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Efficiency of Fabric Repellency to Mosquitoes

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Abstract

Textile finishing sectors had a great development, and health awareness is increasing, the finishing of textile to repel insect is very important and urgent to prevent transmission of mosquitoes diseases. Therefore, the researcher found that the Neem tree can be used in textile finishing as repel mosquitoes, by using the solution extracted from green and dry Neem leaf for future applications, in apparel industry, tents, curtains and furnishings. This research used the experimental descriptive method, which describes the phenomenon, summarizes data and information to analyze it for conclusion and recommendation. The researcher surveyed data and information about the neem tree and used it for textile finishing as repel insects, some properties of textile were tested to evaluate the effect of solution extracted from green and dry leaf of Neem tree on the performance of textile properties and repel insects. It was found that the fabric finished by using green Neem leaf, has the ability to repel 80% of mosquitoes, and the fabric finished by using dry Neem leaf, has the ability to repel 60% of mosquitoes, and the finishing of fabric with the extracted solution green and dry Neem leaf has a significant effect on the fabric properties.

Keywords

Textile Finishing, Efficiency, Mosquitoes, Neem Tree

1. Introduction

In line with the improvement of people's living standard and the growing awareness and need to preserve the environment, several regulations were introduced, also in the textile industry in order to control the use of chemicals in textile processes and use natural material for textile finishing.

Due to the severity of diseases, which transmitted by Mosquitoes, great efforts have been done to search new treatment of textile based on plant to be more effective and safe for fighting Mosquitoes instead of insecticides that gain the

mosquitoes immunity, in addition, the insecticides are high toxicity.

Mosquitoes are one of the worst enemies for humans and animals and are considered the first enemy of the harmful insects to transmit many diseases between people a year such as malaria fever, dengue fever, rift valley fever, and other diseases.

The progress and development in the textile sectors lead to finish the textiles to be repelling insects by using natural plants.

Neem trees contain many compounds, the Salannun compound is one of them and has significant effect to be insect repellent, especially against mosquito, and many compounds were extracted from Neem seeds and leaf, and were used as natural insecticides, insect repellent that affected on some kinds of insects, mites and worms.

Neem extracted for insect repelling is antibacterial, some studies recommended for more researches on the plants to apply on the textile finishing and treatment to improve the textile finishing, being an alternative of harmful chemicals treatments.

2. Review of Literature

Due to the increment of awareness of green environment, the requirements of consumers for apparel to be healthy, environmentally friendly. The idea of eco-friendly clothing is to develop the product from raw materials to the recycling for healthy and clean environment.

All processes of apparel production as fiber, spinning, weaving, finishing, treatments, readymade garment, and recycling must be friendly for environment, also the materials used for apparel manufacturing must be recycled and reuse again to be eco friendly and for sustainability to save the sources of new raw materials (Nassif, 1999).

In many studies, the researchers have focused to produce fabric with special treatments as, anti bacteria, anti mold, insect repelling, oil repellency and flame resistance, etc. (Sheta & Nader, 1999).

Despite of the great importance of the finishing processes for textile to meet the requirements of textile sector, as expansion, the ability to compete in domestic and international markets to add high value, most of the studies have shown that the manufacture of wet processing for textile is one of the largest sources of pollution in the textile sector. More than 300 to 800 different types of chemicals items are used, most of them do not have safety data sheet (Nassif & Okda, 2004).

So the researchers interested of nature, where they found more facilities that could be helpful for new modern technologies.

“Biomimetic Nature” has become the focus of the researchers, using this simulation technique to understand the natural structures for its applications, because the nature is the first teacher of human for inventions.

The research of Hatem et al. (2011) evaluated the efficiency of water extracts and dry powders of some plants as Oak, Eucalyptus, Civet and Sorrel on some

aspects of fly insect, the water extract showed the rate of mortality of fly insects between 51.1% and 78.8%. Also deformities of the appearance and reduction of the weight of larva, in other sides the dry powder had a significant effect on the rate of mortality of the house fly.

Girish and Shankara Bhat (2008) have named the Green Treasure on the Neem because of its multiple of applications.

Neem belongs to the family Meliaceae, subfamily Meloideae and tribe Melieae. Neem is the most versatile, multifarious trees of tropics, with immense potential. It possesses maximum useful non-wood products (leaf, bark, flowers, fruits, seed, gum, oil and Neem cake) than any other tree species. These non-wood products are known to have antifungal, antipyorrhoeic, antiscabic, insecticidal, larvicidal, and other biological activities.

Because of these activities of Neem, it has found enormous applications making it a green treasure (Girish & Shankara Bhat, 2008).

Neem tree was introduced in places such as Australia, East and sub-Saharan Africa, South East Asia, and South America. Today, the neem is well established in at least 30 countries worldwide, in Asia, Africa and Central and South America. Some small scale plantations are also reportedly successful in Europe and United States of America (Qaisi, 1998).

Neem is a multipurpose agro forestry tree that is well adapted to a wide range of climatic, soil conditions, and has gained worldwide recognition for its pharmaceutical and pesticides properties. The world's largest pure Neem plantations are available in the plains of Arafat, Saudi Arabia where thousands Neem trees were planted to provide shade from the blazing summer sun for the millions of Hajjis (Muslim pilgrims).

Mature Neem trees are found in Medinah, Taif and elsewhere of the Kingdom of Saudi Arabia (Mridha & Al-Suhaibani, 2014).

Figure 1 shows that in the Kingdom of Saudi Arabia, there are about more than one hundred thousand tree of Neem, distributed around the holy sites between



Figure 1. Neem plantation on plains of Arafat in Makkah, Kingdom of Saudi Arabia.

Makkah and Arafat. They are planted in order to provide the shade, comfort for about two million pilgrims, also there are Neem trees in other regions which has hot climate in the Kingdom of Saudi Arabia (Abu Abdoun, 2000).

The Indian people are the first human to use all parts of tree Neem, as leaf, bark, seed and branches of their medical uses. They extracted oils as natural compounds, which proved health benefits, the flowers of Neem release an aromatic smell which is good for human and is repel for the insects (Michel, 1993).

Neem plants have affect against great groups of insects and are not only specialized to treat a particular insect but also the extracted Neem has efficacy against 60 kinds of insects when used with very low concentrations, as the study which carried out in US universities, it has affect against the white fly that infects sweet potatoes, and snaky worm.

Alouani et al. (2009) studied the effect of Azadirachtin as natural pesticides, which extracted from the Neem tree on the Larvae and virgin of Mosquito, in this study the rate of Fertility decreased and the female infertility increased, the study recommended using the Neem as natural pesticide instead of chemical pesticides.

Al-Mohmadi, and Al-Khalef (2008) found that the deactivation of egg production and mosquito repellent, depended on the concentration of the plant extract. In addition to the possibility of Neem extract for insect repelling, it is also antibacterial. Thilagavath et al. (2005) proved that the neem is 100% antibacterial, the study recommended for more researches on the plants to apply on the textile finishing and treatment to improve the washing fastness, also to be an alternative of harmful chemicals treatments.

The researchers are inspired by their patents and innovations from Nature, which offers multiple means that can be invested to improve the end use of the smart textile.

3. The Aim of the Research Are as the Following

- 1) Application the extracted solution from green and dry Neem leaf on textile finishing.
- 2) Evaluation the textile finishing, by using the extracted green and dry Neem leaf.
- 3) Evaluation the effect of the solution extracted from green and dry Neem on the textile properties as (Weight, thickness, hardness, drapeability, air permeability, and crease recovery).

4. Experimental of Work

4.1. Preparation the Extracted Solution from Green Neem Leaf

The Neem leaf samples were collected from the area of Arafat, Makkah, Saudi Arabia, and were packed in plastic bags and were transported to the Textile Laboratory, University of Umm Al Qura. Leaf samples were washed using water to remove dust and particles. The leaves were separated from the stalk, the leaves

were kept in plastic bag.

The Neem leaves were covered with water at a ratio of one kilogram of leaves to five liters of water, and soaked over night without heat or boil to get high concentration of Azadirachtin content. After that the leaves were grind in the water and liquid was filtered to get clear liquid as shown in **Figure 2**, and the liquid used for finishing the textile fabric.

4.2. Preparation the Extracted Solution from Dry Neem Leaf

Leaf samples were washed using water to remove dust and particles. The leaves were separated from the stalk and dried in the ambient temperature for one week, after drying, the leaves were grinded into a powder by using mill, and the powder sample was kept in dark glass bottle.

The Neem powder were mixed with water at a ratio of one kilogram of powder to five liters of water, and mixed without heat or boil to get high concentration of Azadirachtin content, after that the liquid was filtered to get clear liquid which used for finishing the textile fabric, as shown in **Figure 3**.

4.3. The Processing of Fabric Finishing, Using Solution Extracted from Green and Dry Neem Leaf

The extracted solution from green and dry has been applied as coating directly to the surfaces of the fabric by using laboratory padding machine.

Textile fabric was immersed in the diluted extracted solution from green and dry Neem leaf at room temperature, the fabric picks up from the solution set to be (2% - 5%), by adjust the squeezer system.

The color of solution from green Neem leaf was light but the color of solution



Figure 2. Diluted extracted solution from green Neem leaf.



Figure 3. Diluted extracted solution from dry Neem leaf.

from dry Neem leaf was dark, the color of solutions will affect certainly on the color of treated fabric.

4.4. Testing the Mosquito Repellency by Effect of Fabric Finishing with Solution of Extracted Neem

Figure 4 shows the instrument used for evaluation the mosquito repellency by the effect of fabric finishing with solution of extracted Neem.

Three samples of fabric were used, control fabric sample without finishing, fabric sample finished with extracted solution from green Neem leaf, and fabric sample finished with extracted solution from dry Neem leaf. The tested samples of fabric were placed in the instrument from the right side of the tube, and in the left side, a wet cotton swab as medium neutral was placed.

The mosquitoes were placed in the middle slot of the tube of the instrument, the slot and box were closed and light of instrument was off. After 20 minutes, the box was opened, and numbers of insects were counted, either that moved to the right direction from the middle of the tube to the solution extracted, or that moved to the left direction to wet cotton swab, as shown in **Table 1**.

5. Results and Discussion

5.1. Effect of the Types Fabric Finishing on the Mosquitoes Repellent

It is clear from **Table 1** that the percentage of mosquitoes moved to the direction

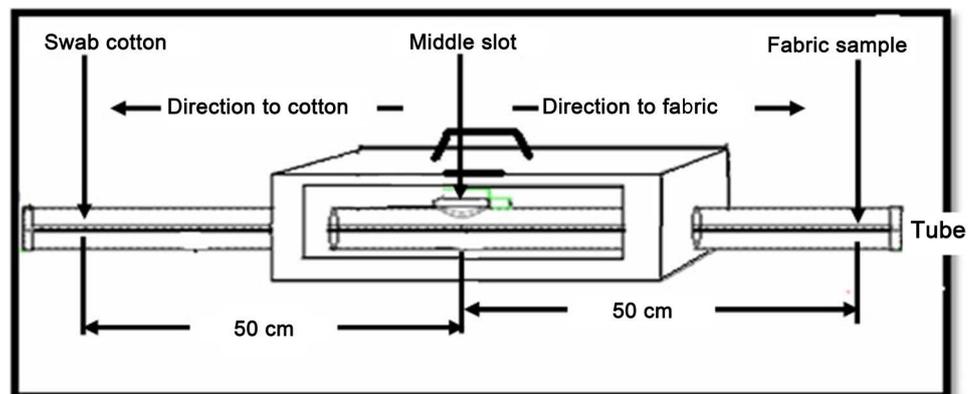


Figure 4. Instrument for evaluation mosquito repellency.

Table 1. Effect of fabric finishing by using the extracted green and dry solution of Neem leaf, on the repel mosquito.

Samples	Percentage of mosquitoes moved to samples	Percentage of mosquitoes moved to wet cotton	Percentage of repellent	Percentage of attraction
Control fabric sample	100	0	0	100%
Fabric finished with extracted solution from green Neem Leaf	20%	80%	80%	20%
Fabric finished with extracted solution from dry Neem Leaf	40%	60%	60%	40%

of the control fabric sample was 100%, i.e., the percent of mosquitoes repellent for control fabric sample is (zero %), and the percent of mosquitoes attraction for control fabric sample is 100%.

The percentage of mosquitoes moved to the direction of the fabric finished with extracted solution from green Neem Leaf was 20%, %, i.e., the percent of mosquitoes repellent for fabric finished with extracted solution from green Neem Leaf is 80%, and the percent of mosquitoes attraction for fabric finished with extracted solution from green Neem Leaf is 20%.

The percentage of mosquitoes moved to the direction of the fabric finished with extracted solution from dry Neem Leaf was 40%, %, i.e., the percent of mosquitoes repellent for fabric finished with extracted solution from dry Neem Leaf is 60%, and the percent of mosquitoes attraction for fabric finished with extracted solution from green is 40%.

To increase the efficiency of repellent, the concentration of Neem should increase for both of dry and green Neem in extracted solution.

From all of above, the finishing fabric with Neem leaf has a significant effect on repel mosquitoes.

5.2. Effect of the Finishing Types on the Fabric Properties

The researcher carried out some experiments on the finished samples to study the effect of the finishing on the fabric properties and evaluate the end use of the samples, the following tests carried out on plain weave fabric 100% cotton, as shown in **Table 2**.

5.2.1. Weight of Fabric

Figure 5 shows the weight of control fabric sample was 88.8 g/m², after finishing the weight of fabric increased, the weight of fabric finished with the extracted solution green Neem leaf was 93.2 g/m², in the other side the weight of fabric finished with the extracted solution dry Neem leaf was 96.8 g/m².

The increment of weight for finished fabric with dry Neem leaf was due to the more concentration substance of Neem in the extracted solution.

Table 2. Fabric properties after finishing by using the extracted solution from green and dry Neem leaf.

Fabric Properties	Types of fabric finishing		
	Control fabric sample	Fabric finished with solution green Neem Leaf	Fabric finished with solution dry Neem Leaf
Weight (g/m ²)	88.8	93.2	96.8
Air Permeability (cm ³ /cm ² /s)	35	33.3	34.2
Stiffness	52.2	49.8	53.4
Thickness (mm)	0.3	0.33	0.32
Drapeability	56.64	55	49.4
Crease Recovery Angle	150	180	130

5.2.2. Air Permeability

Figure 6 shows the air permeability of control fabric sample was $35 \text{ cm}^3/\text{cm}^2/\text{s}$, but after finishing with green and dry Neem, the air permeability of fabric decreased. The air permeability of treated fabric with the extracted solution of green Neem leaf was $33.3 \text{ cm}^3/\text{cm}^2/\text{s}$, and the air permeability of finished fabric with the extracted solution dry Neem leaf was $34.2 \text{ cm}^3/\text{cm}^2/\text{s}$.

The decrement of air permeability of fabric after finishing with dry and green Neem leaf comparing with the control fabric sample was due to the increment of non fibrous materials during finishing processing.

5.2.3. Fabric Stiffness

Figure 7 shows the stiffness index of control fabric sample was 52.2 but after

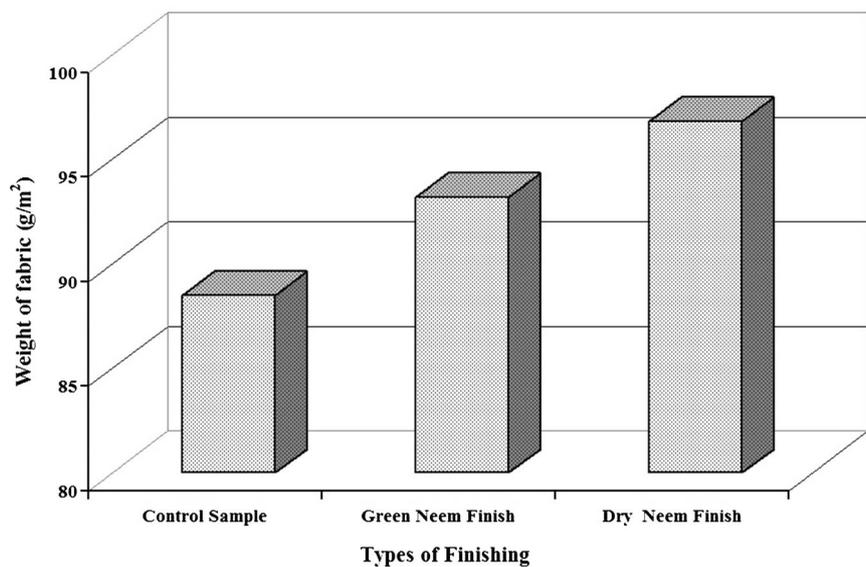


Figure 5. Effect of types of finishing on the weight of fabric.

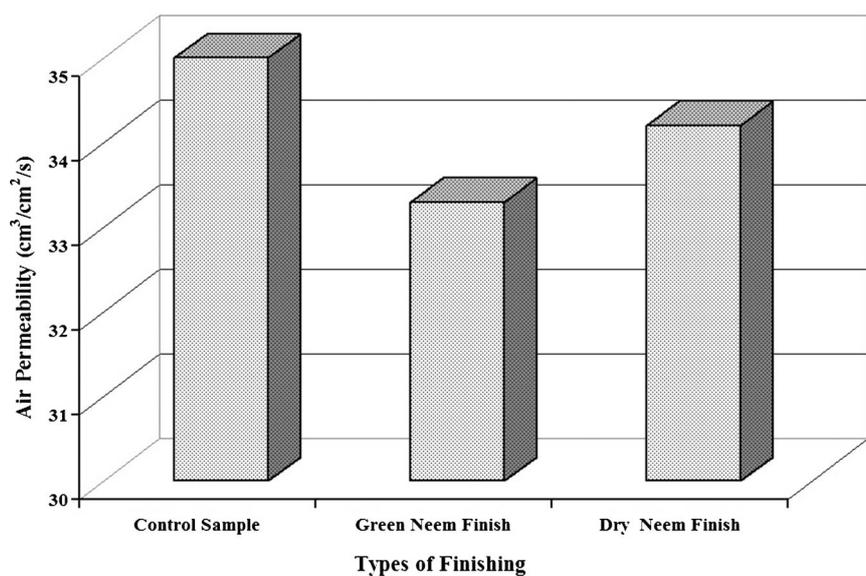


Figure 6. Effect of types of finishing on air permeability.

finishing with green and dry Neem, the stiffness of fabric changed.

The stiffness of fabric treated with the extracted solution green Neem leaf was 49.8, in the other side the stiffness of fabric treated with the extracted solution dry Neem leaf was 53.4.

The increment of stiffness index for the treated fabric with dry Neem leaf was due to the more concentration substance of Neem in the extracted solution which leads to more non fibrous materials in the textile fabric.

5.2.4. Thickness of the Fabric.

Figure 8 shows the thickness of control fabric sample was (0.3 mm), after finishing the thickness of fabric increased.

The thickness of finished fabric with the extracted solution green Neem leaf

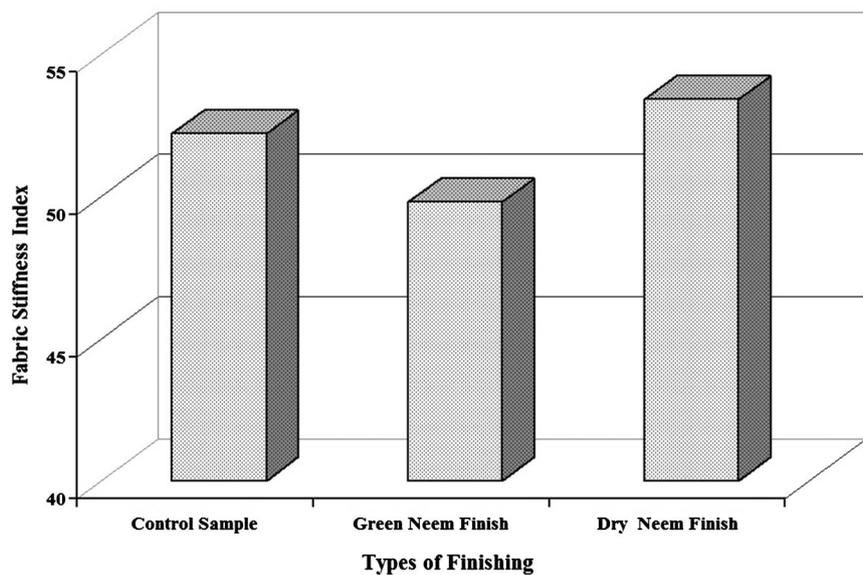


Figure 7. Effect of types of finishing on fabric stiffness.

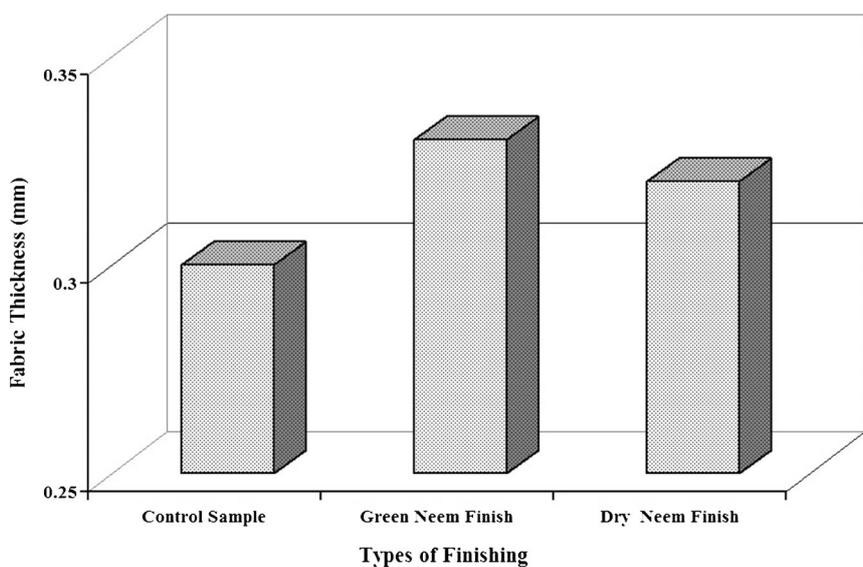


Figure 8. Effect of types of finishing on thickness of fabric.

was (0.33 mm) and the thickness of treated fabric with the extracted solution dry Neem leaf was (0.32 mm).

The increment of the fabric thickness after finishing with dry Neem leaf was due to the non fibrous materials after finishing.

5.2.5. Drapeability

Figure 9 shows the drapeability index of control fabric sample was (56.64), after finishing the drapeability of decreased.

The drapeability index of finished fabric with the extracted solution green Neem leaf was (55%) and the drapeability index of treated fabric with the extracted solution dry Neem leaf was (49.4%).

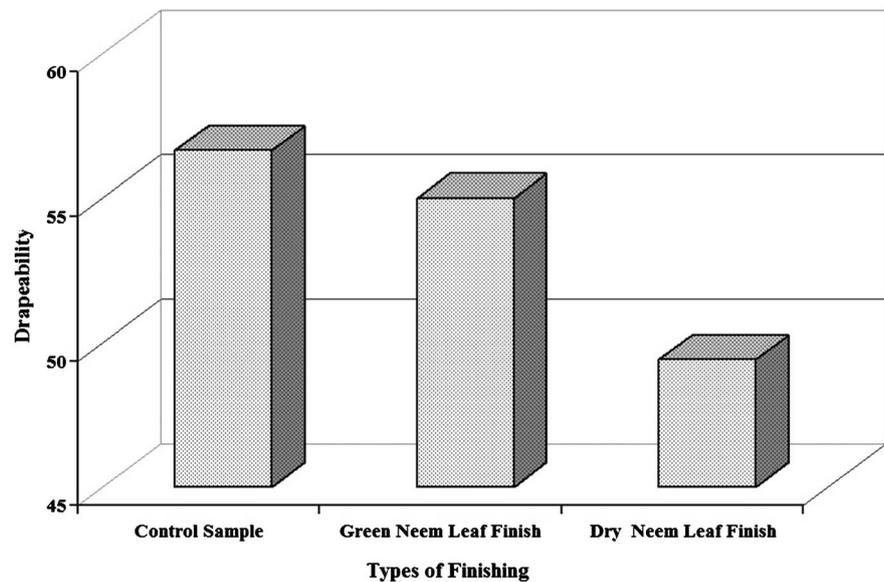


Figure 9. Effect of types of finishing on fabric drapeability.

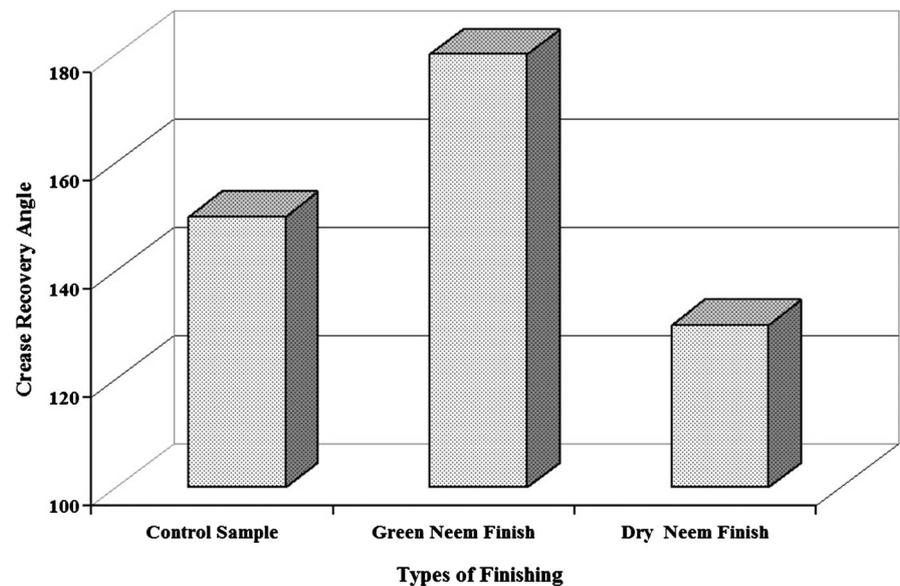


Figure 10. Effect of types of finishing on the fabric crease recovery angle.

The drapeability index after finishing shows that the drape of fabric improved after finishing with both dry and green Neem leaf.

5.2.6. Crease Recovery Angle of Fabric

Figure 10 shows the crease recovery angle of fabric control fabric sample was (150), after finishing the crease recovery angle changed depending on the finished type.

The crease recovery angle of finished fabric with the extracted solution green Neem leaf was (180) and the crease recovery angle of treated fabric with the extracted solution dry Neem leaf was (130).

The crease recovery angle of treated fabric with the extracted solution green Neem was better than crease recovery angle of treated fabric with the extracted solution dry Neem, because the increment of non fibrous due to using dry Neem leaf, which lead to be stiff.

6. Summary

- 1) The fabric finished by using green Neem leaf has the ability to repel 80% of mosquitoes, and the fabric finished by using dry Neem leaf has the ability to repel 60% of mosquitoes.
- 2) The finishing of fabric with the extracted solution green and dry Neem leaf has a significant effect on the fabric properties.
- 3) The extracted solution from green and dry Neem leaf can be used as spray to repel mosquitoes
- 4) Being eco-friendly for the textile finishing is top urgent.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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The Dynamics of Architectural Form: Space, Emotion and Memory

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Abstract

The focus of this paper is in the area of architectural psychological impacts on human senses, behaviours and experiences. Such a study is important and essential in order to unite the senses, feelings and experiences together with the traditional architectural design theories and methods, and then understand how we should design and what we should concern about during design. This paper summarises an approach for architectural design on how to integrate multi-senses into practice and reflect human senses, behaviours and experiences in the realm of environmental psychology. This paper also recommends that architects should be aware of these psychological influences for future design; a consideration of environmental perception and responses should be taken during interior design, architectural design and urban planning.

Keywords

Architecture, Environmental Psychology, Senses, Behaviours, Experiences

1. Introduction

How to level up the visual standard of city landscape? How to enhance the social communication with the help of public space? How to lay out the classroom to promote the enthusiasm of study? How to design an office to improve the work efficiency?

Distinctly, all of these above connect the design of architectural spaces and places with our mind, senses and environmental-impact experiences, which are indeed vital aspects during design and planning. Architectural and scientific research studies on the relations of environmental factors and human psychological, physical behaviours and experiences have already directed architects to improve, or even change the way of design. These researches are mostly focusing

on three objectives: The first one is to talk about the close relations of human senses and architecture. Steven [Holl \(1994\)](#), [Pallasmaa \(2005a, 2005b\)](#), and Peter [Zumthor \(2006\)](#) write to explain the importance of human senses and perception; Rudolf [Arnheim \(1977\)](#) focuses on the dynamics of visual aspect; [Malnar and Vodvarka \(2004\)](#) put forward multi-sensory concern in architectural and landscape design. The second one is to describe the different psychological experiences from different architectural forms. In this area, there are many reports, studies, articles, and books about the relationships between architectural elements, forms, spaces, places and human psychological experiences, such as Richard [Weston's description \(2003\)](#) of the meanings of each material, and Benson [Lau's study \(2007\)](#) on luminous environment in the Monastery of La Tourette. The last one is to find what people really need in the realm of architecture and environment, which is called environmental psychology or architectural psychology. Edward [Hall \(1969\)](#) gives the basic theory of psychology; [Bell, Green, Fisher and Baum \(2001\)](#) as well as Robert [Gifford \(2002\)](#) put the theories into concrete practice.

Till now, these researches and studies have helped design in hospitals, schools, and unit residential. For example, in classrooms with increased natural light, students could achieve higher test scores than those in normal classrooms. And, at least according to research done in London, unfashionable “hospital green” walls did help speed up the healing process. In San Diego, hospital patients, their families and medical staff reported positive effects from exposure to uplifting art and healing gardens ([Jarmusch, 2003](#)).

Consequently, the prospect of design with concern about both architectural form and human psychological needs will make it possible for architects to approach design in a new way, and also could have far-reaching social, personal and economic benefits in the field of urban planning, interior design and architectural design theoretically and practically.

Therefore, the overall aim of this paper is to explore the relationships between architecture and human through analysing emotional and psychological effects on our behaviour, actions, emotions and perceptions influenced by our built environment (buildings and the spaces inside out). Thus, this paper consists of five main parts. Section One explains the people-architecture relations and provides a direction of the roles of architecture itself and human in architectural design and contemporary society; Section Two mainly characterizes the human sense on buildings and the essence of architectural senses, which will provide the communication between people and buildings; Section Three, according to different types of architectural form from basic elements to specified places, will identify the distinct meanings of dissimilar modes of spaces. In Section Four, standing on the point of normal people, an exploration of relationship of environment, psychological impact and behaviour will be presented. And in the last section, the case study of Peter Zumthor's Thermal Bath will help provide a comprehensive understanding of design associated with applications of environmental psychology.

2. People-Architecture Relations

Sir Winston Churchill says: “*We shape our buildings, thereafter they shape us.*”. Indeed, people are the creators of artificial environment especially the buildings, also we are influenced by architectural environment gradually and constantly.

2.1. Influences from Architecture as Buildings and Places

In accordance with the different needs and functions, we create different places such as supermarket and sports hall; then, consequentially, we join in and use these places. Afterwards, impacts from the different environmental factors we built lead us to distinct psychological responses and behaviour reactions, and sometimes the appearance of a new type of architectural form could change the original activity content, or even bring a fresh one. For instant, a newly-built swimming pool where accessing a swim, dive or water polo might bring people who live nearby a new habit—swim in the afternoon, but these people would hardly buy food from there. That is all because a place consists of not only the physical size but also the participations and responses from people. Similarly, architecture is not only a construction but also a media of communicating with us and representing the aesthetics, philosophy and our value idea which all give enormous impetus to the progress of human ourselves.

2.2. Influences from Architecture as History, Culture, Politics and Society

Architecture itself not just has a close relationship with us, it reflects a social image. Most of the history, culture and politics of a city are exhibited as the fine art of architecture.

It is obvious that in the architectural history, besides the functions of residence and work, a building is a remarkable promotion of economy and civilization. Take Acropolis, Athens as an example: The Acropolis of Athens was built in fifth century BC. Built on a flat-topped rock which rises 150 meters above sea level, the whole building complex was a monument of the golden period and a witness of fully prosperity of the city of Athens. The reason for its boom is that the construction of Acropolis had three clear themes: the first one is to celebrate and memorize the victory against the Persian army’s aggression. The second one is to glorify and decorate the city, to state and strengthen the status of Athens. The last one is to make the economy increase rapidly, which was the most important aspect. The vast city-building provided a large number of employment opportunities and the extensive construction also attracted all the Greek philosophers, artists, craftsmen and other people to Athens. That made Athens which was originally a small town and did not attract so much attention to a rapid developed economic and cultural centre of Greece.

In like manner, architecture contributes the politics. In the 17th century France, most of the classical architecture was the large-scale national constructions and some of them were specified for the glory of Louis XIV and his regime.

He believed that with the exception of military power, only the great architecture could perform the king of the great and solemn spirit. During this period, the construction of the Louvre East elevation, the Place Vendome and the Palace of Versailles were built for Louis XIV of the “great era” and the “great style”. Napoleon also understood the political role of architecture. The Triumphal Arch (**Figure 1**), the biggest “door” in the world with a construction of 49.4 meters height, 44.8 meters width and 22.3 meters thick, was the best evidence to prove the “military honour”. Such form of the “Empire style” affected people’s cognition of majesty; it brought a great impact on the 19th century European architecture as well.

2.3. Concern with Human Senses, Behaviours and Experiences

Architecture itself not just has a close relationship with us, it reflects a social image. Most of the history, culture and politics of a city are exhibited as the fine art of architecture.

According to the state of the relationship between architecture and us, therefore, the architectural creation is a communication between buildings and human, and among physical elements (facades, structures and landscapes), social factors (history, culture and politics) and our psychological context (emotion, memory and behaviours). Thus, a good designer should not only consider the decisions made for the styles and forms, but also be awareness of the influence from the buildings and places on the people who are using these, and then, on the basis of the psychological responses and behaviour reactions, develop design methods to improve the environmental quality.

Contrarily, less consideration of the psychological influences on human senses, behaviours and responses might cause social and psychological failure. The Pruitt-Igoe housing project (**Figure 2** and **Figure 3**), built in St. Louis, Missouri, USA, has been regarded as one of the most infamous failures of public housing in American history. Katharine G. Bristol (1991) had described that “This version of the Pruitt-Igoe story is a myth. At the Core of the myth is the idea that architectural design was responsible for the demise of Pruitt-Igoe”.



Figure 1. The triumphal arch.



Figure 2. The Pruitt-Igoe housing project.



Figure 3. The demise of Pruitt-Igoe.

This project was designed in 1951 by architect Minoru Yamasaki (who would later design the World Trade Centre) as a part of the post-WWII federal housing program for bringing back the demobilized servicemen to the city life. However, owing to the inattention of social communication and human reaction, within a few years it quickly fell into disrepair and disuse, and heavily vandalized by its own residents. Even worse, many of the architectural design elements of Pruitt-Igoe which were innovations of modernist architecture (high-rise, high-tech, green plants, designed for sunlight and reducing industrial pollution) turned out to be at best inconveniences and breeding grounds for crime, such as its recreational galleries which no one would feel ownership of and “skip-stop” elevators which stopped only at fifth, seventh and tenth floors in an attempt to lessen congestion.

The buildings remained largely vacant for years, and after spending more than five million dollars and several failed attempts to rehabilitate the area, the first building was demolished on March 16, 1972. The demolition of the entire complex was completed in 1976.

3. Senses of Architectural Form

Architecture is the link between nature and man-made realm. Through the

senses of architectural forms, we could have perception and experience, and then we understand the world and ourselves much better.

3.1. Perception through Senses

“Our immediate awareness of the phenomenal world is given through perception. We are highly dependent upon seeing our surroundings in a satisfactory manner. Not only do we have to find our way through the multitude of things, but we should also ‘understand’ or ‘judge’ the things to make them serviceable to us.” Christian Norberg-Schulz (1963).

People attempt to make the environment surrounded familiar through perception, so that they could organize activities in it confidently and favourably. The varieties of senses to perception reflect different possibilities of understanding surroundings. Senses are joined together, so that we learn, following we clear about what establishes important information. Thus, the way we understand surroundings including architecture is directly related to the way we process received environmental information from senses.

The five classical senses (sight, hearing, touch, smell and taste) are the most essential sensory experiences in architectural realm. We interact with the architectural form through these senses. With these intersections, we could realize the value of spaces and places, and they become meaningful to us too.

It is also worth to remember that there are some more sensations we experience that are not formally categorised as one of the five classical senses, such as orientation, gravity, balance, temperature, enclosure and moods.

3.2. Planning and Design for Human Senses

“The task of architecture is to strengthen our sense of the real, not to create settings of mere fabrication and fantasy. The essential mental task of the art of building is mediation and integration. Architecture articulates the experiences of being-in-the-world and it strengthens the sense of reality and self. It frames and structures experiences and projects a specific horizon of perception and meaning.” Juhani Pallasmaa (2005b).

Multi-sensory design is becoming more and more popular in unit residential, special schools and hospitals; in particular the ones focus on touching effects for the blind people. All these are concentrating on offering psychological experiences and multi-sensory responses which express the identities of these designs. Several architectures have been constructed on the basis of emphasising specified senses, particularly the senses of sight and touch. The examples are The Church of Light (visual sense) (Figure 4), Civil Rights Memorial (sense of touch) (Figure 5) and Vietnam Veterans Memorial (sense of touch) (Figure 6).

It is regrettable that there are few buildings presenting other senses except sight and touch. But it is indubitable that through careful and imaginative design, it is possible to build more buildings which provide a wider range of sensory experiences to the users. It is worth to note that when planning for a multi-sensory



Figure 4. The church of light.



Figure 5. Civil rights memorial.



Figure 6. Vietnam veterans memorial.

design, in order to maximise the value of certain experiences, a systemic and imaginative design method is required. Additionally, the things being introduced should be concerned about seriously: the objectives of multi-sensory designs should be clear, the range of senses should be confirmed, the accessibility should be easy, as well as the safety issues should be carefully thought about.

4. Impacts from Architectural Experiences

We have innate abilities to perceive the environment around us; our bodies can be aware of the subtleties of changes in patterns and proportions. Therefore, no matter consciously or unconsciously, the human body is physiologically receiving information from surroundings which may be at work influencing us on psychological behaviours when we are living, working, studying or playing within the built environment. The investigation of artificial structures and their possible impact on human behaviours would surely, but not completely, confirm why and how people might behave in a particular space or place, such as people always show their awe at the sight of the awesome vertical interior of a Medieval or Gothic cathedral (**Figure 7**); a huge structure makes a person feel overwhelmed and vulnerable; a deviant temperature (too cold or too hot) or noise level (too noisy or too quiet) may cause a person psychological pressure. For revealing these emotionally or spiritually factors, the physical surroundings which would affect the senses in any environment should be concerned.

The psychological and behavioural effects between people and their physical environments are complex. However, when the elements, spaces and places are taken into account separately, they become quite clear.

4.1. Experiences from Elements

In a manner of speaking, if a building is a body, light & shadow, materials, colour, water and structure are the spirit, muscle, skin, blood and bones respectively. Concrete elements such as material, colour and light (which are considered as the main aspects of visual art by Donald Judd, 1994), and some other ambient environments, such as water, sound and temperature make up the whole built environment. These elements are experienced as characteristics of a building through the senses of body, including not only the visual sense, but also senses such as hearing, smell, touch and taste.

4.2. Experiences from Spaces

“Space has since become such an integral part of our thinking about architecture



Figure 7. The interior of Cathédrale Notre Dame de Paris.

that we are practically incapable of thinking about it at all without putting our main emphasis on the spatial displacement of the subject in time.” Kenneth Frampton, 1995.

The experiences of spaces are from concepts of human inventions (such as scale, vertical or horizontal, straight or curve, order or disorder, symmetry or asymmetry, and mobility) which are not tangible but are observable and contain an element of measure. These concepts give form to building elements and help order these elements in order to describe a built environment.

4.3. Experiences from Places

The experiences of places with the help of architectural elements and spatial forms give meanings to spaces, memorable, fantastic, or common. Generally, the properties of places include religion and quotidian.

4.4. Planning and Design for Human Experiences

Naturally, people want to seek a place where they will experience the feelings of competent, confident, comfortable and enjoyable. Thus, the creation of an appropriate environment is believed to increase the good experience of well-being and behavioural effectiveness in people.

For this reason, the most important thing is having attentions on how people notice their environment and understanding the meaning of each architectural elements and forms. For example, the understanding of people perceiving architecture the applications of psychological responses from architectural elements and forms in Acropolis, Athens received huge rewards: besides the rectangular base and the canopy were designed with subtle curves (**Figure 8**), the corner columns of the Parthenon were designed to be thicker and spaced closer to surrounding columns to realize visually interpreted as being of equal size and spacing; the entire structure and the columns are slightly tapered. This method was also used in “David” (**Figure 9**), though it is not a building. Therefore, elements, spaces, and places of architecture seem to have the ability to influence and reflect the psychological experiences of its users.



Figure 8. Parthenon in Acropolis, Athens.



Figure 9. David.

5. Environment Psychologies: “Space, Emotion and Memory” & Human Behaviours

Understanding human behaviours and psychological responses from architecture starts with understanding how people notice the environment surrounded.

5.1. Environmental Psychology

With the birth of architecture, it provides us an artificial environment different from nature; it is not only a space with three dimensions, but an important aspect influencing our physiological, psychological and social consciousness. So carefully thinking about our bodies and the relationships between our bodies and environmental psychology is essential.

In the real lives, our behaviours and moods just occur in the context of an environment which includes all the natural and built surroundings; they are meaningful only if they can be understood in terms of the environmental context. Thus, the environment determines whether or not behaviours are possible and significant, for instance, one cannot walk through where a wall blocks his way; one cannot lie on a bed where no bed exists. Therefore, when we change the environment to make buildings humane and suitable for activities, our behaviours and experiences are changed and enriched by the environment. This study of psychological reaction in relation to environment is environmental psychology. Robert Gifford (2002) gives the definition of Environment Psychology that “Environmental Psychology is the study of transactions between individuals and their physical settings”.

Standing on the point of normal individual, environmental psychology involves four main parts: personal space, territoriality, crowding and privacy, as well as other ambient environments. Individual differences should be respected during the research of individual environmental psychology. As a function of the characteristics, individual environmental psychology follows different individual situations, such as gender, age and personality, and each of these personal situa-

tions plays an important role in forming individual environmental psychological responses. Duo to the differences of backgrounds and situations, the spatial and psychological behaviours vary widely. For instance, great changes took place in personal space with the change of gender and age: with the increase of ages, personal space increases with time for both men and women, and the growth rate of men is more obvious than that of women (Figure 10¹).

5.2. Planning and Design for Human Behaviours

Ultimately, can environmental psychology contribute to a better planning or design? The answer is absolutely yes. The aim of environmental psychology is oriented towards influencing the work of planning and design, which include architectural design, interior design, and urban planning, and improving the human environment. In this circumstance, processing a planning or a design with the help of environmental psychology is essential, as shown in Figure 11.

First of all, emphasize the importance of research in individuals' situations (such as age, gender, lifestyle and background for private buildings) and social conditions (such as standard of living, culture and history for public constructions). That can minimize the gap between the designers and the people who will eventually live and work in these buildings. Sufficient communication between designers and clients should be taken at the first step. Second, design with concern about environmental psychology. The feelings of personal space, territoriality, crowding and privacy exist everywhere, even though they may change in a different condition. Designers should develop ways to fulfil these requirements, especially in detail design. The last but not the least, gather responses from these users, analyse them and then improve the design method for the coming projects. After these three steps, substantive benefits could be seen and an improved, cleared idea can contribute for the future planning and design.

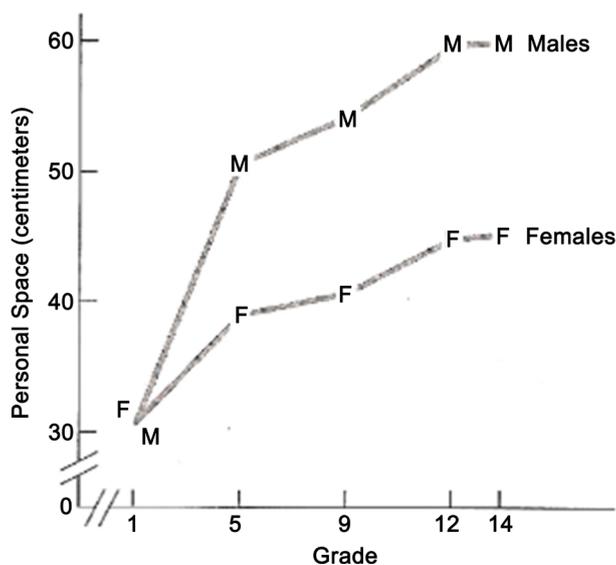


Figure 10. Personal space increases with the age and gender.

¹Picture from Environmental psychology: principles and practices, Robert Gifford, 2002.

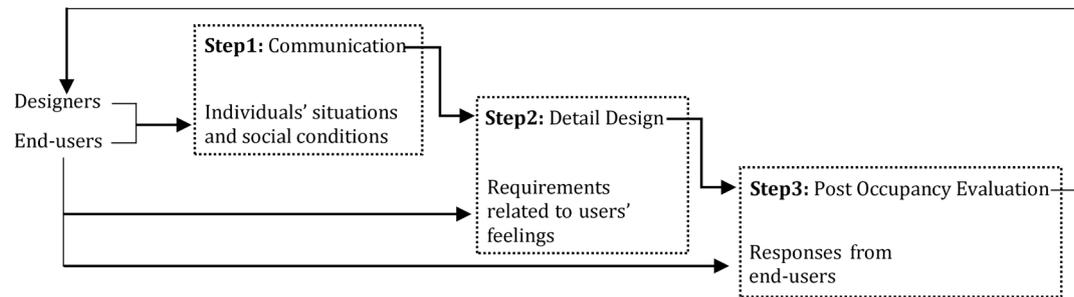


Figure 11. Three steps processing designs with environmental psychology.

6. Design with Space, Emotion and Memory: Peter Zumthor's Thermal Bath as a Case Study

In 1990, Peter Zumthor designs the Thermal Bath Vals in Switzerland, in his book *Peter Zumthor Works: buildings and projects 1979-1997* (1999), he writes, “*Right from the start, there was a feeling for the mystical nature of a world of stone inside the mountain, for darkness and light, for the reflection of light upon the water, for the diffusion of light through steam-filled air, for the different sounds that water makes in stone surroundings, for warm stone and naked skin, for the ritual of bathing.*”. Indeed, this stone-made building provides us a comprehensive understanding of design associated with applications of environmental psychology.

6.1. Senses from Thermal Bath

“*The rays of light falling through the openings in the starry sky of the cupola illuminate a room that could not be more perfect for bathing: water in stone basins, rising steam luminous rays of light in semidarkness, a quiet relaxed atmosphere, rooms that fade into the shadows; one can hear all the different sounds of water, one can hear the rooms echoing. There was something serene, primeval, meditative about it that was utterly enthralling.*”. Sigrid Hauser & Zumthor (2007) uses his beautiful words to describe this wonderful architecture. In other words, the water, stones, and light in the Thermal Bath give us a multi-sensory experience.

Water in Thermal Bath has two forms: one is vapour, and the other is water itself. The water steam with the help of refraction and reflection creates a psychedelic visual effect which relaxes people in a gentle atmosphere. While the spring water in stone basins is clear and fresh; together with different temperatures and colours in different pools, the water offers different senses of touching, smelling, and sighting. Due to the strong connection between skins and water, activities in pools always make water move in basins; the intimate relations between water and stone basins with the water movements always produce sounds. Hereby, water also performs a role of acoustic tasting.

Stone is the material of Thermal Bath. Peter Zumthor (1999: p. 156) describes his building as a “large porous stone” from the exterior and a “geometric cave system” from the interior space. Thus, we can say this “stone” is built of stones. The uniform of this building including the ceilings, walls, and floors are deter-

mined by a conscious series of natural stones strata: layer upon layer of the Vals gneisses (**Figure 12**). The profile, destiny, and texture all strengthen the sense of reality and weight performance. Through touching the rough surface, we can feel both the history of the place and artificial power.

Light differs from main entrance to the central bath until the rest places or exterior bath in the Thermal Bath. From the entrance to the changing rooms, there are no windows, no view permissions towards exterior; only artificial lights are provided (**Figure 13(a)**); in the central indoor bath, there is no window too, but dim natural sunlight through the glass-covered fissures in the ceiling together with the artificial lights (**Figure 13(b)**) offer the luminous environment; in the terraces (**Figure 13(c)**) or the outdoor bath (**Figure 13(d)**), there are all natural sunlight. Varieties of lightings, in this wise, give guests in the Thermal Bath different luminous experiences: natural light and artificial light, semidarkness and bright, even shadows, which are all visual senses.

6.2. Thermal Bath and Psychological Experiences

Actually, besides the feeling of calmness and massiness from horizontal layers of stones; the pithiness and intimacy from the simple architectural form—block



Figure 12. Layers of Vals gneisses (Zumthor, 1998).

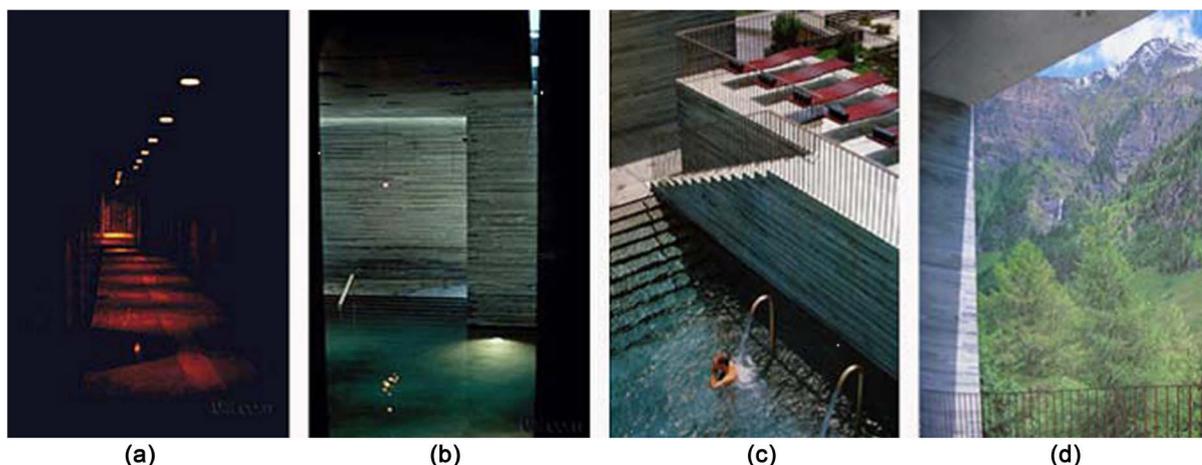


Figure 13. Light-differing line: from the main entrance to main bath until exterior bath or terraces. A: from the entrance to the changing rooms; B: in the central indoor bath; C: in the terraces; D: in the outdoor bath.

structure and local materials, the most significant experience and psychological responses are from the light, including natural light and artificial light. Natural light consists fissure-light in the ceiling and light from windows. A network of six centimetres glass fissures in the stone ceiling brings light to the baths and adds to the sense of fluidity of overall space; these straight light lines indicate the direction in narrow spaces and illuminate the material (**Figure 14**); the shadows on the stone walls are somewhat like the marks left by the spring water (**Figure 15**).

According to the functions and different sizes, some windows bring light and beautiful landscape into the building to provide a bright space for activities; the others restrict the input of light to create a semidarkness environment for relaxing (**Figure 16**).

Artificial light include different colours. For example, the orange light means the route of circulation; the blue light indicates the places next to the water (**Figure 17**).

6.3. Behaviours Control in Thermal Bath

Peter Zumthor made a space with stones to create a dynamic, maze-like space



Figure 14. Fissure-light in the ceiling.



Figure 15. Light, shadow and the marks of spring water.



Figure 16. Big windows and small windows.



Figure 17. Orange light and blue light.

which evokes curiosity in cavern spaces; meanwhile, he used stones walls, block structures, even the ways of lighting to control the access to self-behaviours.

According to the spaces and functions, the plan of the building utilizes two contrasting space types: inside or outside the structural blocks (**Figure 18**). Inside the blocks, we can see from **Figure 19**, they are all private places which include changing rooms, make-up rooms, shower rooms, special baths, and therapy rooms. However, the spaces outside the blocks are public places: the meander serves the central space for circulation, permitting the access of the baths and other private places; one of baths is interior and the other is exterior; the terraces provide the places for rest. These approximate circle-shaped public spaces around the private blocks promote movements in the building.

Moreover, what we have talked about is there is a light-differing line, from the entrance to terraces or to exterior bath. With more and more natural light is introduced, the degree of privacy is weakened.

From what have been exhibited, we can see the Thermal Bath is a building providing satisfactions with multi-senses, behavioural control and plenty of experiences. It takes psychological impacts into account and contributes a template of design with applications of environmental psychology.

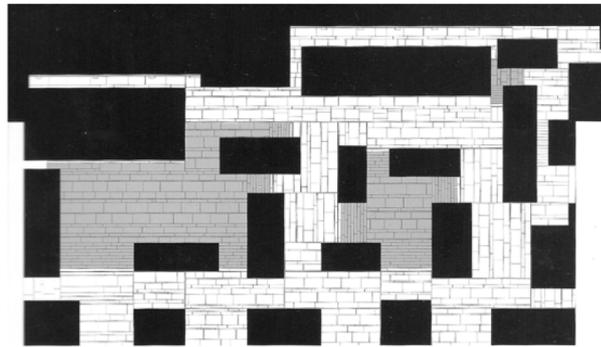


Figure 18. Structure blocks, bathing level.

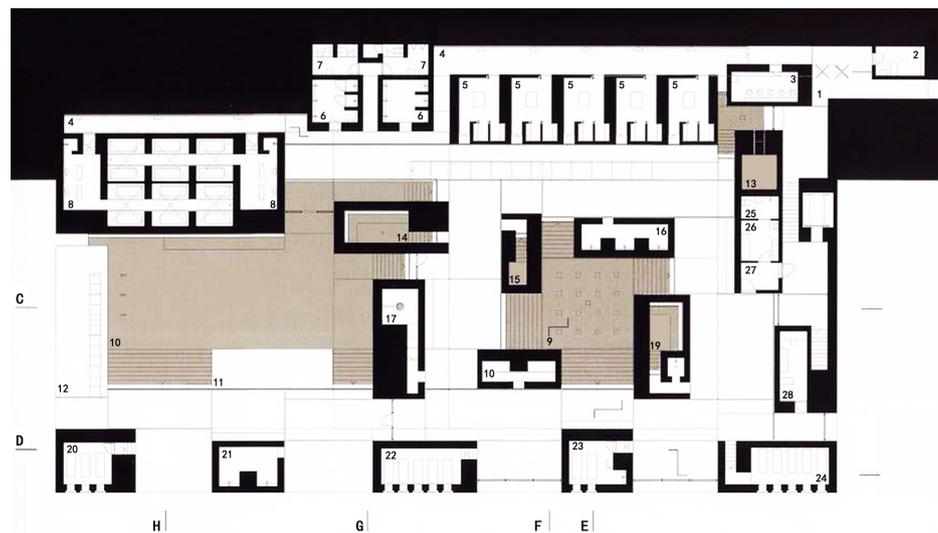


Figure 19. Floor plan, bathing level.

7. An Approach for Architectural Design

7.1. Design and Planning for Senses

In the book *Sensory Design* written by Joy Monice Malnar and Frank Vodvarka (2004: p. 151, p. 152), it is said that, “*the real world is complex, sending out millions of information signals, we can only be aware of a small portion of them. This information is experienced and recorded as differentials of colour, heat, motion, sound, pressure, direction, and whatever else is present and within the range of senses.*” (Figure 20). Thus, for strengthening the feeling of the real world, especially the feelings of buildings we talk about, we have to create sensory components, forms and places to induce activities such as touch, smell, and hearing and encourage people to sending themselves into the activities, then enhance the information-communicating with nature and built environment, as well as enrich the senses experience.

7.2. Design and Planning for Experiences

As we have seen materials, lights, colours, architectural forms as well as other ambient environments all have great impacts on our psychological responses

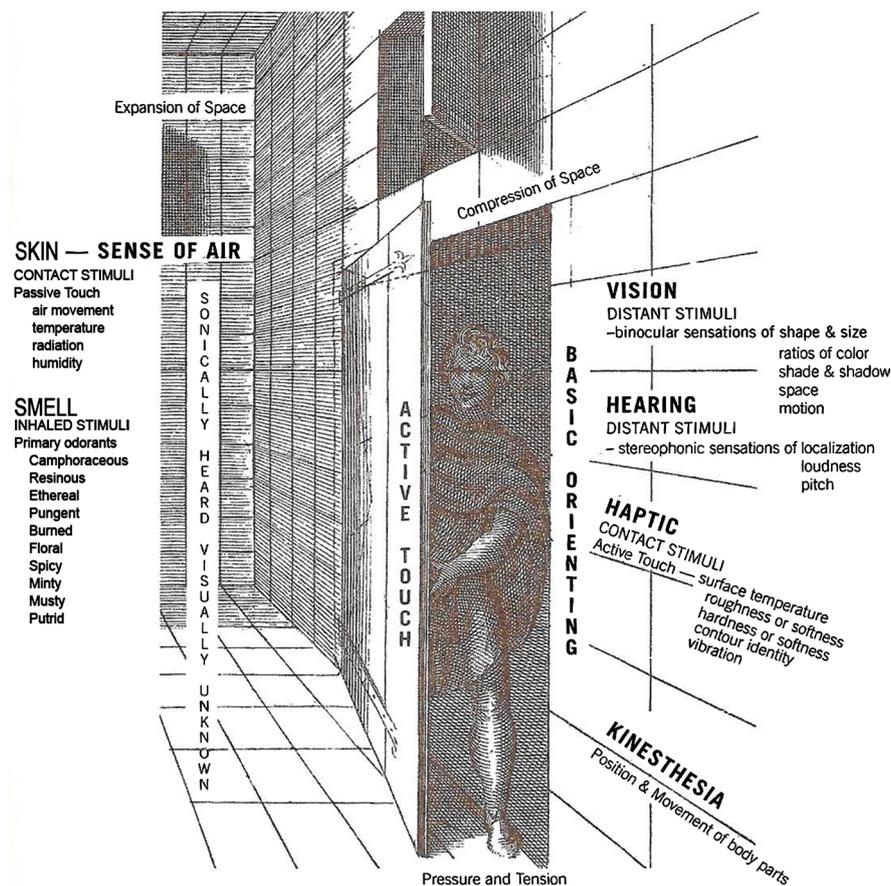


Figure 20. Ranges of senses (Malnar & Vodvarka, 2004).

and experiences. If these factors cannot match the individuals' needs or requirements, they may cause detrimental influences on human emotion, work performance, even mental health. Thus, we have to understand the meaning of every element of the space, and use them in combination with clients' requirements properly. Too much or too less employment of the architectural elements are unbecoming; too much use may cause stress and discomfort; too little may not take effect. Although at times it is intelligible that some architects, for preventing negative consequences, may just use the simplest architectural forms to shape a building, however, particular buildings, such as temples, cathedrals, and other religious or memorable constructions, need to be enhanced by the specified building elements. For example, particular types of light can create a sense of mystery and awe; and vertical architectural form suggests an overpowering grandeur which can enhance human experience and behaviour in religious spaces.

7.3. Design and Planning for Behaviours

We have known that personal space, territoriality, crowding, and privacy are interrelated and interdependent aspects. They can decide and explain most of our behaviours in or around the buildings. For a better behavioural environment, we have to think about them and find an effective way. It is said that one of the most

significant approach is “control of access to the self” (Cassidy, 1997: p. 178). It is strange but evident that everybody has two faces: one face is people want to be in participation of social interactions to seek opportunities of communication and social support; the other is, sometimes, people need to withdraw the busy and noisy conditions and enjoy a quiet place belonging to themselves solely to be certain of they are holding their personal space, territory, and privacy. Thus, the most importance of control of access to the self is to provide a place in which people can control over the choices of being alone or participating in social communication. This method of choosing-control is more useful in crowded building environment, such as prisons, offices and dealing with communities and neighbourhoods in residential complexes.

8. Conclusion

As has been discussed, the fact is that besides the Architectural History, Theory, Structure and Technology, the studies on psychological impacts from architectural forms have been considered as an integral and mandatory part of architectural design. Also it is one of the dynamics of formatting architectural forms.

The primary focus in this paper is the interaction between architectural form and psychological effects on human, which consists of three aspects; the first one is the effects from the cognitive and affective senses on the built environment conditions; the second one is the influences from specified architectural form; and the third one is the individual psychological requirements. The relationships between architecture and human have been explored through a series of theoretical studies in investigating architectural psychological behaviours and illustrating cases. With the help of the case study of Thermal Bath from Peter Zumthor, a design and planning approach for reflecting human senses, experiences and behaviours in the realm of environmental psychology has been summarised.

The whole case-study strategy provides multiple source of architectural form. The illustrating cases and case studies in this paper are drawn from famous architects, whose architectures, Pallasmaa (2005a) describes, clearly favour sight and incorporate strong tactile experiences in the forceful presence of materiality and weight. It helps to analyse the concrete and complex situations, and the benefit of using the case study is more clear and straightforward. However, the collected case studies and related pictures are from different architectural types, and the coherence and connectivity between theories and those case studies are difficult to be consistent. More cases are needed for future research development.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Analysis of the Narrative Types of “Metaphor” in Animated Short Films

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Abstract

The most presented storytelling medium of animation and film are images. The narrative messages that viewers obtain through images are much more rigorous than those from dictation or narration. Therefore, the means to construct story context in an animation narrative is more than the intuitive narrative of character language. Message transmission by hints seems to be an important technique of image narrative in a plot. Potential messages involve metaphors in rhetoric. When applied to an image narrative, linguistic techniques have gone beyond the scope of literal modification. Meaning the viewers' cognition and past experiences are also involved in the process of image viewing. Therefore, the metaphors in animated movies are a type of narrative produced by multiple elements, as well as a mode of deduction based on real life. According to the related theories of metaphorical mapping, this study explores the analogical narrative process of images in animation cases, as based on Gentner's structural mapping theory and the blending theory of Fauconnier and Turner. The results of case study show that, in animated movies, analogies are made through similarities in form, meaning the attributes of source and target are blended as the means of metaphor, where the lens movement also contributes to the metaphor of space on the visual psychological level. In summary, this study is expected to serve as a reference for further exploration of the metaphoric narrative of animation in the future.

Keywords

Animated Short Films, Metaphor, Animation Narrative

1. Introduction

A metaphor narrative is one of the techniques to describe a plot story, which plays an indispensable role in animated movies. In the film context, in addition

to the image performance of the main characters, through images, the transmission of hidden messages increases the aesthetic value of the short narrative in the film. At the same time, through the description of a metaphor, the viewers can actively participate in the plot and deduce the story, meaning the image narrative constitutes an interactive media. In fact, every animated movie has the manifestations of metaphor narrative, such as *Ratatouille*, as produced by Pixar Animation Studios (**Figure 1**), which used black screen and lines to express the various tastes of delicious foods, and the *Castle in the Sky*, an animation produced by Japanese director Hayao Miyazaki in 2002 (**Figure 2**), which used two spaces as the hints of human beings' yearning for an imaginary Utopian and the essence of human nature.

From the above, we can see that the director elaborated the characteristics of the event by analogy through the relationship between the scenes, thus, highlighting the importance of metaphors for the rigor of an image narrative. A metaphor is a proper noun in rhetoric, which achieves symbolic links through the process of corresponding patterns by similar psychological analogy (Wen, 2010). There are many related researches on the effect of metaphorical cognition from multiple dimensions, as well as the ways to transmit the meaning by the metaphor from the perspectives of cognitive psychology, semantics, etc. The



Source: <https://www.comicsbeat.com/michel-gagne-and-ratatouille/>.

Figure 1. *Ratatouille* guides through hints in the back lines.



Source: <https://ciatr.jp/topics/32054>.

Figure 2. Another imaginary space beyond reality in the *Space Castle in the Sky*.

most important classic work *Metaphors We Live By*, as written by George Lakoff and Mark Johnson, put forward the concept of metaphors in 1980, which held that metaphors not only exist in written expression, but also exist in life, thus, extending the dimensions of metaphor research from linguistics to perceptions, including visual sense, auditory sense, tactual sense, etc.

However, in terms of visual sense, in 2008, Charles Forceville proposed a way for images to convey implicit messages, meaning that metaphors may provide non-verbal information through the expression of dynamic images. While a lot of literature has analyzed the image metaphor cases in semiotics and advertisements, it is seldom discussed in the field of animation or film. This study takes the metaphor narrative of animation media as the starting point to explore the metaphor technique of image media. The commonly used theoretical bases of the metaphor are: contrast model, feature salience imbalance, conceptual metaphor theory, blending theory, structural mapping theory, etc. (Wang, 2012). As the purpose of animated film itself is to make viewers feel the link between specific phenomena and practical experience in stylized image manifestations through image narrative, this paper believes that the blending theory and the structural mapping theory are suitable theories for the exploration of the basic framework of image metaphors, where the corresponding image is the metaphor link. Therefore, this study analyzes the symbols and images in animated movies on the basis of the above two theories, and analyzes and summarizes how they are operated and conveyed by rhetorical metaphors and metaphors manifested by image narratives.

This study attempts to analyze the expression technique of metaphors in animation by taking the narrative of animated films as the point of penetration, explores the process of metaphoric reference, and deduces the application of rhetoric in images through literature review. Secondly, this study analyzes the link from the cognition of dynamic images to experience knowledge through a case study of the mapping relationship between multiple attributes and the meanings of images. With award-winning cases as the research samples, this study summarizes the forms and techniques of the expression of metaphoric foreshadowing in animation image narratives, and analyzes its mapping relationship, in order to explore the rigor conveyed by images in animation. The purposes of the study are summarized, as follows:

- 1) Discuss the application of metaphor rhetoric in animation narratives through literature review.
- 2) Analyze the image presentation of metaphor narratives in animation and films.

2. Literature Review

2.1. From Metaphor Rhetoric to Image Relationship in Movies

Rhetoric itself is a means of description, which makes the text closer to the real life state or enables the reader to perceive the essence of the text. In order to

make the description of the text more precise or more rigorous, different reference methods are used in language to express some abstract states, such as “time is money”, “knowledge is power”, etc. The advantage of rhetoric is that it enables the meaning of language to be understood without specifying all the details (Gannon, 2001).

Gannon (2001) *The point and virtue of particularization is that it enables language comprehension to take place without the need for message to explicitly spell out all the details* (p. 12).

Metaphoric rhetoric has a specific way of reference in rhetoric. In 1980, *Metaphors We Live By* pointed out that metaphors are a part of life that makes artistic expression more diverse. From this, we can see that the technique of metaphors has been applied in linguistics, as well as an expression approach in reality. In the traditional view, metaphor rhetoric can only be used in speech or text, but in fact, metaphors can be expressed by images (Sajaniemi & Stützle, 2007).

Sajaniemi, J. & Stützle, T. (2007) *Metaphors may appear in several forms. Traditionally they have been verbal, but they can be pictorial, also* (p. 457).

In view of the above, the purpose of conveying expression through metaphors is to enable the audience to understand its meaning more concretely. Particularly in the field of animation or films, the metaphor is an indispensable means of narrative aesthetics, which not only gives the manifestation of abstract meaning, but also motivates the viewers to uncover the context of the story, which makes the narrative context deeply rooted in the hearts of the audience through the hidden relationship.

Modern Times, as directed by Chaplin in 1936, begins by describing the background of the working class, and analogizes crowded sheep with workers in the next scene (Figure 3), where the characteristics of sheep and the relationship between the workers in the story describing the same concepts. In the analogy process of a metaphor, the common attributes of analogy provide the key reference points. In the application of a metaphor, there are common similarities between the objects and the base representation, while individual attributes must be left behind in the mapping process (Gentner, 1983).

Gentner (1983). *If the base representation includes concrete objects whose*



Source: <https://www.youtube.com/watch?v=HAPilyrEzC4>.

Figure 3. Analogy between the first and the second scenes of *Modern Times*.

individual attributes must be left behind in the mapping, the comparison is an analogy (p. 161).

It is generally acknowledged that sheep are characterized by obedience, cleanliness, etc. Even the Bible used the metaphor of a shepherd seeking sheep to refer to the relationship between Jesus and the people. In this movie, the traits of workers are obedience to superiors' orders and continuously working in an unquestioning manner. In *The Cambridge Handbook of Metaphor and Thought*, Gibbs Jr. and Raymond W proposed that, after the extended meanings are found through the analogical relationship of a Structure-Mapping Engine (SME), it must also go through the following three discrimination steps: 1) the alignment process of literal meaning; 2) projection of the inference from base to target; 3) directional comprehension of the extended meaning of the metaphor.

- *Metaphor comprehension begins with a symmetric (nondirectional) alignment process.*
- *If an alignment is found, then further inferences are directionally projected from base to target.*
- *Thus, directionality in metaphor comprehension arises after the initial stage of processing.*

(Gibbs Jr., 2008: p.112)

The literal meaning is the original attribute of the object itself. When it comes to dynamic media, the meaning of the scene can be perceived directly. Therefore, it is necessary to analyze the original attributes of the sheep and workers in this case. This paper believes that the analysis of a single picture is not enough to explain the overall meaning of the scene, but must be inferred through the relationship of the image meaning in the neighboring sequence, i.e. the neighboring scenes in the lens. The traits of sheep and workers are analyzed in **Table 1**.

The table summarizes the relationship between the original attributes and artistic conception. The form, quantity, and composition of the original attributes are expressed with similar techniques; therefore, viewers can easily identify the

Table 1. Attribute analysis of sheep and workers.

	Analysis item	Sheep	Workers
Original attributes	Lifestyle	Moving in herds	Operating in groups
	Traits	Aimlessly obedient; only moving forward when driven by shepherds	Operate in accordance with instructions from superiors, lack thinking ability, and act in accordance with instructions
	Guide	Shepherd	Boss
	Image composition	Moving forward in a herd	Moving forward in a group
Artistic conception analysis	Lens description	The first scene of the movie, followed by the scene of the workers approaching the work place	The second scene of the movie, followed by continuous scenes of a large number of workers going to the work sites of the factories, clocking in, etc.

strong correlation between the two scenes. According to Eco's point of view, a symbolic communication system is a communicational framework that conveys the "code", which is regarded as the transference of symbolic messages in communication, and shares some properties during the transference (ECO, 1976).

ECO (1976). *Therefore a non-significant system is called a "code" by a sort of metonymical transference, being understood as part of a semiotic whole with which it shares some properties* (p. 38).

Accordingly, in the case, messages have already been transformed in the form of symbolic representation, while the individual attributes have been left behind in the metaphor mapping, as described by Gentner. Furthermore, in the metaphoric relationship, the extended meanings associated with the original attributes must be searched; however, in film semiotics, the extended meanings can be divided into denotation and connotation. Denotation refers to the entire narrative, including the presentation of narrative elements, the description of people, things, objects, time, and space, all of which are the scope of discussion of denotation (ECO, 1990). According to the analysis of the above table, denotation is also the intuitive discrimination of the original attributes, as well as the basis of the metaphor. Connotation, on the other hand, refers to the overall meaning arising from the denotative symbols, as proposed by Metz in the case of *Que viva México* (Metz, 1964).

Metz (1964). *Le langage esthétique a pour signifiant la totalité signifiante-signifiée d'un langage premier (l'anecdote, le motif) qui vient s'emboîter en lui* (p. 83).

Summarizing the theories proposed by Gibbs Jr. and Raymond W, as well as the denotation and connotation mentioned above, denotation in extended meaning refers to the expression of literal meaning (original attributes). It is worth noting that, according to literature, a metaphor as a narrative is a discrimination based on a general phenomenon. In short, a metaphor narrative is not defined only on the basis of a single phenomenon; instead, it conducts element analogy based on the narrative content in the sequence of the scenes. By editing of the same lens position and composition, Chaplin described the sheep-like state of the workers directly from form similarity, implying that the workers are forced to work aimlessly. He also showed the common relationship between the workers and the sheep, and highlighted their similarities through the pattern and signifier of video pictures. The above analysis confirms the extended meanings described by Gibbs Jr., Raymond W, and Eco, meaning the metaphor is a very important foundation for the nature of original attributes. Furthermore, metaphorical performance is a comprehensive target and base of the whole (Wang, 2012). Therefore, this paper analyzes the mapping relationship and the signifying process of extended meanings in the next chapter.

2.2. Operation Process of the Extension of Metaphor Mapping in Animated Films

One theory of the denotation of metaphors to make deductions using the space

blending theory, as proposed by Fauconnier and Turner, which states that hidden messages are formed by mapping between two different inputs into the final blended space (Fauconnier & Turner, 2008). Secondly, Gentner's exposition put forward that the process of mapping comparison in metaphors is divided into three stages: first, breaking down and analyzing similarities between sources and objects to make preliminary matching of their relationship; secondly, combining cluster models (called "kernels") into structures for comparison; and thirdly, dividing the combined kernels into one or more maximal structures as the result (Markman & Gentner, 2000).

Stage 1: Local matches.

Stage 2: Structural coalescence into consistent mappings.

Stage 3: Small structures combined into maximal interpretation; candidate inferences (Markman & Gentner, 2000: p. 508).

Gentner further proposed the principle of analogy in two domains: analogy shall be based on the relationship between the source and the object, rather than just the attributes of the objects; the specific relationship is determined by the overall analogy system (Gentner, 1983).

Gentner (1983). Two mapping principles are described: (a) Relations between objects, rather than attributes of objects, are mapped from base to target. and (b) The particular relations mapped are determined by systematicity as defined by the existence of higher-order relations (p. 155).

Both the blending theory and the mapping theory are metaphor theories based on the mapping of corresponding attributes. In the analysis of animated movie metaphors, the corresponding relationship between phenomena must be explored and summarized using the mapping concept. The author summarizes the analysis of the two theories in **Table 2** for subsequent theoretical construction.

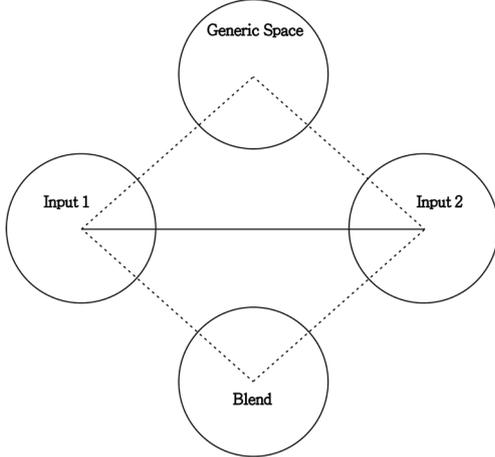
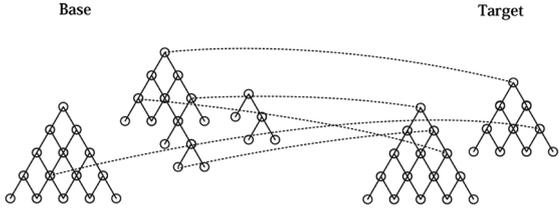
Both the blending theory and structural mapping theory discuss the analogy process of metaphoric analogy, and their viewpoints reveal two metaphor traits: first, the blending theory emphasizes that, besides the mapping of original attributes, other channels are also involved in the process to construct the final blended space; the mapping theory explains that the analogy is made based on the screened concepts and combined in the mapping process. To sum up the above theories, a metaphor is a process of analogy by selecting suitable elements, and then, combining the relevant experience or associative concepts with the source and target domain. Therefore, to induce metaphorical conditions, this paper made a case study based on the theoretical model to explore the techniques in animated movies.

3. Research Method

3.1. A Case Study of the Metaphor Rhetoric in Film Images

Balance is a silent animated short film that won the 1989 Academy Award for Best Animated Short Film. Directors Christoph Lauenstein and Wolfgang Lauenstein constructed a space to maintain a balance of gravity, as based on the

Table 2. Comparison between the blending theory and structural mapping theory.

Name of the theory	Blending Theory	Structural Mapping Theory
Representative scholar	Fauconnier and Turner	Gentner
Viewpoints of the theory	Two distinct input spaces are mapped into a Generic Space, which contains the original attributes of the two sources. Moreover, a blended space leaves its own attributes, and also contains other associative concepts to make it produce a richer blending space.	The main concepts of source and target are filtered and integrated one by one in the attribute structure, and then, the attribute relationship of the metaphor is obtained by matching the concepts of the source and the target.
Model of the theory		
Common viewpoints	The two theories construct the theoretical analogy model by the mapping process, and emphasize that the process of the analogical relationship must be mixed with elements other than two attributes. The construction process is not simply a matching of the relationships between the two attributes.	
Different viewpoints	The blending theory has two different inputs, indicating that the mapping relationship does not point to a single meaning, but produces new meaning by the blending the two inputs; the structural mapping theory interprets the corresponding relationship as mapping to a specific target, indicating that they have a single-point specific metaphor relationship.	

concept that the surviving characters must maintain balance between each other. The treasure box in the narrative implies the benefit or power, etc. desired by people. The process of fighting between the characters reveals different aspects of human nature, while the symbols of the treasure box and unbalanced space are metaphoric references to interests and environments in real life. The author deduced the metaphoric elements in the plot, as shown in **Table 3**.

The cognition of a metaphor is not random, but based on the experience of natural phenomena, or social or cultural cognition, which is enough for metaphor cognition (Lakoff & Johnsen, 2003).

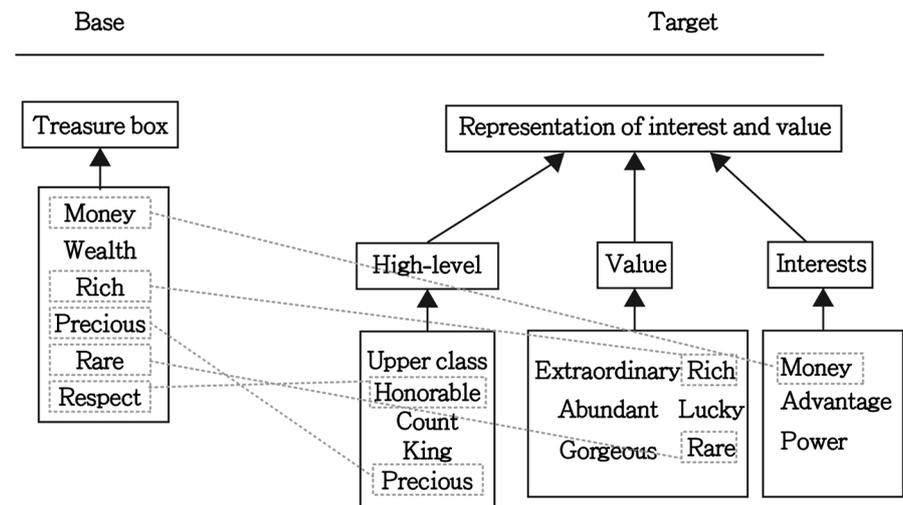
Lakoff, G. & Johnsen, M. (2003). *Such metaphorical orientations are not arbitrary. They have a basis in our physical and cultural experience* (p. 15).

Furthermore, language is a system of social symbols, while speech is the method of expression that individuals reorganize according to broad vocabulary (Chi, 1992). As the meaning of treasure box in experience is wealth, money, assets, resources, rights, interests, etc., after screening out the most reasonable metaphoric reference of the narrative content according to the broad sense, this paper conducted clustering and matching according to Gentner's theoretical model (**Figure 4**).

Table 3. Inference of mapping between base and target.

Scene	Base	Target
	Treasure box	Representation of value and interest
	The process of fighting for the treasure box	Struggle of human interests
	Planes that need to be balanced	Maintenance of human relations

Source: <https://www.youtube.com/watch?v=PADVHR-wOs>.



Source: Compiled by this study.

Figure 4. Mapping analysis of treasure box in *Balance*.

From the inference of **Figure 4**, it is concluded that the treasure box is in line with the referent in the story, while the deduction that the referent is the “representation of value and interest” is defined by the system-based or up-and-down structure, as proposed by Gentner. The treasure box in the film is positioned as a representation of rarity and preciousness, which is defined by the five characters’ fighting for the only interest (**Table 4**).

The description of the front and back pictures is intended to construct the symbolic meaning of the referent of the metaphor, and the representative meaning

Table 4. The process of fighting for the treasure box.

1. One of the characters intentionally stands forward, intending to force those close to the treasure box to stay away from it.



2. Those who were originally close to the treasure box have to stay away from the treasure box in order to avoid losing the balance of space.



3. The character who wants the treasure box keeps going in the direction of the treasure box.



4. When the character who wants the treasure box keeps moving forward, the character who was close to the treasure box does not want him to succeed, so he takes the opportunity to pull his leg.



5. The two characters begin to quarrel and struggle with each other.



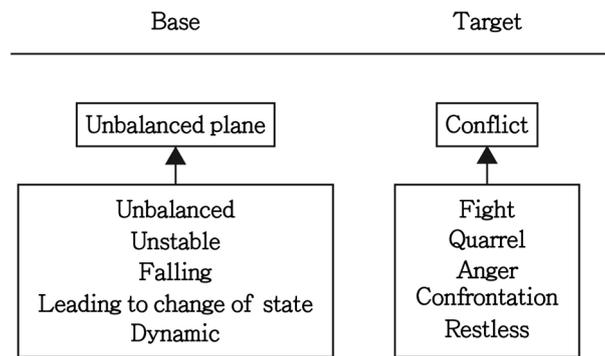
6. The fighting intensifies.

Source: <https://www.youtube.com/watch?v=PADVHR-wOs>.

can be deduced from its content. It can be reversely deduced that if the symbol of the metaphor in *Balance* is not the treasure box, other “representatives of value and interest”, such as diamonds, banknotes, or gold, can also serve as the representation of the metaphor; therefore, the metaphoric relationship has more a single referent. A referent logically analogized in context can be a symbol of reference if it is reasonably established in context.

In the case of *Balance*, the design of space is also an element of the metaphor. In order to maintain balance, the characters have to achieve an average distribution of gravity, and when imbalance appears, the viewer can interpret it as a metaphor of the broken or conflicting relationships between the characters. According to the first scene of the story, the originally distributed balance positions are located at the four corners, and when this balance is broken by the treasure box, it leads to conflict, and this imbalance and conflict become the key metaphor. Therefore, the author made an analogy between the unbalanced plane and the conflict (Figure 5).

If the perceptions between the two are compared according to their respective meanings, the analogy cannot be directly made with the mapping relationship, as their attributes have linked meanings, thus, the above cases cannot be supported in Gentner’s theoretical model. When setting the theoretical model, Fauconnier and Turner set two different attributes at the input of different blocks, meaning the plane and conflicting elements are placed at two input terminals,



Source: Compiled by this study.

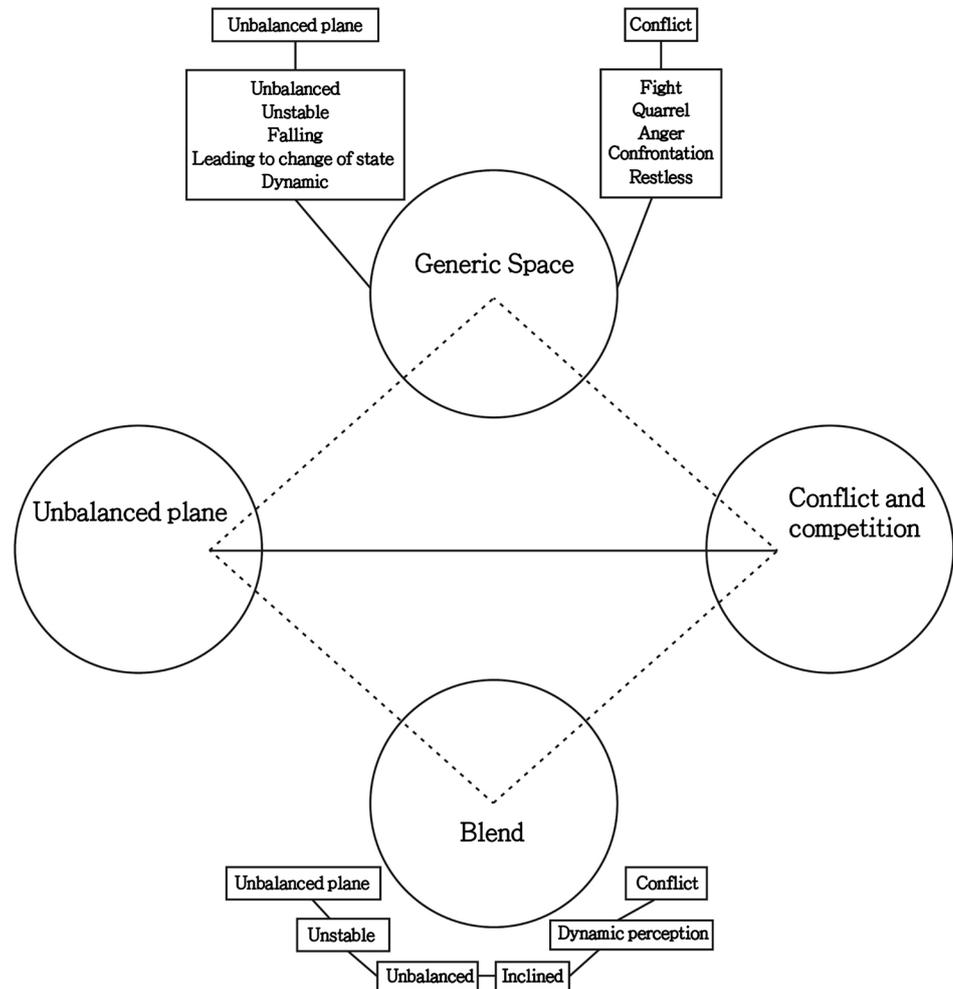
Figure 5. Relationship between the unbalanced plane and conflict.

and then, their attributes are transformed into the final metaphor result by entering the generic space. The conclusion of the analogy is that a metaphoric space with an imbalance is the conflict. The blending theory is supported in this case, as the final blended spaces include not only the attribute elements, as other external elements of the connotations are also involved in the whole metaphor. **Figure 6** shows the process of the blending theory.

According to the blending theory of **Figure 6**, the final metaphor can indirectly connect the abstract concepts of the two through their original attributes, the link, and perception of the past experience, and even the factors of the psychological image. When the “conflict” is connected with the images of “curve” and “inclined”, this is a signifier subject of visual psychology, and not merely a mapping of the metaphorical attributes. In summary, from *Balance* we can sum up three characteristics that constitute the metaphor of animated movies: Firstly, the mapping process includes original attributes, as well as experience elements in multiple channels, which may constitute a blended metaphoric space, and this argument is in line with Lakoff’s view. Secondly, if the referent (treasure box) becomes the element of the metaphor in the narrative, according to the general cognition of popular definition, it can be judged by direct experience, and because this part is based on practical experience, establishment of the metaphor is simple and obvious; Thirdly, both the key element (treasure box) and the space (inclined plane) can be used as a symbol of the metaphor in the movie, meaning it can become an element of the metaphor, which also represents the simultaneous analogy of the multiple elements in the movie. Therefore, this paper discusses the space metaphor in the image in the following chapters.

3.2. Case Study of the Extended Meanings of Metaphor Mapping in Space

In *Balance*, the author created an unbalanced space to motivate the story to continue, thus, the key unbalanced plane is also an element of the metaphor. Regarding whether the space of an animated film can actually become the element of the metaphor, this chapter discusses the case of using space as the element of a metaphor. The construction of an animated film space must give the background



Source: Compiled by this study.

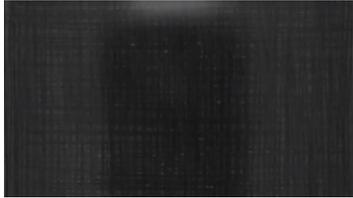
Figure 6. Analysis of the relation between the plane and the conflict with the blending theory.

of the narrative environment. The case of *L'ONDÉE*, a French animation, breaks the traditional idea that environment can only be a narrative background by using objects and phenomena as the metaphor of the described environment. The theory of ontological metaphors was proposed in Lakoff's *Metaphors We Live By*, which pointed out that the metaphor of location and space is constructed in physical and cultural experience, like "high" and "upward" represents "happiness", "dignity", and "positivity" in experience. The link between the two is the recognition of experience, and the mapping relationship integrates experience and culture. Experiences and situations in life are accumulated constantly in the mind to form a system that links repetitive events with experience, systematically stores relevant concepts, and coalesces them together (Chang, 2012). According to the literature review, this paper conducted a case study of *L'ONDÉE* to illustrate the mapping relationship between metaphors in their extended meanings (Table 5).

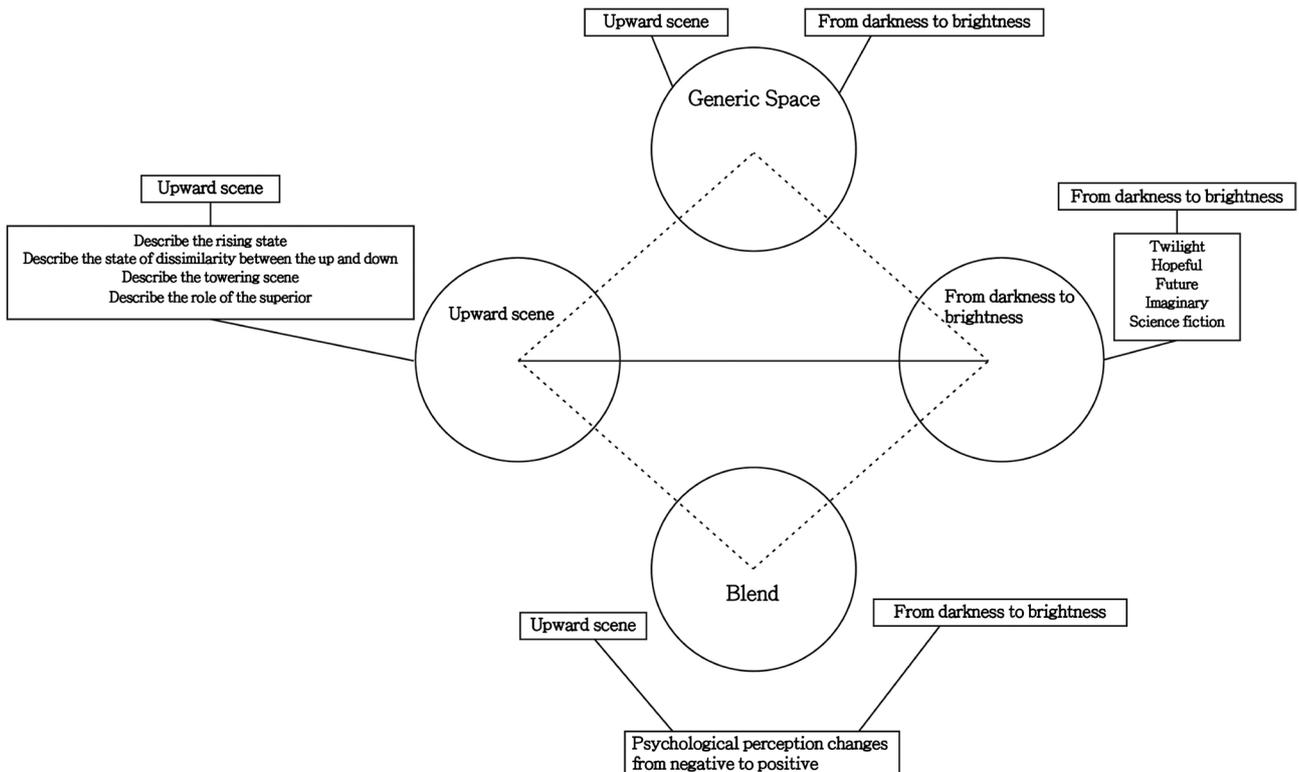
The object of the metaphor in the scene of *L'ONDÉE* is the change of mood. From the violent rain to the calm sky, from the dark to the bright, the viewer can

have perceptions from sadness to joy, from tension to relaxation, tragedy to happiness, etc. Hints are also provided by the lens moving upward. As mentioned above, based on physical and cultural experience, the upward movement is a representation of “noble” and “positive”. The mapping relationships can be collated, as shown in **Figure 7**.

Table 5. Description of rain turning to sunny and the scene of atmospheric change in *L' ONDÉE*.

		
1. Distant view of the building.	2. Signboards above the building (lightness is increased).	3. Birds waiting for sunshine under the water tower on the top floor.
		
4. Clocks rising to the sky.	5. A calm sunny day.	6. A calm sunny day.

Source: <https://vimeo.com/53838485>.



Source: Compiled by this study.

Figure 7. Metaphor mapping process of spaces in *L' ONDÉE*.

The space moving upward and changing from dark to bright is a description of a phenomenon; they are not like the active performance of the characters, but the presentation of the phenomenon. The metaphor narrative is promoted by lens movement and the change of light and shadow in the scene. The mapping relationship is a process of simultaneous analogy with multiple attributes, including lens movement, light and shadow changes, and changes of the sound rhythm, and such combined perceptions constitute the representation of the whole metaphor. Movie art and linguistics are regarded as belonging to the same semiotic hierarchy: first, the composition of aesthetics must be considered; second, the camera movements and light effects will be superimposed over the denoted meaning (Metz, 1991).

Metz (1991). *The art of film is located on the same semiological “plane” as literary art. The properly aesthetic orderings and constraints—versification, composition, and tropes in the first case; framing, camera movements, and light “effects” in the second—serve as the connoted instance, which is superimposed over the denoted meaning* (p. 96).

Therefore, the metaphor of the essential meanings in the space is composed of the description of the phenomena. The above representations are all based on the change of time. The greatest difference between the metaphor of animation and the static image lies in the addition of time elements to construct the dynamic perception. The most important thing for animation is not movement, but the root cause that drives the movement (Whitaker & Halas, 2013). From the time movement in *L'ONDÉE*, viewers could perceive that the lens is moving up diachronically, contributing to an upward feeling.

Another case of using space as the representation of a metaphor is *NEGATIVE SPACE*, which is a French Film nominated for an Academy Award for the Best Short Film in 2018. In this film, the art of packing a suitcase is used as the metaphor of the relationship between the father and the leading character (Riganas, 2017). The author combined time and space as a metaphor of the time travel from the present back to the childhood memory (Table 6). The two spaces are linked by the present time (ready to drive) and the time travel to childhood (with the suitcase zipper analogized as the road). The mapping target is to achieve the representation of retrospective memory.

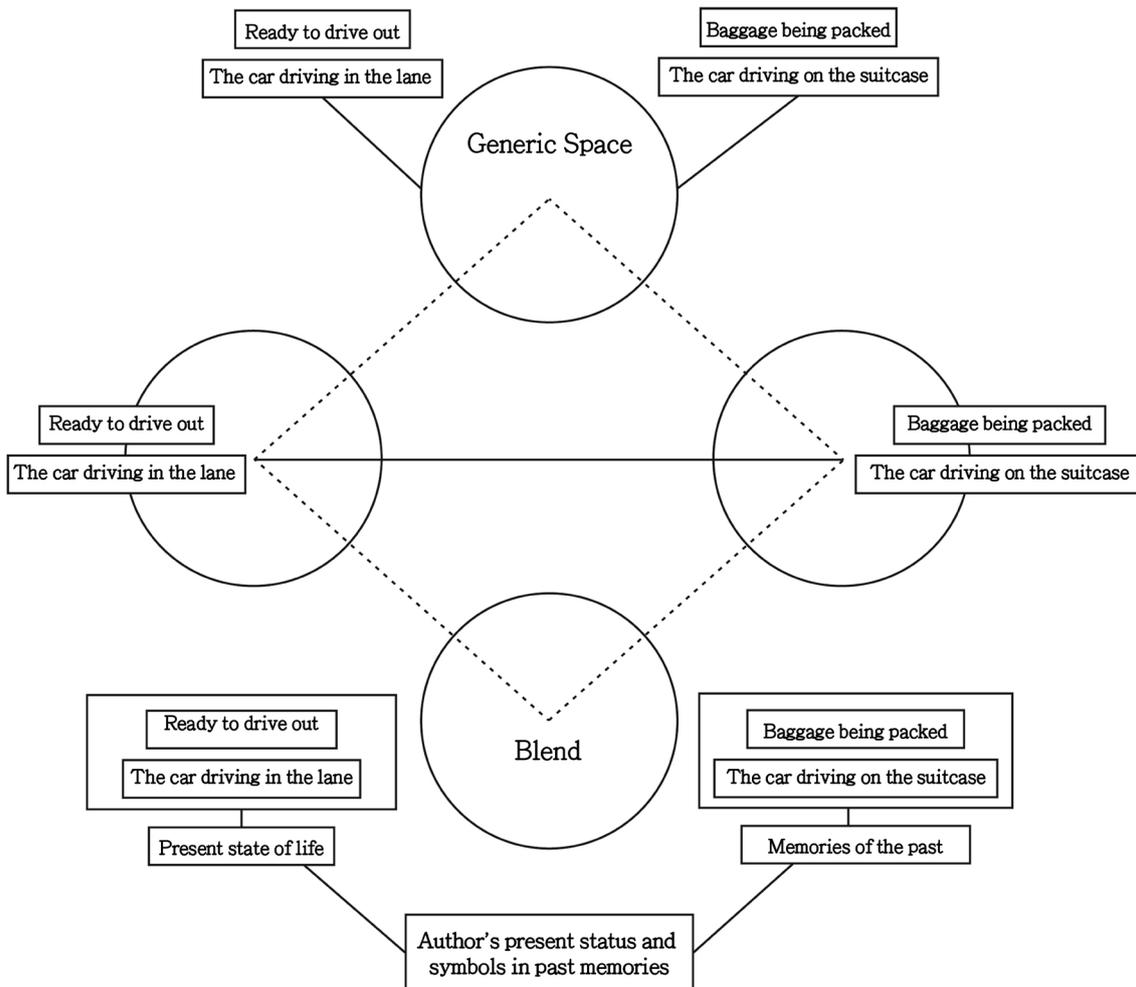
In this case, the change of time is metaphorized through the change of space, where the present action is connected with the past space-time background; therefore, the mapping relationship is the changing of the driving process into the suitcase used in the past. The analysis results of the original attributes of driving and the original attributes of the suitcase show that they are not in line with the narrative of the story. As the content above and below describes a state of recall, the connotations of the representative objects include the objects used now and in the past, which indirectly describes the differences between time and space. The mapping relationships can be collated, as shown in Figure 8.

Therefore, the corresponding target of the mapping relationship is to construct

Table 6. Time-space transformation in *NEGATIVE SPACE*

		
<p>1. Close the door and get ready to drive.</p>	<p>2. Drive toward the tunnel.</p>	<p>3. Pass through the tunnel.</p>
		
<p>4. After leaving the tunnel, the road becomes the suitcase zipper.</p>	<p>5. The car is driving on the suitcase.</p>	<p>6. The suitcase is opened and it has traveled to a past time and space.</p>

Source: <https://vimeo.com/345922827>.



Source: Compiled by this study.

Figure 8. Mapping relation with space as the metaphor of time in *NEGATIVE SPACE*.

the metaphoric meaning of the scene, as constructed in the context of story development. In terms of space, it is also a link between the real space and the imaginary space in the past. The author expressed the return to the past by the technique of “time travel” during driving. The car is the medium of the time travel, and a metaphor of the flow of time, while the zipper on the suitcase is used to replace the original road due to similarity in form, which creates visual continuity and is also a metaphoric symbol for the past in the time and space transformation. Therefore, the metaphor in *NEGATIVE SPACE* is a strong symbolic relationship that is strongly linked to memory. In short, substitution and symbolism are also techniques of metaphors. In comparison, the main technique used in *The Employment* (Figure 9) is the blending of the two attributes.

In summary, spatial metaphors transmit the reference target through the essence of objects. Its biggest difference with role play is that it describes the plot through simple phenomena, and also represents that the original attributes of objects must be transformed into the meaning of context. Even so, the essence of space will not change; for example, *NEGATIVE SPACE* made good use of space to express the concept of “traveling” time to give similar attributes to corresponding goals. The space is conceptualized into expressions of emotions or time and space, while all phenomena are presented through the guidance of the lens, such as the use of the upward movement of the lens in *L' ONDÉE* to guide the viewers' emotions, or elaborate the space, as in the perspective of *NEGATIVE SPACE*. In short, the lens plays the role of an interpreter of guidance and performance in a special metaphor. From the above point of view, the representations of the angle of view and the lens in animated movies also constitute the representative elements of the metaphor.

4. Discussion

The operation of an animated film metaphor is a process of hiding intuitive links and generating analogy through partial similar relations. The analogical basis includes not only the similarity in form, but also a reference of the meanings of



Source: <https://vimeo.com/32966847>.

Figure 9. Superposition of the trait of “Object” and the behavior attribute of “Man” applied in *The Employment*.

specific symbols. The means of analogy hides in the message of the picture through substitution and symbolism. This paper collated the cases according to the mapping of metaphors in animated movies, and in addition to the attributes, the cognitive and psychological perceptions of past experience are mixed in the mapping process, making it a complex mixture that is difficult to demonstrate. From this point of view, the perception of metaphors is a multi-conditional correspondence, which forms the mapping relationship based on specific meanings to convey the whole “event”. This paper summarizes the conditions of the metaphors in the case into the following five points:

1) The mapping relationship of popular symbols is a clear context of a metaphor.

This paper explored the symbols of the treasure box in the case of *Balance*, which is a common symbol under a popular definition. The meaning of the symbolic system is constructed based on the common cognition of the sender and the communicator. A visual design should avoid too many subjective factors and narrow the gap between the conveyed objectives (Su, Yen, & Lee, 2007). Therefore, if the representative symbols of a metaphor can be represented by symbols commonly recognized by the public, the transmission can be understood more directly by the viewers.

2) Mapping with similarity in form can constitute a visual metaphor

The similarity of a visual metaphor is presented through intuitive form, which results in the linking of pictures. From the perspective of mapping, the references of common characteristics are captured to form a mapping relationship among them from the modeling composition.

3) Element substitution and attribute blending are the transmission modes of the mapping method

The mapping theory defines a metaphor as an analogical process of two elements, and a blended space illustrates the results of combining these two elements. The input ratio of the two elements determines whether the results of a metaphor are presented by means of substitution and symbolism. As in the case of *NEGATIVE SPACE*, the road is substituted by the zipper of the suitcase, while in *The Employment*, the attributes of “human” and “object” both coexist.

4) The lens is a guide of the metaphor

From the *L' ONDÉE* case, it is concluded that the movement of the lens, editing, and time are not only the interpretation of the angle of view, but also the guide of the metaphor. A moving lens can reveal scenery and behavior, while switching the lens has the function of strengthening the relationship (Liu, Lee, & Lee, 2018). Therefore, the process of a metaphor for a source and target guided by a lens is also a part of the factors that affect the perception of the viewers.

5) The metaphor of animated movies must be understood from the whole “event”, in order to obtain a reasonable mapping relationship.

The common point in the above cases is the simultaneous mapping of multiple attributes. Simultaneous analogy in movies is a complex process of expres-

sion when many elements are involved at the same time, because its constituent elements are not only a single message. In this case, many elements are broken down and analyzed. After combining the mapping relationships of all elements, through “holistic” observation, it is possible to construct the whole metaphorical targets of the events from different perspectives, which is also the basis for the rationality of context.

5. Conclusion

The metaphors of animated films have a mapping relationship construction based on its narrative content and past experience. In terms of the form of expression, apart from analogy by similarity, blending and substitution are the techniques of expression difficult to achieve in general real shot movies. To sum up the previous discussion, the mapping relation conveyed through corresponded metaphor performances, the representation from the graphical symbols and the scenes manipulated with cameras are able to contribute to the mapping form of the metaphor, which is triggered by the similarity of symbols and perception. This study explored dynamic metaphor representation with the mapping and blending theories, and conducted analysis and summarization on actual award-winning cases. However, metaphors cannot be generalized by the above cases. In addition to the link caused by pictures, in fact, understanding the processes of symbols and visual psychology are also factors to be considered in metaphors. Therefore, future scholars can conduct more in-depth discussions on the perceptual process of dynamic art from the perspective of the relationship between psychological perception and metaphoric symbols.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Designing for Revitalization of Communities through New Business Models for Traditional Arts and Crafts

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Abstract

This paper discusses the importance and opportunities of design in helping to revitalize rural and marginalized communities where traditional arts and craft businesses often reside. It argues that traditional arts and craft businesses need to build a symbiotic relationship with the local communities to ensure the survival and thriving of both. It aims to demonstrate that designers should and can work traditional arts and craft business to better tell their stories and pursue new business opportunities with the goal to achieve sustainable development of these businesses and their communities. Through ethnography research and participatory design process, the paper presents the research team's collaborations with a few traditional arts and crafts business owners in three communities and presents a few design concepts resulted from this process. It provides a list of suggestions based on the above analysis for designers who are interested in working as the link between business and traditional arts and design.

Keywords

Revitalization, Business Model, Cultural Heritage, Rural Communities, Co-Design

1. Introduction

1.1. Crisis of Traditional Arts and Crafts

Traditional arts and crafts can be considered as the bridge between our material and non-material cultural heritage. Sadly, the accelerating disappearance of hand-crafted objects in the era of mass manufacturing is undeniably apparent. The reasons behind this phenomenon are multifold. Economically, the tradi-

tional arts and crafts business have been struggling to make a profit in the era of mass production due to its inherently high labor costs. The products from these trades such as Russian Palekh lacquer miniatures are considered luxury items from a bygone era, which do not seem to be of too much use in the day-to-day life (Khaire, 2019). In addition, many traditional products can be easily and cheaply replaced by mass-produced products such as bamboo weaving baskets. Thus, traditional arts and crafts have become an unattractive career path for the younger generations, being dismissed as “old-fashioned” or “difficult to learn” (Bazenkova, 2015; Bratley, 2010). This “inheritance crisis” hinders the preservation and development of these trades.

Beyond these practical reasons, we believe there is a deeper social and cultural reason for their loss: the disconnection between communities and the environment they live in. The cultural heritage, symbolic meanings, and techniques embodied by traditional arts and crafts reflect the local ecology and environment are gradually becoming less relevant in a globalized world. In addition, young people are leaving rural area in droves to cities to seek higher paying jobs. As a result, many traditional arts and crafts trades in rural area find it more difficult to attract new workers and customers. As these trades diminish, so do the communities that bred them. Therefore, revitalizing traditional arts and crafts business is not a simple matter of improving efficiency or reducing costs, or incorporating these aesthetics into new products. Indeed, if our aim is preservation of our unique cultural heritage, the sustainable solution is to retell the story of the unique cultural backgrounds of traditional arts and crafts and connect them with new generations of consumers and makers. While goods produced by traditional arts and crafts can be updated for modern use, there needs to be new business strategies that will create interesting and authentic memories associated with the goods that the traditional arts and crafts trades produce. These memories should be culturally relevant to the local communities, thus, encouraging or stimulating the community’s desire to preserve them. People ought to be proud of their traditions. In turn, consumer support for these businesses will help these communities to thrive again.

Ensuring the survival and continued development of these arts is not a simple matter because the economic, cultural, and social environment for these goods has all dramatically changed in the past hundred years, especially so in fast developing countries with rich cultural heritages like China and India. The paper argues that we should not only preserve traditional arts and crafts in museums, but also to create a healthy “eco-system” for them to continue to exist in the society as functional objects as well as cultural symbols so that artisans and craftsmen can continue to generate sustainable economic interests for their work and contribute to their communities.

Paradoxically, design can play a crucial role in linking traditional arts and crafts with economic development because of its enormous power to communicate at a massive scale. Design thinking methods can be utilized in finding ways

to resolve this complex problem that might involve product development, brand building, business and tourism planning, service design, and much more.

1.2. The Role of Design

Designers' responsibilities have gone beyond merely creating functional and eye-catching artefacts. Design has become an important instrument for building business and social strategies to bring about great cultural and economic changes. Ezio Manzini & Coad (2015) stated that: "Cultural activists, grassroots organizations, and design activists are converging towards a range of initiatives whose purpose is not to offer immediate solutions to problems, but to spark interest in these areas and show, often paradoxically or provocatively, that there are different ways of seeing and resolving them. (p. 46)". Bernardo Calzadilla-Sarmiento, Director of United Nations Industrial Development Organization's Department of Trade, Investment and Innovation, also pointed out: "Industrial design, through innovation and creativity, is essential to attain the objectives of the 2030 Development Agenda and its 17 Sustainable Development Goals, and especially Goal 9 on infrastructure, innovation, and sustainable industrialization." (UNIDO, 2019).

The recognition of this power of design in both private and public sectors leads to policy changes in many countries. The Ministry of Industry and Information Technology of the Chinese Government released the "Design for Poverty Alleviation Action Plan" in 2018, which covers many areas in the development of marginalized communities. Reviving traditional arts and crafts was identified as one of the core strategies for this redevelopment. Under this directive, the China Industrial Design Association (CIDA) subsequently issued ten design strategies. From CIDA's documents, the following business strategies for traditional arts and crafts can be summarized (CIDA, 2019):

- Establish a design-centered new industry chain for traditional industry.
- Create new values for traditional industry through design.
- Enhance consumer experience for traditional business through design.

In these documents, several successful cases were presented.

1.3. Design for a New Experience

Memories are created through experience. In their book, Pine and Gilmore (2011) defined the economic offerings of a business in four categories: commodity, goods, service, and experience. They argued that a rich and compelling experience is the most desirable for consumers in the 21st Century. While most traditional artisans and craftsmen are not in the service industry, they provide services to their clients at many "touch points" (encounters with the clients) to meet their needs. Many traditional arts and crafts businesses are also small non-employer businesses (have no employees except the owners). For any small business, the quality of its service is what its proprietors rely upon to differentiate the business from larger well-established brands. Literature reveals

that face-to-face communication and personal relationship with customers are very important to small business (Holzer & Sapsford-Francis, 2010; Wiswall, 2009). To grow repeat customers, traditional arts and crafts business must create a culturally relevant experience that people want to come back to, not just to purchase goods and services. Designers (broadly referred to industrial designers, fashion designers, graphic designers, as well as architects) with their expertise in mass communication and user-centered design methods can partner with these artisans and craftsmen to explore new business opportunities to create exciting new experience.

The destinies of traditional arts and crafts and the soil that “grew” them are intertwined. The ideas and techniques might be non-material, while the artefacts resulting from these practices stand as a testimonial to the humankind’s rich history and diverse cultural beliefs. We are convinced that the most promising strategy for preserving and developing traditional arts and crafts business is to make them a driving force behind the revitalization and development of marginalized rural communities. The approach must be systematic and interdisciplinary and any research efforts must be conducted not in labs, but within the communities.

Clearly, now is the perfect time for designers to work with traditional arts and crafts businesses towards the ultimate goal of revitalizing depressed communities. Many designers have been working in the field, most recently, Japanese Amezaiku Hanakawado Studio, Fendi of Italy (Povoledo, 2018) and Safina Projects CIC (to revive traditional boat building techniques in Iraq) (Safina Projects CIC, 2017). However, few theoretical studies have been conducted on this subject because long term economic benefits of design’s involvement in revitalizing traditional arts and craft and marginalized communities are difficult to calculate. Albeit, more such studies should emerge in the next decade due to the policy changes mentioned above. This paper discusses several cases that our design team has been involved with and attempts to distill a set of principles useful for designing for revitalization of culturally significant communities and industries.

1.4. Research Questions

Based on literature and preliminary research, the following assumptions were established before the project was started (Huang & Anderson, 2019):

- First, a multidisciplinary and systematic approach must be taken to generate a wide range of business solutions to revitalize traditional arts and crafts and their surrounding communities;
- Second, design research and design thinking strategies can provide new business ideas for solving complex problems.

Therefore, the research questions become: How can design help tell the story of traditional arts and crafts? What are the opportunities and obstacles that designers must consider when creating new business strategies for traditional arts and crafts businesses?

2. Methodology

2.1. Locations of Research and Design Activities

The researchers choose three communities as the primary research locations. These locations are: Makanda, Illinois, USA; Songkou, Fujian Province, China; Orkney, Scotland, UK. These three communities locate on three continents. Although culturally and geographically vastly different, they have many things in common: they are all rural areas that are relatively close to (within two hours by car or ferry) major metropolitan areas (Makanda is close to St. Louis, Songkou is close to Fuzhou, and Orkney is close to Inverness); they have relatively small populations (Makanda has 600 residents, Songkou has 31,000, Orkney has 21,000); and most significantly, they have been the site of an historically significant local and traditional arts and crafts that date back to over 100 years ago. As such, the researchers have worked to establish local contacts and to build working relationships with arts and crafts business owners in these communities.

2.2. Participatory Design

Through workshops and ethnographic research (interviews and observations), the research team examined the success and failure of some of these new business ideas. Some of the business owners and community activists in Makanda and Songkou were actively involved in the design process to ensure the design team understood their business' goals and their user scenarios. Likewise, the design team participated in the operation of some of these businesses and their various activities in order to test, improve and validate their design concepts. The research team has also participated in several local arts and craft fairs and training workshops to speak with various local artisans, observe their business handling and customer services, and observe the customers' reactions towards the products and services.

2.3. Interviews

Multiple interviews were conducted with designers and local small business owners, which helped the team understand the factors that have contributed to the success and failure of similar business in the past. Interviews were also conducted with potential customers. Since this research project has involved nearly 100 students in a variety of design disciplines and a variety of business owners over several years, and the interviews were mostly conducted in informal settings, the interview questions have been chosen from an evolving list to tailored to the specific businesses and locations. The core questions for the traditional arts and craft business owners and community activists focus on these five aspects:

- Regarding People: Does your practice/business fulfill a local need? Who are your local and global customers?
- Regarding Culture: What are the cultural heritages of your practice? How does your practice/business capitalize on the regional unique characteristics?
- Regarding Environment: Does your business promote local consumption?

Does your practice/business promote sustainable living?

- Regarding Production: What is unique about your production method? What are the products that best represent your local culture?
- Regarding Space: Does your practice/business create a public space for a civil dialogue about cultural heritage?

3. Results

3.1. Analysis of Data

Students went through the typical qualitative data analysis process: interview data was compiled to identify keywords and themes (Figure 1); personas (business owners and potential consumers for the business) were created; competitiveness of the businesses and the current market were analysed (Figure 2); user scenarios were generated.



Jennifer W. S. Paulson
Executive Director
Food Works

“ Farming is really cool!”

Visitors’ feedback

- Your plans for more improvements:
 - *have places to eat food right there*
 - *Add more farms, such as Bison farm*
- Limitations:
 - *Capacity*
 - *Staff time*
 - *Money*
- Supportive funding:
 - *SIH, Southern Illinois Healthcare*
 - *Experimental Station*
 - *State grants or privet funders.*
- Issues in incorporation with schools:
 - *Limited capacity*
 - *Lack of staff to watch the kids*
 - *College students prefer ready or frozen meal*
- Students role:
 - *Most participation of students is in activities related to wineries and breweries.*
- Farmer’s issues:
 - *Depression problems for kind of being isolated in their farm.*
- Participants of Farm Crawl:
 - *Families*
 - *Small farm owners*
 - *Some Students*

Rural Revitalization

Figure 1. Interview data was analyzed and insights shown in design presentations (interview of Jennifer Paulson by Dena Hassani).

Strengths

Genuine artstries
Home-y environment
Near college campus
Friendly owners
Plenty of recreational activities to do around the shop

Opportunities

Expand to younger audience through social media

Weaknesses

Shop is in the back half of Boardwalk (hard to see)
Mostly known by locals
Low budget, expensive to reach out
Poorly advertised to public

Threats

Competition: home-made goods is becoming a popular market and there are many vendors

Figure 2. SWOT analysis (interview of David Dardis of Rainmaker Studio by Peyton Schnurr).

Through these analyses, the design and research team identified several business opportunities and presented them to local communities.

3.2. Business Opportunities: Design for Unique Cultural Heritage

For communities like Songkou and Makanda to succeed, designers must create unique offerings based on their cultural heritage to set them apart from others. This is not an easy process as we found that cultural heritage must be cleverly packaged to become a successful product or service that might generate sustainable economic activities.

For instance, the craftsmen of bamboo weaving in Songkou create beautiful but delicate containers that might be easily crushed in transportation, thus it is difficult to market them to tourists or sell them via the internet. We also discovered that the local craftsmen need extensive help to update their products for a more urban audience. The products they produced are well made, but mostly are plain, lacking the design values that people might be willing to pay more for. One of the solutions that our design team presented was to use bamboo weaving baskets as packaging for locally-made snacks (**Figure 3**). This solution not only creates a new market for the traditional craft products, but also helps to reduce waste associated with packaging materials. Most importantly, it adds value to both the snacks and the bamboo container, resulting in a more culturally and environmentally conscious food product wrapped in an interesting yet practical protective vessel.

Furthermore, we found that these arts and craft trades themselves can be weaved into a compelling and culturally meaningful story of the old town of Songkou. The presence of these artisans and their studios on the main street of the old town of Songkou and Makanda proves to add nostalgic feeling and help to attract tourists. Admittedly, these brick and mortar establishments usually need renovation to provide a better viewing and shopping experience. But this



Figure 3. Bamboo basket gift packaging design for Songkou (designed by Wenyi Wu, Yingxuan Wu, and Anyuan Wang).

investment is justified because integrating these business into the landscape of the town can provide a better cultural experience for both community members and tourists.

One of our design teams decided to take this approach and presented an architectural solution to address the disconnection of the natural environment and the town, as well as the disconnection of history and the present. The Multifunctional Pavilion on the Water in Songkou (**Figure 4**) reminds people of the important role that the river once played in the history of Songkou (The city used to be a busy port for river transportation). While the primary intention of the pavilion is to increase the interaction between people and nature, it could also be used as a resting area along the river bank, or a fishing dock. At night, the space can be transformed into a performance centre for experiencing local opera (another form of traditional arts). The concept incorporates the architectural language of unique local buildings called “Cuo”, as well as the traditional craft of using bamboo as building materials.

For the small and scattered arts and crafts studios in Makanda, the research and design team worked with one of them, a metalsmithing craftsman, to create a new marketing campaign, with the central idea of creating a new tradition by connecting his studio practice with the most notable feature of the area: the town is situated within the heart of the vast Shawnee National Forest. The slogan for the campaign “Capture Nature in its Raw Form” (**Figure 5**) reflects both the craftsman’s practice and its connection with the surrounding areas. These designs exemplify our team’s approach to seek or expand business opportunities based on the historic cultural heritage and unique local features.

We also realized that it is important to look beyond the obvious. For instance, in Orkney, we observed that artisans such as jewellery makers and weavers frequently use the surrounding ocean as their theme, or incorporate Celtic or Viking symbols or patterns into their work. While these cultural references are appropriate, the market is already saturated with similar products. We argue that an often ignored core cultural value of many rural communities is their deep

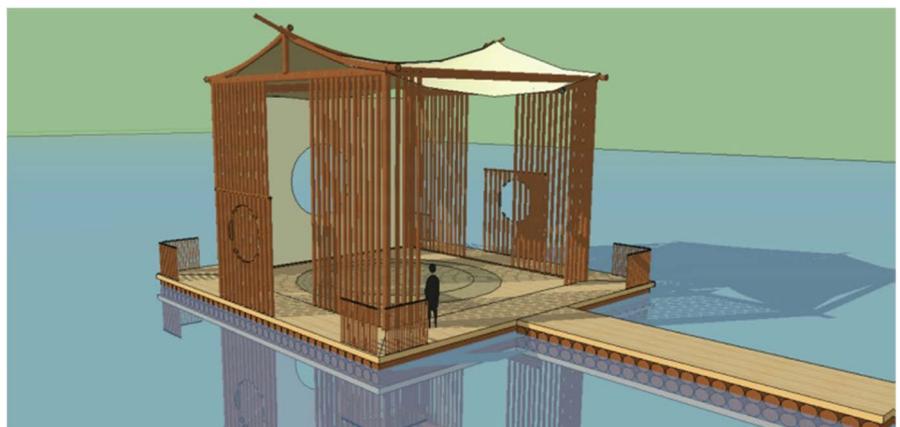


Figure 4. Multifunctional pavilion on the water (designed by Xiaopu Zhou, Shiyun Feng, Qi Qi, and Jiayi Sun).



Figure 5. Promotional campaign for Rainmaker Art Grotto (designed by Peyton Schnurr).

concern for the environment. For instance, despite their proximity to the North Sea petroleum fields, Orkney is leading the way for sustainable renewable energy (McKie, 2019). Using biodegradable materials for packaging, sustainable harvesting, upcycling, etc., these environmentally conscious practices can all be a part of the story of traditional arts and crafts in these communities.

3.3. Business Opportunities: Design for Craft-Tourism

Tourism is one of the main revitalization strategies for many rural communities (Ammirato & Felicetti, 2013; Ikerd, 2008; Allen, Van Dusen, Lundy, & Gliessman, 1991). Traditional arts and crafts can easily fit into this scheme. Songkou opened a Museum of Traditional Life in 2013 and regularly holds workshops to draw visitors to work with local artisans and craftsman to create chopsticks and bamboo weaving decorations. Creative Orkney, an association of craft makers living in the Orkney Islands, created the Creative Orkney Trail in 1995 (Creative Orkney, 2019). Visitors to these islands have a map of these studios and workshops and have the chance to visit and talk directly to the makers. Several potters in the Southern Illinois region (which includes Makanda) started to organize the annual event “Shawnee Hills Pottery Trail” in 2014 to be a part of the overall Shawnee National Forest tourism strategy. The region already promotes the Shawnee Hills Wine Trail of local wineries and this is a fitting addition. By teaming together, these businesses can create a cohesive story to promote the region and their work at the same time (World Tourism Organization, 2018).

Tourism is also about more than selling products (Poon, 1993). It might help tackling the “inheritance crisis”. Making arts and craft is often a personal journey. To take the fear out of starting such a journey, experienced artisans and craftsmen can share their love for their craft with new comers in the form of mentorship. Education and entertainment could both be provided if tours and workshops can be offered regularly to attract local visitors, especially families. For individual studios, craft-tourism is also an opportunity to diversify their income stream.

In addition, these experiences could build new traditions. More innovative

ways are being experimented worldwide. For instance, Rolling Oak Ranch in Makanda, an alpaca farm and weaver studio, started offering yoga with alpaca in June 2019, as a way to attract visitors to their remote location. Neither alpacas nor yoga is part of the historic traditions of Southern Illinois or the Shawnee Forest, but both work well with the emerging tradition of the local eco- and agritourism industries.

3.4. Business Opportunities: Design for Niche Market

Dalgic and Leeuw (1994) defined a niche market as “a small market consisting of an individual customer or a small group of customers with similar characteristics or needs”. Due to their unique cultural values and higher costs, traditional arts and crafts products must target a specific group of consumers who understand the added cultural values of these trades and are not price-sensitive. For instance, because of the long tradition of hippie culture in the town, Makanda tends to attract customers who are interested in unique, custom, natural, spiritual, and handmade arts and craft products. The local artisans already provide these products, but they need to promote their business better to attract new customers, especially young generations who are not particularly tied to the 60 s’ counter-culture movement.

We frequently observed that most small business owners (with the exception of a few) do not have the time nor the tech savvy to create a website or an advertising campaign to promote their businesses. They rely almost solely on digital social platforms such as Facebook or other shared services platforms such as Etsy to keep their customers updated. This is a field where designers can quickly intervene. Designers can partner with these entrepreneurs to celebrate the uniqueness of their small businesses by creating contemporary branding and cohesive marketing strategies that include both physical and digital promotional collaterals, therefore refreshing their brand images and helping them connect with new customers.

4. Suggestions for Designers and Traditional Arts and Craft Business

Through trial and err, our team has been working on this project for the last three years. Several design principles that might be of use to other design teams have emerged:

- Authenticity is the core value of traditional arts and crafts. Designers should work with their clients to fully understand the symbiotic relationship between the traditional arts and crafts and their local cultures. This helps to avoid creating an experience that is deemed manufactured and therefore appears fake to sophisticated customers.
- While working with small communities, designers should not interfere with their way of life, but rather, aim to improve it for modern comfort. New businesses should not be built on complete abolishment of the old, but to

take what is good of the old and market it better.

- Designers must work across disciplines and be prepared to find solutions outside of their comfort zone of established professional expertise.
- Selling more stuff is not necessarily the goal of revitalization of traditional arts and crafts and their communities. Raising awareness, increasing appreciation, creating new interests, and exploring new ways to tell the client's stories, should be the long term objective.

5. Conclusion

While it may be true that without design and business intervention, traditional arts and crafts will continue to exist as parts of collections in museums around the world, knowledge, appreciation and interest in these objects will increasingly be confined to those narrow specialists. They will be regarded as meaningless by the general public. We believe that it is important to preserve this shared cultural memory. To achieve this objective, these artefacts produced must retain their cultural relevance and be recognized by all as part of our cultural heritage as well as daily lives. Designers can play a critical role in this process by creating a cultural bridge between local artisan and the global citizenry by helping these local businesses remain culturally relevant, by constructing unique educational and interesting experiences that tell compelling stories of the products and the business.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Quantitative Analysis of Design Ability of Culture and Creative Designers under Ethical Vision

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Abstract

The rapid development of Culture and creative industries has been promoted by “Internet+”. However, the lack of talent of Culture and creativity has become a bottleneck restricting the development of industries. The development of industry can be aided by the quantitative evaluation system of the design ability of the designer, based on its monitoring, feedback and incentive functions. Based on the study of the existing competence evaluation index system, an evaluation index system for the design competence of creative designers of Culture was constructed by comprehensively investigating the three factors viz. design, ethics and sports. Subsequently, the subjective and objective combination weighting method was used to determine the weighted index of the design competence. Moreover, the fuzzy Topsis method was used to obtain the evaluation model, while the operability and scientificity of the evaluation index system and the evaluation method were verified by an example.

Keywords

Culture and Creativity, Design Ability, Quantitative Analysis, Subjective and Objective Combination Weighting Method, Fuzzy Topsis Method

1. Introduction

In the context of China’s Internet+, “Internet + Wenchuang” combines the innovation of the Internet with the creativity of the cultural industry, and connects the creativity with the producers, users (consumers) and other related articles in a better way through the Internet platform (Xie et al., 2019) (Handy, 2016) (Guang, 2018). It helps to create a subject, thereby expanding the source of crea-

tivity, improving production efficiency, strengthening community interaction, and merging social consensus (Tang, 2016) (Liu, 2018) (Lazzeretti et al., 2016). The development of cultural and creative industries is an inevitable choice to promote China's industrial structure optimization and industrial upgrading, and has an unmatched role in the transformation of economic development mode (Gundolf et al., 2018) (Wu & Li, 2018) (Xu et al., 2016).

The core element of the development of cultural and creative industries is creative talents. The key to develop a cultural and creative industry is by cultivating creative entrepreneurs and specialized talents to provide a good external environment for the growth of creative talents (Moalosi et al., 2016) (Xu et al., 2016) (Kitsios et al., 2017) (Shi, 2013) (Petrova, 2018). Different localities have proposed to support colleges and universities to set up a number of cultural and creative industry-related majors or specializations, cultivate talents such as cultural and creative management, creative design, and cultivate talents of sports, culture, economy, management, science and technology, etc. The cultural and creative enterprises can jointly cultivate and establish a group of cultural and creative training, training bases integrating production, and education and research. Furthermore, they can actively introduce high-quality and innovative talents in the development and construction of cultural and creative industries at home and abroad, establish talent training mechanisms and training bases, and create an environment for good talent development and talent initiatives (Xie, 2018) (Li et al., 2016) (Absalyamov, 2015) (Holmes, 2013) (Chen & Xu, 2016). In addition, from the perspective of design ethics, strengthening the protection of intellectual property rights, protecting the creative achievements of cultural creators and the legal income of property owners, and guiding the positive energy of cultural industry are also important aspects in the development of the cultural and creative industries. It can be seen from the above analysis that talents are crucial in the development of cultural and creative industries, and the designers responsible for creating cultural creations are the main players in the industry, and other practitioners and audiences in the industry affected by the design works. As one of the important components in the cultivation of talents in the cultural and creative industries, the design capability evaluation system is a key factor in the realization of the industrial upgrading target. A scientific and effective design capability evaluation system not only enables the designer to have an objective and comprehensive understanding of his own design capabilities, but also can guide the improvement of design capabilities through its monitoring and feedback functions. More importantly, through its incentive-oriented function it can encourage the innovative designers to actively participate in various cultural and creative activities (Liu, 2014) (Wang et al., 2011) (Wei, 2016) (Liang & Huang, 2016).

Due to the intersection of disciplines and the uncertainty of evaluation indicators, the quantitative evaluation of the design ability of creative design in the Culture has not been studied. However, the current quantitative evaluation me-

thods for ability of the students like enterprise innovation, morality, professional ability, and engineering ability have been reported previously (Biltekoff et al., 2014) (Brown & Annis, 2011) (Zou & Zhou, 2015) (Zhu & Lei, 2012) (Yin, 2011) (Yun et al., 2010) (Lai, 2013). In addition, the negative design and false propaganda in the current design practice have appeared many times. Modern design is also full of negative factors such as money worship, hedonism and pornography (Wang, 2013) (Chance, 2012) (Maciintosh et al., 2015). Therefore, scholars have also issued a call for “designing ethics as the bottom line of design behavior” (Giaretta, 2013) (Gram-Hansen & Ryberg, 2016). From the point of view of modern ethics, the fundamental reason for the lack of design ethics in various design works is due to the fact that the designers lack a systematic thinking about the design consequences in the design process (Li, 2017) (Frias, 2013) (Cao & Wu, 2014) (Leunes, 2012). In summary, the present research limits the evaluation object to the creative designers of Culture and considers the influence of design ethics and sports professional knowledge, while determining the design ability evaluation index set. Furthermore, it uses the subjective and objective weighted combination method to determine the weight of each index of the design ability, and then builds a design ability evaluation system suitable for creative designers of Culture.

2. Construction of the Design Ability Index System of Culture Creative Designers

On the basis of interpreting and combing relevant literatures, the design capability evaluation elements with higher frequency are selected as the candidate indicators based on the characteristics of the design subjects and the usual evaluation indicators of design capabilities. By the survey method, and invited universities, designers, audiences, etc. to conduct joint analysis and research. Ethical factors were added while designing the effective questionnaires. The elements with high recognition rate were selected as evaluation indicators from the reliability analysis. The alpha reliability coefficient method is used, that mainly considers the inherent reliability of the scale—whether there is a high internal consistency between the projects. It is generally believed that the reliability coefficient should be between 0 and 1. If the reliability coefficient of the scale is above 0.9, the reliability of the scale is good; if the reliability coefficient of the scale is between 0.8 and 0.9, the amount is expressed. The reliability of the table is acceptable; if the reliability coefficient of the scale is between 0.7 and 0.8, it indicates that some items of the scale need to be revised; if the reliability coefficient of the scale is below 0.7, it means that some items of the scale need to be discarded. This study conducted a reliability analysis of the questionnaire through SPSS software. The consistency of each score is examined by the alpha coefficient of the primary indicator.

Further by the survey method, the universities and enterprise experts were invited to analyze and research together the selected evaluation indicators that were further classified and summarized, and feedback was obtained. In order to

examine the interaction of the design ethical environment, the ethical level of the client and the audience was also added to the secondary indicators. Finally, according to the principles of hierarchy, comprehensiveness, conciseness, scientificity and operability, comprehensive design ability, and ethical level, a quantitative evaluation index system of design ethics was constructed, as shown in **Table 1**.

By the above method, the internal consistency analysis on all items of the entire scale is conducted, the total internal consistency reliability coefficient of the

Table 1. Evaluation index system of design ability of Culture creative designers.

Primary indicator	Secondary indicators
Knowledge accumulation	Design basics
	Design tool application level
	Sports knowledge level
	Interdisciplinary knowledge
	Level of knowledge in the field of ethics
	Design ethics level
Design thinking	Observation and element refining ability
	Imagination and design expression
	Logic and framework construction capabilities
	Appreciation of design works
Design skills	Market research capability
	Analytical ability
	Planning organizational capacity
	Design implementation capability
	Humanized design presentation ability
	Sports spirit connotation ability
Design personality and team	Curiosity and interest
	Self confidence
	Independent thinking spirit
	Team spirit
	Critical spirit
	Willpower
	Communication skills
Design ethical environment	The ethical level of the client
	Audience ethical level
Design results	Principal's recognition
	Audience recognition
	Peer review
	Promotion of design works

questionnaire is 0.9074, indicating that the reliability of the scale is good enough, and there is no need to modify the whole. All level indicators can be retained.

3. Weight Determination of the Design Ability Index of Culture Creative Designers

On the basis of the reconstructed design ability evaluation index system, the subjective entropy method is used to weight the evaluation index items, and the objective AHP method is used to determine the weight of the sub-criteria level indicators, and the weights obtained by the two methods are normalized. The weights of each index are obtained, the comment set is further determined, the fuzzy evaluation matrix is established, the fuzzy positive and negative ideal solutions are determined, and the distance and closeness of each evaluation object with the positive and negative ideal solutions are calculated, and the evaluation model is obtained.

3.1. Determination of Weights

The methods of weight determination mainly included the subjective weighting method and the objective weighting method. In the subjective weighting method, the weight of the index was obtained by the experts, based on the subjective judgment of the experience. The objective weighting method determined the weight according to the relationship between the original data. Both subjective and objective empowerment possessed their advantages and disadvantages (Wu et al., 2015) (Dai et al., 2018). Therefore, this paper attempts to combine the subjective and objective weighting methods.

1) Objective entropy weight method

Using the entropy weight method to determine the weight of 29 secondary indicator items, the semantic value of the evaluation index was standardized (Beruvides et al., 2016), shown in Equation (1).

$$C_{ij}^* = Con + \frac{C_{ij} - \frac{\sum_{j=1}^m C_j}{n}}{\delta} \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, m) \quad (1)$$

where, δ is the standard deviation and Con is an arbitrary constant such that $C_{ij} \geq 0$. The specific gravity $C_{ij}^{\#}$ and the entropy value S_j of the normalized index value were calculated as per the formula is as shown in Equation (2).

$$C_{ij}^{\#} = \frac{C_{ij}^*}{\sum_{j=1}^m C_{ij}^*}; S_j = -\frac{\frac{1}{\ln(n)}}{\sum_{j=1}^m C_{ij}^{\#} [\ln(C_{ij}^{\#})]} \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, m) \quad (2)$$

The difference value X_j was further calculated, and the weight Q_j of each evaluation index was determined according to Equation (3).

$$X_j = 1 - S_j; Q_j = \frac{X_j}{\sum_{j=1}^m X_j} \quad (3)$$

2) Subjective analytic hierarchy process

In this paper, the analytic hierarchy process was used to determine the weight of six first-level indicators and 29 second-level indicators. A total of 5 experts in the design field, ethical field, sports field, and education field were selected. The hierarchical analysis method was used to determine the hierarchical membership relationship. After the hierarchical structure was established, the factors in the same layer were compared and judged, and the judgment matrix A was constructed (Yeoh & Calantone, 2016).

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & a_{22} & \cdots & a_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nm} \end{bmatrix}$$

The product M_i of each row element of the judgment matrix A was calculated using the n -th root M_p , and finally the weighted value W_j normalized by each index was obtained, using Equation (4).

$$\begin{aligned} M_i &= \prod_{j=1}^n a_{ij} \quad (j = 1, 2, \dots, m) \\ \bar{W}_j &= \sqrt[n]{M_i} \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, m) \\ W_j &= \frac{\bar{W}_j}{\sum_{j=1}^m \bar{W}_j} \end{aligned} \quad (4)$$

3) Combination empowerment

By a comprehensive consideration of the two kinds of weighting methods, the weighting coefficients were determined by the subjective and objective weighting method, which were multiplied correspondingly, and finally normalized. The specific combination weighting formula is shown in Equation (5).

$$zW_j = \frac{Q_j \times W_j}{\sum_{j=1}^m Q_j \times W_j} \quad (j = 1, 2, \dots, m) \quad (5)$$

3.2. Weight Determination Process

From Equations (1)-(3), the weight of the second-level index of the design capability evaluation obtained by the objective method is shown in **Table 2**.

In the next step, 5 experts were selected who scored each pair of indicators according to a scale of 1 - 5 scale. Subsequently, a judgment matrix was established, and the feature vector corresponding to the maximum eigenvalue λ_{\max} was calculated by the product square root method. It was further normalized to determine the weight of each level factor as W_j ; the results are shown in **Tables 3-9**.

The results obtained by the formula 5 are shown in **Table 10**.

3.3. Analysis and Discussion of Weights

It can be seen from the analysis of the weighted results from **Table 10** that the design results was still an important indicator for evaluating the design ability of

Table 2. Weight of design capability evaluation indicators obtained by objective method.

Primary indicator C_i	Secondary indicators C_{ij}	S_i	X_j	Q_j
Knowledge accumulation	Design basics	0.9829	0.0171	0.1825
	Design tool application level	0.9859	0.0141	0.1503
	Sports knowledge level	0.9852	0.0148	0.1578
	Interdisciplinary knowledge	0.9835	0.0165	0.1755
	Level of knowledge in the field of ethics	0.9826	0.0174	0.1852
	Design ethics level	0.9861	0.0139	0.1486
Design thinking	Observation and element refining ability	0.9842	0.0158	0.2645
	Imagination and design expression	0.9840	0.0160	0.2676
	Logic and framework construction capabilities	0.9871	0.0129	0.2157
	Appreciation of design works	0.9849	0.0151	0.2523
Design skills	Market research capability	0.9942	0.0058	0.0732
	Analytical ability	0.9854	0.0146	0.1854
	Planning organizational capacity	0.9841	0.0159	0.2018
	Design implementation capability	0.9877	0.0123	0.1563
	Humanized design presentation ability	0.9855	0.0145	0.1839
	Sports spirit connotation ability	0.9843	0.0157	0.1994
Design personality and team	Curiosity and interest	0.9840	0.0160	0.1475
	Self confidence	0.9858	0.0142	0.1311
	Independent thinking spirit	0.9839	0.0161	0.1483
	Team spirit	0.9835	0.0165	0.1523
	Critical spirit	0.9853	0.0147	0.1361
	Willpower	0.9845	0.0155	0.1435
Design ethical environment	Communication skills	0.9847	0.0153	0.1411
	The ethical level of the client	0.9845	0.0155	0.4888
	Audience ethical level	0.9838	0.0162	0.5112
Design results	Principal's recognition	0.9867	0.0133	0.2390
	Audience recognition	0.9849	0.0151	0.2713
	Peer review	0.9864	0.0136	0.2434
	Promotion of design works	0.9863	0.0137	0.2463

Table 3. Judgment matrix of primary indicators.

	Knowledge accumulation	Design thinking	Design skills	Personality and team	Design ethical environment	Design results
Knowledge accumulation	1					
Design thinking	3	1				
Design skills	2	1	1			
Personality and team	1/3	1/3	1/2	1		
Design ethical environment	1/4	1/4	1/3	1/2	1	
Design results	1/2	1/2	1	2	3	1
Weights W	0.168103	0.291162	0.211796	0.081612	0.067471	0.179855

Table 4. Judgment matrix of knowledge accumulation.

	Design basics	Design tool application level	Sports knowledge level	Interdisciplinary knowledge	Level of knowledge in the field of ethics	Design ethics level
Design basics	1					
Design tool application level	3	1				
Sports knowledge level	2	1/2	1			
Interdisciplinary knowledge	1	1/3	1	1		
Level of knowledge in the field of ethics	2	1	2	2	1	
Design ethics level	2	1/2	1	1	1/2	1
Weights W	0.144959	0.251076	0.144959	0.110145	0.219717	0.129144

Table 5. Judgment matrix of design thinking.

	Observation and element refining ability	Imagination and design expression	Logic and framework construction capabilities	Appreciation of design works
Observation and element refining ability	1			
Imagination and design expression	1/2	1		
Logic and framework construction capabilities	1	2	1	
Appreciation of design works	1	2	1/3	1
Weights W	0.204266	0.353799	0.257359	0.184575

Table 6. Judgment matrix of design skills.

	Market research capability	Analytical ability	Planning organizational capacity	Design implementation capability	Humanized design presentation ability	Sports spirit connotation ability
Market research capability	1					
Analytical ability	1/2	1				
Planning organizational capacity	1/3	1/2	1			
Design implementation capability	1/2	1	1/2	1		
Humanized design presentation ability	1	2	1/2	1	1	
Sports spirit connotation ability	1/3	2	1	1/2	1/2	1
Weights W	0.176199	0.305186	0.096966	0.124591	0.166347	0.130711

Table 7. Personality and team judgment matrix.

	Curiosity and interest	Self confidence	Independent thinking spirit	Team spirit	Critical spirit	Willpower	Communication skills
Curiosity and interest	1						
Self confidence	2	1					
Independent thinking spirit	3	2	1				
Team spirit	2	1/2	2	1			
Critical spirit	1/2	1/2	1/2	1/3	1		
Willpower	2	1	2	2	2	1	
Communication skills	3	2	1	1	2	1/2	1
Weights W	0.113259	0.160173	0.205806	0.134689	0.059983	0.179788	0.146298

Table 8. Judgment matrix of design ethical environment.

	The ethical level of the client	Audience ethical level
The ethical level of the client	1	
Audience ethical level	3	1
Weights W	0.366025	0.633975

Table 9. Judgment matrix of design results.

	Principal's recognition	Audience recognition	Peer review	Promotion of design works
Principal's recognition	1			
Audience recognition	2	1		
Peer review	2	2	1	
Promotion of design works	1/2	1/2	1/3	1
Weights W	0.205900	0.356629	0.326845	0.110627

the designers. All experts believed that their weights were high. The weight of design thinking and design skills was higher than that of knowledge accumulation and personality team, indicating that the evaluation of design ability paid a more attention to the broadening of thinking and its skill factors. Knowledge accumulation and habits can be acquired. For the design ethical environment, the weight was the lowest, because the design ethical environment was not much different for the individual designers.

The analysis of the secondary indicators by the weight calculation results in **Table 10** can be further seen as:

1) In the accumulation of knowledge, the impact of various knowledge levels on the design capabilities was basically the same. Among them, the knowledge level in the ethical field possessed a highest weight value. It is important to incorporate the knowledge level in the ethical field into the evaluation system to accurately evaluate the ability. The corresponding design ethics level had a higher weight, and the ethical total knowledge level occupied the knowledge accumulation over 40% weight, indicating that the current design field paid more attention to the ethical influence, hoping to embody the humanized design and convey correct values in the design. The level of knowledge in the sports field was ranked among the various levels of knowledge accumulation, and the Culture creative design was also an indispensable accumulation. The cross-disciplinary knowledge level was the lowest, due to the difficulty in learning the interdisciplinary knowledge yin daily learning and difficulty in its quantification. Therefore, the survey sample possessed a lower knowledge score in the field.

2) In the indicators of design thinking, the observation and element refinement, and the imagination and design expression ability were both high, and also met the requirements for the basic quality of the designer.

3) In terms of the design skill indicators, the market research ability was much

Table 10. Design ability evaluation indicators after combined empowerment.

Primary indicator C_i	Weights	Secondary indicators C_{ij}	Q_j	W_j	zW_j
Knowledge accumulation	0.1701	Design basics	0.1825	0.1593	0.1732
		Design tool application level	0.1503	0.1593	0.1427
		Sports knowledge level	0.1578	0.1593	0.1498
		Interdisciplinary knowledge	0.1755	0.1210	0.1266
		Level of knowledge in the field of ethics	0.1852	0.2415	0.2665
		Design ethics level	0.1486	0.1593	0.1411
Design thinking	0.2946	Observation and element refining ability	0.2645	0.2704	0.2840
		Imagination and design expression	0.2676	0.2704	0.2873
		Logic and framework construction capabilities	0.2157	0.2146	0.1838
		Appreciation of design works	0.2523	0.2443	0.2448
Design skills	0.2143	Market research capability	0.0732	0.1210	0.0513
		Analytical ability	0.1854	0.1711	0.1838
		Planning organizational capacity	0.2018	0.1921	0.2245
		Design implementation capability	0.1563	0.1592	0.1442
		Humanized design presentation ability	0.1839	0.1732	0.1845
		Sports spirit connotation ability	0.1994	0.1831	0.2115
		Curiosity and interest	0.1475	0.1192	0.1228
		Self confidence	0.1311	0.1192	0.1091
Design personality and team	0.0825	Independent thinking spirit	0.1483	0.1502	0.1556
		Team spirit	0.1523	0.1418	0.1508
		Critical spirit	0.1361	0.1192	0.1133
		Willpower	0.1435	0.1893	0.1897
		Communication skills	0.1411	0.1607	0.1584
Design ethical environment	0.0682	The ethical level of the client	0.4888	0.4142	0.4033
		Audience ethical level	0.5112	0.5857	0.5966
		Principal's recognition	0.2390	0.2214	0.2103
Design results	0.1701	Audience recognition	0.2713	0.3132	0.3376
		Peer review	0.2434	0.2790	0.2698
		Promotion of design works	0.2463	0.1862	0.1822

lower than other indicators, indicating that the designer's design style was less affected by the market trends, and the sports spirit connotation presentation ability had a high impact on the design ability, which was consistent with the Culture.

4) The design personality was basically the same as the weight of each index in the team. The independent thinking spirit and the willpower had the highest weight, which further confirms the difference between design and engineering. The personal quality of the designer was more favorable than the team quality.

5) In the indicators of the design ethical environment, the ethical level of the audience was more affected than the ethical level of the client, emphasizing the view of the scholars that the design should serve the general public.

6) The evaluation of the design results was similar to the design environment. The recognition of the audience was the highest, and the recognition of the peers also affected the designer's reflection on their own design works.

4. Evaluation and Application of the Design Ability of Culture Creative Designers

4.1. Construction of the Evaluation Model

The TOPSIS method used in the evaluation model is a multi-objective decision-making method (Chen et al., 2014) (Liu & Zhang, 2017) (Peng et al., 2016). Compared with the traditional multi-statistic method for evaluating problems, it has the characteristics of intuitive analysis principle, simple calculation and little requirement for sample size. In this paper, based on the combination weight of the evaluation index and the initial fuzzy evaluation matrix, the weighted decision matrix is further constructed; the ideal value and the non-ideal value vector are constructed; the distance and closeness of each evaluation object and the positive and negative ideal solutions are calculated, and the design capability level of each evaluation object is calculated and can be sorted according to the size of the closeness value. The model construction process of the method included the following four processes:

1) Establishment of a fuzzy evaluation matrix

According to the comment set, an initial fuzzy evaluation matrix was constructed, where X_{ij} is the semantic value of the j th evaluation index of the i -th evaluation object.

$$X_{ij} = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1m} \\ X_{21} & X_{22} & \cdots & X_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ X_{n1} & X_{n2} & \cdots & X_{nm} \end{bmatrix} \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, m)$$

2) Establishment of a weighting matrix

The weighted decision matrix was constructed according to the combined weight of the evaluation index and the initial fuzzy evaluation matrix, according to Equation (6).

$$\lambda = \begin{bmatrix} \lambda_{11} & \lambda_{12} & \cdots & \lambda_{1m} \\ \lambda_{21} & \lambda_{22} & \cdots & \lambda_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ \lambda_{n1} & \lambda_{n2} & \cdots & \lambda_{nm} \end{bmatrix}$$

$$\lambda_{ij} = zW_j * X_{ij} \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, m) \quad (6)$$

3) Determination of the fuzzy positive and negative ideal solution

The ideal value λ^+ and the non-ideal value vector λ^- were constructed

using Equation (7).

$$\begin{aligned}\lambda^+ &= (\lambda_1^+, \lambda_2^+, \dots, \lambda_m^+) \\ \lambda^- &= (\lambda_1^-, \lambda_2^-, \dots, \lambda_m^-) \\ \lambda_j^+ &= \max(\lambda_{1j}, \lambda_{2j}, \dots, \lambda_{nj}) \\ \lambda_j^- &= \min(\lambda_{1j}, \lambda_{2j}, \dots, \lambda_{nj})\end{aligned}\quad (7)$$

4) Calculation of the distance and closeness of each evaluation object from positive and negative ideal solutions

The Euclidean distance between each index and the ideal value and the non-ideal value is Z_i^+ and Z_i^- according to Equation (8) and the closeness of each evaluation object to the ideal solution is recorded as ω_i .

$$\begin{aligned}Z_i^+ &= \sqrt{\sum_{j=1}^m (\lambda_{ij} - \lambda_j^+)^2}; \quad Z_i^- = \sqrt{\sum_{j=1}^m (\lambda_{ij} - \lambda_j^-)^2} \\ \omega_i &= \frac{Z_i^-}{Z_i^- + Z_i^+}\end{aligned}\quad (8)$$

The larger the value of ω_i , the closer was the design ability level of the evaluation object to the ideal value, and the design ability level of each evaluation object was sorted according to the size of the ω_i value.

4.2. Analysis of the Application Effect of the Evaluation Model

By applying the obtained evaluation model to the evaluation of design ability of three designers from different companies engaged in the Culture creative design, the scientific and practicality of the whole evaluation index system and evaluation method was verified in the form of examples. The results obtained are shown in **Table 11**.

As can be seen from **Table 11**, the design ability of the designer Du×× is ranked first, and the score obtained by the evaluation model is higher than that of other designers. The main reason is that the designer has been the chief designer of a company for many years, and his abilities have been obtained. It has won praises from peers and customers, and has won various awards in design. Through various weights, its innovation ability ranks first in line with other evaluation systems; it is worth noting that Chen×× designer, the designer's design thinking And the design skills are general, but its design concept has always advocated green simplicity, its design ethics ability is more prominent, and the weighted design ability ranking has been greatly improved, which also shows

Table 11. Quantitative calculation of design ability of evaluation objects.

Number	Company	Name	ω_i	Sort
1	A	Li××	0.5824	3
2	B	Chen××	0.6620	2
3	C	Du××	0.7016	1

that design ethics has an obvious effect on the improvement of design ability. It can be showed from **Table 11** that the model constructed in this paper could quantitatively describe the design ability of the creative designers engaged in the Culture, and the calculated results were consistent with the qualitative judgment. Currently, the design ability of the designers engaged in the Culture and creativity is generally not high. It should be upgraded from multiple angles to make up for the lack of design ability and promote the overall improvement of the creative design level of the Culture.

5. Conclusion

In the present work, initially an index system was constructed for the quantitative evaluation of the design ability of creative designers in the Culture. In the process of construction, the design ethics was innovatively incorporated into the index system, and the index system of the new system was obtained. Combining the weighting method with the fuzzy Temple's evaluation method, and considering the inaccuracy and ambiguity of the evaluation process of different professional background evaluation objects, the semantic value was used to replace the index level, and the evaluation object was used between the positive and negative ideal solutions. The relative closeness was used as the final evaluation criteria. The constructed model ascertained the rationality and scientificity of the index system construction; thus it possesses a significant practical value and can provide a reference for the quantitative evaluation of the design ability of designers in other industries.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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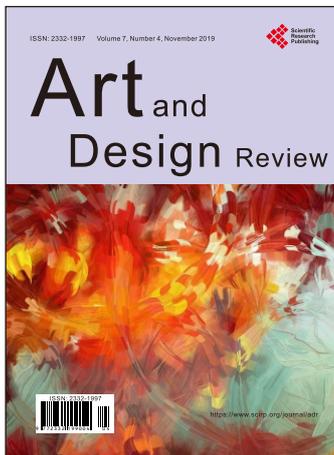
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