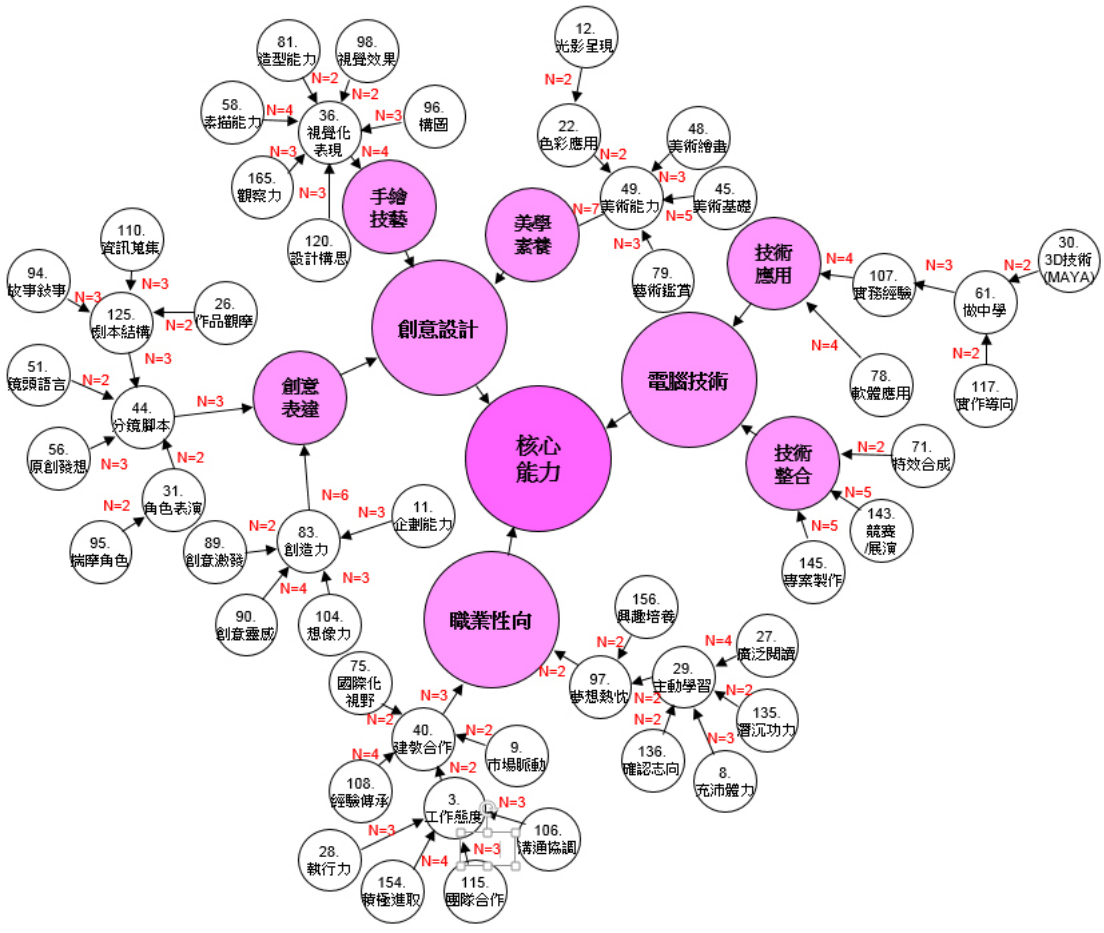


圖 4. 八位受訪者的共同心智地圖

表 4：符合三多原則的共同構念

編碼	構　念	受訪者	提及人數	編碼	構　念	受訪者	提及人數
3	工作態度	ABCDEFH	7	81	造型設計	BCE	3
8	充沛體力	EFG	3	83	創造力	ACDEFH	6

9	市場脈動	ABDF	4	89	創意激發	BCD	3
11	企劃能力	EGH	3	90	創意靈感	BCEH	4
12	光影呈現	BCDG	4	94	故事敍事	BCDEF	5
22	色彩運用	BCDE	4	95	揣摩角色	CEFG	4
26	作品觀摩	ACDH	4	96	構圖	BCDFG	5
27	廣泛閱讀	CDEFGH	6	97	夢想熱忱	ACEFGH	6
28	執行力	BDH	3	98	視覺效果	CDF	3
29	主動學習	ADE	3	104	想像力	ACDH	4
30	3D 技術 (MAYA)	ACH	3	106	溝通協調	BDGH	3
31	角色表演	BCD	3	107	實務經驗	BCEF	4
36	視覺化表現	ABEF	4	108	經驗傳承	ACDEFG	6
40	建教合作	ADE	3	110	資訊蒐集	FGH	3
44	分鏡腳本	DGH	3	115	團隊合作	BCGH	4
45	美術基礎	ABCDEG	6	117	實作導向	BDE	3
48	美術繪畫	BEH	3	120	設計構思	BDH	3
49	美術能力	ABCDEFH	7	125	劇本結構	CDH	3
51	鏡頭語言	AFH	3	135	潛沉功力	CEFG	4
56	原創發想	ADEGH	5	136	確認志向	AFGH	4
58	素描能力	ABCDEFGH	8	143	競賽/展演	BDEGH	5
61	做中學	ACE	3	145	專案製作	ABCDEFGH	8
71	特效合成	ADEG	4	154	積極進取	DEFH	4
75	國際化視野	ABCEF	5	156	興趣培養	ACEFG	5
78	軟體應用	ABCEFG	6	165	觀察力	ABDEFH	6
79	藝術鑑賞	CGH	3				

4.3 構念涵蓋率統計

構念涵蓋率可以看出個別受訪者所提的構念涵蓋共同構念的比例，它亦代表受訪者間所得共識的一致性。本研究每位受訪者的構念總數會因個人的學習歷程與特質的不同而有所差異，本研究訪問的 8 位受訪者中，涵蓋率最低為 52.08%、最高為 79.31%，平均值為 60.7%。此結果整理如表 5，顯示已具備中度(50%)以上的一致性。

表 5：構念涵蓋率統計

受訪者	個人構念數	共同構念數	構念涵蓋率
A	46	24	52.17%
B	48	25	52.08%
C	48	30	62.5%
D	51	30	58.82%
E	53	33	62.26%
F	40	26	65%
G	29	23	79.31%

4.4 核心能力的關連性分析

以下的核心能力分析將以表 4 的共同構念，配合三多原則中的構念相關性被提及達訪談人數的 1/4 以上(即 2)即確認其關連性的存在。從圖 4 共同心智地圖可以發現受訪者所提出的構念，由研究者依訪談資料分析步驟中的第(6)項定義範疇所設定的類別進行關連性的連結。各範疇所涵蓋的構念相關性及分析如下：

4.4.1 創意設計能力

範疇一包括的共同構念有：「企劃能力」、「光影呈現」、「色彩應用」、「作品觀摩」、「角色表演」、「視覺化表現」、「分鏡腳本」、「美術基礎」、「構圖」、「美術繪畫」、「美術能力」、「鏡頭語言」、「原創發想」、「素描能力」、「藝術鑑賞」、「造型設計」、「創造力」、「創意激發」、「創意靈感」、「故事敍事」、「揣摩角色」、「畫面呈現」、「視覺效果」、「想像力」、「資訊蒐集」、「設計構思」、「劇本結構」、「觀察力」。由下往上依據其專業屬性分類、可歸納為「美學素養」、「手繪技藝」以及「創意表達」三個子範疇，再拉高這三項範疇概念為「創意設計」能力。範疇一的共同構念相關統計係由訪談中質化分析得出受訪者提及構念間彼此相關的次數，如表 6：

表 6：創意設計能力構念相關統計

編碼	11	12	22	26	31	36	44	45	48	49	51	56	58	79	81	83	89	90	94	95	96	98	104	110	120	125	165
11	/															**3**											
12		/	**2**																								
22		**2**	/							**2**																	
26				/																						**2**	
31					/		**2**													**2**							
36						/							**4**		**2**						**3**	**2**			**3**		**3**
44					**2**		/				**2**	**3**														**3**	
45								/		**5**																	
48									/	**3**																	
49			**2**					**5**	**3**	/				**3**													
51							**2**				/																
56							**3**					/															
58						**4**							/														
79										**3**				/													
81						**2**									/												
83	**3**															/	**2**	**4**					**3**				
89																**2**	/										
90																**4**		/									
94																			/							**3**	
95					**2**															/							
96						**3**															/						
98						**2**																/					
104																**3**							/				
110																								/		**3**	
120						**3**																			/		
125			**2**				**3**												**3**					**3**		/	
165						**3**																					/

註：表中的底色數字表示提及構念相關的人數

範疇一「創意設計能力」所包含的三個子範疇分析說明如下：

(1)、子範疇「美學素養」包括：「光影呈現」、「色彩應用」、「美術基礎」、「美術繪畫」、「美術能力」、「藝術鑑賞」等。動畫師除了需要高品質的素描能力、美術繪畫的技能基礎功夫需往下紮根之外，這個核心能力需緩慢紮根累積原創的能量。如同受訪者 A 提到：

我覺得台灣動畫產業人才培育應該要往下紮根，像一些基本的能力與更底層的能力，在以前我們的年代，因為升學主義，美術課都被挪用上英文或數學，這是最大的錯誤！尤其這種美術、美藝這麼重要課程，對美的感知應該是從小培養 (A：173-176)。

表 6 中構念相關統計推導為：上述受訪者 A 的逐字稿 173-176，提到了美學素養(子範疇)→美術能力（構念編碼 49）的關連。受訪者在下段逐字稿亦指出，現行大學裡著重軟體教學的操作訓練，反而忽略了美術基礎的訓練與美術理論的認知（49:美術能力→45:美術基礎）。美術的基礎能力包含了美術繪畫的訓練(49:美術能力→48:美術繪畫)、對色彩的感覺(49:美術能力→22:色彩應用)，如果在這方面若無紮實地培養，則會導致日後的技術表現的質感與認知不夠，能力無法達到公司的基本要求。受訪者 B 認為 3D 動畫有 Model 模型與貼圖，因此需具備基礎色彩能力與美學造型的能力。故表 6 中 49→45 有 5 個受訪者提到相同或相似概念，49→48 有 3 個受訪者相到相同或相似概念，49→22 有 2 個受訪者相到相同或相似概念，以下類推。

動畫製作人員的美術素養包含素描、上色，美術理論、美學基礎概念以及動畫理論等均是進入動畫這行必須具備的基本功。素描的訓練包含學習掌握物體結構如何形成(構圖)以及光影的呈現，創作者必須掌握色彩認知，也就是營造空間、時間的感覺。上色訓練，對色彩形成的特性、冷暖色調的運用，搭配畫面的效果可以呈現時間的感覺，動畫師必需了解色彩的語言(B：72-77)。

宏廣動畫導演王童先生亦曾提到：「光與影的表現完全要靠繪畫技術，身為動畫師每天要用心注意光影的變化。動畫畫面要有主光以及光的位置擺置，都是要講究的。一個畫面是要有景深的，它是透過光影和色彩調配出來的。」(G：92-95)

依據表 6 相關性分析結果，範疇一「創意

設計」能力的子範疇「美學素養」所包括的構念及其存在的關連如圖 5。彙整各受訪者對於美學更具體的說明如下：(1). 能具備視覺、色彩相關學理知識(B、C、D、E)。(2). 能分析藝術、設計相關作品(C、D、F、G)。(3). 能瞭解動畫設計基本概念(B、D、F)。(4). 能運用視覺元素創作動畫的方法(B、D、E、H、G)。(5). 藝術的鑑賞能力(C、G、H)。

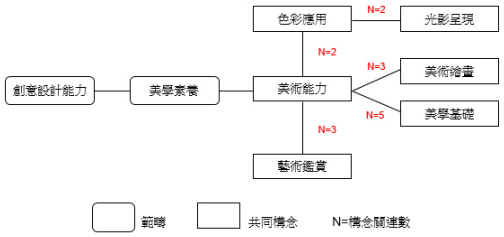


圖 5.「美學素養」所涵蓋的共同構念圖

(2)、子範疇「手繪技藝」包括：「視覺化表現」、「素描能力」、「造型能力」、「視覺效果」、「設計構思」、「構圖」以及「觀察力」。在視覺化表現的部分，受訪者 F 認為手繪技藝並不侷限於 2D 動畫，同樣地它也是 3D 動畫核心能力的表現。

現在許多動畫朝向 3D 視覺方式，每個人的視覺都進化了！每一次被美麗的畫面震撼一次，視覺被刺激一下，視覺就進化一次(F：139-141)。

受訪者 H 認為動畫師需具備有畫分鏡表(story board)的素描基本能力，依據劇本內容，從設計方式、畫面構成繪製成分鏡腳本，作為後續動畫製作上的參考依據。以分鏡設計為例，除了要具備圖像視覺化表現外，鏡頭語言、鏡頭角度、鏡頭運動以及節奏以配合故事劇情的起伏，這是動畫劇本寫作和傳統劇本不同的地方。

素描能力要夠強，而且要快、精準。因為通常是導演在說的時候，你的腦海中就有個想像雛型了(image)，必需抓住精髓把它畫出來(H：2-4)。

為了畫出憾動人心，感動觀眾的動畫作品，除了細微的觀察以外，需要在日常生活中不斷地去做記錄與觀察周遭的人、事、物。

“觀察力”這部份是平常時時刻刻都要去注意的，然後，再來，你有這些觀察的心得，就要用筆記把它做起來，因為基本上這些東西，都是生活的這些經驗所累積，然後去堆積出來的一些感受 (F：100-104)。

激發創作靈感的訓練上，觀察訓練不僅可以產生「敏銳的觀察力」進而激發原創發想(D：267-268)。

至於「手繪技藝」的相關課程有：「基礎及設計素描」、「影像處理」、「插畫設計」、「平面動畫」、「人體動態素描」、「分鏡設計」等。(D:132-133)

在業界對手繪的要求至少應具下列的能力：(1).形體塑造能力。(2).形體的精準度。(3).繪畫表現技法能力。(4).色彩表現張力。(5).視覺表現能力。(H:89-91)

綜合上述各受訪者的意見並依據表 6 相關性分析結果，範疇一「創意設計」能力的子範疇「手繪技藝」所包括的構念及其存在的關連如圖 6。

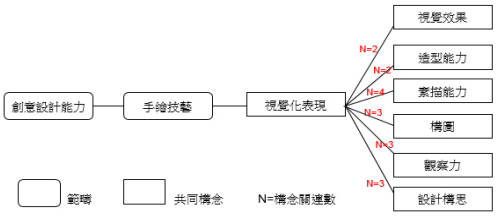


圖 6 「手繪技藝」所涵蓋的共同構念圖

(3)、子範疇「創意表達」包括下列共同構念：「企劃能力」、「作品觀摩」、「角色表演」、「故事腳本」、「鏡頭語言」、「原創發想」、「創造力」、「創意激發」、「創意靈感」、「故事敍事」、「揣摩角色」、「想像力」、「資訊蒐集」、「劇本結構」。動畫除了技術能力與軟體操作熟練之外，最重要的是本身的創意，而創意來自於天馬行空的想法，因此需積極培訓具有創意的專業人才。在創意訓練上受訪者 B 與 D 分別提出下列看法：

好的動畫影片必需充滿幻想、驚奇與不可思議的元素，這些都是需要優秀的創意支撐整個故事的演出(D：98-100)。

要會說故事，對初學者而言，應多看動畫作品分析導演處理說故事的方法與如何畫面美學(D：322-323)。

受訪者 H 提到動畫劇本與一般的劇本寫作最大的不同在於，劇本作家在下筆時腦中所想像的應該是故事畫面的影像，而劇本亦要掌握到時間、空間、人物以及故事情節的舖陳與

佈局。

好的劇本作家要對劇本所發生的時空背景進行資料蒐集與考證工作，融入了解劇本所設定時代、地點的背景與人文因素，如果編劇與導演下的功夫不夠，就拍不出那個時空下的感覺的動畫，也無法感動觀眾(H：190-193)。

動畫本身的核心價值在於「說故事」，在沒有電腦的時代動畫主流為為手繪卡通，在電腦動畫技術成熟之後，雖然開創了新的感官視覺與表演技術，但最重要的仍為「美學素養」、「手繪技藝」以及「創意表達」的能力。用圖像創意敍事是台灣目前動畫產業最為欠缺的核心能力。至於如何培訓學生的創意表達能力與說故事技巧？在日本重視「漫畫創作」與「分鏡腳本」。尤其是漫畫，在日本被視為動畫完美的分鏡腳本，日本東京「數位好萊塢大學」的大學部規劃，大一漫畫課程的圖像表達若無法通過取得學分，則該生沒有資格選修大二動畫課程與大三產學動畫製作專案(數位好萊塢大學，2006)。至於如何訓練創意表達，本文受訪者認為至少必須具備有：(1).主題傳達的切合度能力(A、G)。(2).從影像、聲音、動作與劇情分析故事敍事的能力(B、C、D、E、F)。(3).創作的執行力(B)。(4).趣味表現能力(A、D)。(5).原創發想的敍事(narrative)能力(A、D、E、G、H)。(6).鏡頭語言的運用與表現(A、F、H)。綜合上述各受訪者的意見並依據表 6 相關性分析結果，範疇一「創意設計」能力的子範疇「創意表達」所包括的構念及其存在的關連如圖 7。

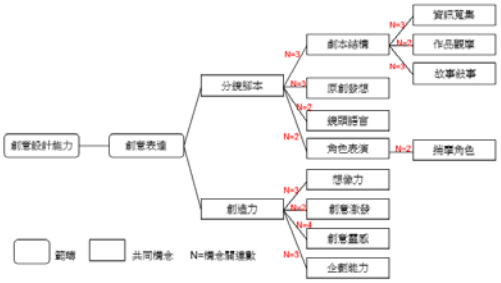


圖 7 「創意表達」所涵蓋的共同構念圖

4.4.2 電腦技術能力

範疇二：「電腦技術能力」包括的共同構念有：「3D 技術(MAYA) 」、「做中學」、「特效合成」、「軟體應用」、「實務經驗」、「實作導向」、「競賽/展演」以及「專案製作」。為進一步釐清電腦技術的層次差異，範疇二再細分為兩個副範疇，分別為「技術應用」、「技術整合」。範疇二的共同構念相關統計如表 7：

表 7：電腦技術能力構念相關統計

編碼	30	61	71	78	107	117	143	145
30	/	**2**						
61	**2**	/	**2**	**2**	**3**	**2**		
71		**2**	/					
78		**2**		/				
107		**3**			/			
117		**2**				/		
143							/	**2**
145							**2**	/

註：表中的底色數字表示提及構念相關的人數

(1)、「技術應用」包括下列共同構念：「企劃能力」、「3D 技術(MAYA) 」、「累積 3D 技術」、「做中學」、「軟體應用」與「實作導向」。3D 動畫製作時需要運用的工具與軟體有 MAYA、3D MAX、PhotoShop、AE…等，具備專業的電腦軟體技能與知識，是就業的基本門檻，一位專業的 3D 動畫師能流暢地運用電腦將構思視覺化表現出來。

MAYA 是現階段 3D 動畫市場的主流工具，我們西基的老板總是這樣告訴我們：鋼琴或小提琴是學音樂的工具，MAYA 是 3D 動畫的主要工具；學動畫的人把 MAYA 這套工具操作練到純熟就像學音樂的人要把鋼琴的指法練好的道理一樣(D：240-243)。

企業最注視的是軟體操作熟練度的問題(C：42-42)。

透由"做中學"的訓練方式，讓新人能從工作中得到基本的訓練(G：152-153)。

大部份受訪者皆一致認為"做中學"是最快使業界新人從工作中得到基本的訓練與提升能力的最好方式，透由"做中學"累積個人的技術能力之經驗，各項工具與軟體本身皆需自我摸索，藉由實務上的磨練與學習可累積自我之創作感覺、獨力思考與應變能力。

(2)、「技術整合」包括下列共同構念：「特效合成」及「專案製作」、「競賽/展演」。業界需具有獨立運作之整合性創作人才與溝通協調的能力，本身能了解所有的製作過程，配合專案團隊進行創意激發，除了順暢的溝通與創意發想外，也需要有視覺傳達的訓練方能維繫整部影片的劇情和風格統一。

要有好的溝通協調能力，才能維持影片整體風格的一致，因此對劇本作家而言，溝通協調能力以及接受新事物的能力都是必要的(D：261-263)。

專案執行過程要讓大家有參與感與榮譽感，有榮譽感之後大家變得有心投入，覺得為了團體榮譽，那他就會希望把這個東西把它做好(H：163-165)。

3D 電腦技術的課程在大專院校通常會開設：「3D 動畫企劃」、「3D 動畫製作(MAYA) 」、「3D 動畫後製(AE) 」等或其他同樣可以製作 3D 角色的軟體操作課程。至於「技術整合」課程學校也多開設「專題製作」或「畢業創作」等課程。讓學生得以累積實作經驗。來自西基動畫的受訪者 D 認為業界對電腦技術的要求至少：(1).能了解 3D 動畫專案企劃內容、檔案格式及播放規格。(2).運用 3D 動畫軟體操作介面進行實作。(3).團體合作的溝通及執行展現的能力。(4).3D 動畫內容的需求評估與分析的能力(D：245-248)。綜合上述各受訪者的意見並依據表 7 相關性分析結果，範疇二「電腦技術」能力所包括的構念及其存在的關連如圖 8。

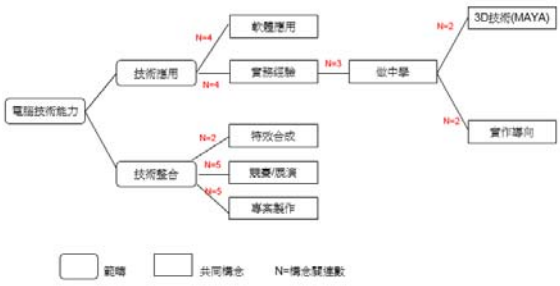


圖 8 「電腦技術能力」所涵蓋的共同構念圖

4.4.3 職業性向

範疇三：「職業性向」包括的共同構念有：「工作態度」、「充沛體力」、「市場脈動」、「廣泛閱讀」、「執行力」、「主動學習」、「建教合作」、「國際化視野」、「夢想熱忱」、「溝通協調」、「經驗傳承」、「團隊合作」、「潛沉功力」、「確認志向」、「積極進取」以及「興趣培養」等

表 8：職業性向構念相關統計

編碼	3	8	9	27	28	29	40	75	97	106	108	115	135	136	154	156
3	/				**3**		**3**			**3**		**3**			**3**	
8		/				**3**										
9			/				**2**									
27				/		**4**										
28	**3**				/											
29		**3**		**4**		/			**2**			**2**	**2**			
40	**3**		**2**				/	**2**			**4**					
75							**2**	/								
97						**2**			/							**2**
106	**3**									/						
108							**4**				/					
115	**3**											/				
135						**2**							/			
136						**2**								/		
154	**3**														/	
156										**2**						/

註：表中的底色數字表示提及構念相關的人數

性向是指個人在學習特定的事務前，其學習的潛在能力或天份。例如，對學音樂的人而言，天生音感好相對表現較為優異；學美術的人，若對物體的精準度及透視感佳，閉上眼睛也能清楚地掌握物體的輪廓形體，在素描、手繪會更容易上手。職業性向係指個人感覺自己受那些職業吸引，喜愛從事該職業工作，投入工作時覺得有成就感與滿足感的，以及自然而然激發該職業應用的正向態度與行為傾向。本研究從訪談專業的 3D 動畫師中發現，除了一般性的工作職能性向，如「廣泛閱讀」、「執行力」、「主動學習」、「夢想熱忱」、「主動學習」、「工作態度」以及「積極進取」等，更需要有「市場脈動」與「國際化視野」。因為，台灣 3D 動畫作品要走出去與國際接軌必需掌握「市場脈動」與「國際化視野」。因此，對 3D 動畫師而言，具備「市場脈動」與「國際化視野」為其重要的能力條件。為此，受訪者 E 也提到：

做創意的人比較大的麻煩在於其創意的完整性和精神，又必須顧慮到市場，許多市場的機能是很難去瞭解的，像我都鼓勵同事一週要撥空 1、2 小時去西門町走走，很難想像做青少年世代產品的人不到西門町去看，停留在辦公室用自己的想法，創造自己的東西很容易跟市場脫節，當然也有剛好符合這市場的可能，但無法掌握市場脈動，對 3D 動畫的行銷會面臨很大的挫折。(E：179-184)

要真正累積對市場的敏感度仍需要透過產學建教合作的模式，在學界與業界密切的互動與共同培育下，可讓學校學生提早累積正確的職能態度與商業化視野，或透由演講的方式，如找企業家或藝術家來演講，了解與貼近業界作品的需求，或利用寒暑假於業界駐點實習，如此可提升自我專業技術能力與學以致用。

能夠極力能夠接觸學生這部份，然後希望能夠提供實習的機會，也是說從學生開始就希望能夠培養好，然後看到你發揮的能力，與發揮你的潛力，進而能夠成為正式的員工(E：121-124)。

「職業性向」核心能力可以透過業界與學

界的「產學實習」、「建教合作」提供給在學學生正確的就業態度。除此之外，受訪者 H 亦建議學生在畢業前應累積以下的作品或正確認知：(1).貼近市場需求（可商業化）的畢業作品。(2).正確的職能態度表現。綜合上述各受訪者的意見並依據表 8 相關性分析結果，範疇三「職業性向」能力所包括的構念及其存在的關連如圖 9。

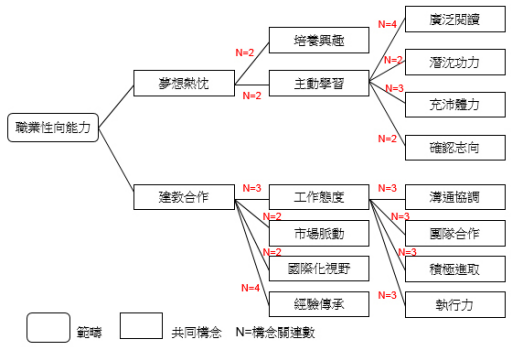


圖 9 「職能性向能力」所涵蓋的共同構念圖

5 結論

本研究以質化方式從訪談、到核心能力的歷經十個步驟描繪 3D 動畫師的心智模型。從 3D 電腦動畫師的自我敍事學習心智歷程，確認自我的心智地圖，透過系統化彙整共同構念，推導 3D 電腦動畫師的外顯核心能力包括：「創意設計能力」、「電腦技術能力」以及「職能性向能力」三大範疇；「創意設計」係指「美學素養」、「手繪技藝」以及「創意表達」三個核心能力；「電腦技術」則包含了「技術應用」與「技術整合」兩個面向，而職能性向則涵蓋了動畫師的人格特質與職業性向。這些核心能力的推導可以協助學校進行檢視系所課程的核心能力定訂及學習地圖的完整性是否符合產業需求。惟 3D 動畫產業關鍵知識與技能的建立都是需要點點滴滴的長期累積。且從動畫產製流程角度，不同階職位的動畫人員在創意設計、電腦技術及職能性向上有不同的比重，如動畫導演、模型師及後製特效師在創意敍事的層次應用上各有不同，電腦技能的使用需求亦不同。共同心智地圖與核心技能的呈現為 3D 動畫產業的共同需求觀點。

從教育的本質來看上述的結果除創意設計能力與電腦技術能力為動畫產業專有的核心技能外，16 個「職能性向」特質亦符合各行各業對人才職場核心性格，即符合企業 5 大職類(定型工作、對人工作、營業工作、非定型工作及創造性工作)適性工作所需，這代表支撐專業核心能力的背後需要許多的正確職能面向，共同的人格特質如：「溝通協調」、「團隊合作」、「主動學習」、「工作態度」、「積極進取」以及「國際視野」等等都可以發揮自我在職場上的優勢。

受訪樣本雖皆為具備動畫師資歷，但在電腦技術方面因為每位動畫師負責之任務不同，以至於其技術應用不會與其他動畫師相同，故在共同心智地圖中重疊的機會相對較少，以至於在電腦技術這一塊，以致於心智地圖呈現出較薄弱現象。從共同心智地圖中雖顯示了本次 8 位受訪者經質化後所提及的次數(可視為各核心能力間的關連強度)，然而過程中質化訪談方式中並未對各構念之權重，對受訪者進行確認，如 3D 技術(MAYA)、美術基礎與創意靈感其需求權重，有些能力尚需具備基本門檻。再者國內教學單位於課程規劃與設計參考規劃而言，有總學分數之限制，是故個別課程學分數安排，及必選修之分配，皆須考量。此外專業課程除 3D 動畫之外，尚有其他領域課程的學習地圖配合，如何依據產製階段不同職類呈現各核心構念的權重是本研究下一階段待探討主題。課程比重及核心能力的重要性排序納入考量將更符合 3D 動畫業界職能需求的專業核心能力。

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數位雲端資料庫BIG DATA提升傳統產業之創新應用－以鞋類設計開發業為例

魏安妤[1]，盧冠華[2]，王年燦[3]
1 囍木設計有限公司，wlinc2010@gmail.com
2 大船設計開發實業，shipinc2010@gmail.com
3 國立臺灣藝術大學，ntwang@ntua.edu.tw

摘要

目前台灣鞋產業有時以網路圖片、名品翻版、拼貼等仿造方式進行新款式設計與開發，跳過專業設計環節，因此背上仿冒之名。為跳脫過去代工環境，我們必須採用新的思維，才能具備競爭力。過去鞋業創新輔導重點大多具聚焦於專利與科學性分析，早已具備了紮實技術的我們，重點應置放於發展產品美學、重視設計、人才培育與掌握國際趨勢潮流的商機。本文為臺南市地方產業創新研發推動計畫補助專案之成果，主要借助雲端科技輔助，結合資料庫，讓企業搶先求得優勢發展的契機，並透過數位化方式，將珍貴的技術有效保留，實際應用於鞋類設計之開發，提升傳統產業競爭力。

關鍵詞：鞋類設計開發、產業聚落、文化創意、數位化資產、雲端

Innovation Application Of Cloud Big Data Of Traditional Industry Improvement– A case study of the design and development of shoe industry

An-Yu Wei[1], Kuan-Hua Lu[2], Nien-Tsan Wang[3]
1 WL Inc, wlinc2010@gmail.com
2 Ship Inc, shipinc2010@gmail.com
3 National Taiwan University of Arts, ntwang@ntua.edu.tw

ABSTRACT

Nowadays, the shoe industry in Taiwan copies other brands to design and develop their new type of shoes. They skip the design process and have been labeled with a bad reputation of counterfeit. Therefore, shoe industry in Taiwan need to advance from the manufacturing industry to be more competitive. The guidance of shoe industry mostly focused on patents and scientific analysis in the past. However, the industry should focus on the development of product esthetics, respect for design, cultivation of talent and capture of international trend newly. This study describes the result of the Small Business Innovation Research in Tainan. Enterprises are able to be more competitive with the assistance of cloud computing and combination of database. Applying digital method to the development of shoe design helps to reserve valuable technique and improve the competitiveness of traditional industry.

***Keywords*: Design and development of shoes, Industrial cluster, Culture and creation, Digital heritage, Cloud**

1 緒論

台灣鞋業累積了半世紀的代工經驗，純熟的技術與聚落，已成為珍貴的文化資產。自1976 輝煌時期就是國際鞋類商品的主要生產國，鞋產業遺留下一群擁有純熟技術製鞋人員，而周邊的產業鏈完整，更形成了一股難得的產業群聚。另一方面，過去鞋業創新輔導重點大多聚焦於專利、測試數據、人因工學、機能等科學分析，在半世紀的代工經驗下我們早已具備了紮實的技術根基，因此重點應置放於發展產品美學、重視設計、人才培育與掌握國際趨勢潮流的商機。

借鏡歐、美、日、韓等國，他們能創造與引領時尚，已跳脫製造業之思考模式，用文化

創意軟實力創造出商品的高利潤。在台南地區，就擁有近五百多家鞋業相關產業，這種「群聚」得天獨厚的力量，更是我們轉型的最佳後盾，以形成一種「文化」。在台灣發展文化創意產業政策下這將是突破轉型的最佳契機。

隨著網際網路科技的發展，網路與資訊結合，本計畫透過數位化方式，將珍貴的技術有效保留，協助產業創新，除了能讓既有技術資產歸納外，還能夠匯入國際同步資訊，內外即時更新，再加上雲端科技輔助，結合資料庫，讓企業搶先求得優勢發展的契機。二十一世紀是個速度的年代，快速充分掌握資訊，將保有競爭優勢，也就能擁有世界。這是一個資訊流動的年代，讓知識的轉化應用與再創新。

2 文獻探討

2.1 雲端運算

時代進步在網路普及下「雲端」已成為產業間最被關注的發展議題，它的應用範圍廣泛，小由個人大至企業、政府等單位運用。凡是透過網際網路(Internet) 提供虛擬化及動態運算資源給不在同一區域內的企業用戶，不論是透過軟體即服務 (Software as a Service, SaaS) 或是 Web 2.0 的方式，只要能夠滿足使用者的運算需求，都可以稱之為雲端運算 (鍾明男，2009)。

雲端運算是全球資訊產業近 50 年來，歷經以企業為主體的系統時代、以專業人士為主體的個人電腦時代、以消費者為主體的網路時代及以個人為主體的內容時代等多次重要的資訊產業典範移轉下，所演化出來的最佳化產物(蘇昭月譯，1999；盧俊成，1998)。在李昀潔(2009)研究中也發現，當企業延用本業原有的服務架構來發展雲端運算，是一條較快速且容易達到成功的捷徑。企業在短期發展策略中，發展 Iaas 及 Paas 等相關應用服務，比較能替企業帶來盈餘，而在長期發展規劃，偏向以發展 Saas 等創新應用服務，會比較能保有持續性的市場地位。

在這產業創新的步伐中，若藉此瞭解客戶需求與反饋意見，並擬定市場策略為之參考依據，必能在這全球化的市場上，搶先求得優勢發展的契機。在雲端運算用途上，更可協助人類在龐大的數據資料充斥的環境裡，更有效率的歸納找尋。劉耀峰(2010)的研究指出，以如何提升圖書館中的搜尋服務，利用知識本體論為基礎，讓圖書館搜尋服務具有智慧化，找出更合乎讀者想要的書目。利用雲端運算概念建構、應用開發將圖書館搜尋服務，提升強化為智慧型搜尋服務。如透過知識本體論所建構雲端服務搜尋元件系統，準確、快速，可大幅提高辨識速度，快速正確的比對。

產業導入雲端科技提升服務價值，已經是無法避免的趨勢。雲端在人類健康上，也有提升的幫助，在王以如(2010)研究裡以個人健康記錄與雲端運算系統做結合，實作出一套雲端系統上的個人健康記錄管理系統，讓個人健康記錄能更廣泛的被運用。以基本通用表單及衛生署公布之 108 表單中之檢查報告、檢驗報告及出院病歷摘要。提供使用者在網路連通的狀況下，可隨時隨地能存取個人健康記錄。透過虛擬化的資源利用最佳化，以及可量化計費的服務型態，經由網路分送，提供使用者隨時隨地可透過網路存取的服務平台。

在彭康桓(2008)的雲端商業智慧服務策略之研究中，整合性的分析模式－創新密集服務分析模式，來描繪商業智慧軟體服務商，未來若採用雲端運算模式提供服務之策略定位，產生兩大方向「服務價值」活動與「外部資源」關鍵成功因素進行評量分析，讓屬於傳統的製鞋產業，有效的歸納與建構內部既有的技術資源，與外部預拓展的產業創新之方向。

2.2 數位化資料庫特性

隨著網際網路科技的發展，透過網路與資訊結合，並藉助資料庫系統進行「資料數位化管理」協助產業創新。「資訊就是權力，能掌握資訊，就能掌握未來，就能掌握世界」，能充分掌握資訊，快速處理資訊，將能做出最適切有效的反應，保有競爭優勢，也就能擁有世界。二十一世紀是個速度的年代，更是一個資訊流動的年代，強調資訊的快速取得，知識的轉化應用與再創新。

在數位化知識管理上的優勢中，林聰明(2008)研究線上傳播資料找出模式，可了解整體的趨勢並對個別受服務者提供個別化的服務。黃旭鈞(2001)以學校推動數位化知識管理研究中提出之優勢有：建立資訊合作共享的共識，創新的學校組織文化、善用知識領導創新，激化各學習領域研究發展，建構學習型組織、測量與評估知識價值，隨時更新留下最新最有價值的知識、開發科技技術與管理系統(資料庫、網路、蒐集工具、文件管理及郵件傳遞)以及利於知識管理等優勢。

數位化保存的意義，在於有價值之文獻史料可藉由數位科技永久保存，這些知識能以數位檔案形式儲存並快速傳播，達到文化教育及傳承的意義(楊順安，2009)。成功大學陳世軸研究中提出創新設計與產品開發的觀點，表示：創新設計本身就是一種天馬行空的工作，設計的構想往往只是設計者的靈光乍現，如果沒有即時捕捉到這份靈感，就可能埋沒了一份創意

十足的設計。運用資料庫內收集之資訊，確實可輔助設計者快速的得到符合需求之設計概念。此外，資料庫內的資訊除了可以輔助設計外，也方便公司產品資訊的保留或傳承，或可作為新進人員的訓練教材(陳世軸，2004)。

2.3 鞋業聚落文化與概況

台灣鞋業，半世紀的代工經驗，留下純熟的技術與聚落，這正是我們珍貴的文化資產，更曾是製鞋王國的幕後推手。台灣的鞋業已超越五十年，自 1976 輝煌時期就是國際鞋類商品的主要生產國，因產業版圖轉移，逐漸沒落，但製鞋業遺留下一群擁有純熟技術製鞋人員，且周邊的產業鏈完整，更形成了一股難得的產業群聚。在台南地區，就擁有近五百多家鞋業相關產業，這種得天獨厚的力量，更是我們轉型的最佳後盾。

因全球化經濟、網路資訊發展快速，中國有世界工廠之稱，而大陸淘寶網商品、韓國流行商品是目前普遍商家之貨源，它的便利性結合上韓國戲劇、音樂、流行文化之渲染使得商品熱賣，導致大陸（低價）和韓國（流行）商品占盡台灣鞋類市場。

台灣鞋業是本國邁入工業化的最佳代表，宛如產業的進化史。鞋類更是台灣出口量最多的產品，占全國出口量的百分之七，民國七十六年年出口高達八億雙，賺進三十七億美元，鞋類出口蟬聯三年世界第一(鞋技中心，1992)。工業化成長中，勞資上升問題，營運成本年年攀升，從民國七十八年鞋廠一千一百五十一間，至民國八十三年驟降至八十間，員工數也從十八萬三千人減至三萬人，短短六年產業結構便發生如此劇烈變化（楊凱成，2007）。產業興盛時，累積財富，成就許多「頭家」，而這些資本者在這轉變期便將資金、設備淘空，整廠輸出至中國、東南亞國家設廠，遺留下一群鞋類技術人員，許多勞工頓時失業，除此之外，製鞋業影響層級廣泛，包括周邊產業如：五金、模具、楦頭、皮革、塑膠、機械工具等，讓多年所累積的智慧寶藏逐漸沒落。

有完整的群聚，也形成了自己的文化，這將是台灣發展鞋類文創商品與量產的最佳依據。我們有絕佳的技術實力發展屬於在地的文化影響力，借鏡義大利製鞋工藝發展，以創新的角度，讓世界看見屬於台灣的驕傲。

2.4 文化創意&設計力

世界各國如：義、美、英、西班牙、日、韓等國，重視時尚、品牌、流行、文化等設計活動，已跳脫製造業之思考模式，用文化創意軟實力創造出商品的高利潤；而中國勞資成本低、市場反應快速，相較於台灣鞋業還在期盼代工訂單、流水式生產模式，我們更急需轉型。

在文獻中也提及：具有創意的產品，能快速吸引消費者的目光，造就高額獲益，創意也往往為傳統產品注入新的生命。鞋技中心(2008)的問卷統計結果顯示：目前台灣製鞋業所需之人才，以設計類為最多，研發類次之，工程類再次之。表示我國鞋業，從過去專注代工的單向獲益模式，轉變為重視鞋品開發與設計的創意行銷策略。專家也提到，過去我們不重視製鞋技術訓練，不去發展創作設計環境，沒有投入研究發展的工作，不重視產品行銷，不必藉降低生產成本以增加國際競爭力的做法，在今日都可能成為製鞋業發展的限制或障礙（周屏芬、李美玲，2004）。

在陳忠正、王年燦(2007)研究中，鑽石體系能夠使國家產生競爭優勢。相關與支援產業能夠加速整個產業創新的步伐，激發更多創造的可能性。使知識避免近親繁殖，打破專業領域的知識嫁接，才能結出美好的果實(韋杰岱譯，2009)。大前研一於 2010 年 6 月總統府發表演講，建議台灣需告別過去的營運模式，進入"Sense & Life"為核心的產業發展階段。「美力即獲利」，以設計美學突破低毛利的陷阱。

3 實施方式與流程

鞋類開發過程中，絕大部分是機器無法取代的，從鞋面的設計、製版、放版、縫紉、模具等，機器僅能輔助卻無法完全取代，一雙「手工鞋」的誕生，內含許多寶貴的智慧。在全球化的趨勢下，屬於傳統產業的製鞋業，面臨中國、東南亞低成本與韓國流行市場的雙面夾擊。本計畫期間，與台灣流行時尚產業聯盟陳中聖祕書長交流後也表示：若不改變製造業思維無法創新，本土鞋業對於品牌化認知上有極大的落差。

透過本計畫與參與瞭解到，過去鞋業創新輔導重點大多具聚焦於專利、測試數據、人因工學、機能等科學分析；鞋款式開發大多由男性廠方負責人主導，以仿造、改造等土法煉鋼之方式進行商品開發，卻非由專業性設計師與流程來產生；並透過網路截圖方式、口述、簡易手繪、拼貼來進行新商品的開發。參訪本國鞋展與市場考察，製鞋技術力純熟、款式五花八門，卻似乎缺少些許魅力。

產業半世紀代工經驗與純熟技術下，台灣鞋類早已具備足夠的基本條件，借鏡歐、美、日、韓等國，它們能創造與引領時尚，而我們真正缺乏的是發展產品美學、重視設計、人才培育與掌握國際趨勢潮流的商機。

3.1 資產數位化 BIG DATA

台灣經過製鞋王國的洗禮，留下許多智慧的寶藏。若以工法技術面來看，一雙鞋的開發由楦頭、鞋面設計、打版、鞋底加工、鞋底材料、裁斷、模具加工、五金等，就可細分超過數百項技術類有效資源，本計畫以鞋類設計開發單位－囍木設計有限公司內部發展為核心來共同發展，製鞋技術的珍貴，過數位化與雲端方式來建構資料庫，欲運用科技將經驗與技術保留下來，先以「資產數位化」為目標（圖1），奠定根基，成為發展創新產業之後盾。

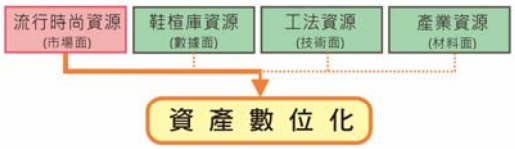

圖 1. 本計畫的 Big Data 四大面向

3.2 BIG DATA 資料歸納

透過研究資料庫實務探討後，我們以資料探勘（Data Mining）與資料倉儲（Data Warehousing）概念來延伸，與產業現況、當代環境、商業性來做結合，如何將內部與外部的資料做完整的整合為課題，以便讓使用者在最快的時間內看到整合後的各種面貌，進而產生「商業智慧」；再配合「知識管理」的機制來協助使用者快速制定商業上的各種決策。公司所資源分為內部及外部：內部屬於知識化的技術檔案，例如製作工法、鞋楦檔案、關鍵技術等；外部資源來自全球動態有：時尚資訊、展場資訊、鞋樣、實地考察、期刊雜誌、設計師聚焦等，數量龐大，且不斷更新，無論是內外資源都須同步歸納整合，轉換成具商業性的有效資源（圖 2）。

圖 2. 將內外資源有效整合成有效的知識樹

3.3 發展架構

本計畫著重於產業開發端，輔助產品設計開發為目的，未來更可擴展運用至行銷、宣傳、金流、管理等運用。在這產業精緻化年代，科技發達、工具使用便利，與過去相較之下，我們將善用跨領域能量與知識，讓傳統產業開發人員專心於本領域，以獲取與管理最新開發資訊，整合新舊世代的專長，形成了知識傳承的橋樑，共同專注提升產業的創新任務。經過研究後，規劃架構如圖 3。

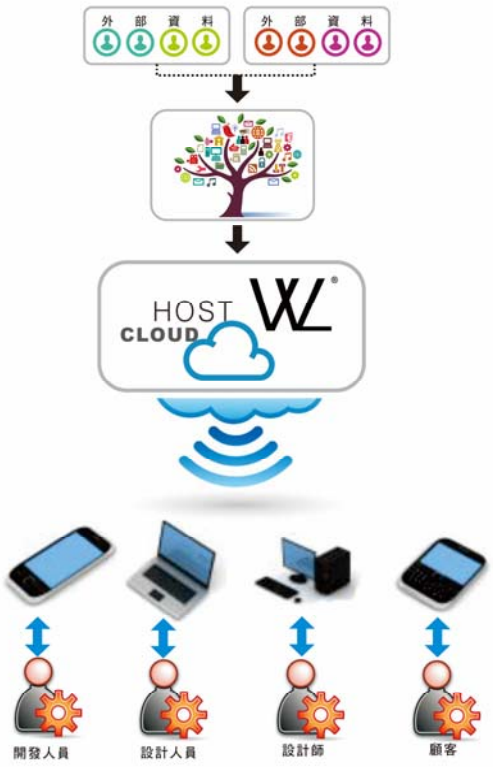

圖 3. 本計畫規劃架構

3.4 創新應用

國際資源隨時在更新，每年九月更是國際時尚重點月份，除了親訪國際性展覽外，其他外部資源更包括：知名設計師、名品牌發表秀、國際時尚周、國際時尚雜誌、國際色彩機構、材料製造商等，都是連動性的產業鏈，內蘊藏著商機趨勢資源，更是國內產業與國際同步的關鍵。透過設計人員的蒐集與歸納，將有效資源分類並建構於 WL 雲端資料庫，而傳統技術人員透過平板電腦獲取資源，即使人員分別在外地，也能夠及時連線，達成資訊同步提升整體效益，更增加內部人員的國際視野（圖 4）。

圖 4. 本計畫建置之雲端資料庫

4 結論

具有創意的產品能快速吸引消費者的目光，造就高額獲益；創意也往往為傳統產品注入新的生命。本計畫以核心開發技術來創造出與國際市場同步之鞋類商品，掌握趨勢時效、設計力、產品美力提升商品利潤與整體產業價值形成「技術力＋設計力」。

誌謝

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動畫中的陰影及其特性對深度知覺之影響

林倩妏 [1]，林達隆 [2]
1 天主教輔仁大學應用美術學系所，pam@mail.fju.edu.tw
2 國立臺灣師範大學美術學系所，findart@ntnu.edu.tw

摘要

近年由於行動裝置的日益普及，動畫成為其影像視覺包裝的主要媒材，動畫正透過這些行動裝置不知不覺地滲透到我們每日的尋常生活中。而動畫中的陰影經常扮演著空間暗示與故事催化的重要角色，Birn (2006)針對電腦動畫應用即曾提出陰影的主要視覺功能有:定義視覺對象間的特殊關係、強化構圖的張力、整合物件…等。空間再現一直是人類藝術及視覺表現追求的重點，不論是文藝復興時期的藝術作品甚或今日蔚為風潮的裸眼 3D 影像，都致力於立體空間的再現。本研究將針對動畫中的陰影特性對受測者在深度知覺判斷上的影響加以分析。研究實驗的部分使用 3D 動畫工具根據三組自變項：陰影的投射光源類型、陰影邊緣的銳利程度及畫面渲染方式等，分別計算出 12 種陰影的影像呈現，本研究之受測對象為 18~22 歲大學學生共計 47 人。研究發現，當增加陰影邊緣模糊與否的變項時，不論是獨立討論此一自變項，或增加投射光源類型及 2D、3D 動畫場景渲染呈現方式的變數，皆會顯著影響深度知覺判斷。其中特別針對兩組顯著影響估計誤差百分比的二維交互作用進一步分析，研究成果可提供動畫及藝術設計相關領域空間再現多元化發展的可能性，亦能協助學界與相關業界在教學研究與實務設計上更多的參考與應用。

關鍵詞：動畫、陰影、深度知覺。

The Influence of Shadow and Characteristics in Animation on Perceived Depth

Chien-Wen Lin[1], Ta-Long Lin[2]
1 Fu Jen Catholic University, Assistant Professor, Department of Applied Arts, pam@mail.fju.edu.tw
2 National Taiwan Normal University, Associate Professor, Department of Fine Arts, findart@ntnu.edu.tw

ABSTRACT

While mobile devices become increasingly popular, animation has already turned to a key media material in image visionary package. Through mobile devices, animation has unknowingly penetrated our daily life. The shadow of animation usually plays a significant role in space implication and story stimulation. Aiming at computer animation application, Birn (2006) states that the major visionary functions of shadow include defining the special relation between visionary targets, enhancing tension in composition and integrating objects, etc. Space re-emergence has always been a priority in human art and visionary performance. No matter it is the artwork during Renaissance or the prevailing naked-eye 3D images nowadays, the solid space re-emergence is what being pursued mostly. This study has analysed the influence of shadow characteristics in animation on testees' perceived depth. In the experiment, a 3D animation instrument was utilized to calculate twelve images of shadow based on three independent variables – the projected lighting of shadow, the sharpness of shadow edge and picture rendering. In total, there were 47 testees, who are university students aged between 18 and 22. It is found that when the variable of whether the shadow edge is blurred or not has been considered, no matter it is studied independently or the other two variables were jointly considered – projected lighting and 2D or 3D picture rendering, the perceived depth would be affected apparently. Aiming at two groups of two-way interactions with apparent influence by deviation percentage, further analysis was conducted. The study result could be explored for the possibility of developing diversification in animation and art-related field. Also, it could be the reference or application information for educational research and pragmatic design in academic or relevant industries.

***Keywords*:** Animation, Perceived Depth, Shadow.

1 前言

陰影在繪畫史中總是與光源對立搭配並成為空間暗示重要的線索，光影對繪畫的影響開始被深入討論，可追溯至十五世紀義大利文藝復興時期的李奧納多·達文西，達文西提出暈塗法試圖再現空間光影的真實感受，而視覺藝術發展至今，從早期利用陰影將平面視覺藝術空間再現，近二三十年又加入了各式新的表現媒材與手法，如 2.5D、3D 甚至是 real 3D 動畫，都記錄著人類為追求視覺空間與立體再現所做的努力。

Birn (2006)針對電腦動畫領域應用即曾提到陰影的主要視覺功能有:定義視覺對象間的特殊關係、揭示不同的觀察角度、強化構圖的張力、增加對比、螢幕畫面外的空間對象暗示、整合物件…等。有關陰影與符號之間的關係，Bauer (1987)則提出，陰影投影是一種透視影像，且此投影提供了投影中心的立體模型一個視覺化的簡單抽象幾何造型。Isenberg, Freudenberg, Halper, Schlechtweg and Strothotte (2003) 在其有關如何利用電腦運算自動產生物件線條圖形的研究中指出，剪影在形狀識別的過程中發揮了重要作用，因為剪影是影像呈現時區別圖與地的主要線索。Block(2008)曾指出 Visual Story 視覺故事表現主要目的在傳達氣氛、情緒及想法，本研究將進一步探索陰影在 Visual Story 視覺故事表現上所扮演的角色，如故事催化情緒暗示等，透過文獻探討陰影於不同時代的定義，藉由符號學大師皮爾斯（Charles Saunders Peirce, 1839-1914）將符號分成 Icon 圖像符號、Index 索引、Symbol 象徵符號三種類型的論點，進而分析陰影 Shadow 符號於動畫創作與視覺故事表現的聯結及其意涵，動畫中的陰影對動畫故事本身及故事空間再現皆扮演著重要的角色，而陰影呈現，如何影響人們對空間深度的判斷，值得進一步深入探討。

2 文獻探討

2.1 陰影與視覺藝術表現

Price(2011)曾說，對藝術家而言理解亮面與和暗面之間固有的關係與價值是極為重要的。光線沒有陰影便無法存在，而陰影也總是伴隨著光源呈現並進而定義物體的形態。陰影的存在是創造一幅成功畫作的必要且無價的資訊。Kaufmann(1975)則指出，當三度空間視覺再現再度成為繪畫時的重要任務，解決主題對象與光線、影子在空間中交互遮蔽的結果便成為重要課題，當主題對象的陰影投射到其他物件上，某種程度強化了主體對象的立體造型呈現，並進而幫助觀者理解主體在空間中的位置，陰影投射可提供物件外型、方向、視角與距離等線索，有助於更精確地繪製主體對象。因此文藝復興時期的藝術家和理論家，對光影再現及陰影的適當的描述抱持極大興趣，在風格、技法、題材上都有著許多不可計數的創新，尤其是物體光影的處理方法。

巴洛克風格特徵是著重強烈情感的表現，強調流動感、戲劇性、誇張性，常採用對角線、弧線等構圖方式，並用明暗對比來描寫物體及統一畫面，產生戲劇性的光影和色彩。巴洛克藝術中的光影已經不再只是單純為了塑造物象的形體而存在。這樣的發展延用至今日的動畫表現，在許多動畫作品中，甚至以剪影作為故事主要角色的呈現（如圖 4-5 法國動畫片 Prince and Princess）。印象主義則提出陰影是有色彩的，早期的畫家都認為沒有光線照到的地方，就是黑色或暗色；而印象主義卻認為陰暗處的影子也是一種色彩，在陽光的反射下，這些陰影可以用紫色或者其它顏色來呈現的(古韻芬，2008)。陰影的色彩發展對照到今日的動畫應用，即為動畫中 Ambient Color 陰暗面顏色設定，可透過陰暗面的顏色調整與光影呈現，創造特殊的場景風格以利故事的陳述。

十七世紀著名的光影繪畫大師林布蘭特 Rembrandt，擅長處理畫面的光影安排，繪製如聚光燈般的特殊視覺效果，因此後人稱他為捕捉光影的魔術師。林布蘭特認為最適宜的解決方法是透過區分色彩的強弱來呈現不同比例的光線接受度，而非單靠對比來凸顯光線的強弱 (古韻芬，2008)。

以影子為主角，在動態表演呈現時多半被討論到的是如傳統的皮影戲或多媒體互動的形式。皮影戲，意即利用光影效果來表演的一種戲劇。中國的影戲，根據宋人的記載，大致可分為「手影戲」、「紙影戲」、「皮影戲」三大類。邱一峰（1999）指出此三類戲劇演出的原理相同，而以媒材的使用來進行分類，用手影成像的，就稱之為手影戲，用紙雕刻的稱之為紙影戲，用皮雕刻的稱之為皮影戲 (蘇巨暉，2008，頁 60)。皮影戲以影子為主，以非具象的演出，讓觀者有遐想的樂趣。每個人因歷程不同而產生視覺想像的差異，極具空間感的表演，透過布幕投射的光，形成影子的迷濛感 (許寧珍，2011，頁 170)。此類將觀眾目光聚焦在影子上的表演藝術，藉由剪影的不確定性，提供如動畫中預備動作般的暗示作用，引導觀眾自由想像，如圖 12 的動畫作品，先以暗夜中的影子讓觀眾產生期待與未知的恐懼，再以圖 13 劃破黑夜的閃電揭露事實的真相，以剪影操作增加劇情的戲劇張力。

2.2 陰影暗示 Shadow Cue 與空間感知

而空間的視覺能力與「空間感知（spatial perception）」密切相關，Linn 與 Petersen（1985）認為空間感知是指個體能在心中想像旋轉 2D 或 3D 圖像之表現能力，Lohman（1988）提出「空間視覺能力（spatial visualization）」，類似於空間感知的概念，同時是指能將平面圖形想像成立體圖形的能力，且皆認為空間感知是源於空間能力的一種概念，(劉奕帆，2011，頁 47)。而數位藝術發展至今，陰影與空間暗示除了 2D 或 3D 圖像之表現外，更多了 2.5D 及 Real 3D 的應用可能。影像繪圖軟體所提供的裝飾字型（圖 1），2D 二度空間陰影表現，利用暗面著色，表現文字空間厚度；荷蘭畫家 M.C. Escher 藉由陰影表現空間異想，透過錯置的暗面，表現交錯顛倒的空間（圖 2）；圖 3 則為研究者利用 Illustrator 電腦繪圖工具製作 2D 二度空間陰影表現，利用陰影強化文字與背景的距離；近 10 年發展出的 2.5D 動畫利用真實的 Z 軸深度，表現 2D 圖像在鏡頭下的空間感；有關 3D 三度空間陰影表現（圖 4），陰影能指出螢幕畫面外的空間對象暗示。

電腦動畫領域中，當光線碰到一個物體表面時，可能產生三種新型別的光線：反射、折射與陰影。針對陰影，Birn (2006)曾提到陰影的主要視覺功能有:定義視覺對象間的特殊關係，透過陰影呈現主體與背景之間的距離關係如（圖 5）；圖 6 為作者以 3ds Max 3D 電腦動畫工具製作，呈現陰影在動畫中的表現；利用陰影揭示不同的觀察角度，顯示主體在畫面因取景限制無法同時看到的角度造型（圖 7）；強化構圖的張力、增加對比、螢幕畫面外的空間對象暗示（圖 4），利用陰影整合物件…使之構圖完整等。

圖 1. 二度空間陰影表現示例

圖 2. Escher, M.C.(1994, p.83)

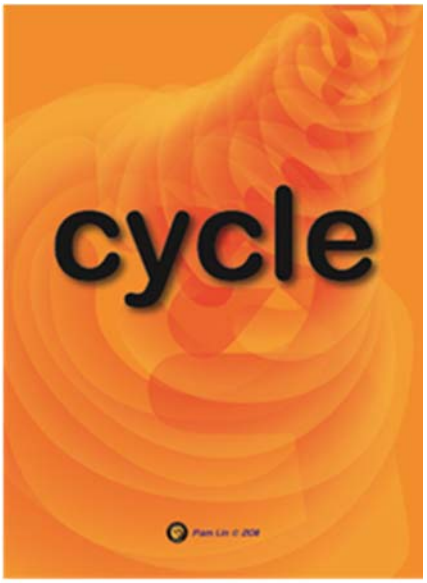


圖 3. 本研究整理

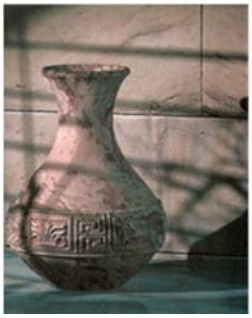


圖 4. Birn (2006)

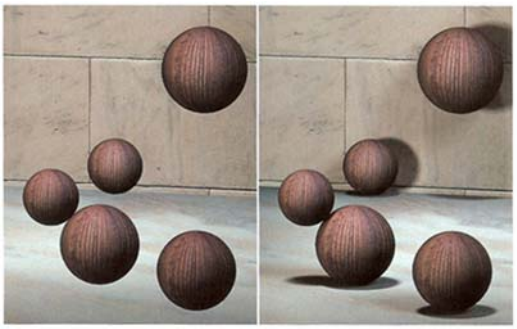


圖 5.　Birn (2006, p. 44) 陰影 Shadow 定義視覺對象間的特殊關係。

圖 6. 三度空間角色模型製作與陰影表現 (作者動畫作品)

圖 7.　Birn (2006, p. 45) 陰影 Shadow 揭示不同的觀察角度。

2.3　Shadow 在動畫中的符號象徵意義

Castati (2003) 在 Shadows 一書中曾提到:「據我所知許多人害怕陰影更甚於投射出陰影本身的物體對象」，而此種對人性的觀察，經常被應用在戲劇及影片拍攝中，動畫片中主角被圖 8 的剪影所驚嚇，以為怪獸出現，仔細一看才發現是一堆破銅爛鐵所堆砌產生的陰影投射(圖 9)，此手法成功吸引觀眾的目光，並製造懸疑的戲劇性情緒起伏。

透過以上研究我們可以了解到陰影在畫面呈現上的重要性，而剪影與陰影其產生的狀況有些許差別，本研究亦一併討論，傳統動畫自 20 世紀初發展至今已逾百年，動畫經典著作 The Illusion of Life Disney Animation(1981) 裡首度提出製作動畫的十二項原則，此十二項原則被沿用至今已成為多數學習或製作動畫者的參考依據，十二項原則中的 Staging 強調的是選擇適當的鏡頭角度安排與故事場景的呈現，Walt 在書中亦曾提到，透過觀察剪影來檢視動作表達是否恰當，圖 10 左側為較佳的動作表演角度，右側則否，觀察剪影讓事情變得清楚易懂。Chaplin 卓別林亦曾指出，如果一個演員很清楚他想表達的動作或情緒時，他應該可以用剪影將這個動作表現出來。這提醒了人們開始利用剪影 Silhouette 來選擇明確清楚的動作視角，或說是理想的說故事角度。

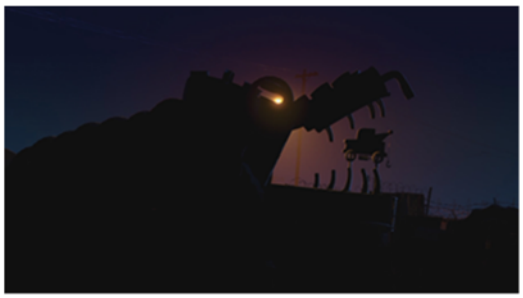


圖 8.　Pixar 動畫短片 (剪影)

Mater And The Ghost Light

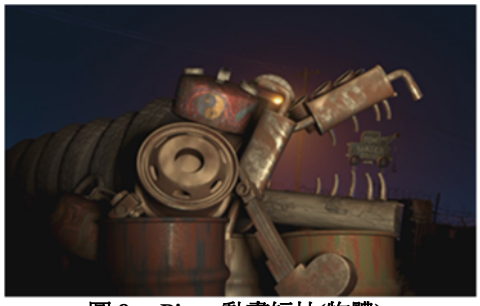


圖 9.　Pixar 動畫短片 (物體)

Mater And The Ghost Light

圖 10、資料來源：Blair (1994, p.179)

皮爾斯將符號分成三種類型並加以定義，Icon 圖像符號、Index 索引、Symbol 象徵符號，

Icon 圖像符號表示該符號與所指涉物體形象相似，可經由觀察符號本身即可了解其意義，如一個人的照片即是他的 icon，是一種寫實描摹；Index 索引表符號與指涉物之間有直接關係，看到符號會聯想到指涉物，如指示方向的箭頭， Symbol 象徵符號則具有約定成俗的意義，需經由學習了解符號的意義，例如數字或交通標誌等。

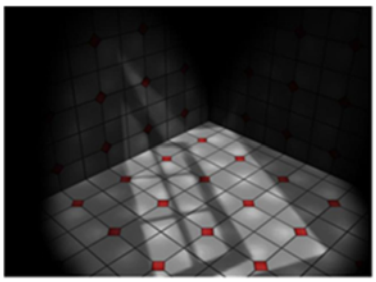


圖 11、作為 Index 索引符號的陰影表現

(作者動畫作品)

圖 12、作為 Index 索引符號的陰影表現

(學生張茗嫣動畫作品)

圖 13、作為 Index 索引符號的陰影表現

(學生張茗嫣動畫作品)

陰影在動畫中多半擔任空間暗示的角色，就如同皮爾斯 Peirce 所提的 Index 索引符號，藉由 3D 三度空間陰影的投射暗示螢幕畫面外的空間對象存在，圖 11 為作者以 3ds Max 3D 電腦動畫工具製作，使觀眾產生攝影機視角外窗框的聯想；透過陰影或剪影來說故事，讓觀眾增加更多的想像空間，對投射陰影的主體多了想像與期待，例如畫面先出現陰影，就像動畫十二項原則裡的預備動作一般，讓觀眾產生期待，同時強化了後續呈現主要畫面的反差效果，並誇張了故事情節的戲劇張力(圖 12, 圖 13)，圖 12 剪影的畫面如同預備動作般讓觀眾產生期待，圖 13 接著帶出投射主體，加強畫面的戲劇張力。Mateu (2010)就曾提到，「預兆」經常被有效地運用在一部電影裡，它能創造懸而未決的氣氛及預期心理，使整部電影充滿戲劇張力，尤其是在故事結束前加上這樣的緊張效果，對於故事的結局將產生重大影響。

圖 14、Icon 圖像符號，

資料來源：TBA 動畫「Shadow」

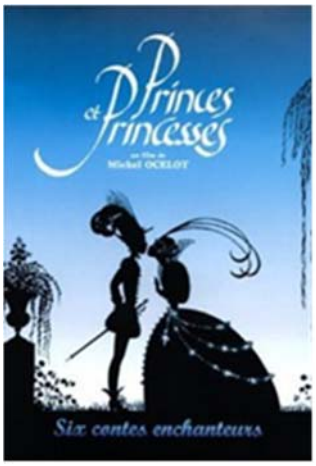


圖 15、Icon 圖像符號，

資料來源：王子與公主

陰影也經常成為動畫故事中的主角，如加拿大 TBA 公司的「Shadow」動畫短片裡的主角(圖 14)，以剪影為動畫主要角色，作為 Icon 圖像符號的陰影表現。更甚者有法國動畫大師米休歐斯洛 Michel Ocelot 於 2000 年推出的動畫 DVD「Prince and Princess」(圖 15)，DVD

中共集結了六部經典動畫短片，其中除了背景圖以彩色水彩形式表現外，長達近一小時的動畫中主要角色及場景都是以剪影繪製表現，亦同時展現了傳統皮影戲的關節旋轉動作樂趣。剪影做為動畫主角的說故事方式，此可對照皮爾斯 Peirce 所提的 Icon 圖像符號，此時 Shadow 符號即代表主角亦即指涉物本體。

而蝙蝠俠影片中探照燈所投射的蝙蝠圖像陰影，可視為皮爾斯 Peirce 所提的 Symbol 象徵符號，需經由學習了解此符號乃代表蝙蝠俠的意義(圖 16)。

圖 16、資料來源：

http://tommycoulter-liston.blogspo

3 研究方法與步驟

透過文獻探討陰影於不同時代的定義，分析在視覺故事 Visual Story 構成中陰影所扮演的角色與符號象徵意義，本研究將利用電腦動畫軟體 3ds Max 製作 3D 版本的電腦動畫陰影投射，探討 3D 陰影投射對空間知覺的影響。研究的成果可提供動畫及藝術設計相關領域空間再現多元化的發展可能性，亦能提供學界與相關業界在教學研究與實務設計上有更多的參考與應用。

預定以電腦動畫軟體 3ds Max，分別進行模型、材質、燈光、鏡頭設定、算圖，製作 3D 版本的電腦動畫陰影投射。3ds Max 為美國 Autodesk 公司開發之功能強大的 3D 電腦動畫軟體，具有 Modeling、Material Editor、Shading、Particle、Animation Setting、Lighting、Camera Moving 等完整豐富的動畫設地功能，本研究將利用 3ds Max 創造 3D 角色及物件，並透過不同 Shadow 演算法，如 Shadow Map、Ray trace，或搭配不同燈光投射如聚光燈、點光源、平行光源等，嘗試模擬陰影自然再現，做為受測者之參考依據。

3.1 受試者特性

本研究之受測對象為 18~22 歲大學學生，所有受試者均悉修習過 2D 電腦繪圖工具（如 photoshop 及 Illustrator）及 3D 動畫軟體(修習 3ds Max 動畫課程)，共 47 人。

3.2 實驗設計與材料製作

本研究採實驗法探討不同的動畫場景設定所產生的陰影呈現，對測試者在空間深度感知判斷上的影響。實驗探討的自變項分別包括三組，敘述如下（圖 17）：

產生陰影的投射光源：有聚光燈、點光源、平行光源。陰影邊緣的銳利程度：可以暗示光源的大小，例如銳利的陰影邊緣表示光源較小，柔和的陰影邊緣表示光源較大，故此組自變項包括銳利陰影邊緣、柔和陰影邊緣。動畫場景光影渲染呈現方式：2D 渲染算圖及 3D 渲染算圖。

[3（光源類型）x 2（渲染方式）x 2（陰影邊緣）]

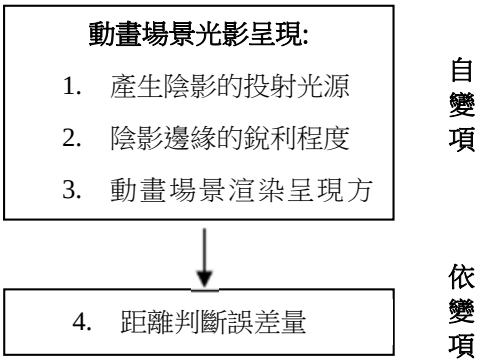


圖 17、研究架構

以 3D 軟體 3ds Max 製作 3D 場景，所有變項皆為受試者內的設計，因此每位受試者需進行 12 張圖的測試。為避免受試者測試過程產生學習效果，本實驗將採隨機播放畫面方式進行如下不同畫面測試。

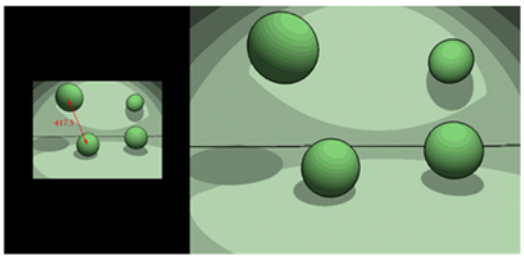


圖 18、為實驗材料示例 - 2D 渲染方式、銳利陰影邊緣、聚光燈

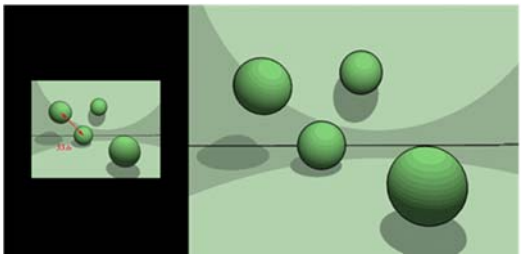


圖 19、為實驗材料示例 - 2D 渲染方式、銳利陰影邊緣、點光源

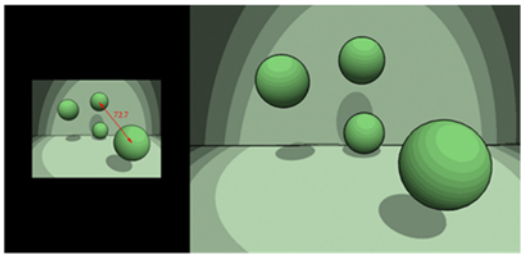


圖 20、為實驗材料示例 - 2D 渲染方式、銳利陰影邊緣、平行光源

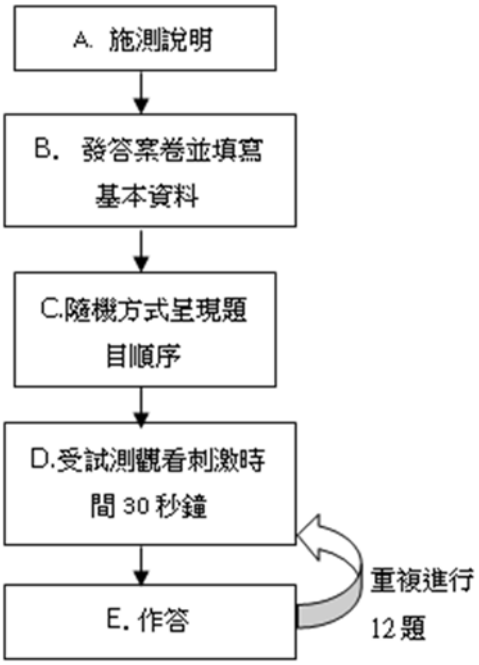


圖 21、實驗操作流程

3.3 實驗程序

主試者於施測開始前以抽籤方式隨機排出 12 張動畫場景圖片順序，依此順序作為施測畫面先後之依據。

(A) 施測過程先透過約 3 至 5 分鐘的施測說明，告知受試者實驗目的、步驟與操作流程。

(B) 並藉由 1 次場景畫面及問題作答，讓受測者了解整體實驗流程與內容。透過圖 22 呈現 3D 場景中沒有陰影暗示時，受測者無法判斷物體間的距離關係。接著展示圖 23 清楚告知受測者左側兩球間的距離為標準值 10，並請受測者在後續的場景中根據陰影的呈現判斷右側兩球間的距離。圖 24 為 3D 場景中具陰影暗示的示例。

(C) 發問卷並填寫基本資料(性別、年齡、是否具 3D 製作經驗)

(D) 正式測試時由主試者透過電腦教室廣播系統統一要求開始進行。每題有 30 秒時間讓受試者判斷題目，30 秒後由主試者切換畫面並請受試者於問卷上作答。

(E) 作答。
主試者統一切換畫面進行下一題，每位受試者需重複進行上述程序 D~E 共 12 題。

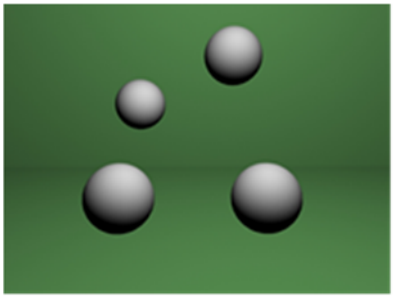


圖 22 沒有陰影暗示

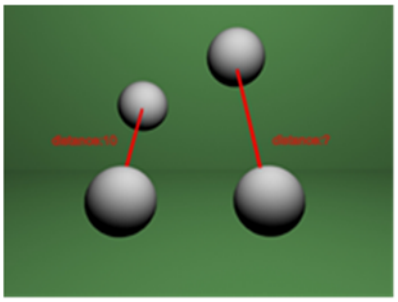


圖 23 距離為標準值 10

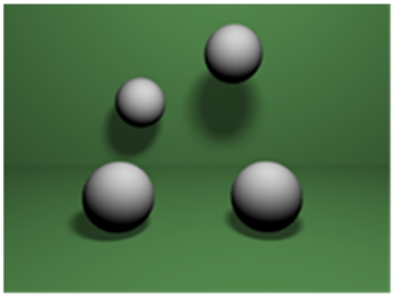


圖 24 具陰影暗示

3.4 效標蒐集

本研究蒐集的效標即依變項為受試者深度知覺誤差百分比（$\frac{\text{標準}-\text{估計}}{\text{標準}} \times 100\%$），數據資料以 SPSS 統計進行分析。

4 研究結果與討論

實驗變項水準設定如表 1，實驗結果經 SPSS 分析發現變項 C 陰影邊緣的銳利程度，顯著影響深度判斷的誤差量（$F_{1,45} = 37.79, P < 0.001$），表示當投射陰影的光源設定為銳利或柔和的陰影邊緣呈現，會顯著影響受試者對物件距離遠近的判斷，由此可推論針對深度知覺判斷，陰影邊緣的銳利程度是較有利的暗示。然而變項 A 產生陰影的投射光源（$F_{2,90} = 1.30, P = 0.277$）與變項 B 動畫場景渲染呈現方式（$F_{1,45} = 3.14, P = 0.083$）並未顯著影響。

本研究發現三個二維的交互作用，第一，變項 A 產生陰影的投射光源與變項 C 陰影邊緣的銳利程度的交互作用 P 值小於 0.05，表顯著影響估計誤差百分比（$F_{2,90} = 5.18, P = 0.007$），其影響情形如圖 25 所示，由圖 25 得知，無論何種陰影投射光源類型 A1（點光源）、A2（聚光燈）、A3（平行光），銳利陰影邊緣的估計誤差百分比皆較柔和陰影邊緣為高(如圖 25，C1 藍色線段分佈)；其中兩者在聚光燈設定下估計誤差百分比達最高(如圖 25，A2 水準所示)，銳利陰影邊緣在點光源設定下估計誤差百分比最低(如圖 25，C1A1 水準所示)，
柔和陰影邊緣在平行光設定下估計誤差百分比最低(如圖 25，C2A3 水準所示)；且當陰影投射光源類型為點光源時，銳利陰影邊緣與柔和陰影邊緣的估計誤差百分比數值相對接近，當陰影投射光源依次改變為聚光燈與平行光時，估計誤差百分比數值差距相對遞增。

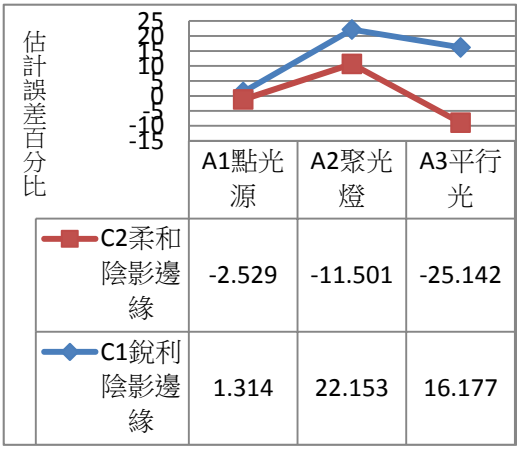
第二，變項 B 動畫場景渲染呈現方式與變項 C 陰影邊緣的銳利程度的交互作用 P 值小於 0.05，表顯著影響估計誤差百分比（$F_{1,45} = 5.89, P = 0.019$），其影響情形如圖 26 所示，由圖 26 得知，無論何種動畫場景渲染呈現方式 B1(3D 渲染)、B2（2D 渲染），銳利陰影邊緣的估計誤差百分比皆較柔和陰影邊緣為高；其中銳利陰影邊緣在 3D 渲染設定下估計誤差百分比最低，柔和陰影邊緣在 2D 渲染設定下估計誤差百分比最低；反之，銳利陰影邊緣在 2D 渲染設定下估計誤差百分比最高，柔和陰影邊緣在 3D 渲染設定下估計誤差百分比最高；且當動畫場景渲染呈現方式為 3D 渲染時，銳利陰影邊緣與柔和陰影邊緣的估計誤差百分比數值相對接近，當動畫場景渲染呈現方式為 2D 渲染時，估計誤差百分比數值差距相對遞增。

實驗結果如以絕對值判斷誤差大小，由圖 26 得知，在 3D 渲染條件下，銳利陰影邊緣的估計誤差百分比絕對值大於柔和陰影邊緣；反之，而當 2D 渲染條件下，銳利陰影邊緣的估計誤差百分比絕對值小於柔和陰影邊緣。

第三，變項 A 產生陰影的投射光源與變項 B 動畫場景渲染呈現方式的交互作用無顯著影響（$F_{2,90} = 4.15, P = 0.01$），對誤差百分比之影響情形如圖 27，由圖 27 得知，陰影投射光源類型為點光源時，3D 渲染方式的估計誤差百分比較 2D 渲染方式為高；反之，光源類型為平行光時，3D 渲染方式的估計誤差百分比較 2D 渲染方式為低；光源類型為聚光燈時，無論何種動畫場景渲染呈現方式的估計誤差百分比數值相對接近。

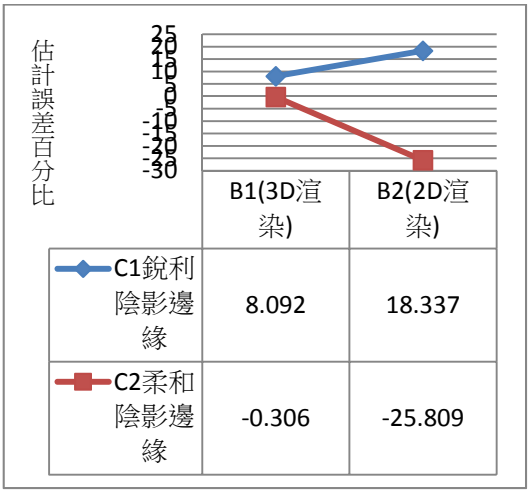
表 1. 實驗變項水準設定

水準 / 變項	a1b1c1	a1b1c2	a1b2c1	a1b2c2	a2b1c1	a2b1c2	a2b2c1	a2b2c2	a3b1c1	a3b1c2	a3b2c1	a3b2c2
A	點光源	點光源	點光源	點光源	聚光燈	聚光燈	聚光燈	聚光燈	平行光	平行光	平行光	平行光
B	3D 渲染方式	3D 渲染方式	2D 渲染方式	2D 渲染方式	3D 渲染方式	3D 渲染方式	2D 渲染方式	2D 渲染方式	3D 渲染方式	3D 渲染方式	2D 渲染方式	2D 渲染方式
C	銳利陰影邊緣	柔和陰影邊緣	銳利陰影邊緣	柔和陰影邊緣	銳利陰影邊緣	柔和陰影邊緣	銳利陰影邊緣	柔和陰影邊緣	銳利陰影邊緣	柔和陰影邊緣	銳利陰影邊緣	柔和陰影邊緣



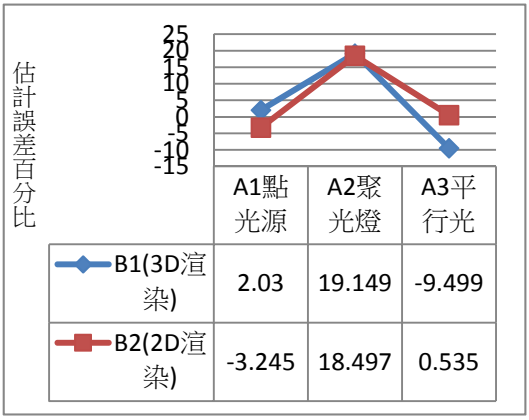
	A1點光源	A2聚光燈	A3平行光
C2柔和陰影邊緣	-2.529	-11.501	-25.142
C1銳利陰影邊緣	1.314	22.153	16.177

圖 25、變項 A 與變項 C 的交互作用對誤差百分比之影響情形



	B1(3D渲染)	B2(2D渲染)
C1銳利陰影邊緣	8.092	18.337
C2柔和陰影邊緣	-0.306	-25.809

圖 26、變項 B 與變項 C 的交互作用對誤差百分比之影響情形



	A1點光源	A2聚光燈	A3平行光
B1(3D渲染)	2.03	19.149	-9.499
B2(2D渲染)	-3.245	18.497	0.535

圖 27、變項 A 與變項 B 的交互作用對誤差百分比之影響情形

5 結論與建議

研究結果發現，陰影邊緣的模糊程度顯著影響深度知覺判斷的誤差百分比；另兩組二維交互作用（一）陰影投射光源類型與陰影邊緣的銳利程度，（二）動畫場景渲染呈現方式與陰影邊緣的銳利程度皆顯著影響深度知覺判斷的誤差百分比；由此實驗分析可知，當深度判斷增加陰影邊緣的銳利程度變項時，不論是獨立討論此一自變項，或增加投射光源類型及 2D、3D 動畫場景渲染呈現方式的變數，皆會顯著影響深度知覺判斷。其中特別針對兩組顯著影響估計誤差百分比的二維交互作用進一步分析討論如下:

5.1 陰影投射光源類型與陰影邊緣銳利程度的交互作用

實驗結果如以誤差百分比絕對值判斷誤差量大小，由圖 25 得知，在點光源與平行光條件下，銳利陰影邊緣的深度估計誤差百分比絕對值皆小於柔和陰影邊緣，點光源 1.314<2.529，平行光 16.177<25.142，可由此推論，點光源與平行光搭配銳利陰影邊緣時，提供受測者較佳的深度空間暗示，點光源的特性是從四面八方平均發射光線，並從光源位置以輻射方式投射陰影；平行光則創造平行的陰影和照明，以相同的角度投射到每個對象上，經常被用來模擬無限遠的太陽光，因為點光源與平行光的特性，減少了光源在方向上所可能產生的複雜性，與明確的銳利陰影邊緣加乘後的結果，讓受試者易於做出誤差較少的判斷。

唯獨在聚光燈條件下，柔和陰影邊緣的深度估計誤差百分比絕對值 11.501 小於銳利陰影邊緣 22.153；聚光燈的特性是光線投射被限制在一個如圓錐瞄準投射的特定方向上，其陰影提供受測者較多的方向判斷資訊，搭配相對複雜的柔和陰影邊緣，受測者經由陰影方向及陰影模糊的程度，相對銳利陰影邊緣得到誤差百分比絕對值較小的誤差量，但相較於另外兩組點光源、平行光搭配銳利陰影邊緣所得到的誤差量，聚光燈與柔和陰影邊緣誤差量仍為最大。

5.2 動畫場景渲染呈現方式與陰影邊緣銳利程度的交互作用

實驗結果如以誤差百分比絕對值判斷誤差量大小，由圖 26 得知，在 3D 動畫場景渲染狀態下，柔和陰影邊緣的深度估計誤差百分比絕對值 0.306 小於銳利陰影邊緣 8.092，可由此推論，由於 3D 動畫場景渲染相較於 2D 動畫場景渲染較為寫實，柔和陰影邊緣可藉由不同距離演算出具差異的陰影模糊程度，近者較清楚，遠者較模糊，提供更多深度判斷的訊息，

在寫實的 3D 動畫場景裡較為有利。反之，在 2D 動畫場景渲染狀態下，銳利陰影邊緣的深度估計誤差百分比絕對值 18.337 小於柔和陰影邊緣 25.809，可由此推論，2D 動畫場景渲染深度判斷訊息相對條件有限，模糊的陰影邊緣過多的資訊反而干擾了受測者的深度判斷，此時銳利陰影邊緣反而較有利受測者作出較佳的深度判斷。

由於真實立體呈現的視覺效果一直是人類所共同追求的感官體驗，不論是早期文藝復興古典藝術，甚或今日蔚為流行的裸眼立體 3D 表現，針對動畫藝術，利用空間與透視來達到氣氛營造與故事的陳述，更少不了陰影的空間與情節暗示，此實驗結果可推論並非提供越多元、越複雜的陰影訊息，就能幫助受測者進行正確的深度判斷（如圖 25），而是必須搭配不同的視覺產生因素如陰影投射光源類型、陰影邊緣銳利程度及動畫場景渲染呈現方式等加以綜合考量後，方能定義並產生最有利於深度知覺判斷的陰影投射效果。本研究推論期能提供遊戲、影視動畫、行動裝置等視覺媒體在進行立體光影深度表現時之設定參考。未來研究建議可針對陰影在 3D 三度空間及 Real 3D 擬真三度空間甚至是裸眼 3D 的空間感知能力上進一步深入探討。

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