



EXPLORING VISUAL ELEMENTS THROUGH NATURAL RESOURCES: FOREST, TREE AND
LEAF AT KHAO NAM KHANG NATIONAL PARK, THAILAND



By
MISS Pailin THAWORNWIJIT

A Thesis Submitted in Partial Fulfillment of the Requirements
for Doctor of Philosophy DESIGN ARTS (INTERNATIONAL PROGRAM)

Graduate School, Silpakorn University

Academic Year 2019

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MISS PAILIN THAWORNWIJIT : EXPLORING VISUAL ELEMENTS THROUGH NATURAL RESOURCES: FOREST, TREE AND LEAF AT KHAO NAM KHANG NATIONAL PARK, THAILAND THESIS ADVISOR : PROFESSOR EAKACHAT JONEURAIRATANA

Located in the south of Thailand, there hides a quiet and peaceful tropical rain forest called 'Khao Nam Khang National Park'. The 220 square kilometers national park holds plenty of conserved plant and important woods that sustain the balance in the environment. The area served as the Malayan Communist fighters' hideout during the 40 years of political insurgency between Thai government and the Communist Party of Malaya. With that reason, the area was almost abandoned from the outside world. It was somehow benefit to the biodiversity of flora and fauna that wait for the natural exploration.

Aiming to explore the beauty of nature, the research has applied visual elements from "Leaf" together with fundamental of L-system and Fibonacci theory. Although "Leaf" is a small element, it can represent trees in the forest. It also demonstrates a small universe about life and beauty. Furthermore, leaf is able to tell us about climate change, seasons and ecology. Visual elements, occurred in leaves, are able to tell us about life nourishing and growing. The purpose of this research is to collect data from leaf which composes of visual elements such as shape, form, color and vein's pattern to decode and use in visual communication design system. All elements showed on leaf can be developed and applied in many design fields. Referring to the purposes of the research, it targets to assemble data collection for the designers to employ in their careers and provoke their concern and awareness about climate change as well as the benefit of forest through story telling (Illustration).

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Chapter 1

Leaf exploration: Visual Element through Natural Resources; Khao Nam Khang National Park, Thailand

1.1 Introduction

Located in the south of Thailand, there hides a quiet and peaceful tropical rain forest called 'Khao Nam Khang National Park'. The 220 square kilometers national park holds plenty of conserved plant and important woods that sustain the balance in the environment. The area served as the Malayan Communist fighters' hideout during the 40 years of political insurgency between Thai government and the Communist Party of Malaya. With that reason, the area was almost abandoned from the outside world. It was somehow benefit to the biodiversity of flora and fauna that wait for the natural exploration.

Aiming to explore the beauty of nature, the research has applied visual elements from "Leaf" together with fundamental of L-system and Fibonacci theory. Although "Leaf" is a small element, it can represent trees in the forest. It also demonstrates a small universe about life and beauty. Furthermore, leaf is able to tell us about climate change, seasons and ecology. Visual elements, occurred in leaves, are able to tell us about life nourishing and growing. The purpose of this research is to collect data from leaf which composes of visual elements such as shape, form, color and vein pattern to decode and use in visual communication design system. All elements showed on leaf can be developed and applied in many design fields. Referring to the purposes of the research, it targets to assemble data collection for people to provoke their concern and awareness about climate change as well as the benefit of forest through story telling (Illustration).

Nowadays, problems about climate change and green space are what the world concerns and pays attention to. Also, how to solve the problem seems to be major topic among discussion these days. The fact about forest in Thailand is shockingly surprise especially in the north where bush fire, smoke and haze

continuously occur. As major concern, deforestation for agriculture and industry has destroyed large pieces of land and green area. Moreover, in 2018, air pollution problem in Bangkok was brought up to consideration since there were many areas with beyond – safe PM 2.5 level. It was found out that construction, traffic and insufficient green space had led to air pollution problem. Thai government had done the decisive action because the UN environment was giving particular attention on how they seek for appropriate solutions.

In addition, if the problem why pollution rate in Thailand is rising rapidly was carefully examined, we would realize that green space and nature awareness are the first thing we should think of. Climate change campaign was quietly launched to public by national government and private organizations which take role of position into the problems. Yet, it seems like not so many people pay their attention or the campaign comes into public interest. By employing visual communication design, the designer and researcher has to reach for several ways to communicate and convince people to be fascinated with the idea hidden behind this beauty.

‘Illustration’ is a part of communication design which chosen to convey story about forest and how climate change affected the earth. By using illustration, the research attempt to tell the story and create awareness into the artwork. In term of techniques, the research aspires to combine hand drawing and technology which show narrative by apply L-system and Fibonacci in the artworks.

1.2 Research question

How visual communication design create conversation about climate change and deforestation through studying natural resources.

1.3 Objectives

- To establish the significant of nature from studying elements of leaves
- To collect and analysis visual elements of leaves as a data collection
- To create visual communication design (illustration) combined with L-system/Fibonacci theory
- To build up awareness about forest conservation and climate change to people

1.4 Hypothesis

The research expects to use visual communication design in order to send message about forest, nature and how climate change affect our life by using framework of Fibonacci and L-system to create artwork. Moreover, the aim of research has anticipation to use the technology to make young generation pay more attention about climate change that can be considered as big issue nowadays. However, the research goal not only make an effort about the result of new artwork or aesthetic since it should convey and convince people to care more about the nature. The hypothesis of the research follows from these steps.

Firstly, the research specific to study about elements of leaves from Khao Nam Khang National Park in the south of Thailand. The elements in the nature are so mysterious, it could link with design element and develop to use in many ways in the design field such as product design, jewelry design and more. Although, the elements of nature were widely used in the design field yet for the aesthetic more than communication. Likewise, the research would attempt to bring the aesthetic from the elements of the nature to create the artwork, however the goal is to communicate the knowledge and recreate the new perception to the viewer about the forest and climate change.

Secondly, the research aims to collect data from element of leaves and create the catalogue. The catalogue includes the photographs and nature's elements which people can examine leaf's details. Also, it could make people conceive an aesthetic of nature. On the contrary, the catalogue will collect the design elements which could be use in others design area.

Thirdly, the research demonstrates the data and use it as a source to apply in the artworks which determine the knowledge about L-system and Fibonacci. L-system is a system which used in programing and mathematic to create the prototype of tree's growth in 3 dimensions. The research experiment has used L-system in the visual communication design compound with Fibonacci theory. Fibonacci is a sequence number in mathematic yet also well-known in art area as golden section. It was applied as a tool to make an artwork that has more harmony and balance. Particularly, the Fibonacci combine with L-system in the art and design

may yield good outcome of the research proposes. Above all, how to determining the use of stated theories in visual communication design and create storytelling would be a great challenge of the research. Perhaps, this approach could work, or it could not, somehow, the research aims to have hypothesis with the last result.

Finally, the main goal of the research is communication about forest conservation and climate change to the people via illustration. To raise awareness among younger generation and people nowadays could be difficult due to human behavior and consumption rate. The era of consumerism is the most important thing which separates people from nature. In other words, it could be a wall against us from sufficiency. We lost a large number of trees and forest area to serve investors and industries for example, problems about palm oils in Indonesia. Palm oil is grown in Indonesia, Malaysia and Thailand. This could benefit to economic and help local people to avoid from poverty yet it also destroys the green rainforest area. The palm oil industries expand rapidly in many countries in South East Asia. This becomes big issue for climate change and how we could protect our forest. However as a researcher, we might do something to convey the message by using our skills and knowledge to people.

1.5 Scope of research

1.5.1 Specific the research area only at the Khao Nam Khang National Park, Thailand

1.5.2 Collect the data from the nature particular on 'Leaves'

1.5.3 Analyze the data and decode the element of leaves as a catalogue and design elements

1.5.4 Create the illustrations and artworks by apply L-system and Fibonacci theories

1.5.5 Use visual communication design to convey the message about forest conservative and climate change to the people

1.6 Result of research

1.6.1 The main reason of the research is to create awareness about climate change and forest conservation to people, society, local community and younger generation. The result of research should illustrate and encourage people to take good care of the surrounded environment especially forest and nature.

1.6.2 The research may reflect idea of climate change which was hidden behind the artwork. The important things of the result do not only let people conceive an aesthetic because it includes knowledge and consciences about environment.

1.6.3 The research could also provide data as a collection catalogue and could develop it to use in both design area and education area.

1.6.4 In term of technical areas in the research, the research was combined with 3 different techniques, which are illustration, motion graphic and projection mapping. The result of these techniques could show the academic disciplines in several areas of design in order to demonstrate knowledge in different criteria.

1.7 Research Budget

- Paper 2,000 Baht
- Pen, ink and pencil 1,500 Baht
- Projectors (rental rate per day) 30,000 Baht per 2-3 projectors
- Delivery cost 5,000 Baht
- Frames 8,000 Baht
- Set up team for exhibition 10,000 Baht
- Translation 20,000 Baht
- Books thesis and printing 15,000

Total 91,500 Baht (Cost estimation)

1.8 Key words

Illustration, motion graphic, forest, national park, environment, climate change, awareness Flora and Fuana.

“**Illustration**” – the picture or story telling which communicate a story by various techniques such as drawing, digital painting, collage, graphic design and more.

“**Leaf**” - a flattened structure of a higher plant, typically green and blade-like, that is attached to a stem directly or via a stalk. Leaves are the main organs of photosynthesis and transpiration.

“**Motion Graphic**” – are pieces of digital footage or animation which create the illusion of motion or rotation and are usually combined with audio for use in multimedia projects.

“**Forest**” – a large area covered chiefly with trees and undergrowth.

“**Deforestation**” – the cutting down of trees in a large area, or the destruction of forests by people.

“**National park**” – an area of countryside, or occasionally sea or fresh water, protected by the state for the enjoyment of the general public or the preservation of wildlife.

“**Environment**” – the surrounding or conditions in which a person, animal, or plant lives or operates

“**Climate change**” – a change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

“**Awareness**” - knowledge or perception of a situation or fact.

“**Flora and Fauna**” – Biology or environment.

Chapter 2

Theories and Literature reviews

The research aims at studying and examining theories which could be merged and applied into illustration design especially Fibonacci and L-system that share the main roles in the research. Both of them were used in the experiments and applied in the artworks. In addition, the research also did the literature review on forest and deforestation which affect the overall environment and responsible for the climate change issue. The literature also involves in the case study from the research area as well.

2.1 Fibonacci

The sequence of Fibonacci is a series of numbers in which each successor number (after the second) is the sum of the preceding two. The most renowned sequence of Fibonacci is 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89 This sequence reflects many natural interactions in the globe of plants. Leonardo Bigollo is Italian man who invented the Fibonacci sequence. He published a famous book called the Liber Abaci about his Fibonacci sequence knowledge which was the outcome of a mathematical problem about rabbit breeding.

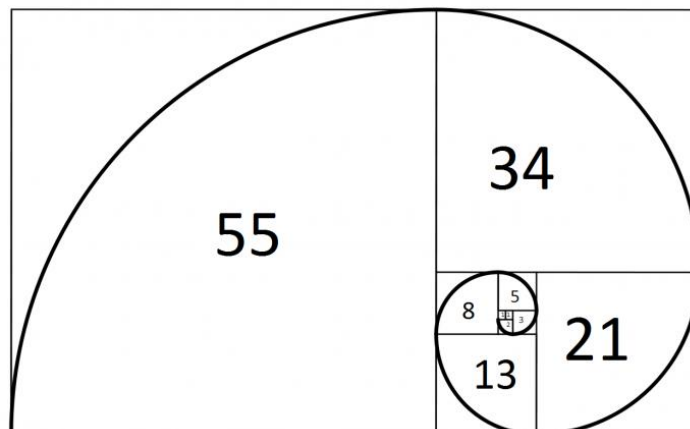


Figure 1 The illustration of Fibonacci sequence in spiral shape

The Fibonacci sequence can be commonly found in nature especially in the number of petals on flowers, in the number of row of seed in sunflower or even in the arrangement of leaves on a plant stem. Why are crop development Fibonacci figures so prevalent? In the initial concepts of Fibonacci about the pace of rise in rabbit populations, one clue appears. The development described in Fibonacci may portray the spread of seeds or petals in some flower's species. That is, these phenomena can be an expression of the effectiveness of nature. As each row of seeds grows radially away from the center in a sunflower or each row of scales in a pinecone, it tries to grow as many seeds (or scales) as possible in the smallest space. The sequence of Fibonacci can simply convey the most effective seed packing (or scales) in the accessible room (Ghose, & Bahadur, 2019).

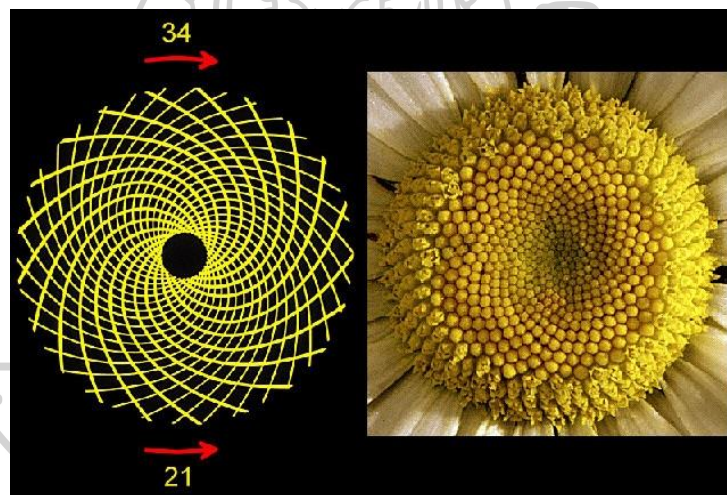


Figure 2 The Fibonacci sequence appears in sunflower seeds

2.2 How Fibonacci effect the beauty

If we examine the beauty in nature, we might find it link with human emotional such as we see a rose blooming. Then, our brain will perceive that it looks unconditionally beautiful. A complexity of beautiful rose becomes the question why we perceive that rose is more beautiful than other flowers. Perhaps, golden section would be a good answer for beauty in nature. Thus, following the beauty in nature could lead us from small creature into the universe. We might have realized that perfect shape of landscape or plants could show us the beauty which cover by golden

section. In addition, Fibonacci or Golden section can link together in the way of mathematic yet in art golden section might be the thing which illustrate about how nature works.

In term of beauty in nature and golden section, we could explain by the case studies such as when we look at the landscape of huge forest area comparing with the landscape of Sahara dessert. We normally sense that both of them look beautiful, however, we cannot explain why the two places are perfectly matched. That's because our perception indeed plays something with our instinct like we love beautiful rose. However, the answer of beauty in nature could derive from Fibonacci and golden section. By considering Fibonacci series number and golden section in plan systems, the well-known shape of phyllotaxis of leaf-rosettes or so-called angle of divergence is presented. We can obtain it if we take a rosette in our hands upside down, mark a leaf and then go around in spirals until we arrive at another leaf which is positioned exactly above the leaf we started with. We need to note the number of turns we had to make, and the number of leaves passed while doing that. The divergence angle in degrees is then given by the ratio of turns to the number of leaves touched times 360° (Lüttge, 2018).

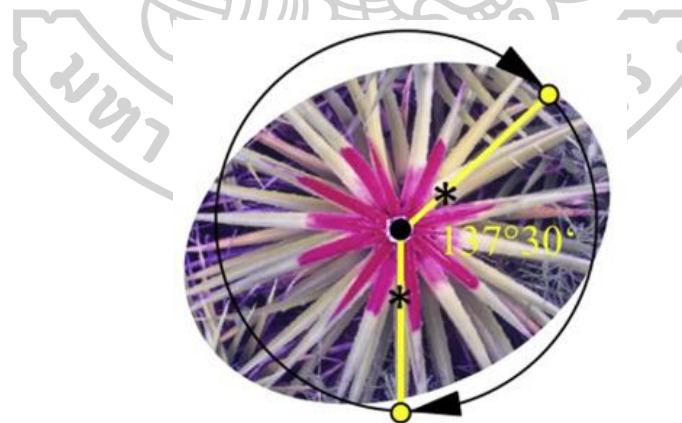


Figure 3 The illustration of leaf rosettes in 360°

Leonardo Fibonacci or Leonardo Pisano (ca.1180-1250) was the man who changed the way of history mathematic society. Fibonacci is an Italian mathematician who found the series of number is 1,1,2,3,5,8,13,21... in each number following next is

the sum of two preceding numbers. Moreover, his theory could lead us to the more understanding towards mathematic, nature and art. In the kingdom of plant, we might find many Fibonacci spirals almost everywhere such as leaf rosettes, sunflower, cones of cycads and seashell.

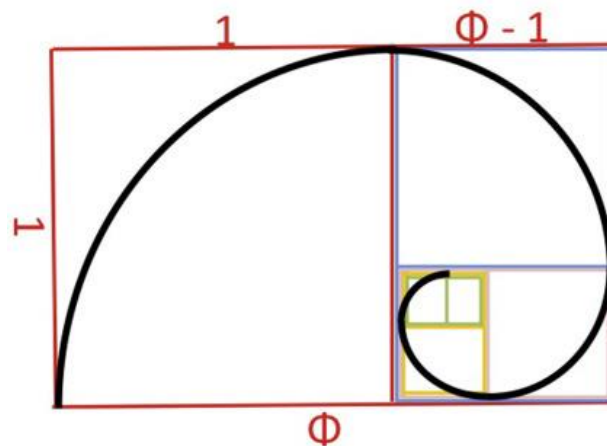


Figure 4 The picture shows the Fibonacci spiral or Golden section

“Regarding the question of why we find flowers so beautiful we have realized at the outset that with the problem of psychology of perception of esthetical sensations of humans natural sciences do not help us. Similarly, while it is so easy to scientifically describe the Golden section in mathematical terms, to perform it with ruler and compass and to show how we find it realized in nature, it is impossible to explain why we find it so beautiful. Natural science does not provide an answer to this question. The esthetical impression of the Golden Angle on humans we cannot explain by the biological evolution of man. How has the evolution of our behavior led to the selection of a sensation of beauty of this universal principle of optimization? Are these the pleasant sensations elicited by different stimuli to which our brain is adapted?” (Wilson, 2002).

“asymmetry, symmetry and continuous topological transformation from simple to complex are the three fundamental patterns of processes, and that asymmetry and symmetry represent a primordial opposition accounting for creativity in nature as well as in art”. (Sabelli et al, 2010).

Following the quote above, it seems asymmetry and symmetry are the important things which provide us the answer of beauty. Such as the artwork which created by Haekel, he created artwork in nineteenth century which inspired from animal that show on his drawing. He drew morphological symmetry for many thousands of animal species in several volumes, including an enormous number that display fivefold symmetry. (György, 2007)

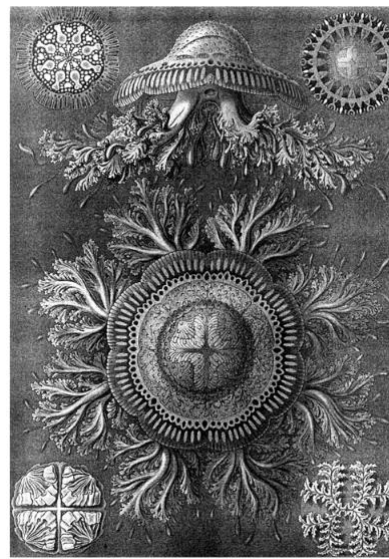


Figure 5 The picture shows the eightfold symmetry in the animal kingdom

Thus, the Haekel work show the symmetry of creature also the sequence number 2,3,5,8,13.... which match with Fibonacci number as well. If we utilize the benefit from studying nature, we will find that golden section always occurs in nature, for example a tree branches have their own structure which grow in different pattern but still balance themselves on the ground. The plant branching systems can be categorized in 2 ways by analyze the branches.

2.2.1 Golden Section in Branching

(1) Single-axis patterns: for example, pine trees which have six or more branches, the angle between the main stem and each branch is close to 34.4° which is the golden section of 90° . The angle of the branches makes the tree can absorb the light and useful for photosynthesis (Lanling, & Guozhao, 2009)

(2) Gather-axis pattern: such as pear tree, it is 2-5 branches which mature tree produces and make its different from pine tree since the main stem and branches 'angle is not random. That's why the pear's branches have growth more balance than pine trees.

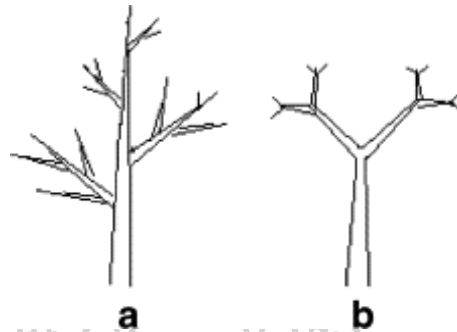


Figure 6 The illustrations of (a) Single-axis pattern. (b) Gather-axis pattern

2.2.2 Golden Section in Leaves

Leaves has beautiful arrangement by nature which relate to golden section. Leaf has two growth direction; first, the angle between needles and the stem is 55.6° and second, the angle between the main venation and branches is 34.4° . From 100 of needle pairs, 84 pairs satisfy this golden section (Lanling, & Guozhao, 2009).

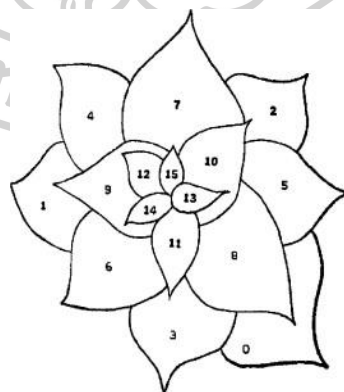


Figure 7 The illustrations of leaves pair which show the growth in golden section

2.3 How proportion from Fibonacci and golden section make the artwork looks perfect

The golden section begins with Fibonacci spiral and continually repeats from small to big square. If we analyze the shape of seashell and apply golden section into them, we will get the result as a perfect proportion.

György Doczi (2011) said “The power of the golden section to create harmony arises from its unique capacity to unite different parts of a whole so that each preserves its own identity, and yet blends into greater pattern of single whole.”

However, not only plants like sunflower or pine cone share the same spiral growth pattern but animal like fish also share the relationship with the golden section.

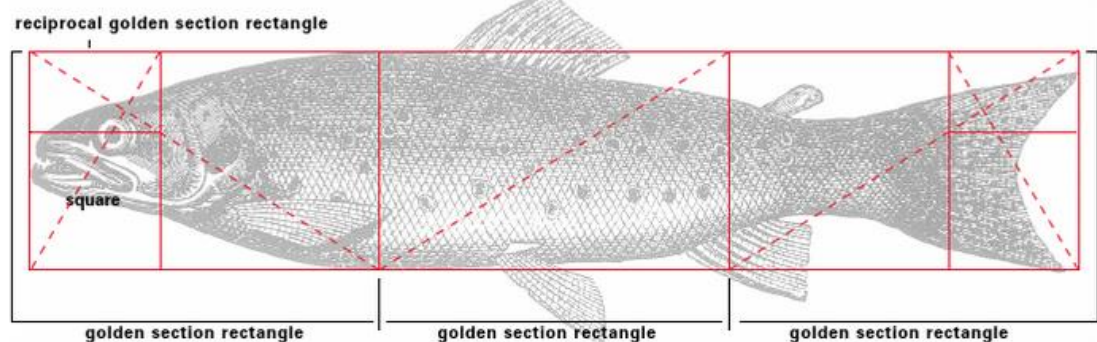


Figure 8 The illustration shows the picture of the trout that fit into three golden section rectangles

Following the fig.8 above, you can analyze the proportion of a fish by use 3 golden section rectangles in the picture. It seems like fish physically looks perfect and fit with the grids. However, from nature to art, Fibonacci number or golden section helps artist and designer to understand proportion of works since the golden section was applied to use in the picture. Viewer could notice the relationship that was created between proportion and harmony in the picture.

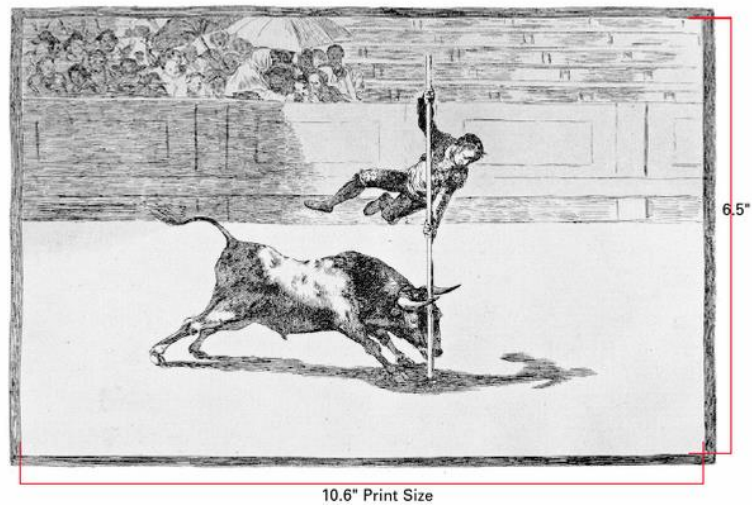


Figure 9 The picture of Goya by aquatint etching technique which show the golden section composition in the visual art

If we examine the picture of Goya, we will also find the golden section which match to the torador and the bull in the picture. Goya was a well-known artist who studied the golden section and applied it into his work by creating perfect proportion portrait.

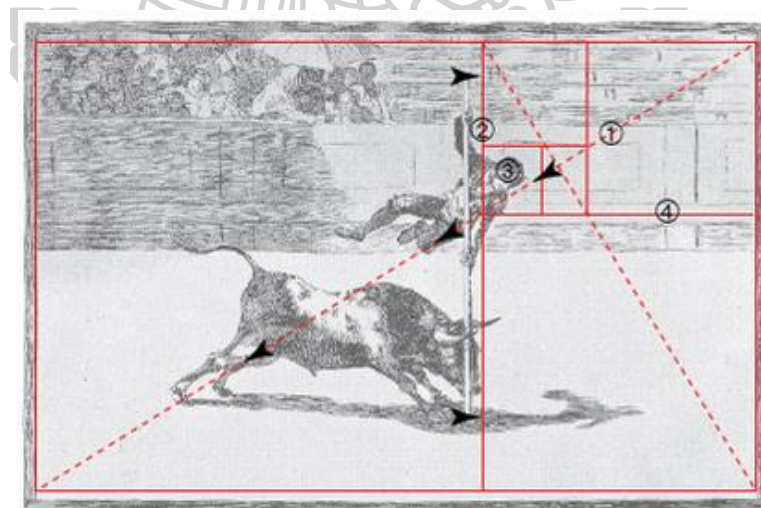


Figure 10 The golden section was applied in Goya's work

In addition, studies of Fibonacci and golden section could lead us to create better artwork by creating pictures that are more symmetry and harmony.

Referring to the review of Harold J. McWhinnie about golden section and dynamic symmetry in contemporary art, his work explored the relationship between art and science in twentieth-century art and design. By reviewing works from American artists from 1920 to the present which influence by golden section and dynamic symmetry.

The work was called 'Concerning the spiritual in Art', created by Kandinsky who introduced questions about art, symmetry and geometry into production of abstract works (Harold,1986, page 241). In an essay, "The Golden Section and Human Evolution" by David Fensom, he had analyzed the ancient Greek geometric system of proportion known as the its innately satisfying qualities. (Harold, 1986). American design theorist named Jay Hambidge had also introduced his theory of art and design, which he called 'dynamic symmetry'. It was a theory that he analyzed from Greek art and architecture. His theory was famous in art and design education from 1920 to 1940. Moreover, one doctoral study completed in 1970s had given a point of view of dynamic symmetry theories. E. Walter had explored the interrelationships between Cubism, the Golden Section and Hambidge's formulation of dynamic symmetry. She had studied particular ways, in which the Golden Section, the logarithmic spiral and the Fibonacci series of number related to structure of the fifth-century classical Greek art and architecture. By investigating the twentieth-century art history, she had examined the influence of Hambidge's on American art. (Harold, 1986)

One case study came from students who directly studied Hambidge. It was said that dynamic symmetry and golden section had been used in at least 3 ways in visual arts; method of pure abstraction, underlying means of visual composition and mode of cubistic abstraction with figurative images. (Harold, 1986).

Fibonacci Sequence

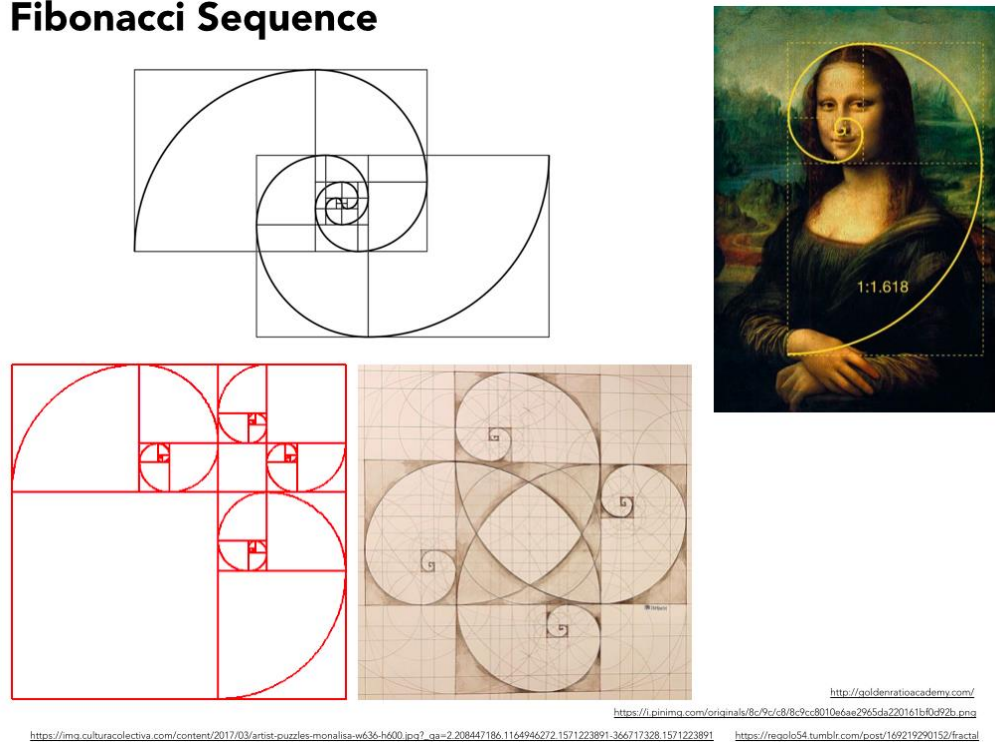


Figure 11 The golden ratio or Fibonacci Sequence in Davinci's work

Da Vinci also derived the Golden Section, as we could see it through his paintings and sculptures. The Renaissance artist had applied this theory in *The Last Supper*, *Vitruvian Man* and *the Mona Lisa*. Apart from Da Vinci, other artist such as Michelangelo, Raphael, Rembrandt, Seurat and Salvador Dali also applied the theory in their work as well. (J. Hom, 2013)

2.4 L-system

In 1968, Aristid Lindensmayer had introduced L-system, a theory adapted to used in modeling of growth phenomena which came from studying mathematical formalism for parallel grammars. Also, in 1984, the researcher named Alvy Ray Smith had pointed out the relationship between concept of Fractals and L-systems which could be used to synthesize realistic image. In addition, it can generate cell growth, geometric patterns and plants with or without inflorescence. In short, L-systems are a specific sort of symbolic dynamic system with the addition of a geometric interpretation of the system's evolution. Created in 1968, Aristid Lidenmayer had created L-systems

in order to model biological growth. Extraordinary fractals can also be the restricting geometry of even simple structures (Mishra, Jibitesh, & Mishra, 2007).

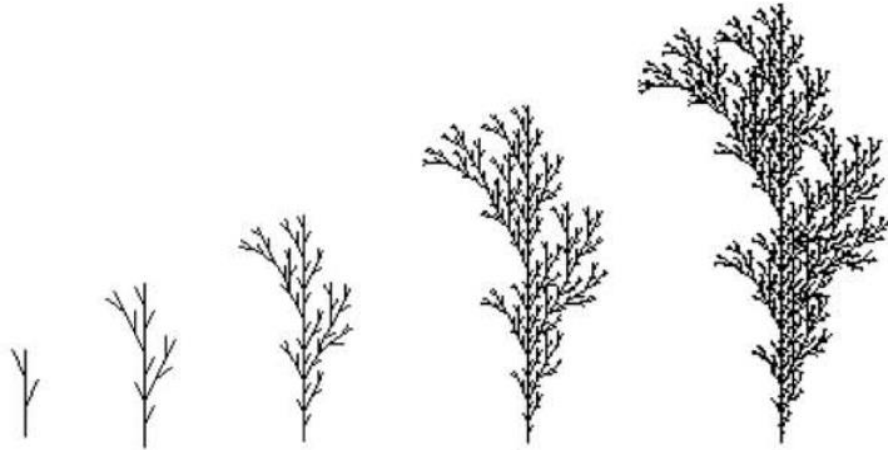


Figure 12 The fractals of plant which use L-system to be generated

On the other hand, L-system can be used to generate geometric shapes and algorithms. The use of fitness function had based on present evolutionary hypotheses about variables that had biggest impact on plant evolution. Unlike plant, visually appealing numbers were also acquired when using fitness-functioning genetic algorithm that promotes bilateral symmetric structure.

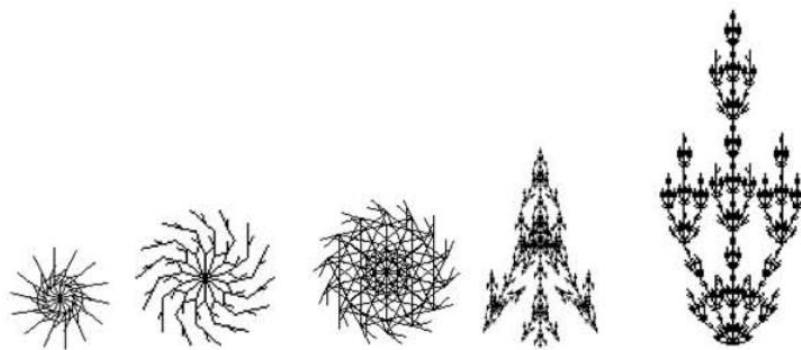


Figure 13 The figure using Genetic algorithm

L-system and case studies

Looking back in the history, plant modeling has the captivating attraction of reproducing nature's visual beauty while offering insights into how nature operates. This interplay between science and art is well rooted in history and can be traced back to Leonardo da Vinci (1970), who in mathematical terms described his observations of plant composition as a painting guide (Acta, 2004). According to, numerous surveys and notes on trees and plants had represented the deep interest of Leonardo da Vinci, particularly after 1502, in botanical subjects and metaphors. At the same time, the drawing showed the universalizing, geometric concerns of Leonardo that raised from classical and intellectual issues. This includes Leonardo's adjustment of empirical evidence in search of perfection in his topic to a mathematical ideal. With the primary branch fanning in an idealizing, graceful curve, circular rhythms had repeated across the square sheet. Berries appeared as frequently patterned, ideal solids: as perfect bodies within spheres, reminiscent of early modern research into the representation of complicated, crystalline solids using the concepts of harmonious proportions in the natural world of Euclid and Luca Pacioli (Catherine, 2014).



Figure 14 Leonardo da Vinci, *Studies of Brambles* (with details), red chalk and white heightening on prepared paper, c. 1505-10, Windsor, Royal Library 12419

Studying from Leonardo da Vinci's works, they show several patterns that could inspired artists. By studying nature by themselves without L-system principle, it had been connected with each element naturally for instance the study of shapes and mathematical characteristics of the Flower of Life. Davinci had drawn the Flower of Life on his own, as well as different elements like the Seed of Life. He drew geometric figures representing forms such as platonic solids, a sphere, a torus, etc., and used them in his artwork, the golden ratio of phi; all of which can be derived from the design of the Flower of Life.

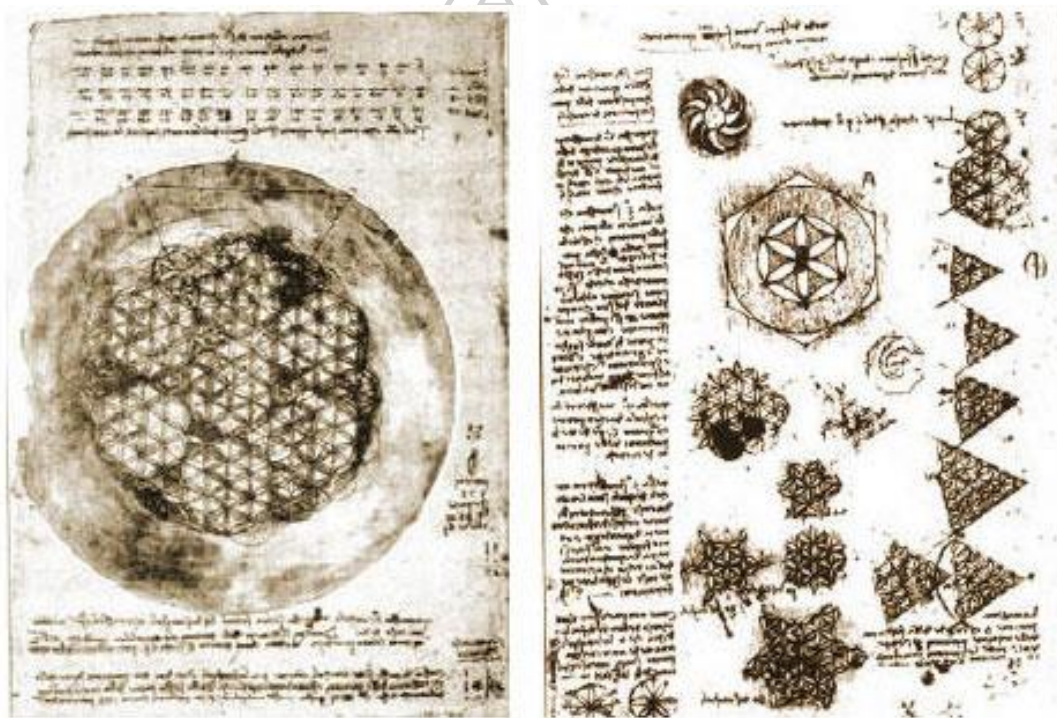


Figure 15 Flower of life by Leonardo da Vinci which has similarity with L-system algorithm

Technically, the research areas mainly focus about leaf, tree and nature. Therefore, L-system was applied as a fundamental knowledge to understand on how plants grow. By analyzing trees branches and leaf veins, it made researcher comprehend more about the nature system and could apply it to use in the next state of design area.

2.5 Biomimicry

The word biomimicry consists of two Greek words bios, means life, and mimesis, means imitation. It is an innovation technique that seeks to provide viable solutions to human issues in a multitude of fields such as the production of new products, manufacturing procedures, construction, and new product creation by copying or adapting and using thoughts from nature. Therefore, logic behind biomimicry is quite simple. For over 3.8 billion years, animal and plant in the planet have adjusted and survived. Despite facing fundamental and similar difficulties the human race, we can certainly learn from the track record of adaptation in our fight for water, food, space and shelter, and not only incorrectly to bring this natural know-how into science fields to enhance the quality of life, but also to develop methods of supplying it (Cohen, 2019). Biomimicry is a useful instrument for generating more sustainable products and methods-and, more importantly, for adapting to climate change because nature generates habitats where each organism is tailored to its location and circumstances. As habitat conditions changed, organisms are continually evolving and evolving in synch to survive (Priesnitz, 2012). According to the research which combine the principle of biomimicry in visual communication design, many case studies had showed the benefit of biomimicry that could be able to solve problems and create innovation in many ways for examples, like all cephalopods, squids can glow (bioluminescence) as well as change their skin color. This camouflaging ability allows them to hide from predators while the bioluminescence allows them to interact with and/or attract a mate. This complicated conduct is generated by a network of specific skin cells and muscles. (<https://www.digitaltrends.com/cool-tech/biomimicry-examples/>)



Figure 16 The camouflaging ability was used to design for soldier clothes

Another interesting case study is the way human imitate animal function like whale. A study group led by Harvard University determined that these nodules allow the whales to choose a steeper "angle of assault." The angle of attack is the angle between the stream of water and the face of the flipper. For the Humpback whales, this angle of assault can be up to 40 percent steeper than a soft flipper. Sectional stalls happen at distinct points along the end due to these tiny ridges. This makes it much simpler to prevent a complete on stall. Moreover, the U.S. Navy had done some experiments using model flippers. Naval Academy demonstrated that these biomimetic fins lowered drag by nearly third and enhanced general lift by 8 percent. Whale Power, a Toronto-based corporation, had already capitalized on this recent tubercle tech. According to MIT, the biomimetic blades of Whale Power assistance produce the "same quantity of energy at 10 miles per hour while standard turbines produce only 17 miles per hour." (<https://www.digitaltrends.com/cool-tech/biomimicry-examples/>).



Figure 17 Wind turbines modeled after Humpback whales
(<https://www.digitaltrends.com/cool-tech/biomimicry-examples/>)

Why do we mimic natural patterns in the built environment? Human have learnt from nature for a long time. We have explored, observed and navigated the advantages from nature because human do not have ability to survive alone in this world. Some species are stronger than us and more capable of adapting themselves with the surrounded environment. That is why human need to respect and cherish the mother of nature. In the research, it aims at learning about nature especially on leaves which connect to the forest and nature. A leaf contains a lot of hidden information

that nature provides us to explore the appeared elements on it. Leaf vein is a good example that we notice using visual element. If we carefully inspect leaf vein, we will find system which look so much like a map leading us to the mystery of forest. The system which appear on leaf vein is unique and difference so the research attempt to decode and mimic that information and apply that information in the illustration. The main purpose of mimicking leaf vein system to use in communication pattern design because we expect the different results gaining from new knowledge to the art and design area especially on illustration.



Figure 18 The studying leaf vein could lead us to the map and space

Therefore, studying the nature maybe an answer that makes us understand ourselves and creates a better world.

2.6 Research Area: “Khao Nam Khang National Park”

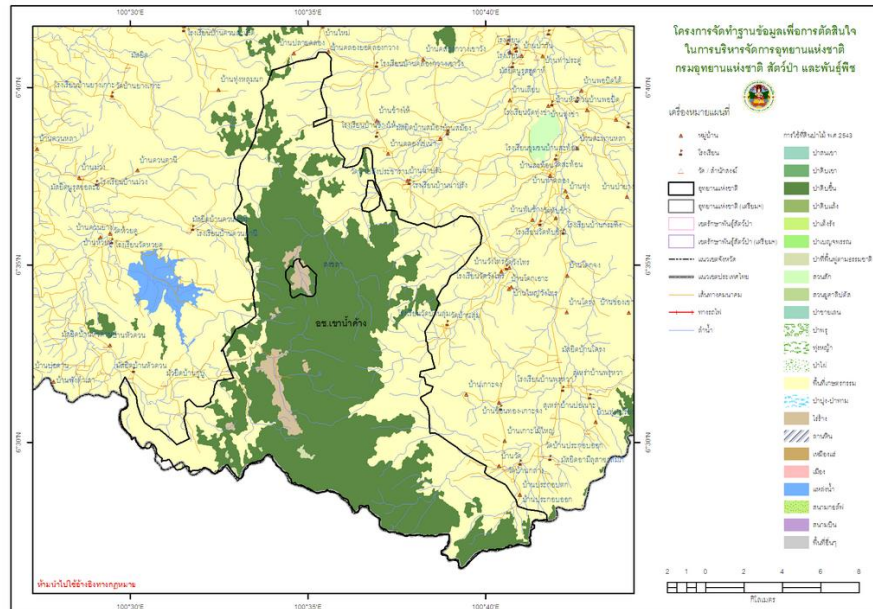


Figure 19 The map shows the area of Khao Nam Khang National Park

Meaning of Khao Nam Khang

First known in the local language as "Khao Nam Khang", the national park was known as the Namkhang National Park, which implies to Namkhang Mountain. "Khao" means mountain from this mountain's name, and in English "Namkhang" means dew. From the initial legend, it was told that the Namkhang Mountain hill top temperature is quite low throughout the year. People who climbed up to the mountain top in the old days said they tended to discover a web like dew on grass even at night. It was named after the natural beauty of its own as the Namkhang Mountain gives a distinct and fascinating landscape of the mountain. The Namkhang Mountain was later proclaimed as "Namkhang National Park" in 1991 (2534 B.E.). It was Thailand's 65th National Park with 212 square kilometers. (http://park.dnp.go.th/visitor/nationparkshow.php?PTA_CODE=1065)

Flora and fauna

National Park of Namkhang is fertile rain forest, crops and biological diversity. Various plant species are established in the national park such as Hlumpa, Iron Wood, Meranti, Mesawa, Orange Champak, Bullet Wood, Mangifera Caloneura Kurz, Rattan, Bamboo, Orchid, Fern and Moss. It has also been reported various animal species in Namkhang National Park as well i.e. boar, bear, gibbon, tortoise, barking deer, 43 chamois, tapir, panther, mouse deer, palm civet, lizard, hornbills, pheasant, arborophila, peacock, mountain myna and magpie. (http://park.dnp.go.th/visitor/nationparkshow.php?PTA_CODE=1065)

Climate

Like most parts of the area, annual climate in Namkhang National Park is affected by the Northeastern and Southwestern monsoons resulting in elevated precipitation levels. Rainy season usually lasts for 9 months (May-January) and summer lasts for only 3 months (February-April):

Geography

A rugged mountain range stretches from Thailand to Malaysia border. The most significant peaks include Khuan Saya and Khuan Khao Mai. The highest peak of Khao Nam Khang is 710 meters above mean sea level. The watershed feeds many streams such as Khlong Na Thawi, Khlong Prik, Khlong Thap Chang and Khlong Sai Khao. (http://park.dnp.go.th/visitor/nationparkshow.php?PTA_CODE=1065)

2.7 Forest and Deforestation

When we think about the forest, we might imagine a quiet, cold and scent of fresh green leaf area covering with tons of big trees. There are some green, orange, yellow and brown colors in different area of the forest around the world. The mysterious place is full of hidden plants, birds, animals and small insects. They are all living in the forest made us curious about nature. When we walk through the forest, we can perceive the smell of fresh air from the atmosphere, sound of insect and birds combining with the sound of the waterfall. By sitting on a rock, observing green ferns and looking at the ground, we can see plenty of falling leaves. We realize how small we are and how trees can heal our soul and make our mind calm.

Forest had created surrounded environment and provided us shelter, food and oxygen for human for a long time. Moreover, forest is the main part of the ecosystem and biodiversity where a large number of animals and birds live. In fact, the forest area provides us with livelihood and food supply. Like other studies, they suggest that forest and trees may provide 20 percent of income for rural households in developing countries. It seems that forest provides a lot of benefit not only for animals but also for human and all living things. The green area supplies a lot of oxygen which human need and absorb the carbon dioxide to make the air clean. It is like a big lung of the world which never require anything from human. It seems like forest gives a lot of advantages to human than harm. However, natural disasters seem to happen more frequently.

At present, deforestation occurs all over the world in other words it seems like the problem continually occur continuously every day. In fact, if we examine the number of the forest in the world, we will realize that we got only 30% forest area cover the earth. According to the analysis from World Bank, the world lost 1.3 million square kilometers of forest between 1990 and 2016. The lost area was considered to be larger than south Africa (Cristina, 2019). There are various causes of deforestation, some of which are farming, agriculture and mining. In Indonesia and Malaysia, the most typical cause of deforestation comes from palm tree plantation. Moreover, the urbanization is a major reason for deforestation as well. The quicker and larger a city becomes; the faster rate of deforestation will be. Losing forest area is one thing, however, losing green space in the neighboring area should bring up to the consideration as well. Forest is a lung for the city. Once we lose green area, it means we lose the oxygen plant for our lives. It seems like forest and urbanization stay in an opposite opposition especially when technology dominates human life. However, we should have some hope that we as a small element can protect our own green area. In Paris climate agreement 2016, there is an agreement which help promoting forest conservation and decreasing deforestation around the world. The goals of the agreement are to set up net-zero emission and reduce deforestation. We can said that the agreement is light at the end of the tunnel, which save out forest and our world. (Deforestation and Climatechange,2019)

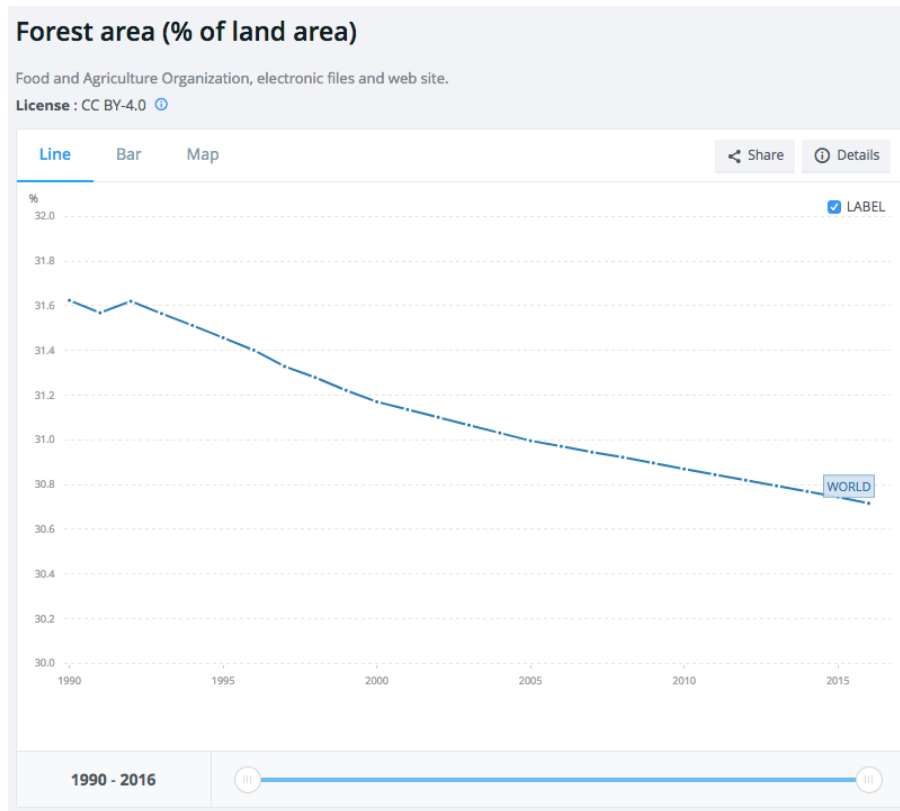


Figure 20 The diagram shows the forest area from 1990 – 2016
(<https://data.worldbank.org/indicator/AG.LND.FRST.ZS?end=2016&start=1990>)

World Bank Group for developing nations is one of the world's biggest sources of financing and expertise. Referring to the objectives of the organization, it has stated that it aims to share a dedication to poverty reduction, increase shared prosperity, and encourage sustainable development. (<https://www.worldbank.org/en/who-we-are>)

It was examined that forest area had kept declining continuously from 1990 to 2016 owing to deforestation. Moreover, it was found out that deforestation was considered to be second major cause of climate change and accounted for almost 20 percent of all greenhouse gas emission.

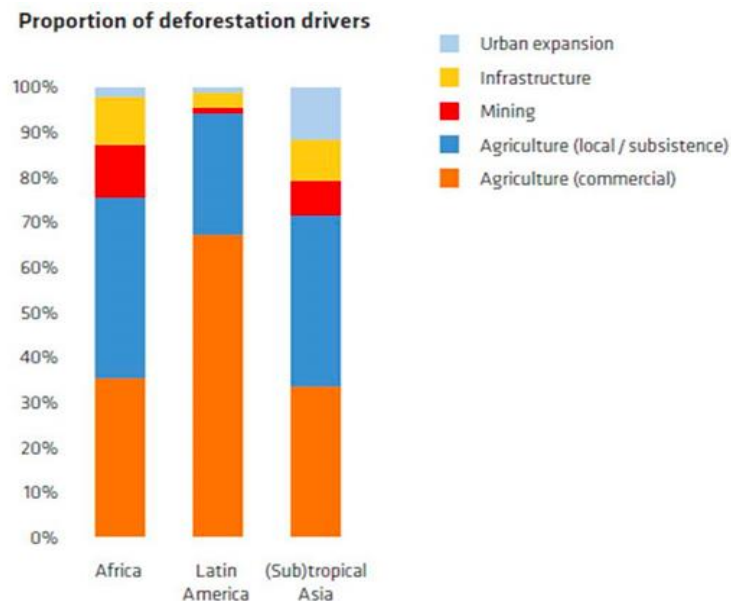


Figure 21 Proportion of deforestation drivers

(<http://blogs.worldbank.org/climatechange/save-forests-think-beyond-trees>)

On the other hand, if we carefully investigate on the causes that destroy forest area the most, the result, somehow, shows that agriculture from both commercial and local/subsistence is the main reason. At the same time, mining and the development of infrastructure do not consider as major reason like agricultural do. When consider town/urban expansion, Asia is the main factor on this attribute.

Climate Change Issue

Result of deforestation has affected the overall world temperature as it is the consequence of natural disaster such as flooding, landslide and damaged agricultural crops.

According to United Nations Climate Action Summit 2019 in New York, President Donald Trump had met up with the youngest protestor Greta Thunberg who built up environment protests. Thunberg has asked for cooperation from young people around the world. She also criticized the restricted expectations at the summit, claiming that none of the countries' proposals are in line with the rate of reduction necessary to restrict warming to 1.5 degrees Celsius. The more ambitious goal of the Paris Climate Agreement. Countries like Germany has suggested a reduction in coal reliance, the introduction of more renewable energy and support for warming

adaptation. However, Thunberg said they don't move the needle far enough and fast enough when comparing to the rate of global warming and climate change. (<https://www.vox.com/2019/9/23/20879924/greta-thunberg-climate-action-summit-2019-un>) The movement occurs all over the world to protest and evoke government concern about climate change issue.

In addition, the information from United Nations Development Programme (UNDP) has regarded that climate change effect happens in many countries around the world include Thailand. Climate change has direct impact on Thailand's food export and agricultural products, which is one of the country's main sources of income.

We all know that agriculture is the main source of income for poor farmers in the country. Therefore, climate change has tremendous impact on individual farmer and has exacerbated the issue of poverty. (file:///C:/Users/PC/Desktop/case_study_2.pdf)

Fortunately, the late King Bhumibol Adulyadej (King Rama the 9th) has established the philosophy call 'The Sufficiency Economy Philosophy (SEP)' to help and support people.

The Sufficiency Economy Philosophy (SEP) originates from the development philosophy of the late King Bhumibol Adulyadej (Rama 9).

The SEP is built on three pillars:

- Moderation:** Sufficiency, manifested as not acting too little or too much at the expense of oneself or others. For example, producing and consuming at a moderate level.
- Reasonableness:** The decision concerning the level of sufficiency must be made rationally, with consideration of the factors involved and careful anticipation of the outcomes that may be expected from such action.
- Risk Management:** Preparing to cope with the likely impact and changes in various aspects by considering the possibility of future situations.

His Majesty King Bhumibol initiated the New Theory of Agriculture (NTA), which is the clearest application of SEP, to help Thai farmers build resilience against economic crisis and natural disasters. NTA is a system of integrated and sustainable agriculture which aims to optimise farmland. It is apparent how both the SEP, particularly its applied NTA, supports the successful climate change adaptation processes of Thailand's agriculture sectors. Proposed adaptation actions include multi-cropping systems, diversified land-use, focus on households rather than commercialisation (mass production), and promotion of resilient seed varieties.

Figure 22 SEP Philosophy by King Bhumibol Adulyadej (Rama9)

The SEP is created on 3 main pillars: Moderate, Reasonableness, Risk Management.

Moderate

Sufficiency manifested an action that is not too much or too frugal. It can be achieved by producing and consuming at moderate level.

Reasonableness

The decision on the level of sufficiency must be made in a rational manner, taking into account the factors involved and carefully anticipating expected results.

Risk Management

Risk management is how to prepare for the predicted impact and changes in different aspects by considering potential and possibility of future situation.

SEP Philosophy helps Thai farmers build resilience to natural disasters and economic crises. NTA is an integrated and sustainable farming system aimed at optimizing farmland.

It is apparent how both the SEP supports the successful climate change adaptation processes of Thailand's agricultural sectors, particularly applied NTA. The proposed adaptation measures include multi-cropping systems.

How we engage in the mysteries of the forest when we become more remote

The sound of car horn, passing trains, shouting people, are what we hear every day in big cities. Moreover, we also smell the smoke of car, cigarette, air pollution that surround us wherever we walk pass by. Those are the elements of city where people get familiar with. With that reason, the problem is how we stay connect with nature despite our busy lifestyle. With that reason, how we engage with green space when we become more and more remote from nature.

Living in the big city with chaos and pollution makes our life becoming stress and unhealthy. That's not the reason making us concern about green area and climate change. The important reason that people concern most about forest is so significant to our life. Moreover, when we were affected from climate change such as flooding, earthquake and haze. At the same time, pollution also raise awareness about the important of forest among people. There is a case study area where remote from the

city in the south of Thailand calls 'Khao Nam Khang'. The national park has diversity of flora and fauna. The rainforest, 'Khao Nam Khang National Park' is located in Songkhla province, Thailand. The national park covers over 220 square kilometers of the suburb in the south of Thailand and far away from the city. There is diversity of plants which included economic plants and conserved plants. The forest has produced huge quantity of oxygen in the area. The national park has a beautiful landscape which was abandoned from the outside world for more than 40 years since the world war II. It was where Chinese communist soldiers fight with Thai soldier resulting in the shutting down of the area. After the long period of war finished, Thai government could finally control the areas and announced 'Khao Nam Khang' to be national park of Thailand. The researcher had explored the areas of the national park area where environment is plentiful grown with biodiversity. The case study is a good studying area since it was closed for a long time and isolated from the world. Surrounded around Khao Nam Khang, there is a small village where people have been living for a long time. They respect the nature and believe in the spiritual of the trees in the local area of Thailand. Most of the local people are farmers and agriculturists. They plant rubbers tree and local plant around the forest. Some of them have a knowledge about herbs and they go to the forest to find the herb using to make the traditional medicines. The reason why people show their respect to the forest because the forest gives many advantages to them. Because they were born there. It could give an explanation to the local people who have deep relationship with nature more than people who live in the city. The relationship is so tight and grow in the roots of their culture.

On the other hand, people who live in the city do not have much chance to feel in the way people interact with the forest. In the city, although people are too busy with their life but we cannot live without nature. We still need green space to improve our well-being, health and mindfulness thus we attempt to engage the green space into houses, building and some small area of the city. In the case study, city of Melbourne is facing big issue about climate change and urban heating. So, they create the project called 'Urban forest strategy' aims to adapt the city to climate change and create healthier ecosystem to the city. The project involves engagement of community and people to improve the green space to the city. This project can be touchable and practical to the people in the physical ways. Another case study is in Singapore,

we might know that Singapore is a small land which is rich and have a lot of economic flow. Singapore has set up the program call ‘Greenery Incentive Scheme (SGIS)’ which has objective to encourage the installation of ski rise greenery on existing building across Singapore and create a distinctive image of the city in the tropical climate through extensive greenery adorning building façades and ski rise levels. All those case studies show that as far as human remote from the nature, it seems we attempt to bring the nature back to us as much as we can. (Skyrise Greenery Incentive Scheme 2.0, 2019)

2.8 The situation of forest in Thailand

อันดับร้อยละพื้นที่ป่าของประเทศไทย

ระดับโลก อันดับที่ 118 จาก 239 ประเทศ	ระดับภูมิภาคเอเชีย อันดับที่ 16 จาก 48 ประเทศ	ระดับภูมิภาคเอเชียตะวันออกเฉียงใต้ อันดับที่ 9 จาก 11 ประเทศ
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*ข้อมูลร้อยละพื้นที่ป่าจาก World Bank ปี 2558

ร้อยละพื้นที่ป่าไม้กับจำนวนประชากรไทย

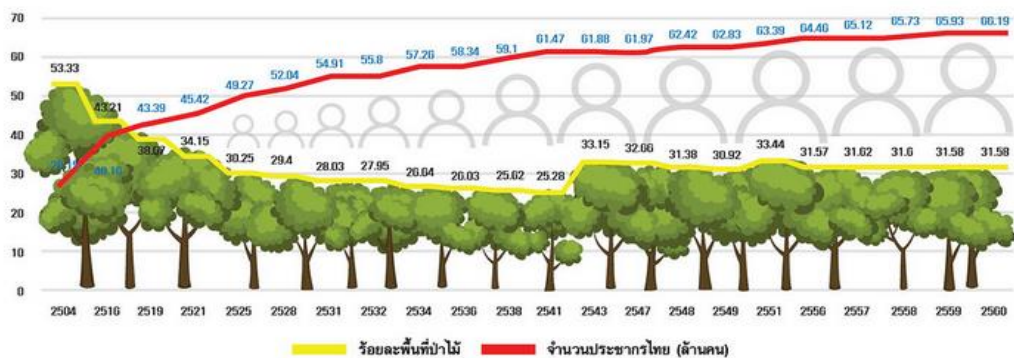


Figure 23 The amount of forest compares with population

About the deforestation situation in Thailand, following the report from Sueb Nakhasathien Foudation, it shows the information about number of forests compare with population. The diagram was used to illustrate the population rapidly grow up while the number of forests slightly dropped. The issues which effect the smaller number of forests come from the expanding of city, agriculture and manufacture industry.



Figure 24 The Picture shows percentage of Forest in Thailand and other countries

According to the report, forest area in Thailand rapidly decreased every year until the present. Today, Thailand has only 102.17 million sq. kilometers area of forest. If we examine the picture above, we may find out that the north of Thailand shares the biggest area of forest area if compare with other parts. In contrast, the number of forest area can guarantee about the abundance of forest. Today, Thai government attempts to create strategies which combine 6 main topics.

1. **Green sustainability:** build up the balance between natural resources and economy. The aim of green sustainability is to produce organic products without bad side effect to the environment.

2. **Blue sustainability:** recovery, clean up the beaches and sea area to become an eco-friendly area to marine life.

3. **Economic and weather:** reduce the emission of the green house gas and developing the ability to people in order to encounter with natural disasters.

4. **Developing rural areas, agriculture and green industry:** develop the green area and reduce the emission also support clean energy. Sustainability conserve the environment and local identity.

5. **Developing water resource, energy and green agriculture:** develop the clean energy and substantial food for people in the country.

6. **Paradigm shift and the future:** develop the tools and system to create better environment in the future.

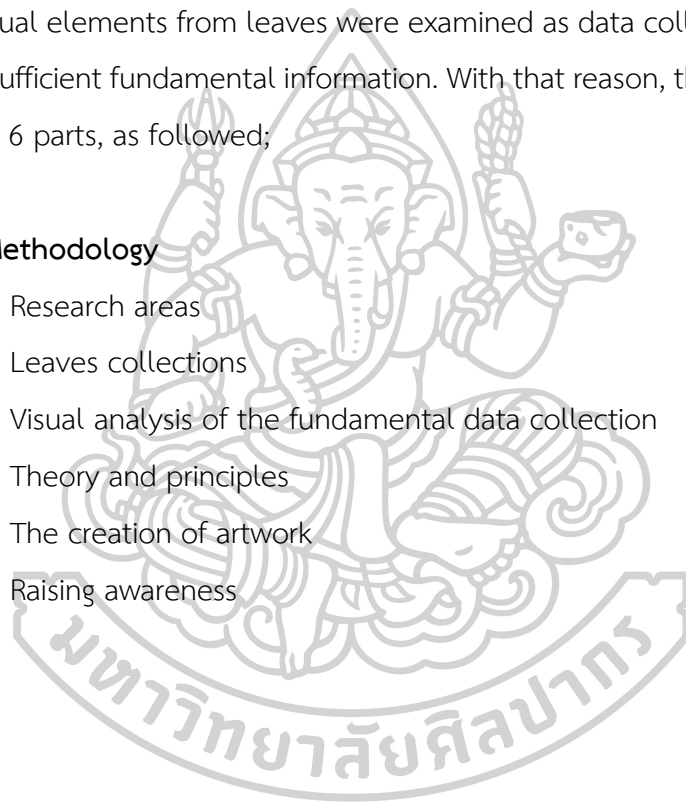
Chapter 3

Methodology and Processes

This part of the research mainly focuses on research methodology and processes. This chapter has investigated on visual elements from leaves and how to apply and develop them with Fibonacci and L – system in illustration design. With the attempt, visual elements from leaves were examined as data collection book in order to provide sufficient fundamental information. With that reason, the methodology was divided into 6 parts, as followed;

Methodology

1. Research areas
2. Leaves collections
3. Visual analysis of the fundamental data collection
4. Theory and principles
5. The creation of artwork
6. Raising awareness



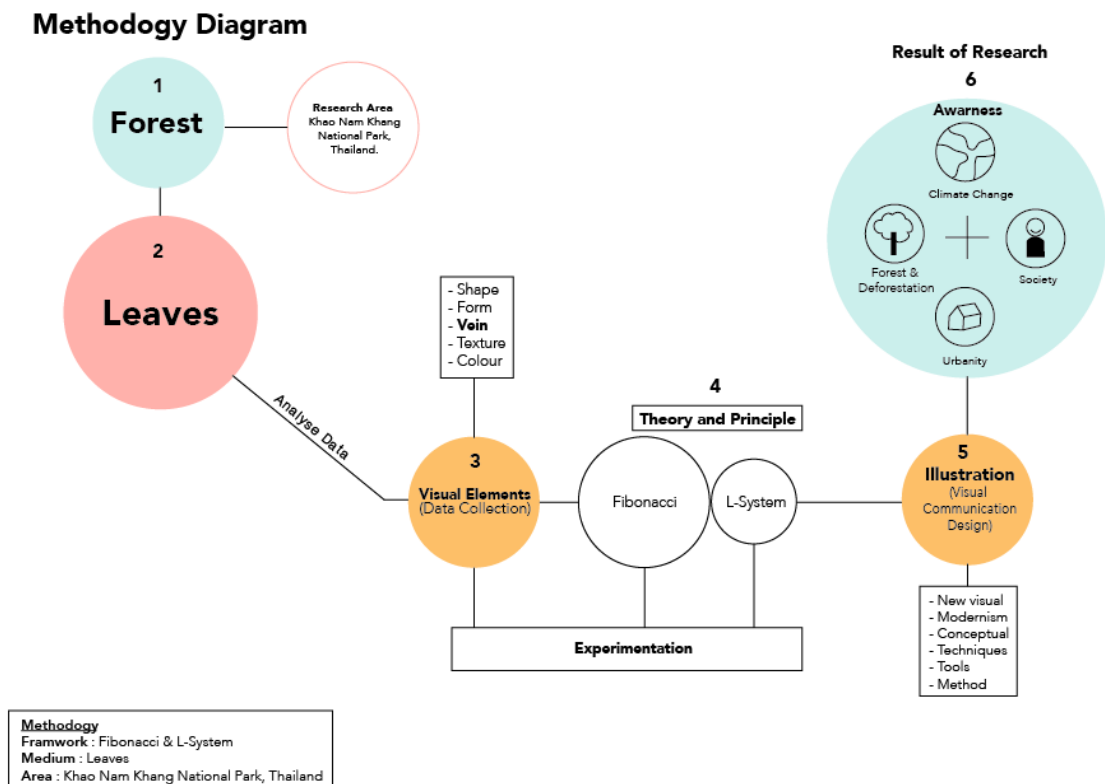


Figure 25 Research Methodology

3.1 Research areas and data collecting process

Referring to the research methodology, the research use practice base research to develop the ideas and employ it to create the final artwork. Moreover, practice Base Research also had many benefits to researchers who were experts in real practice. Because artwork can be applied from the creative work, the thesis will be experimented on artwork and design work. The research area had focused on Khao Nam Khang National Park, located in the south of Thailand. Since the national park was abandoned from the outside world for almost 40 years, the area has high diversity of flora and fauna. The researcher had done the survey and explored the national park with forest officers by trekking along the stream to note names of existing trees and collect leaves samples.

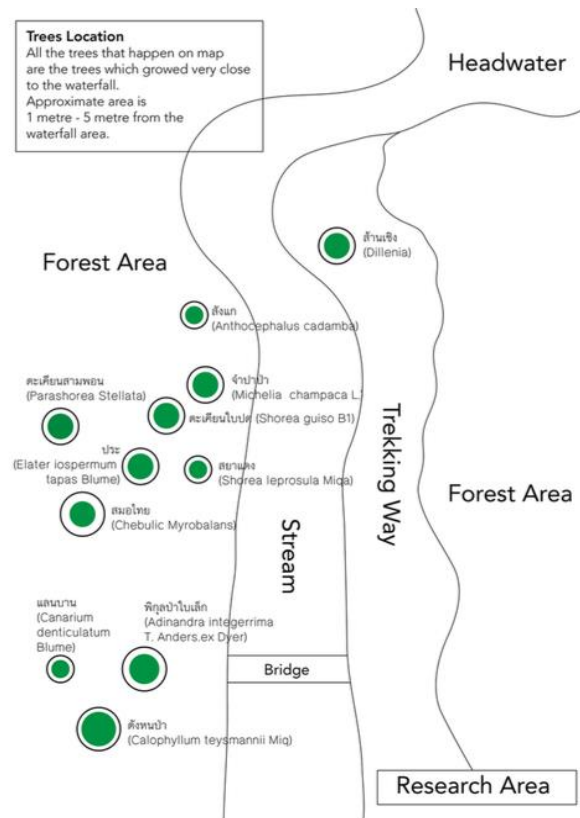


Figure 26 Tree's located in the forest area

The first approach of research methodology was to collect leaves along the stream bank randomly. According to the survey, the researcher had found plenty of economic trees in the area, such as Parashorea Stellata, Michelia Champaca L., Elater lospermum, Dilenia, Anthocephalus Cadamba, Shorea Leprosula Miqa, Calophyllum Teysmanii Mig, Adinandra Integerrima T. Anders.ex Dyer, Canarium Denticulatum Blume, Chebulic Myrobalans, Shorea Guiso.

Economic Plants and Conserved Planted
 Khao Nam Khang National Park,
 Songkhla, Thailand.

11 Types of Tree in tropical rain forest.



Figure 27 The pictures of economic trees which grow close to the stream

The researcher has focused on the collected leaves in the national park and separated into 2 groups as followed;

1. Rainy leaves
2. Summer leaves

Rainy leaves

According to the collected data of rainy leaves, detail of the leaves can be analyzed referring to their colors, shapes, leaf stalks, veins and textures. During rainy season in the south of Thailand, the forest normally turns green, water level of the stream gets higher and the overall temperature of the national park area gets lower and more humid. Photographs of leaves below also represent fancy imagination of leaves in a very impressive pattern.



Figure 28 Leaves collection from Rainy season

Summer leaves

As summer approaches, some trees in the national park turn brown or warm color. Owing to the location of Khao Nam Khang national park, which was categorized as a tropical rain forest, the environment is pretty wet and maintains high humidity. Somehow, hot color tree leaves can be found. In this case, if we compare these 2 leaves collections, we will find visual elements of tree leaves in different style



Figure 29 Leaves collection from Summer season

According to the analysis of visual elements from leaves in each collection, the researcher attempts to pursue research methodology strictly. The methods are as followed;

1. Randomly collect leaves along the river bank by considering from shapes, colors, textures and veins.
2. Take photographs of each leaf using light box as to examine pattern and detail appearing on the surface
3. Analyze visual elements of leaves and apply Photoshop program and Illustrator program in order to dissect them
4. Gather all information of the data collection in a book

3.2 Visual Element

The next step coming after photography part was the analysis of visual elements that appear on leaves and its data collection. The data collection book has categorized visual elements of leaves in 4 different groups based on their shape, branch, vein, angle, texture and color. Owing to visual element presentation, graphic was adopted to make the clear statement toward the research in the design area.

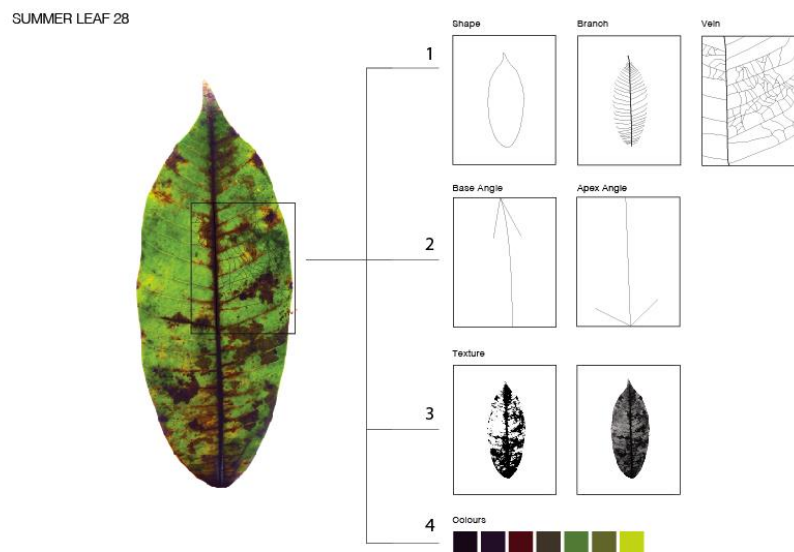


Figure 30 Visual elements which analyzed and present as data collection

According to the stated data above, it shows the process of deconstruction visual elements that occur on leaf. Details of each leaf can be identified as below;

1. No.1 in the first line presents 3 different elements include; shape, branch and vein.

2. No.2 shows leaf stalk angles include; base angle on top of the leaf and apex angle on the bottom of the leaf.

3. No.3 shows texture of the leaf by using Photoshop program to analyze the elements in detail.

4. No.4 presents color theme deriving from a leaf.



Figure 31 The picture shows the processes of deconstruction the leaf's vein

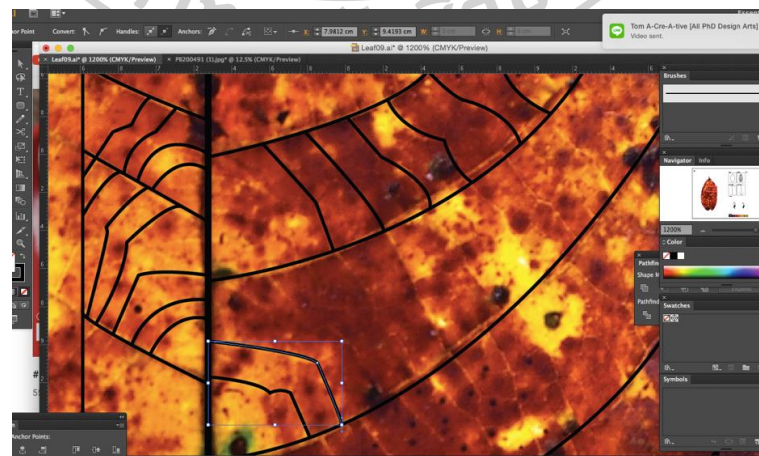


Figure 32 The illustration shows the process how to decode the leaf's vein by using Photoshop program

The next step of the research mainly focuses on data experimentation in order to create suitable narrative story without applying further theories. The research tries to adopt pure data from the collection to draw 2 different stories, which inspire from rainy and summer season in Khao Nam Khang national park.

3.3 Experimentation method

The experimentation venture to use biomimicry principle to metaphor between landscape and leaf's vein which looks similar. The design process aims to use visual elements as a map that conveys the story in the forest in different seasons.

Rainy season

After conducting visual element on leaves during rainy season, it was found out that the leaf itself shows delicate lines which look so much like a small stream in the research area. Hence, the illustrations are employed to narrate the story of water, diversity and landscape of Kao Nam Khang National Park. Visual element of veins can be used as a metaphor of wet land like rivers or streams while ponds represent environmental circumstance of forest.

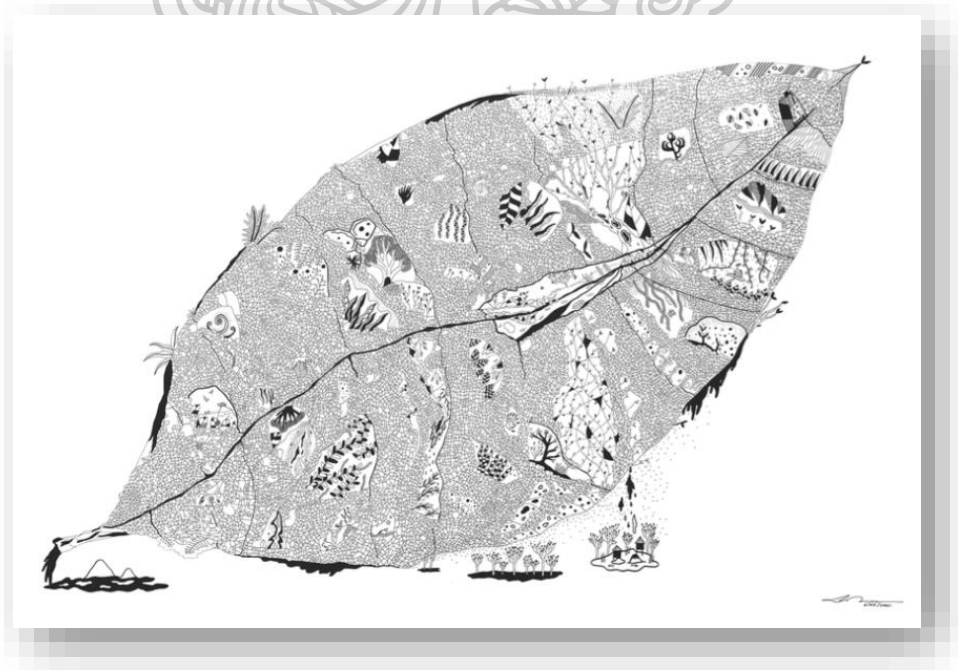


Figure 33 The picture presents the illustration which created from visual elements in data collection

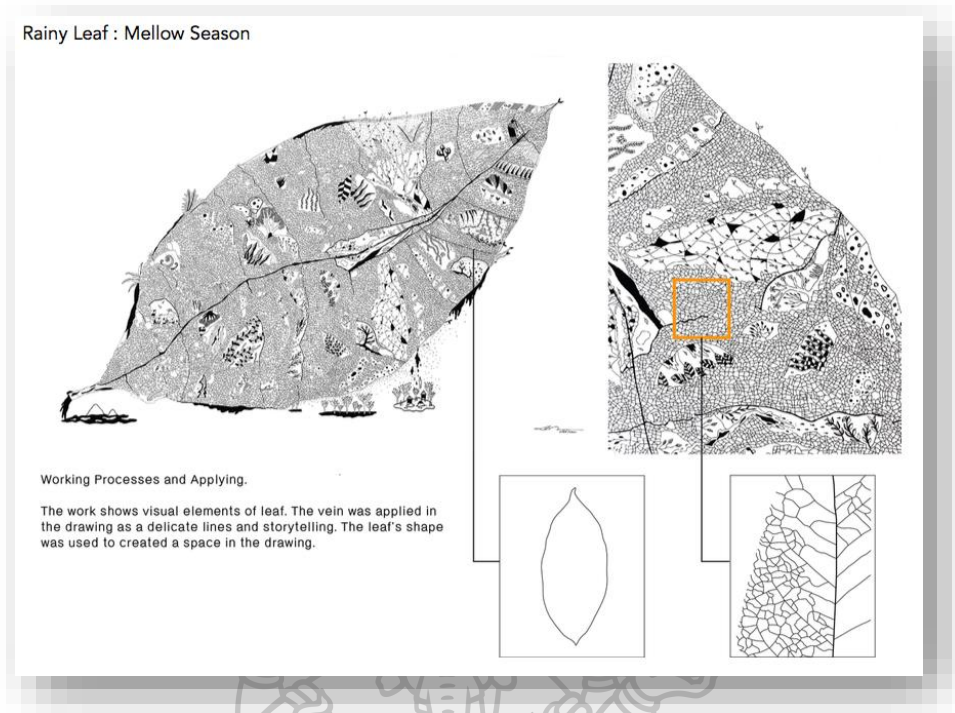


Figure 34 The illustration used the data and applied in the details of artwork which represent the story about rainy season

Summer season

June to April is considered to be summer in the south of Thailand. During the season, all flowers bloom and variety kinds of insect such as dragonfly, butterfly and bees can be spotted while they are indulging with flowers. According to the illustration, it represents the atmosphere of the forest during summer time. Visual elements are applied in different patterns if we carefully examine the works in detail. This illustration also includes elements of fine lines and uncomplicated elements combined with flower's elements.

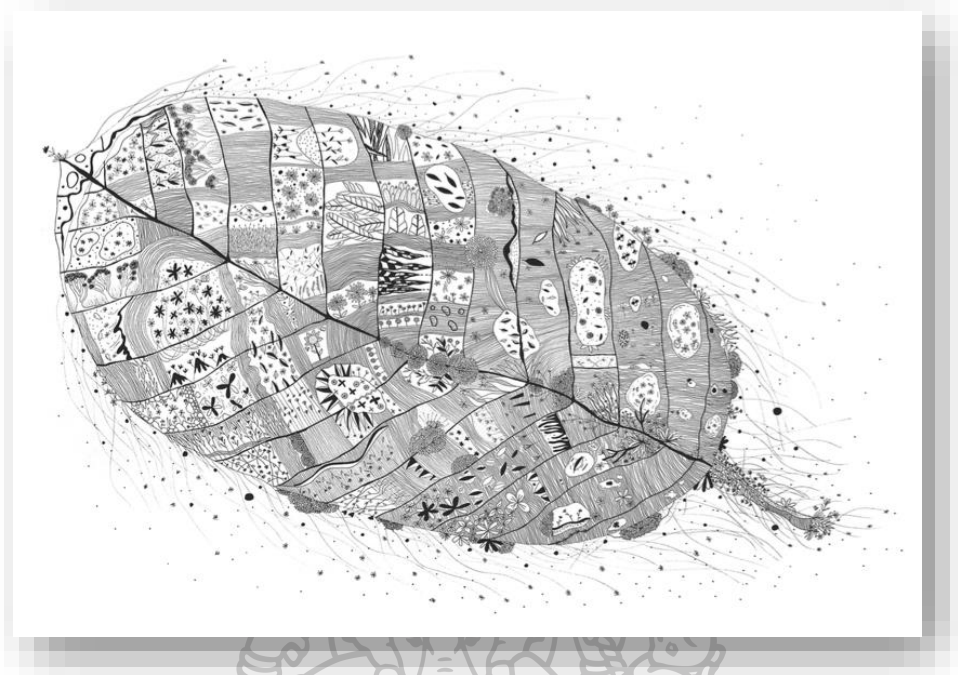


Figure 35 The illustration shows the visual elements which represent the atmosphere of summer season inspired from flowers, insect and flower's pollens

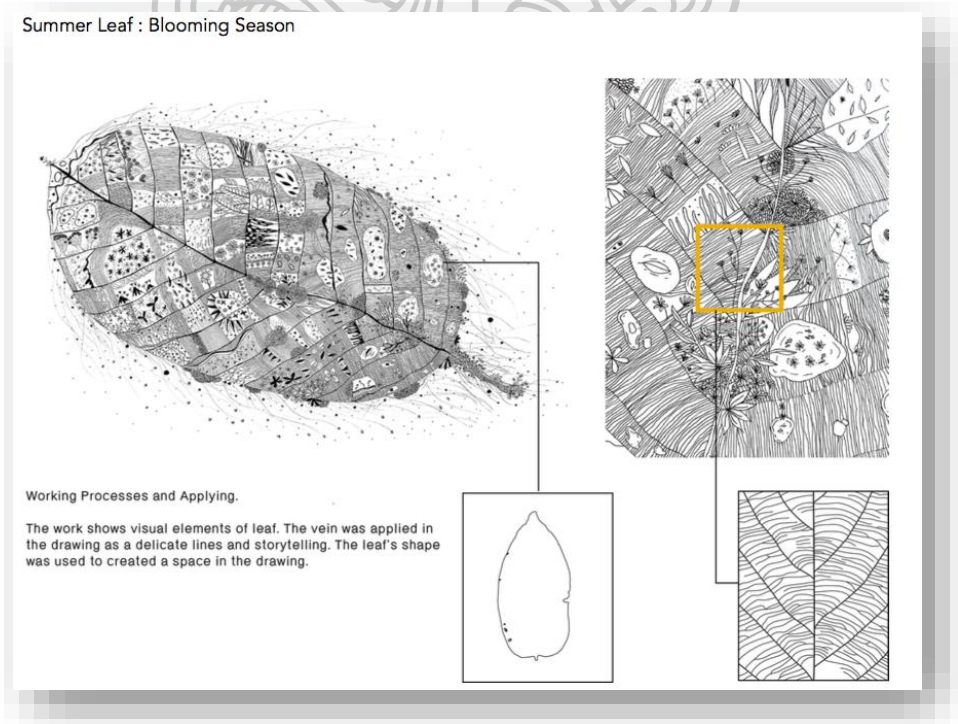


Figure 36 The illustration shows the visual elements which apply to use in drawing

After creating hand drawing from visual elements, the researcher would like to do the experimentation with motion graphic in order to create story about different seasons throughout a year. According to the experimentation process, the artwork shows both technical term and artistic. Rainy represents the emotion of water/stream in the forest which nourish and moisten the trees. In contrast Summer shows the feeling of blooming and blossoming while flower's pollen was carried all around the forest. The drawing also represents the diversity of animals and insects which come to play with the sun as well.

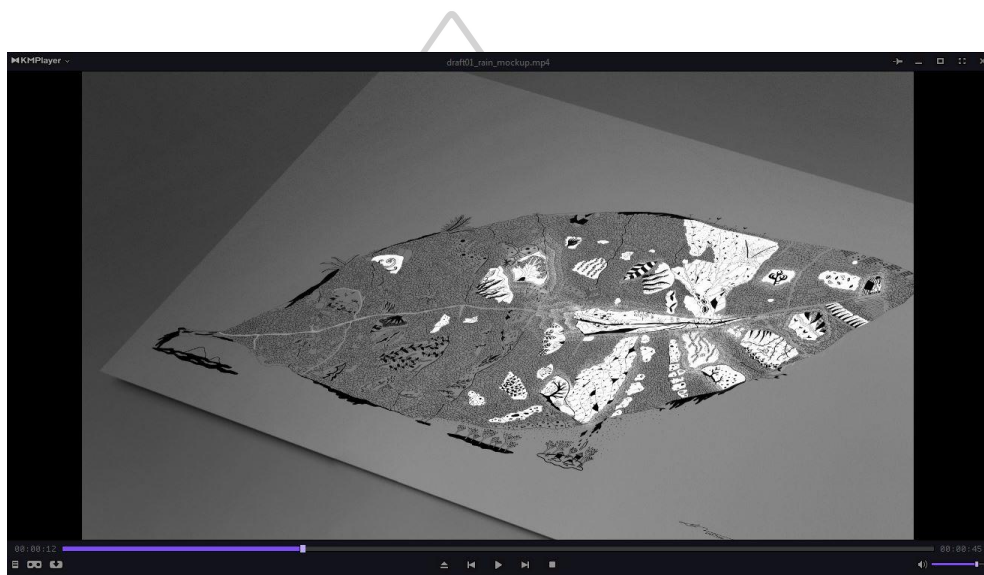


Figure 37 Motion graphic represent Rainy season

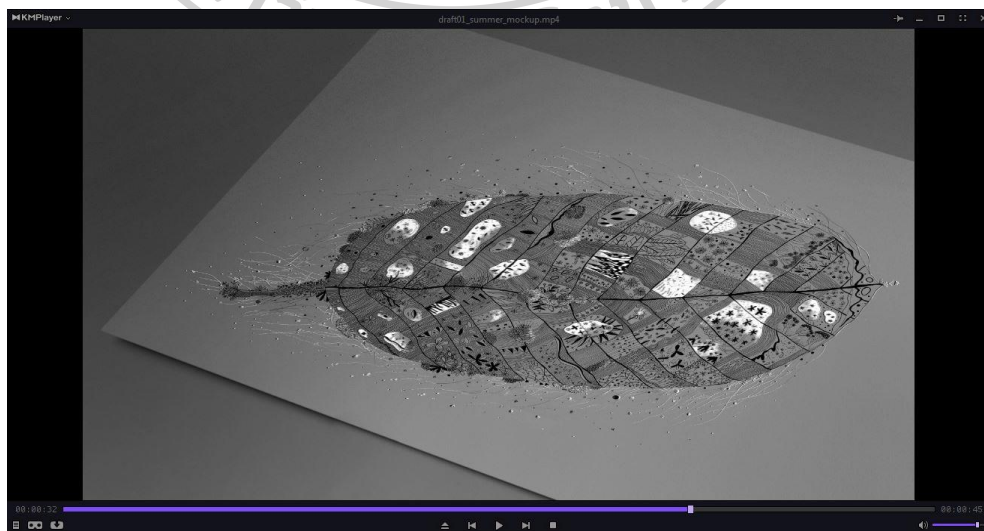


Figure 38 Motion graphic represent Summer season

3.4 L – System (Experimentation process)

L – System is a principle applied in the beginning of the research. To make a clear understanding toward the growth pattern of a tree, the research requires to apply L – System in order to create fundamental visuality presenting form and pattern of trees.

L-System Tree's Branches Data
from Khao NamKhing National Park.

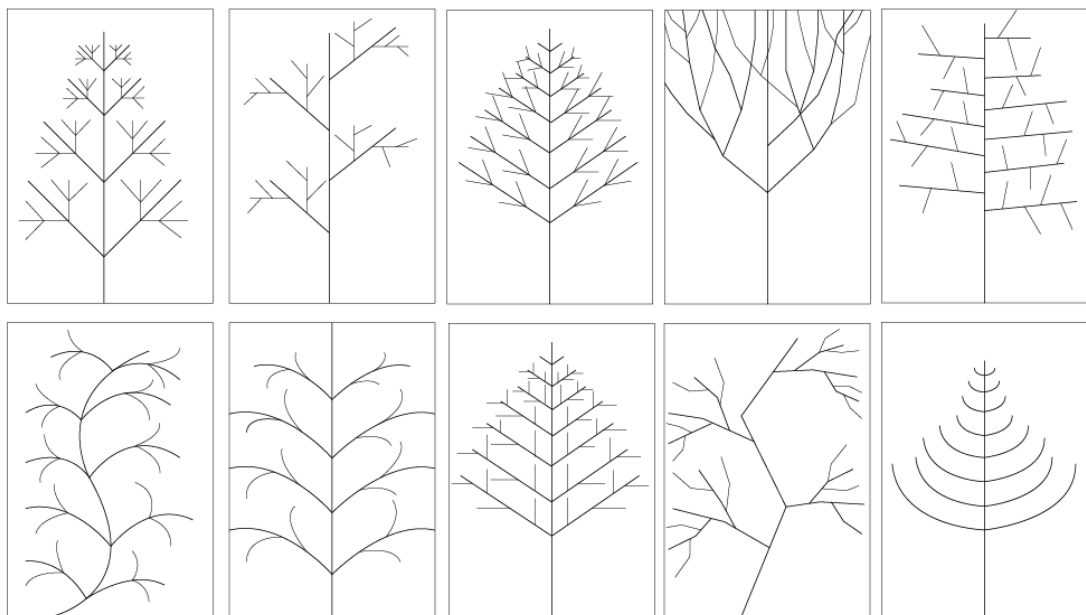


Figure 39 The experimentation of tree's branches by applying L-System from the visual element 01

This section of the research seeks to create shape and form by employing L – System to analyze tree branches. Data above show result of the experimentation of different types of visual. Furthermore, the experiment not only works with L-system but it also applies biomimicry principle to observe and copy the structures.

L-System Tree's Branches Data
from Khao NamKhong National Park.

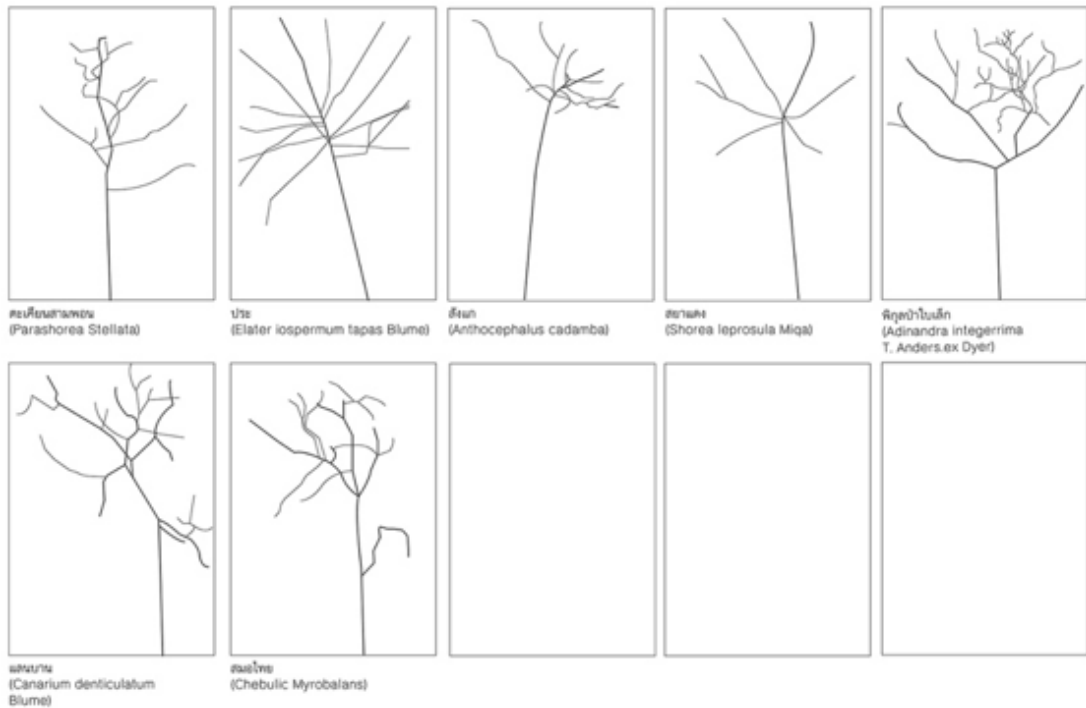


Figure 40 The experimentation of tree's branches by applying L-System from the visual element 02

Fibonacci and space design

Fibonacci is considered to be the main theory applied in the experiment with illustration and narrative. In the first part of the experimentation, the researcher tried to apply Fibonacci into space. In other words, this process is an attempt to find out how Fibonacci works with real space design.

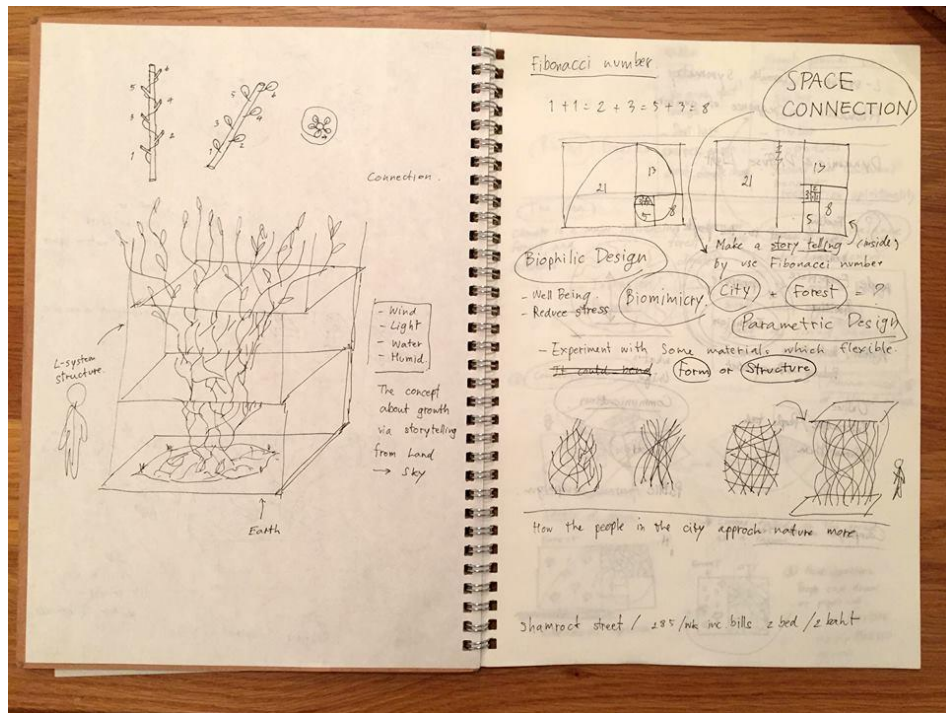


Figure 41 The picture shows the sketches design which illustrate the primary ideas

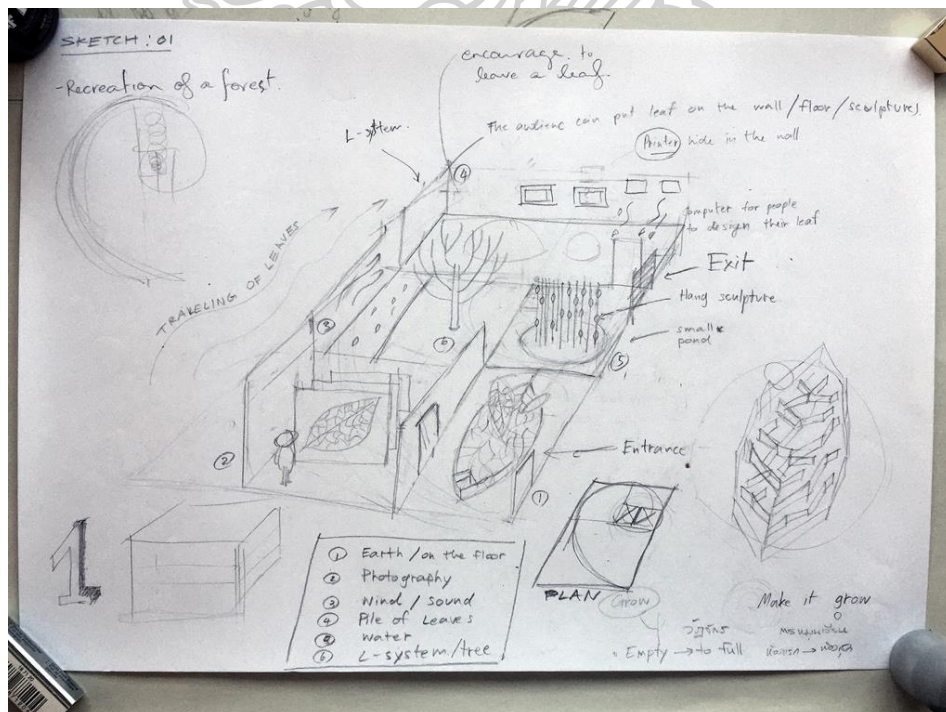


Figure 42 The picture shows a drawing that created by applying Fibonacci into the space

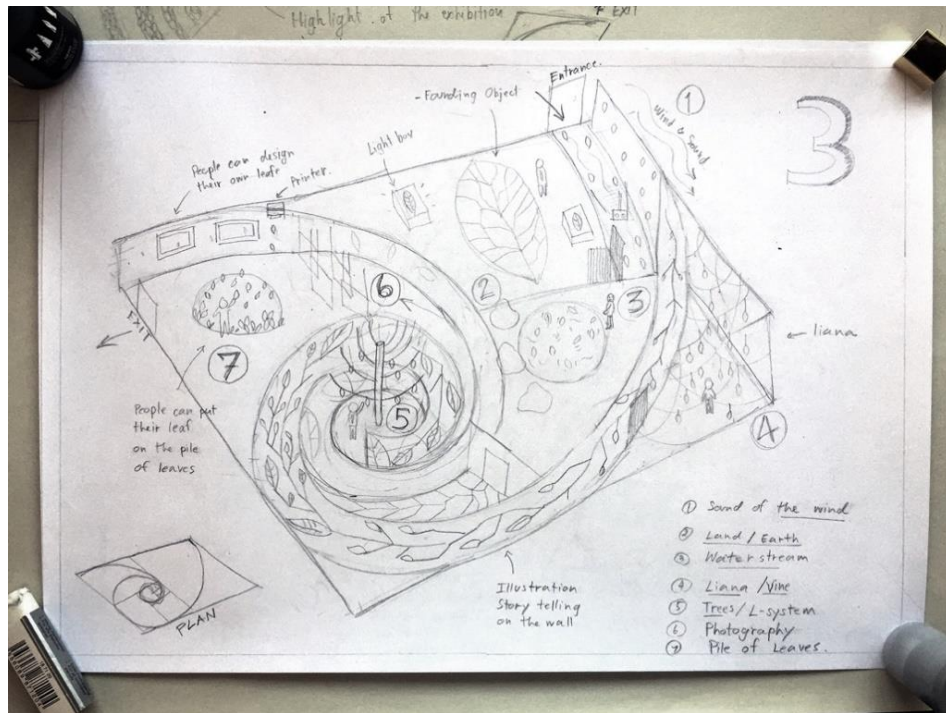


Figure 43 The drawing of another space which used Fibonacci to create the space

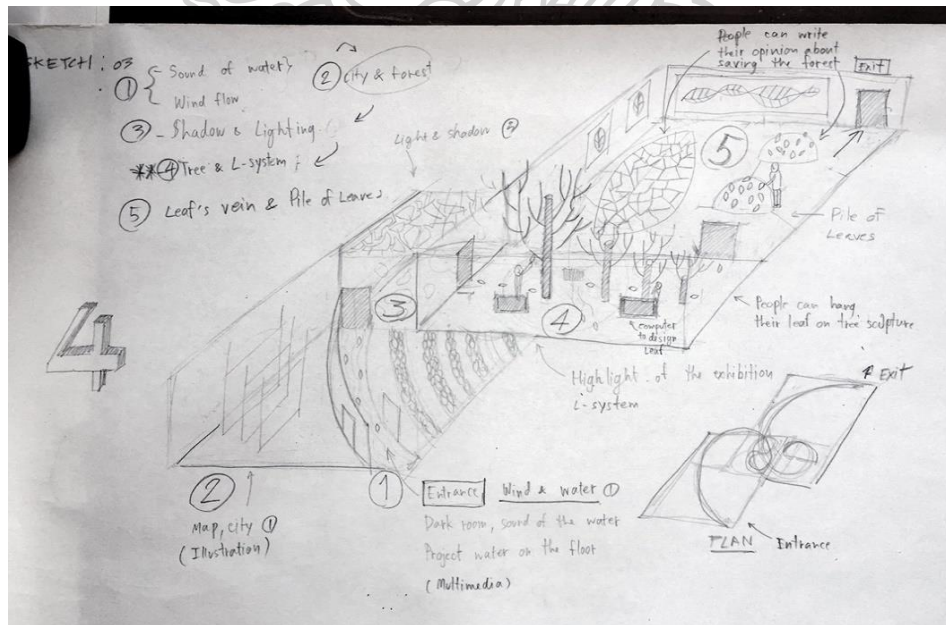


Figure 44 The biggest space which used Fibonacci to design the way for an audience

As to examine how Fibonacci works in space, models are created after space design with Fibonacci was finished.



Figure 45 The model was created to figure out how Fibonacci works with the *space*

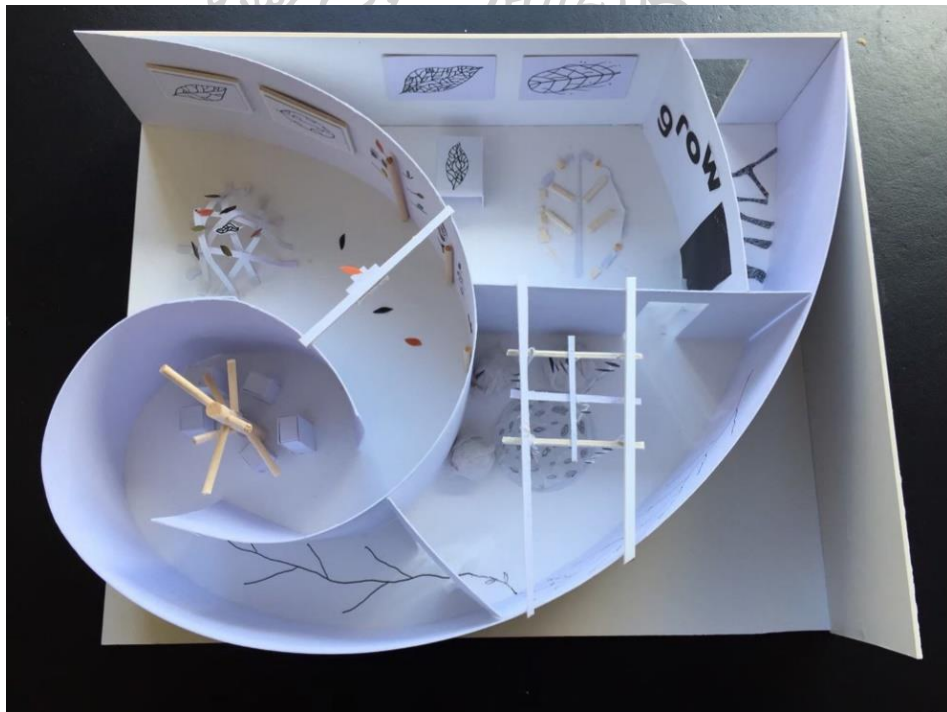


Figure 46 The Fibonacci can create the spaces which lead an audience into different rooms

In summary, the attempt to play with Fibonacci and L – System into space and exhibition design is a fundamental experiment. Although these methods were not applied in the next step of the research, we are able to sum up research result as followed;

1. Both Fibonacci and L – system can work well together in organizing space but with different functions.
2. Fibonacci can not only create good composition for 2-dimensional work but it can also apply with 3-dimensional work.
3. Fibonacci can lead audiences to reach the comprehension of space easily.

Fibonacci and illustration design with motion graphic

The last section of the research aims at creating artwork which combines Fibonacci and L-system into illustration. The combination has merged up the two different techniques; traditional hand drawing and modern technique like motion graphic. In the final part, Fibonacci still remained in the illustration. It was randomly applied in visual elements from the leaf veins. Moreover, the drawn storyline demonstrates the current situation of forest, deforestation and climate change that directly affect the world at present. Hence, this part of the research shows research approach from sketch design to final outcome.



Figure 47 The rough sketches of layout before creating an illustration which apply Fibonacci to design a composition of the artwork

Referring to the figure above, it presents how Fibonacci draws the flow of storyline and creates climax in each story. Specifically, it can be said that the idea of drawing has provoked the design of stories and divided into parts

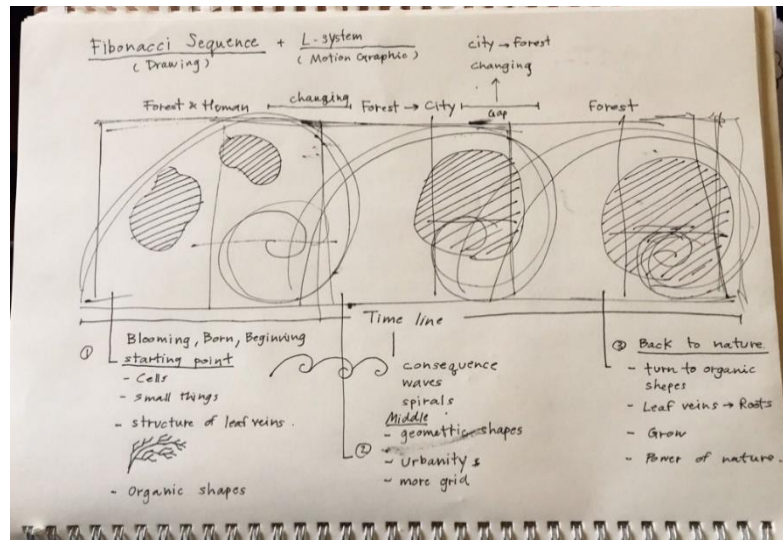


Figure 48 The illustration shows the Fibonacci sequence which cut to 3 parts

Furthermore, the illustration was designed into 3 dissimilar parts. The sketch design above presents an obvious timeline of the artwork that tells the stories about forest, city and power of nature. In addition, the illustration was used to reveal visual elements hidden inside the narrative. In other words, this part of the research was developed from hand writing with added motion graphic to an artwork.

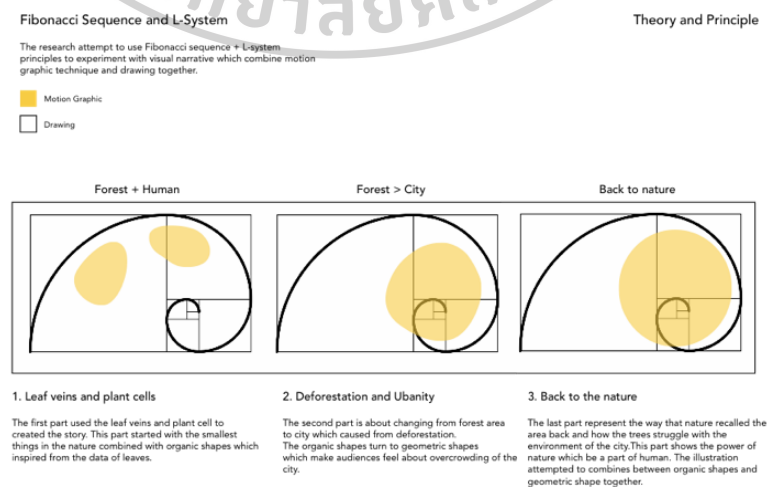


Figure 49 The diagram of sketch design which use Fibonacci sequence

To enhance the quality of work, the researcher had integrated the diagram that applied motion graphics with hand drawing. According to the figure, the white space represents the area of hand drawing while the yellow shape demonstrates the area of motion graphics. The idea and concept of the research can be clarified as followed;

Illustration (Drawing)

1. Forest and Human

The very first part of the narrative story had depicted the story about how human take advantage over nature and how human live harmoniously without destroying nature. In order to give clear statement, art work in this part of the research conveys an approach of how visual elements from leaf veins and plant's cells were used to weave the connection among every fraction in nature for example; cell pattern and universe. Also, organic shapes from nature such as vein, roots and cells were used to develop the landscape.

2. Forest and Urban world

The second part of the story tells the consequence of Fibonacci sequence from the first part where forest was destroyed by human. Since more and more forest area turns into city, the phenomenon of deforestation occurs almost everywhere in the world. According to this part of the research, visual elements has been changed from organic shape (trees) to geometric shape (buildings).

3. Back to nature

The last section of the illustration is the climax of final artwork. In this part, the power of nature was unveiled and the forest would like to reclaim its territory back from human. Human will perceive that nature is so powerful that it cannot be defeated and why they ought to respect nature. The last part is the combination of organic shapes and geometric shapes. Eventually, if you study the detail of this illustration closely and carefully, you will figure out why and how tree are so furious at human.

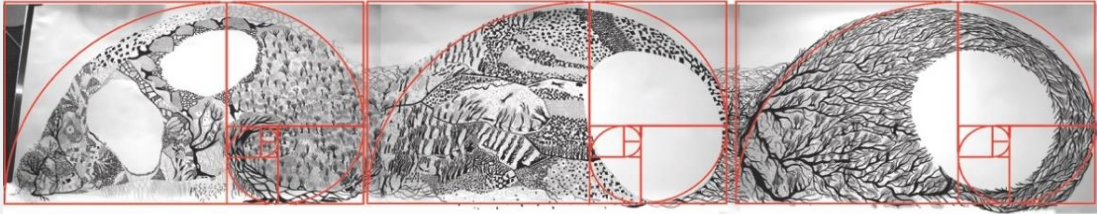


Figure 50 The illustration shows how Fibonacci can make a consequence of storytelling which more flow and connected to each other

As shown on the drawing, we are capable of inspecting Fibonacci sequence that benefit the illustration design. If we carefully look into the detail of each section, we will be able to observe hidden visual elements behind the stories line. Furthermore, it is the intension of the researcher to adapt Fibonacci sequence with illustration and graphic layout. In this situation, if we consider the red boxes as a layout, we will be incapable to lead the consequence of Fibonacci into the deepest climax part which was laid in the center of presented spiral shape.

The illustration Part 1

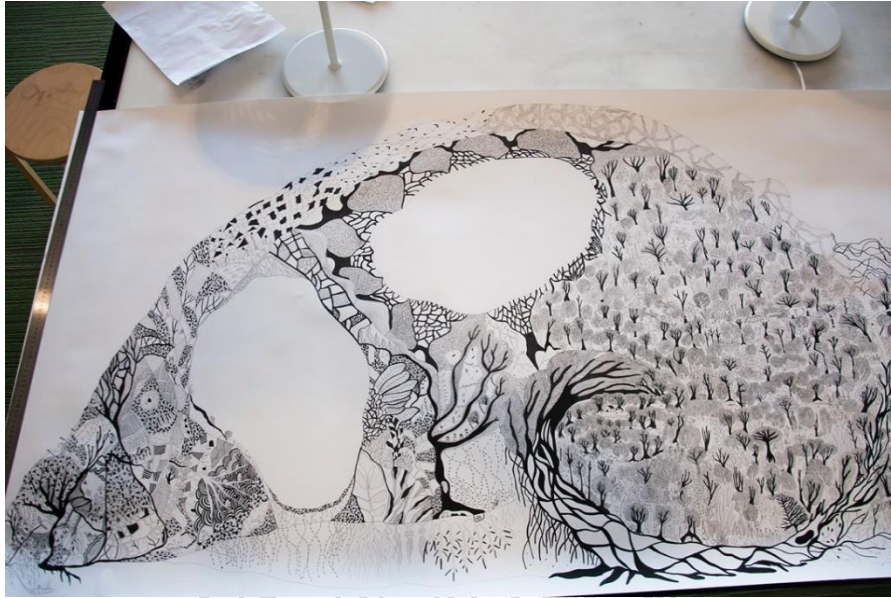


Figure 51 The first part of illustration shows the story about human and nature

The first part of the illustration shows details that employ visual elements from leaf veins. Those visual elements will be considered as basis of the story line. The shape of Fibonacci will lead the audiences' eyes from the first part of the spiral to the center of this work.



Figure 52 The artwork represents the forest, trees and organic shape from nature

The illustration Part 2



Figure 53 The picture shows the second part which present a story of deforestation and how human destroyed the forest area

The illustration in the second part conveys story of man-made deforestation. The story reflects how the world is changing and the reason why climate change becomes a big issue. Visual elements were selected and applied in the space area. The process represents the dynamic movement of the organic shapes that turned to be geometric shapes. In other words, the visual element is the metaphor of the transformation of forest into city.

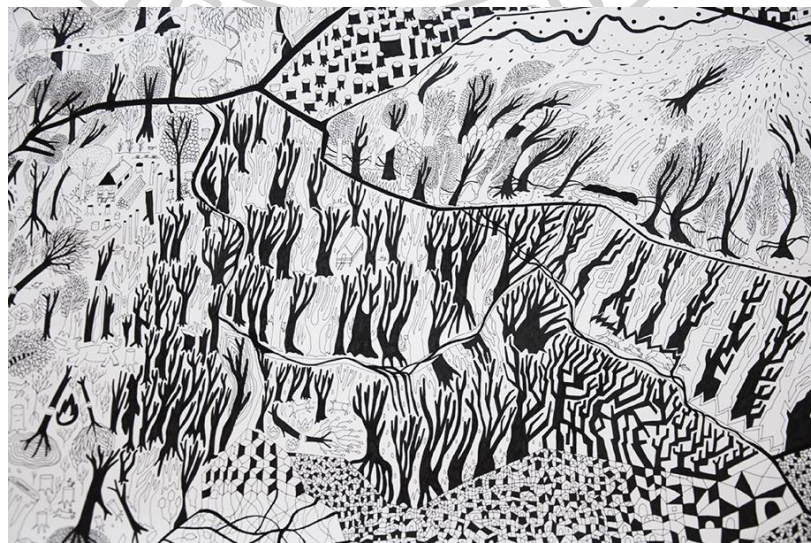


Figure 54 The picture shows the second part which forest area slightly changed to the city

The illustration Part 3

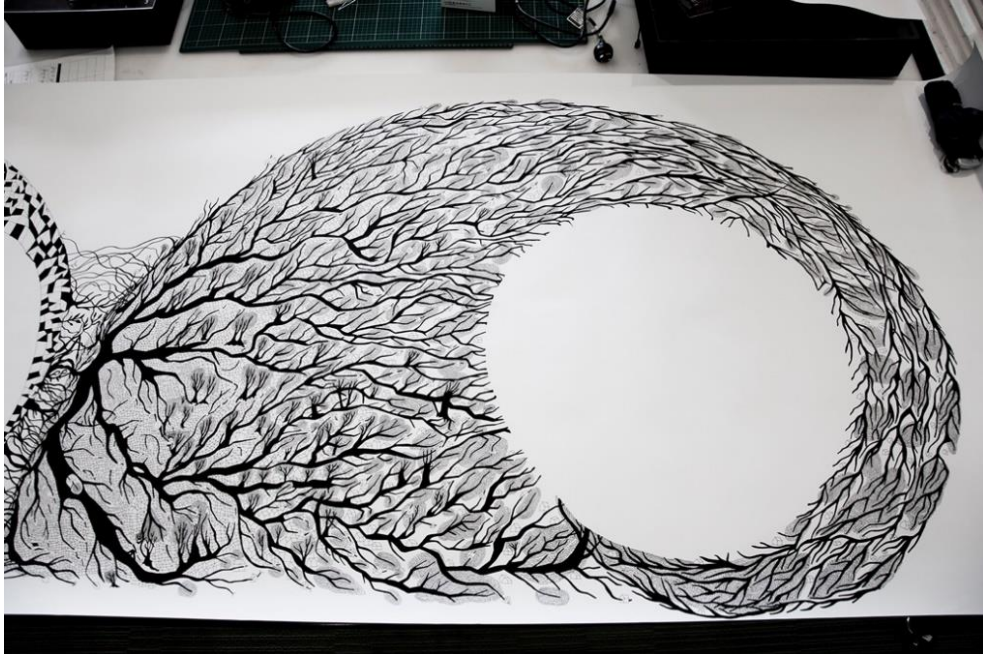


Figure 55 The last part of final artwork which represent the power of nature

The last section of the show demonstrates power of nature via organic shapes, which overshadow geometric shapes. With the dominant of the organic shapes, the geometric shapes are eventually covered up in the background. The storytelling was trying to reflect that nature could not be defeated and its power could not be overlooked either. People are one of the elements of nature so that they should pay more respect to it. The applied artwork in this section is the combination of L-system principles. Small models of houses were an experiment of motion graphic.



Figure 56 The details of illustration contains a story that nature want to reclaim everything back

To sum up, the applied artwork can be considered as a communication tool among audiences. Moreover, the researcher has strong determination to depict current circumstance and issue of concern that relate to nature, deforestation and climate change. Being a main tool, there is an aspiration that illustration technique will help the environment by raising more awareness in people's mind. Fibonacci is adopted to control the layout of the displayed artwork and make the connected consequence of each segment.

Motion graphic

In order to make the artwork become more attractive and fascinating, the researcher has opted 2 different techniques; media and traditional hand drawing. Right after the hand drawing was done, the researcher had continued to put the effort on motion graphic and moving images. First of all, the researcher started creating media storyline that consistence with the drawing. Deriving from drawing concept, all visual element was then developed into motion graphic. At present, we have embraced with technology and its advancement. Later on, it becomes an important element of our

daily life especially the youngster. However, we have to keep in mind that traditional technique like hand drawing will perform a significant contradiction in the artwork. As to accomplish the research objectives, the researcher tried to focus on the followed procedures:

1. Design appropriate positions that fit in the illustration
2. Design the consistent storyline and illustration
3. Employ an After Effect program to create motion graphic
4. Employ projection mapping to cut the shape that perfectly fit in the blank space of the illustration

space of the illustration

1. Design appropriate positions that fit in the illustration

The 4 yellow shapes shown on the diagram are the shapes designed for motion graphic. Finally, the researcher made a decision to employ 4 projectors into the yellow spaces.

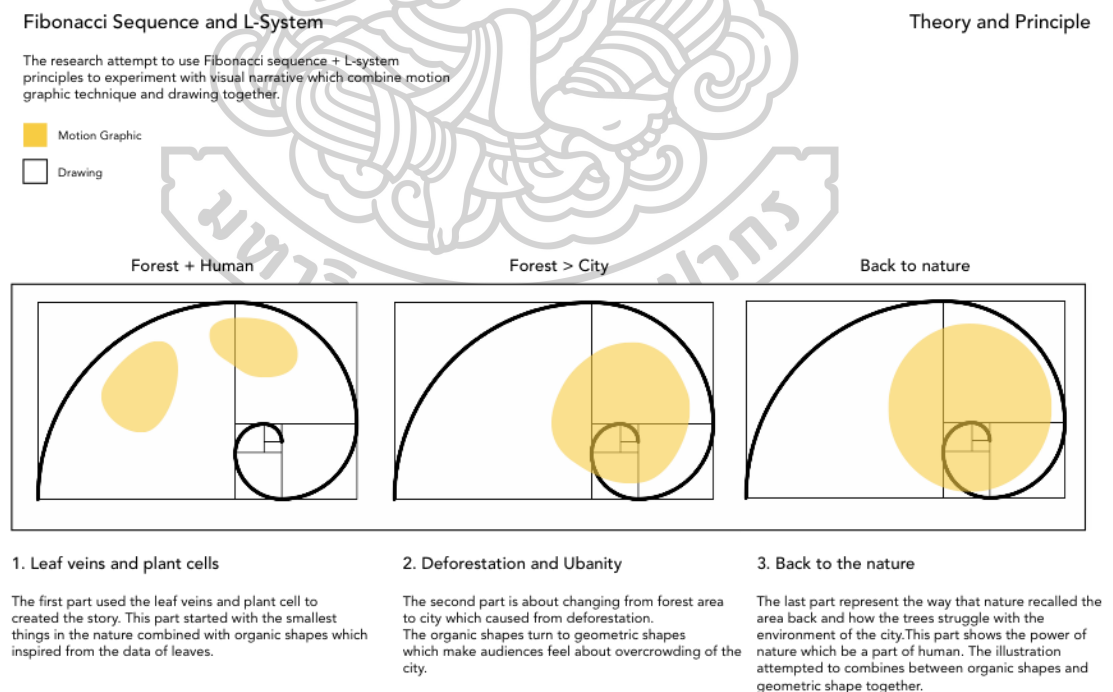


Figure 57 In diagram shows the position of motion graphic in yellow shapes

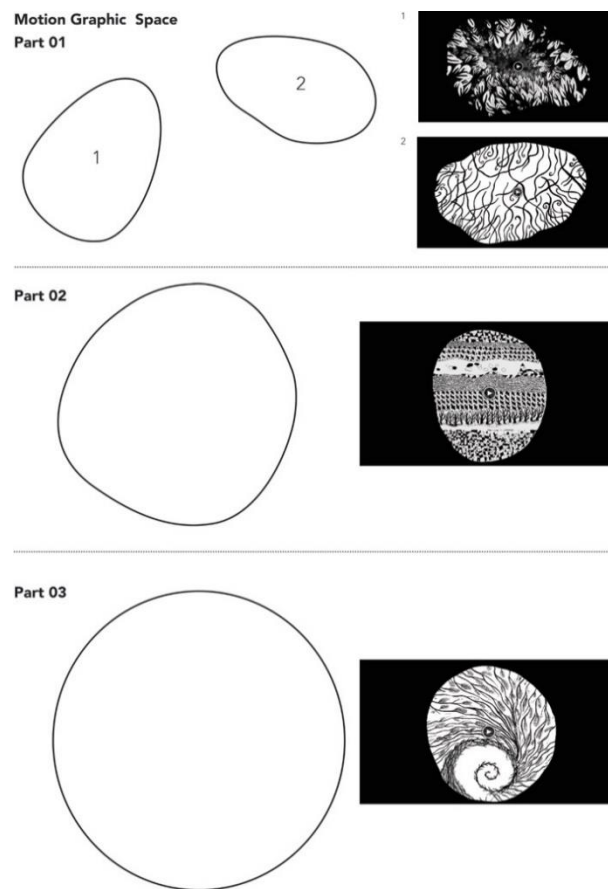


Figure 58 The diagram present 3 different parts of motion graphic that fit in a drawing



Figure 59 The picture shows draft processes which used tracing papers to copy the shapes from drawing



Figure 60 The picture shows details which inspired from vein and cells from leaves

Providing blank spaces for motion graphic, the researcher had drafted all of the shapes in exact scope since the inner motion graphic should be well fitted in order to project linkage among elements in the illustration.

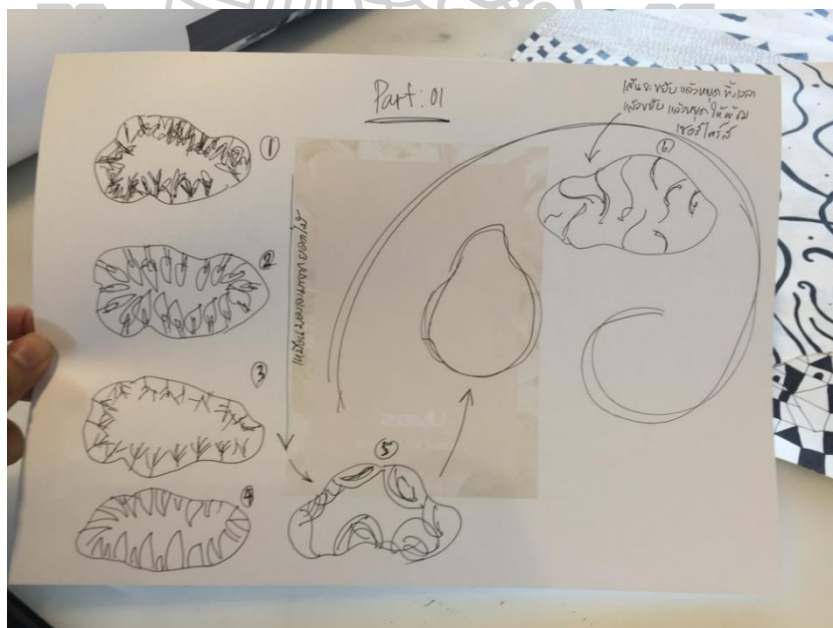


Figure 61 The picture shows sketch which tell various stories in each part

2. Design stories that connect with the illustration

In a second method attempts to communicate stories which relevant with main ideas about forest, deforestation and climate change in each part. For the first part of work has two black spaces which show different stories.

2.1 The beginning of a story

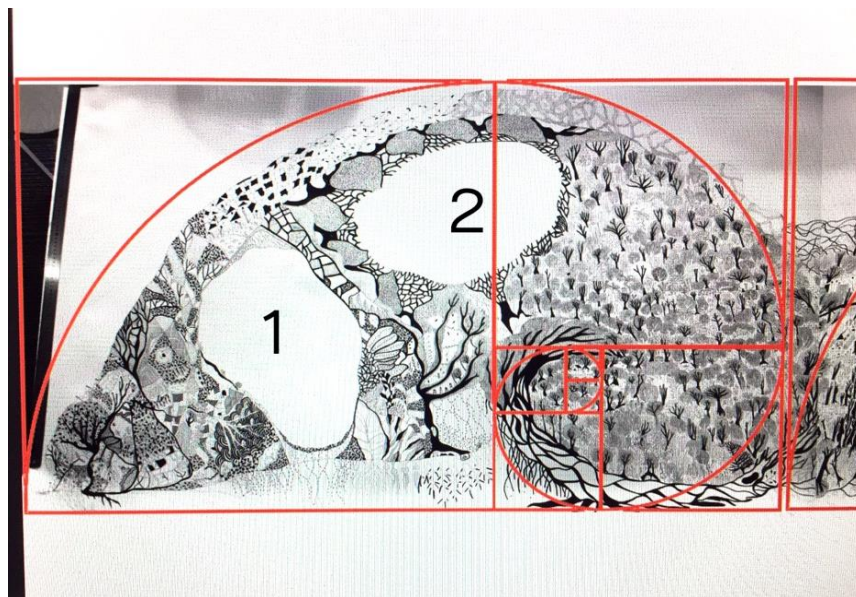
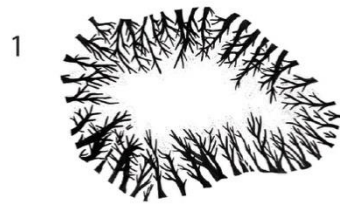


Figure 62 The illustration shows the blank spaces which present different stories

If we examine the number 1 from figure 63, we can see four layers which symbolize five stories in each part that can explain more in the next figure.

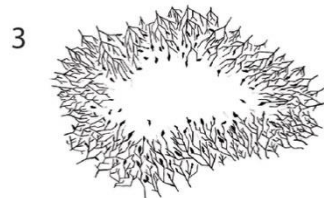
Motion Graphic Layers in Part 01 : The motion graphic attempts to participate with an audience to look deeply into the forest that changes like a life cycle in nature.



The first part represents the environment of a forest which inspired from nature. It is the beginning of a life that trees start to grow.



The second part illustrates the maturity of trees which fully grew and became the forest area.



The third part is part of changing. When a season change and the autumn season comes, all trees leave their leaves to welcome a new life.



The fourth part of the work shows new leaves that have a lot of diversity. This part represents a new life cycle.



The fifth part is the last part which shows the smallest details and zoom in the plant's cells that connect with the universe.

Figure 63 In the picture shows the divergent layers which present the stories in each layer

Referring to the space no.1 from figure 63, it demonstrates 5 different stories about the circle of life in the forest. The illustration can be interpreted as below;

1. The first section was inspired by the surrounded nature, which is the origin of life.

2. The second layer had illustrated how fully-grown trees became forest.

3. The third part represented the idea of “changing”. The illustration tried to manifest the dynamic of tree leaves in different seasons.

4. The fourth pattern not only illustrated the picturesque and diversity of tree leaves but it also presented the new cycle of life in the forest.

5. The fifth illustration was the last part showing the smallest detail and magnifying the plant’s cell, which connect to the universe.



Figure 64 The screen capture of motion graphic in the first layer

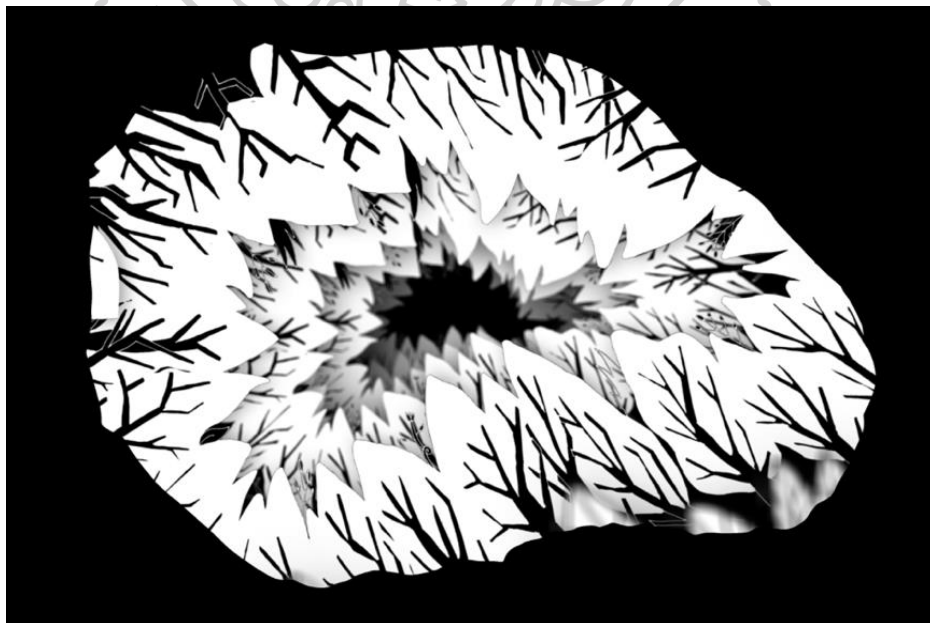


Figure 65 The screen capture of motion graphic in the second layer

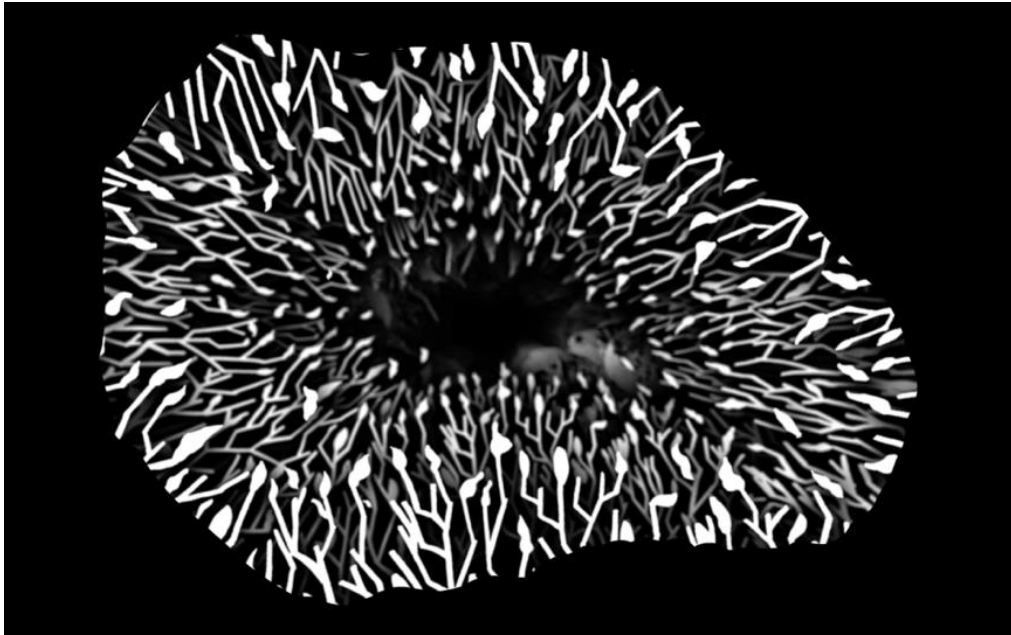


Figure 66 The screen capture of motion graphic in the third layer

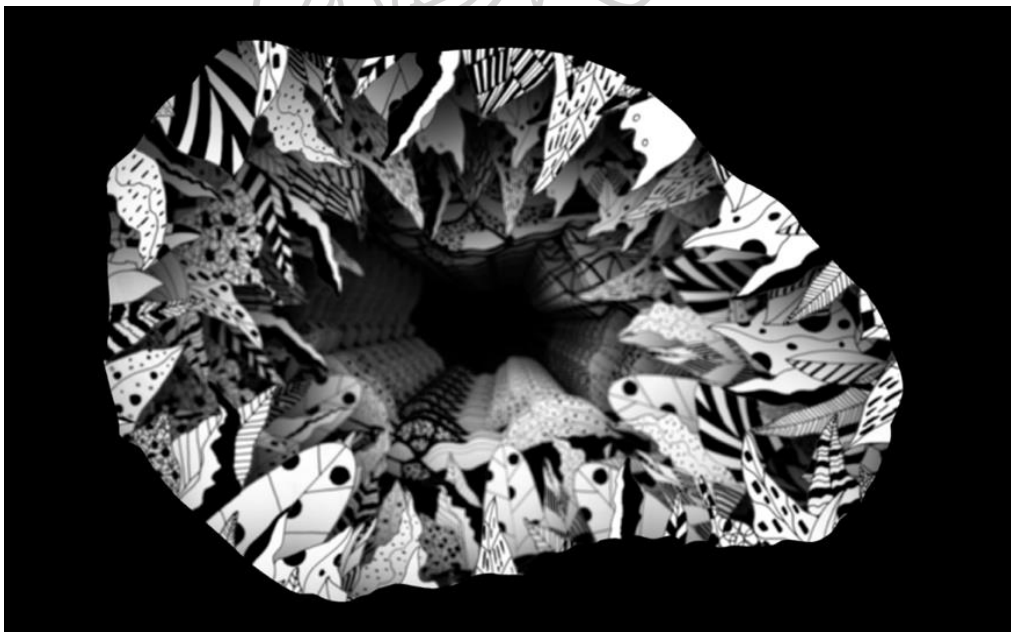


Figure 67 The screen capture of motion graphic in the fourth layer

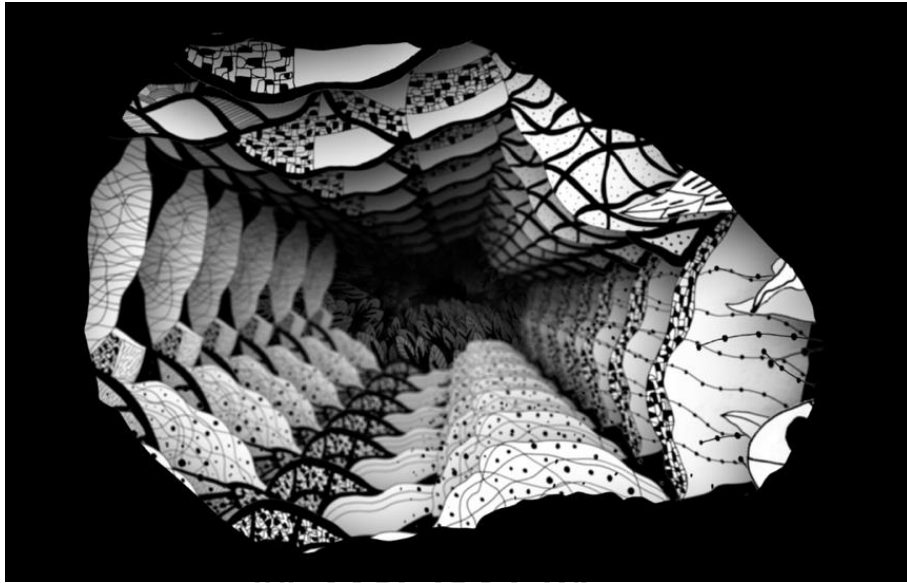


Figure 68 The screen capture of motion graphic in the fifth layer

2.2 Small creatures and emotive elements

Referring to figure 62 the motion graphic movement in picture number 2 is trying to tell the story about creatures and emotive elements. A small pond is the metaphor of the origin of lives.



Figure 69 The draft process of drawing that show visual elements from drawing connected with motion graphic part

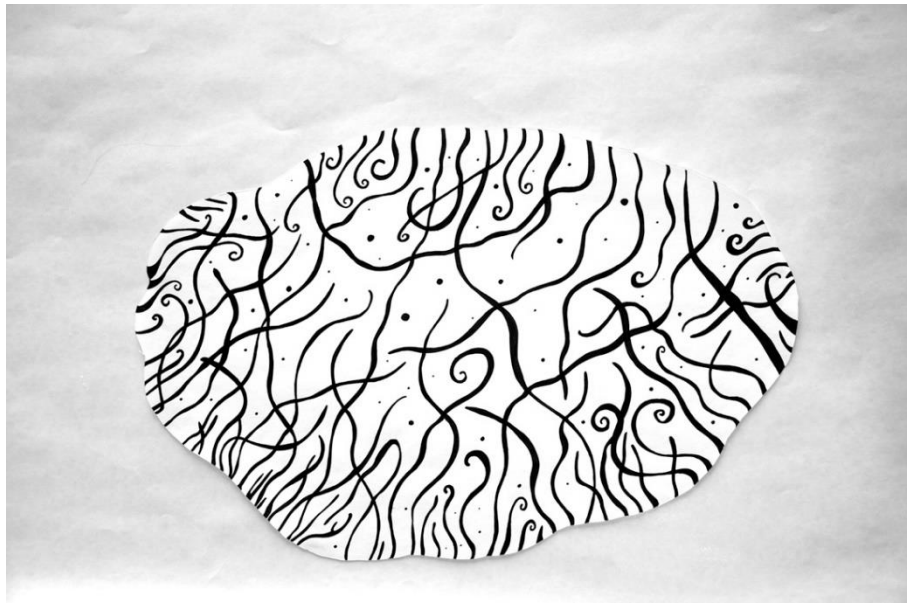


Figure 70 The picture of visual elements before developing to be motion graphic

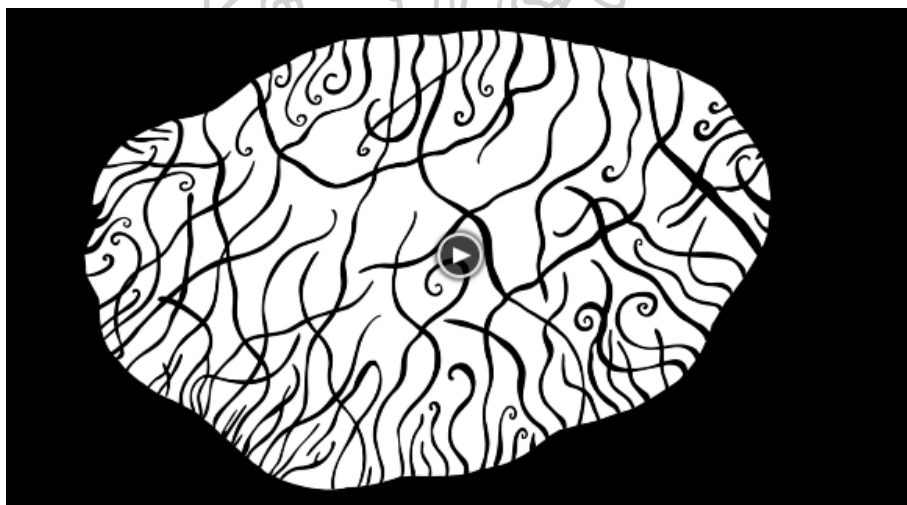


Figure 71 The picture of visual elements after used After Effect Program to make motion graphic

2.3 Deforestation: once nature now city

The created dialogue in the second part of the final artwork can be interpreted that human activity is to blame for deforestation. The artwork shows how eco-system collapses, bush fire starts and flooding occurs all over the area. Moreover, visual element has also depicted the situation by showing how geometric shapes penetrating over organic elements.

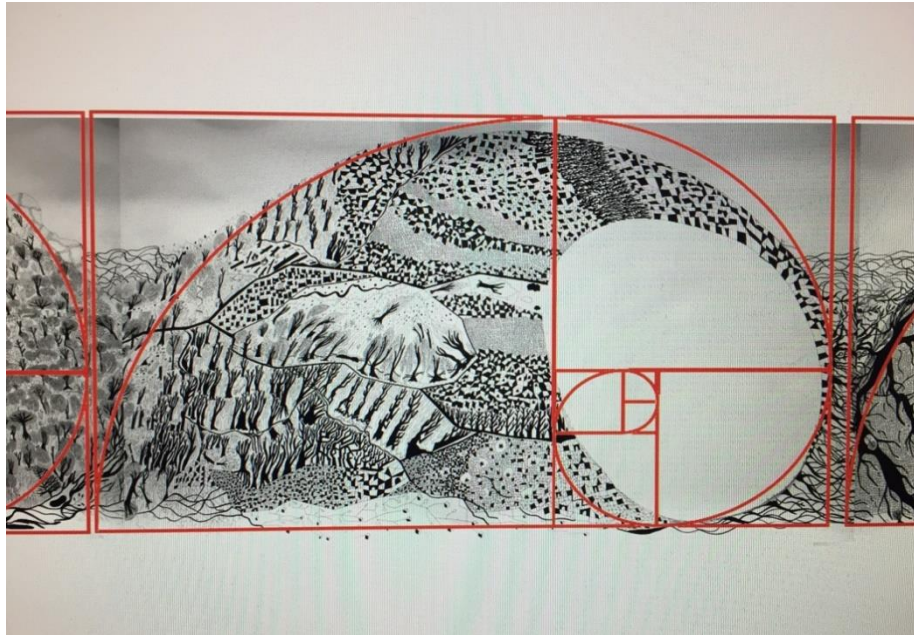


Figure 72 The illustration shows an area where motion graphic fit in which merge with Fibonacci spiral

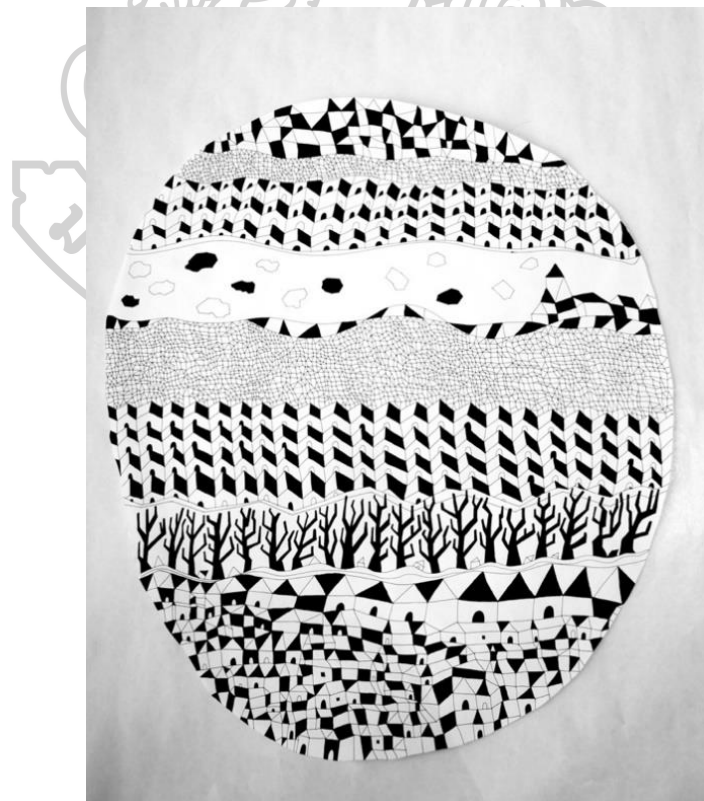


Figure 73 The illustration part before turn to be moving image with Program

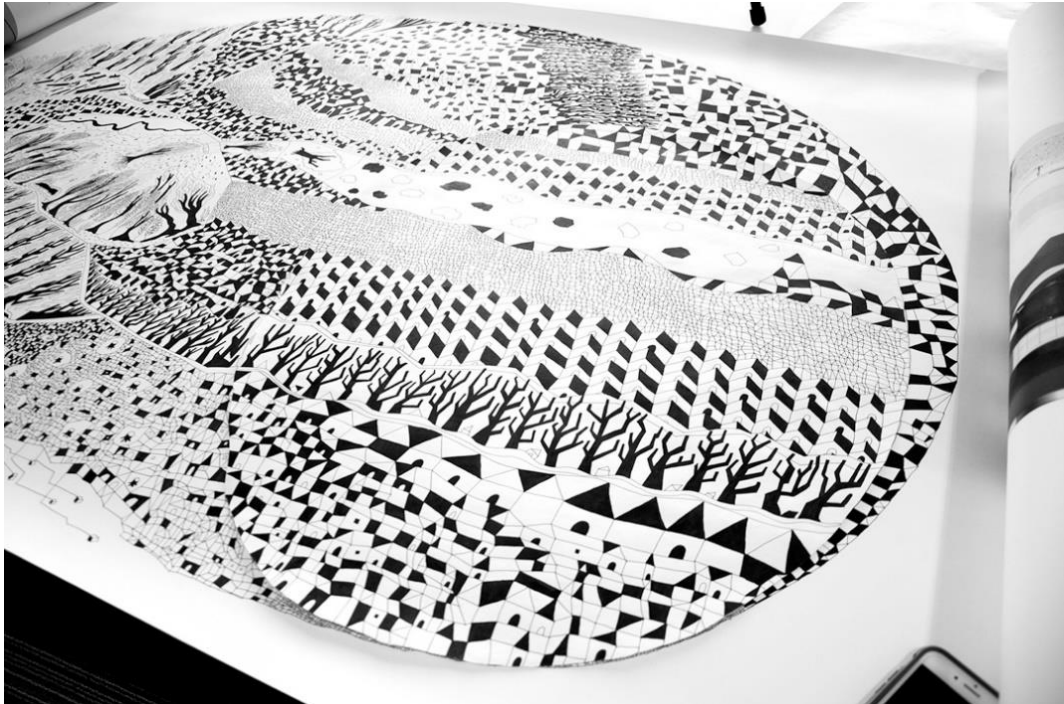


Figure 74 The picture shows when the piece of paper fit with drawing

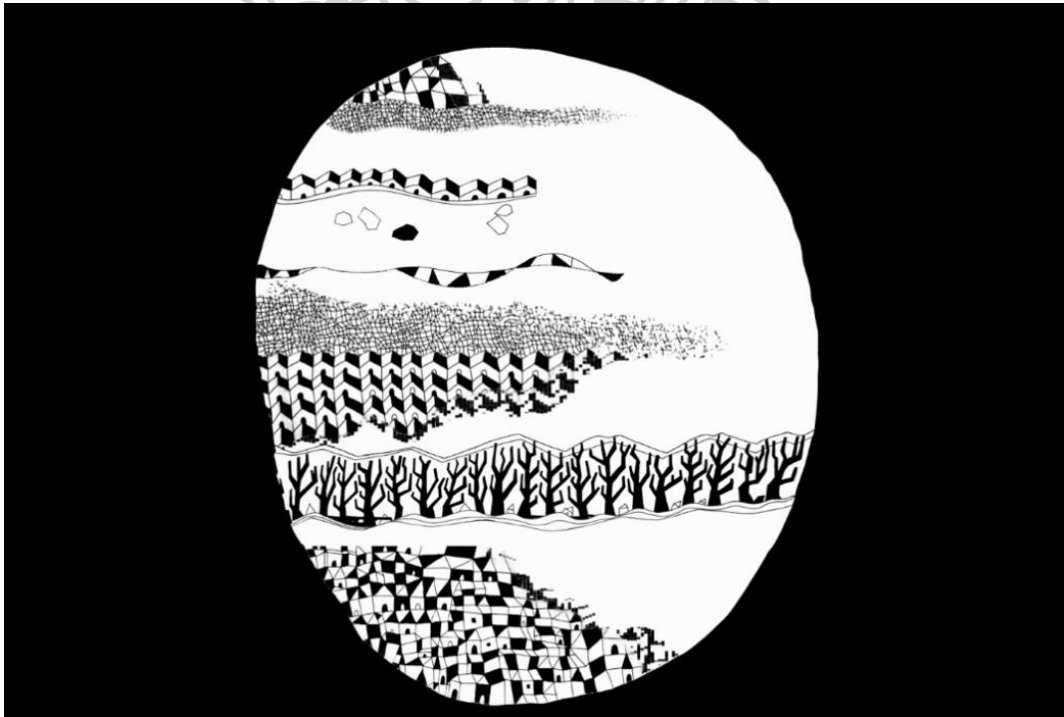


Figure 75 The picture exhibit the story when city area replace the forest zone

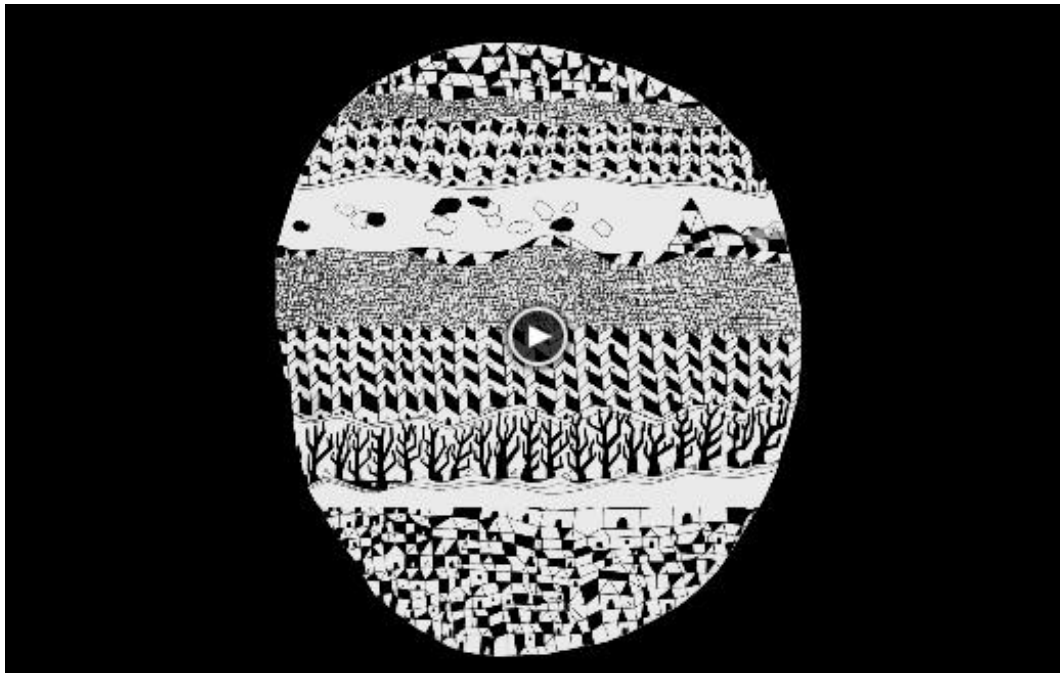


Figure 76 The picture shows when forest areas were replaced by city and building

2.4 The power of nature

The last part of motion graphic contains both 2D and 3D visual element. It can be considered as surface experimentation. The researcher has utilized a projection mapping to project small paper sculptures which were put on the drawing. In addition, the researcher also intends to raise awareness among audiences after they appreciate the work. It is hoped that they will be able to touch with the hidden messages that they will have feeling for the power of nature.

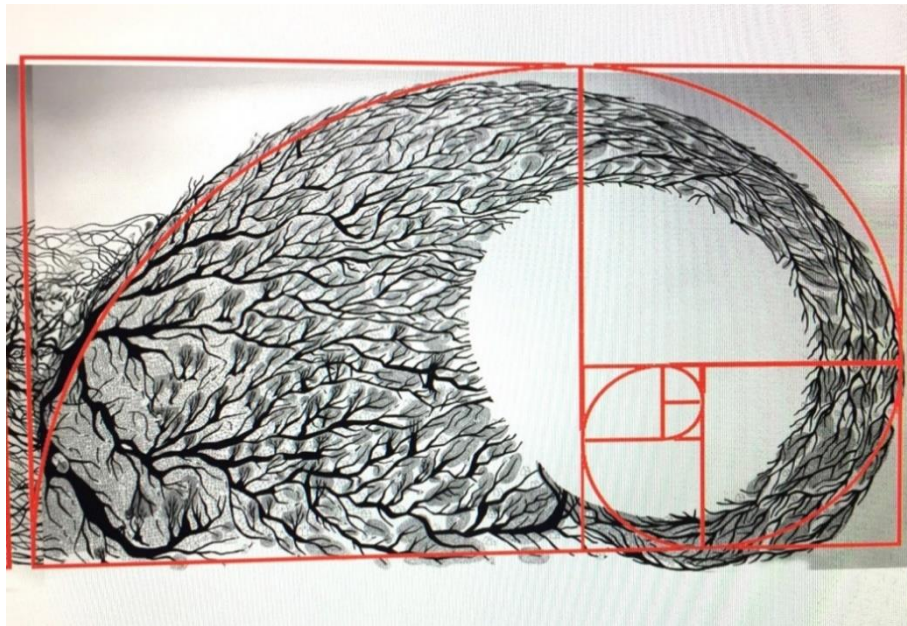


Figure 77 The picture shows the blank space which contain motion graphic in the last part



Figure 78 The illustration in the last part which appear in spiral shape



Figure 79 The picture demonstrates when put the drawing from figure 78 into the drawing

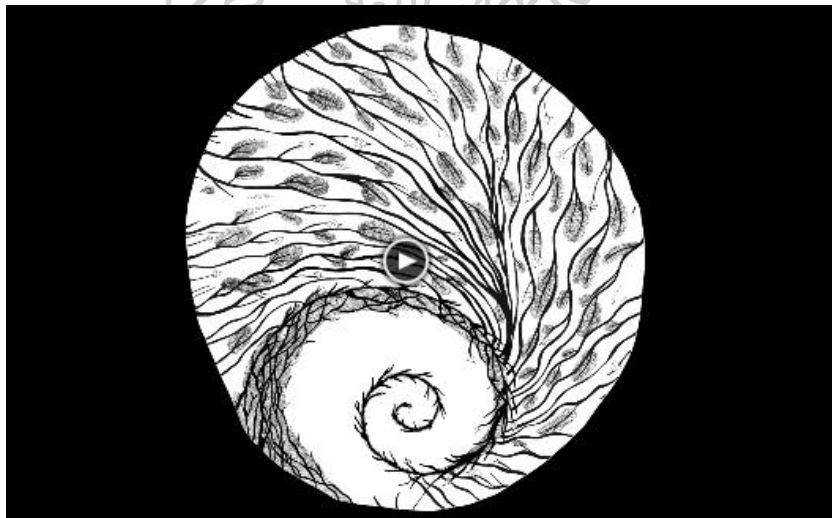


Figure 80 The picture shows a screen caption of motion graphic in the last part which consist of tree's branches

In short, all of the motion graphics have clearly attached with hand drawing. The main objective of producing motion graphic is the determination to conduct the experiment with the two mismatched techniques in order to receive more attention from audiences. Furthermore, the final part of the motion graphic also includes small 3D sculptures that symbolize a city. Placed on the drawing, model of houses has opted projector to project motion graphic on the hand drawing part.

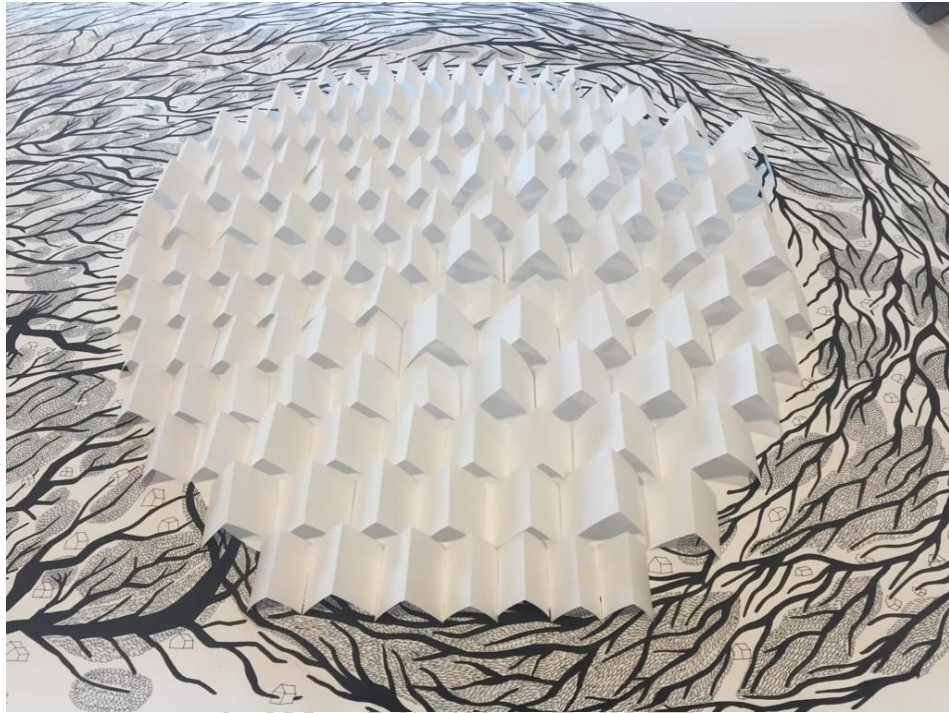


Figure 81 The photograph of small houses which symbolize a city

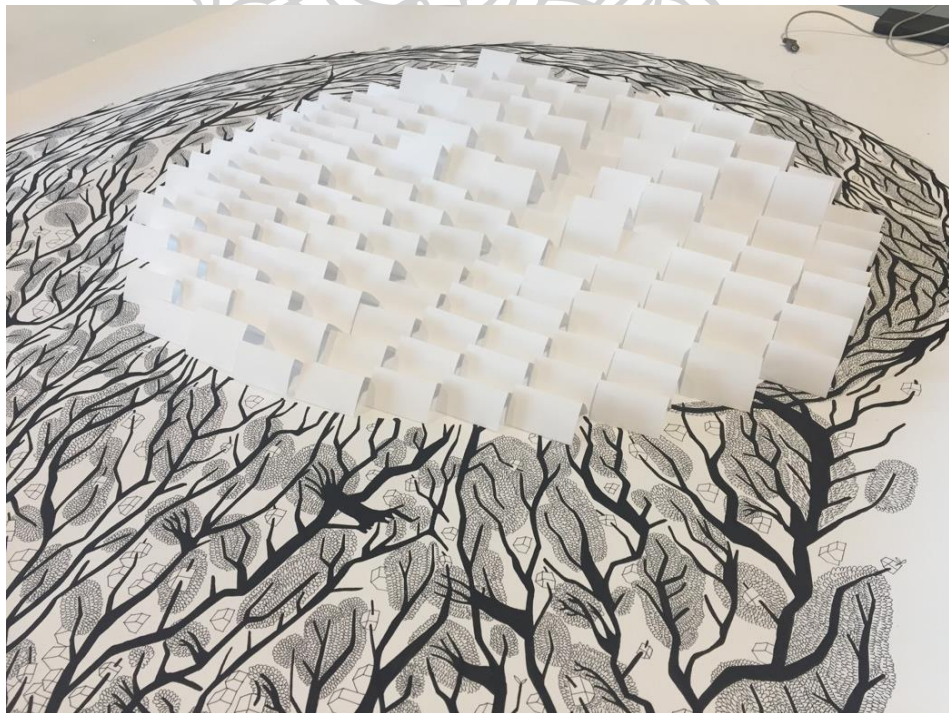


Figure 82 The photograph of small houses which symbolize a city in another *angle*

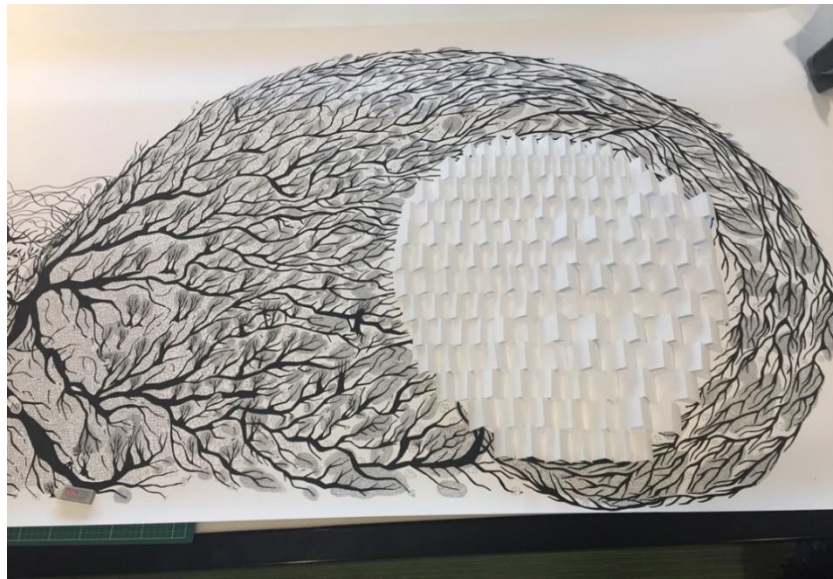


Figure 83 The photograph of drawing and paper sculptures

Technique and program

Referring to the previous part, the researcher has stated that technology and traditional hand drawing would be adopted in conducting the research. In order to fulfilling the research objective, Adobe After Effect was considered to be an effective tool that could develop hand drawing technique into motion graphic.

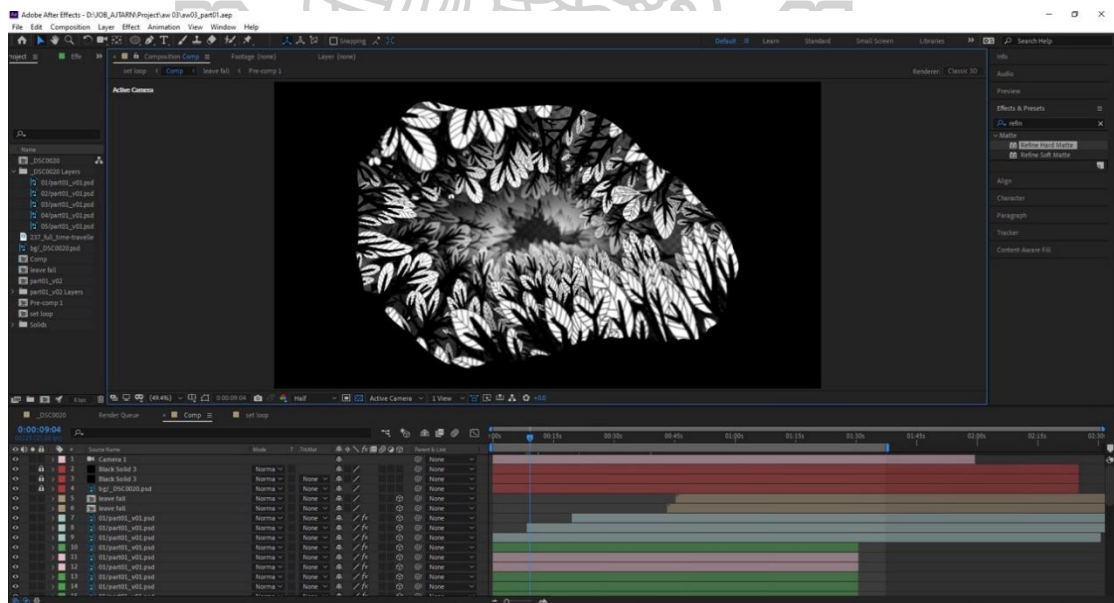


Figure 84 The picture shows screen capture from Adobe After Effect program which help and develop illustration to be livelier

By carefully observe and examine figure 84, processes and techniques of After Effect program were quite significant. Initiating from frame by frame, the illustrations were separated into layers before they became motion picture. In other word, opted program was an informative tool supporting motion picture and developing idea inside the story. With motion picture technique, the telling story became to be more alive. However, the most difficult task during the process was timing and rhythm of the story since the illustration needed to be perfectly fit in drawing and had to be able to convey message to viewer. Therefore, all of the processes were carefully developed and edited step by step. Due to the reasons, the process of enhancing motion picture was a time-consuming task.

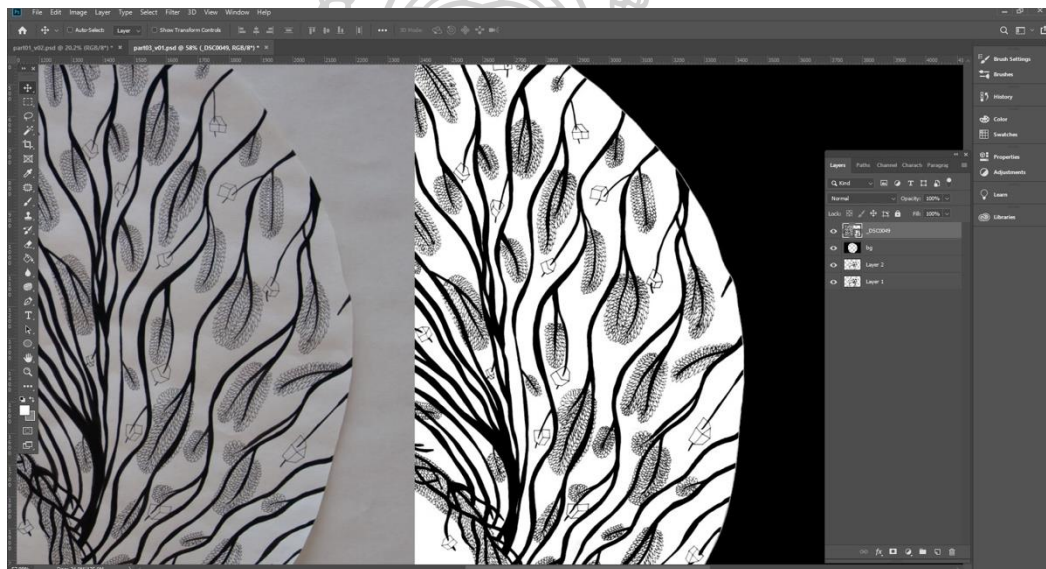


Figure 85 The screen shows the method which adjusts color from photographs to be a graphic style

Time lapse record

Time lapse record can be counted as one research tool since it helps revealing the process of accomplishing artwork in each part. Start with the preparation process, camera needed to be set up and turned the time-lapse function on in order to capture the moment. It was the non-stop record not until each part of the drawing was finished. With the continual record, consequence and working procedure was displayed from scratch to the complete artwork.



Figure 86 The picture shows the process when use a Gopro camera to record the drawing

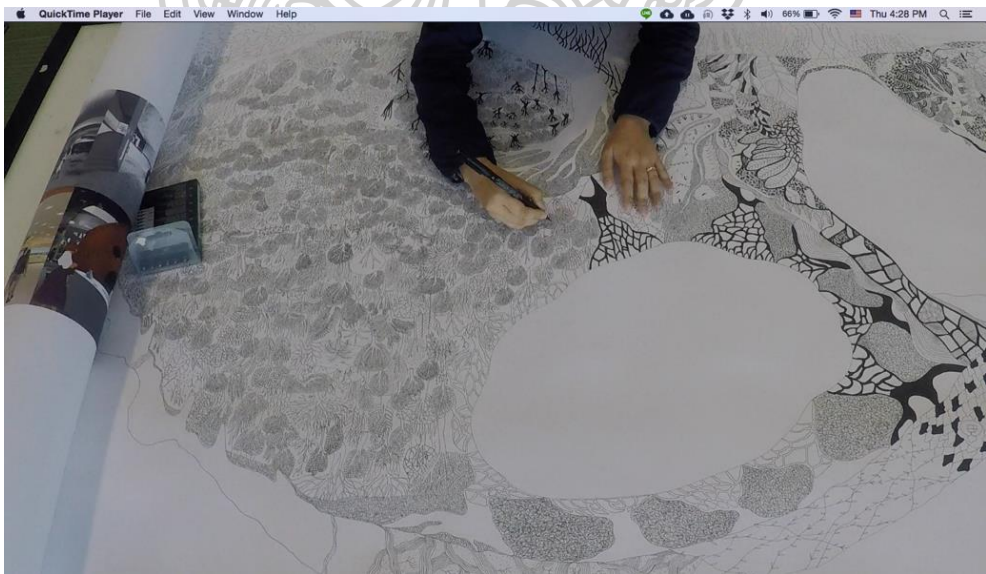


Figure 87 The picture shows the video recording that record with time lapse function

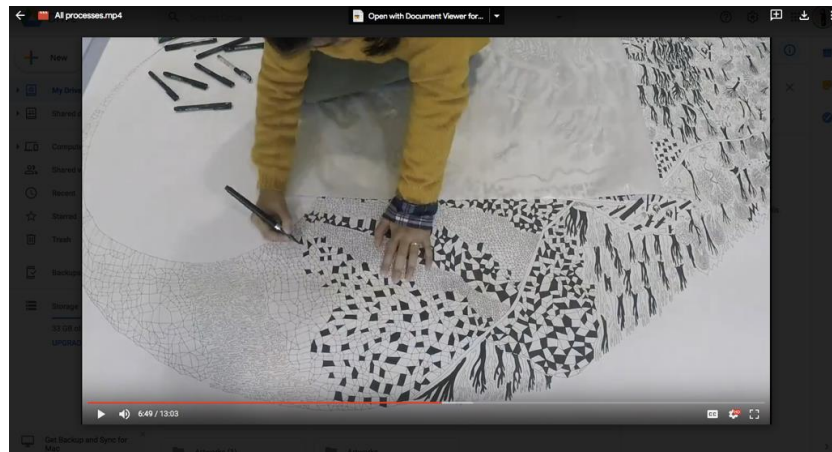


Figure 88 The picture shows screen capture from a time lapse video

Projector Mapping

During motion graphic process, the researcher had to test picture quality from the projector from time to time. In this stage, powerful projector is needed because motion graphic files were created with high resolution picture. Dealing with precision, the process consumed a large amount of time when motion graphic file demanded for attention in order to fit in spaces.

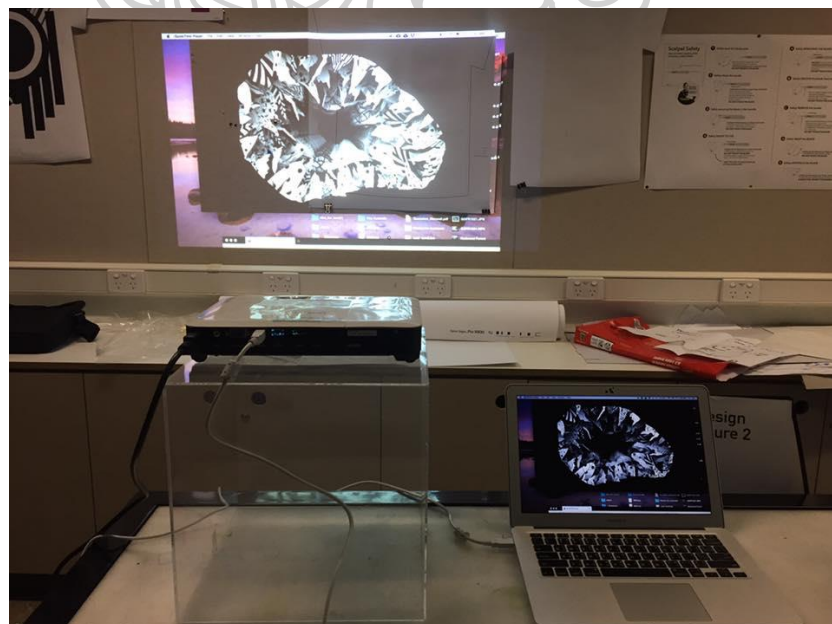


Figure 89 The pictures shows the process when test motion graphic with projector on the wall

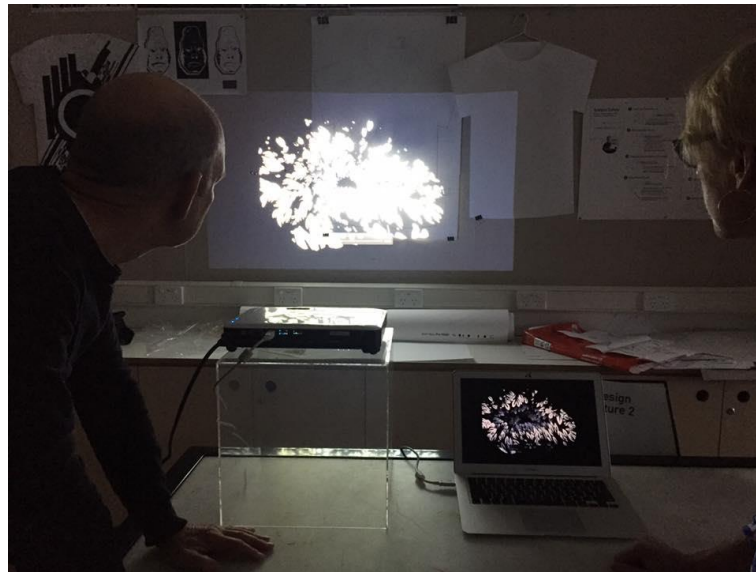


Figure 90 The pictures shows the time when test motion graphic with a *projector*

After the testing process, it was found out that one motion graphic did not run smoothly due to some technical problems. The researcher as a result had to assess and find the best solution. Thanks to technical support, the researcher finally realized that one of the motion graphic files was too big and the laptop's ram could not support the file properly. Once again, the file's size needed to be resized and adjusted with another computer.

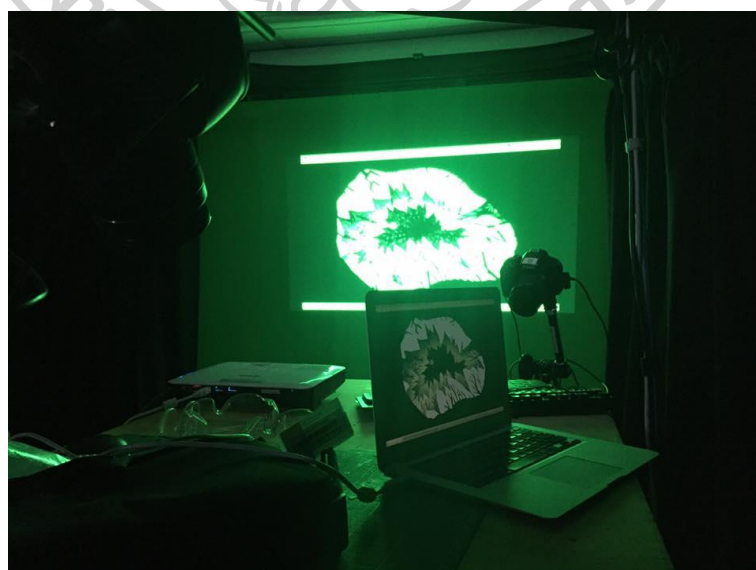


Figure 91 The pictures shows the second time of testing with projector

In the second attempt, the motion picture files ran smoother and the images seemed to be clearer.

“Mini Mad” program was another research tool introducing to the research project. The program could be applied in the real practice for several fields including architectural video projection, art installation, stage design and live performance. According to previous works, MadMapper software had made hundreds of projects feasible. Users who experienced this program also found it practical. Moreover, it was suggested that MadMapper was suitable for artists who were seeking for quick, strong and user-friendly mapping software. (<https://madmapper.com/madmapper>)

During project mapping, the researcher had to do the experiments on shapes that perfectly fit in the drawing. “Mini Mad Program” was chosen and utilized to adjust shapes in order to make them fit on the surface of provided areas. Furthermore, “Mini Mad Program” also played an important role in supporting the work with projectors. With its high potential, the program was able to adjust and project motion graphic on small or even large area like building.



Figure 92 The pictures shows the process which used Mini Mad Program to test on a small paper

According to figure 92, the adjusting process of motion graphic was demonstrated. Since they were considered as an important component, the researcher had put a large amount of effort and time to fill the spaces up with designed shapes. Despite several tests, small errors continued to occur so the researcher had to fix, develop and modify all of the error the day before the exhibition.

The exhibition

The exhibition came from the collaboration between Silpakorn University and Swinburne University of Technology with the support from RGJ scholarship (Thailand). It was held at Swinburne University of Technology, Melbourne, Australia during February-July. Moreover, the scholarship had expected to exchange further knowledge among international lecturers.

There were 4 main processes of preparing and setting the exhibition as follow;

1. Set up projectors and bar with Minimad boxes
2. Prepare some space for the artwork and comment board for audiences
3. Test the projectors with the prepared illustrations

Firstly, projectors would be employed to run motion graphic of the illustration work in the exhibition. Exact position of each projector was considered to be the main key of success. The researcher as a result had to adjust position and height of the projectors for several times during the installation. More importantly, all projectors were set up with Minimad Boxes.



Figure 93 The pictures shows the process on set up the bar to hang the projectors

Secondly, the researcher had arranged a long table and put it in the middle of the room. It was an approach that should not be overlooked since a clear and flat table would result in vivid motion graphic on the surface.



Figure 94 The pictures shows the table with paper board covers



Figure 95 The pictures shows the artwork put on the wood board

Thirdly, this step was believed to be the hardest part of organizing an exhibition. It was the final preparation, which included setting up and testing the motion graphic and artwork. Minimad boxes were introduced during this stage with the intention to link projectors with computer. In this step, all motion graphic files were transferred to Minimad boxes and the program will transfer motion to projectors.

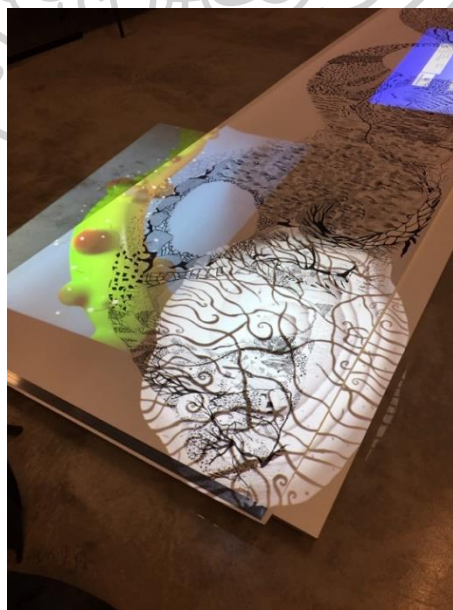


Figure 96 The picture shows projector mapping with the illustration



Figure 97 The picture shows the process of projector mapping in each positions

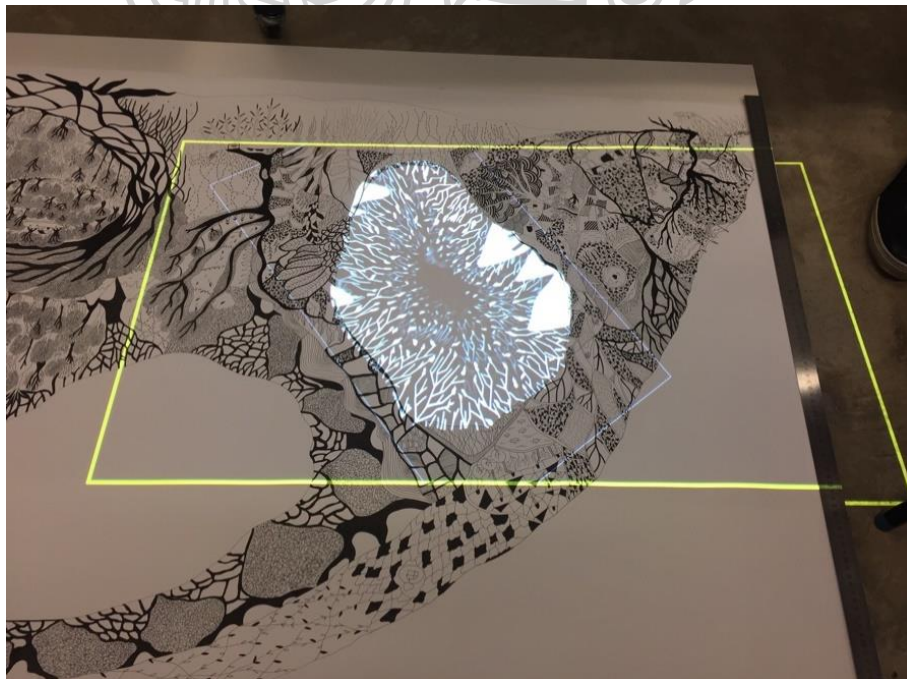


Figure 98 The picture shows the motion graphic that fit in the hand drawing artwork



Figure 99 The picture shows when project the motion graphic on the illustration

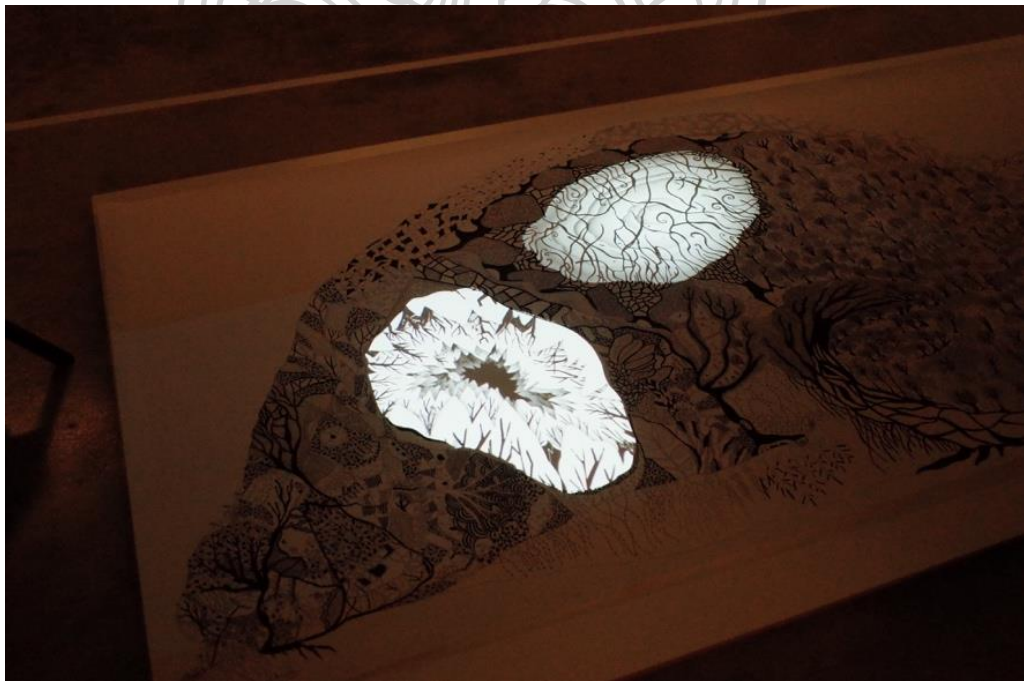


Figure 100 The picture shows the motion graphic in the first part was projected on the artwork

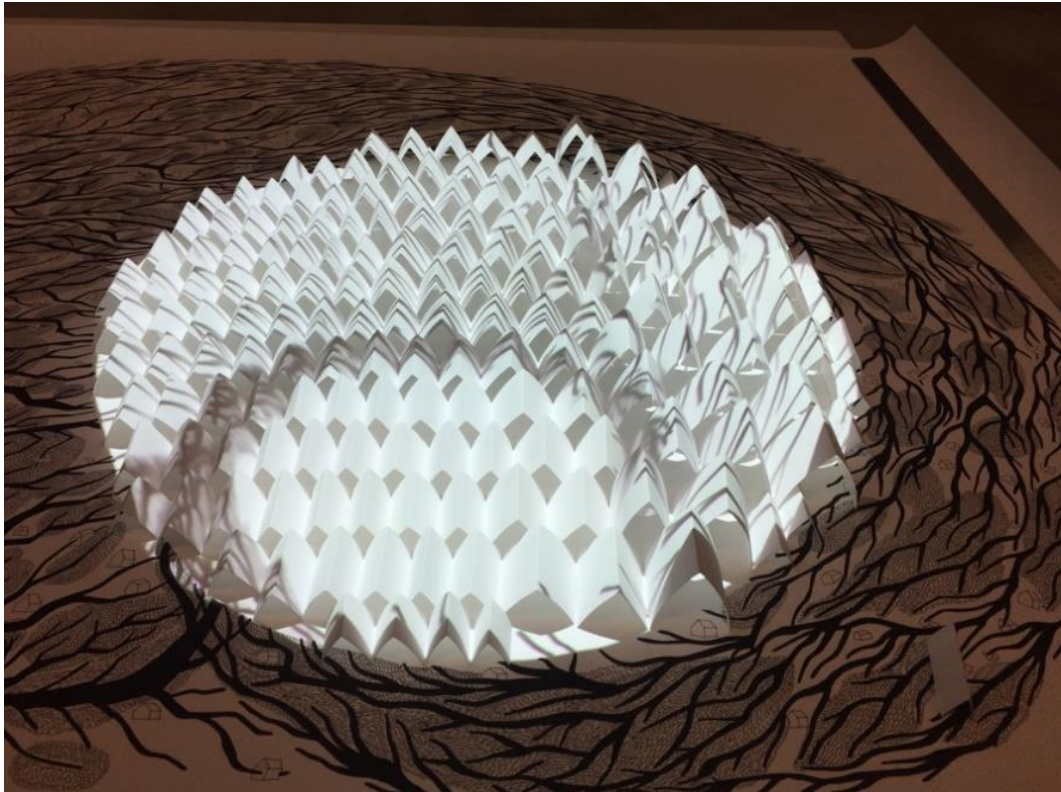


Figure 101 The picture shows the third part of illustration which experiment with small paper sculptures

Finally, the process of the exhibition had to deal with some special techniques. It was an experiment with small paper sculptures. Wishing to make the exhibition became more fascinating, the researcher chose to project the motion graphic on the 3D surface. Audiences would be able to observe and notice continual change on paper work. The last section, however, exhibited the combination work between Fibonacci theory in motion graphic and L-system on small paper sculptures. With various attempts, the researcher tried to give different feeling among audiences.

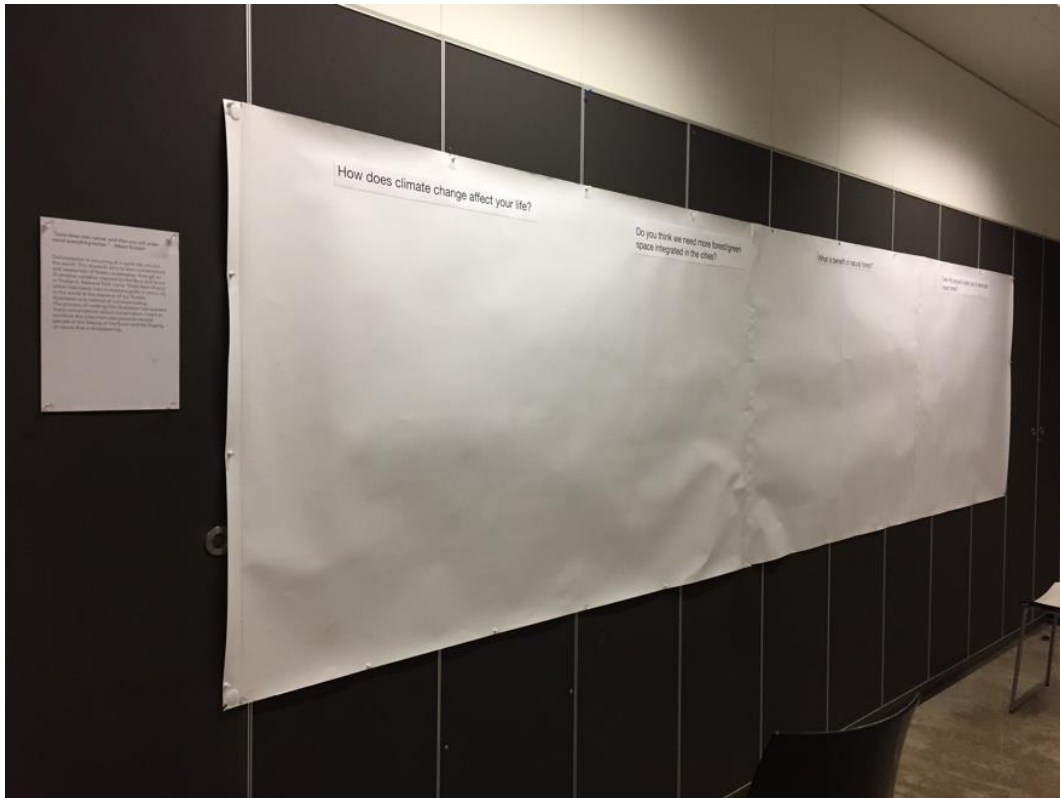


Figure 102 The picture of whiteboard that put on the wall for viewers to write their comments

Acquiring to receive some feedback from the exhibition attendants, the researcher had put up the opinion board. Apart from the opinion board, the researcher had come up with 4 different questions related to the exhibition and artwork as below;

1. How does climate change affect to your daily life?
2. What is the benefits provided by forest?
3. Does this project raise your awareness of the importance of forest and urge you to save it for future generations?
4. Do you agree we should have more forest/green space to integrate in the cities?



Figure 103 The picture of exhibition space at Swinburne university of Technology

The exhibition was exhibited in the university's space which open for public to participate in the exhibition.



Figure 104 The picture of co-advisor Assoc.Prof. Nicole Wragg give the knowledge to groups of student who visit the exhibition



Figure 105 The picture of viewers who visited the exhibition



Figure 106 The picture of the final artwork in the exhibition

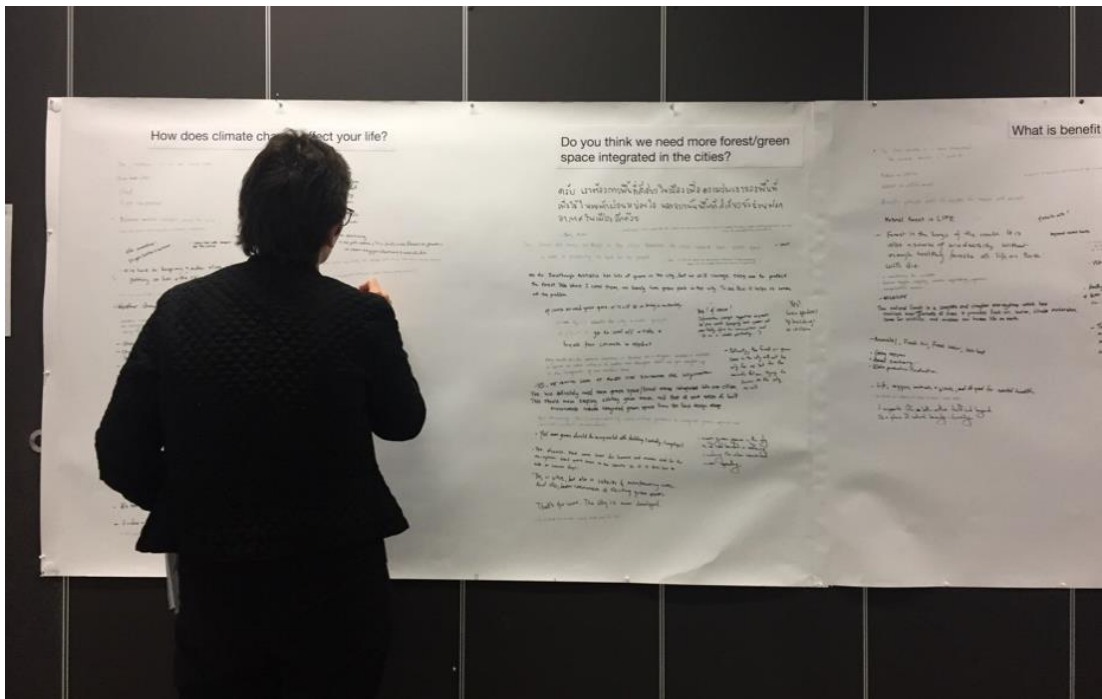


Figure 107 The picture shows when an audience write the answers on the whiteboard

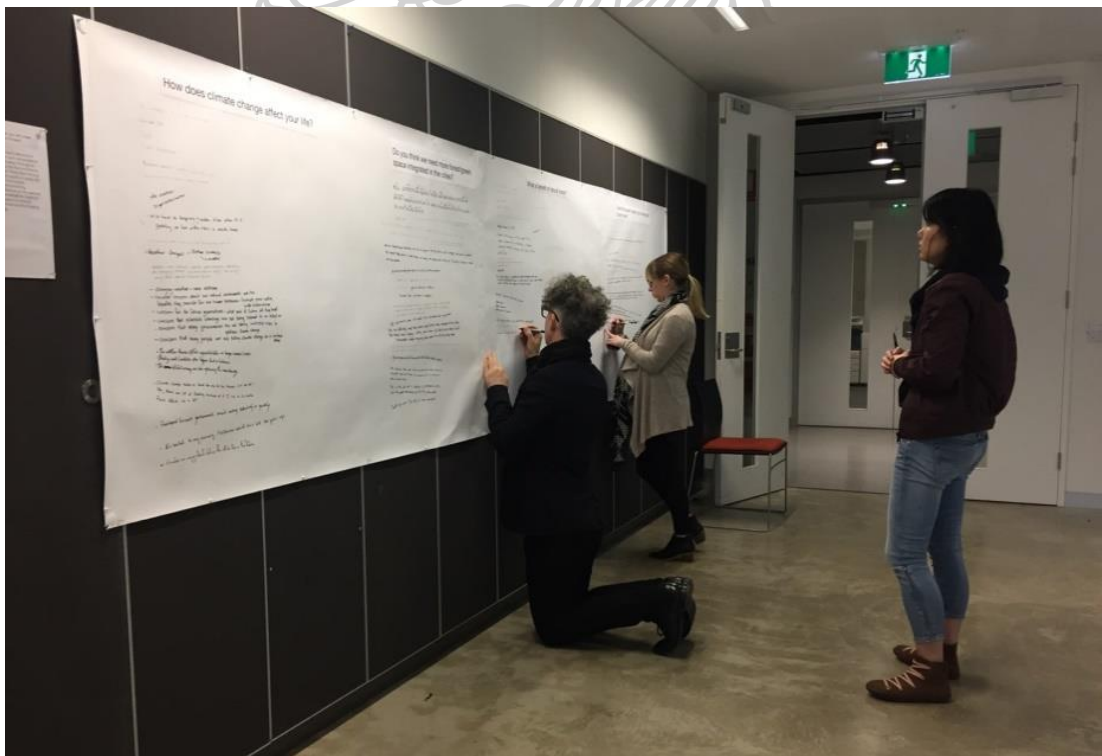


Figure 108 The picture of audiences leaves their opinions about the exhibition

Poster Design

Published poster was required to promote the exhibition in public. Referring to Swinburne University's regulation, the poster needed to be designed according to the university's format. All of the design came from the illustration that the researcher had carefully selected.



Figure 109 The picture of poster design 01



Figure 110 The picture of poster design 02



Figure 111 The picture of poster design 03



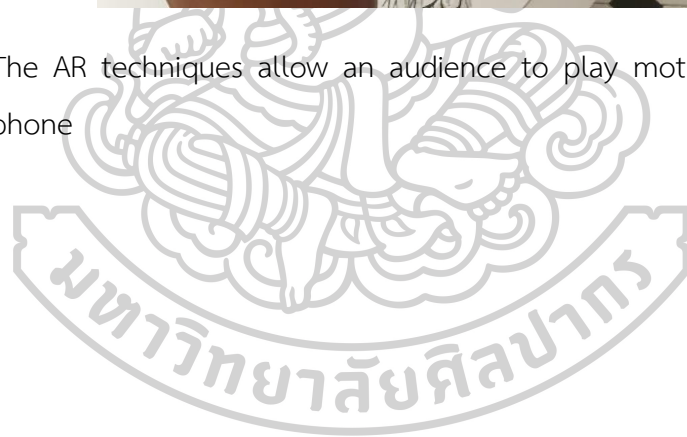
Figure 112 The picture of poster design 04

AR Technique

AR technique was applied to develop to use in the artwork and viewer can download application by themselves to see the motion graphic from mobile phone. This step was developed before the exhibition in Bangkok, Thailand began. Due with limited conditions which in the exhibition couldn't set up the projectors. The application calls 'Artive' which let student, designer and artist uses in their platform and make the artwork more alive. In addition, the viewers can play motion graphic on their phone and record short video to keep in mobile phone too.



Figure 113 The AR techniques allow an audience to play motion graphic on their phone



Chapter 4

Research Result

The research aims at exploring and experimenting visual elements from leaves in order to create story and conversation to audiences in the modernism approach. To sum up, knowledge and information gaining from the research result can be categorized into 3 parts as follow;

- 4.1 Result of data collection
- 4.2 Result of applying Fibonacci Theory and L-system into the illustration
- 4.3 Result of the experimentation
- 4.4 Result of the exhibition (Conversation and awareness)

4.1 Result of data collection

The researcher had done the data collection in Khao Nam Khang National Park area. The national park is considered to be an important rain forest with high diversity of flora and fauna in the south of Thailand. The data collection consists of some important detail like names of the trees and photographs. According to the record, there are 11 tree species that are considered to be significant to the research area.

Economic Plants and Conserved Planted
 Khao Nam Khang National Park,
 Songkhla, Thailand.

11 Types of Tree in tropical rain forest.



Figure 114 The picture of economic plants and conserve plants in Khao Nam Khang National Park

L-System Tree's Branches Data
 from Khao NamKhang National Park.

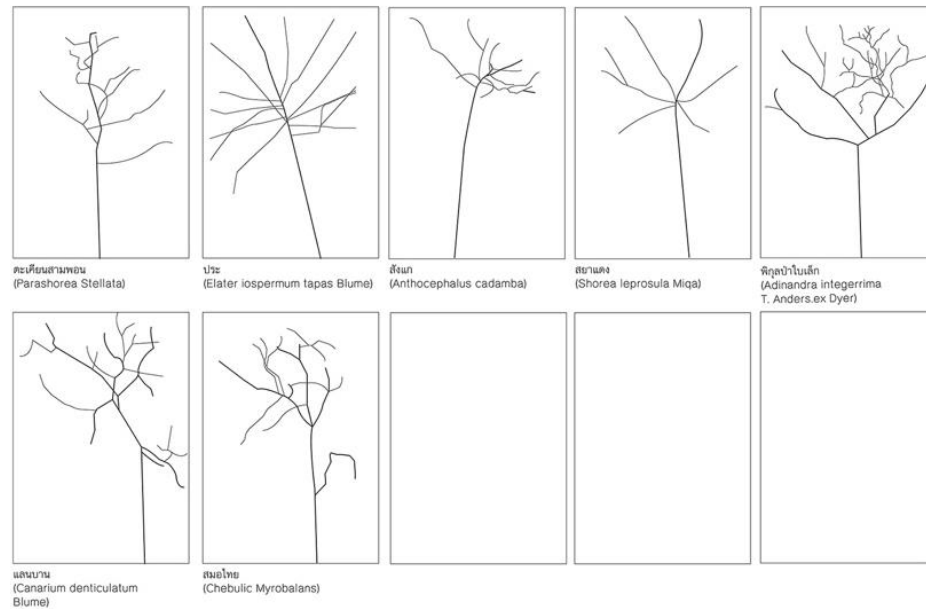


Figure 115 The table shows the result from experiment with L-system to decode tree's structure

Referring to figure 115, the collected data had represented the deconstruction of tree's structure when applying L-system. Although not all the data was implemented in the next process, it could somehow provide some fundamental evidences to users.



Figure 116 The picture shows example of leaves in Summer season from Khao Nam Khang national Park



Figure 117 The picture shows example of leaves in Rainy season from Khao Nam Khang national Park

After analyzing the randomly collected leaves, the fundamental analysis demonstrated that there were 52 different types of leaves as follow;

Table 1 The table shows the amount of leaves which collected from National Park

Season	Amount	Usable	Unusable
Summer leaves	24	23	1
Rainy leaves	28	16	12

As stated in the table above, the information derived from leaves was decoded to implemented in visual elements. From the collected data, there were 24 summer leaves and 28 rainy leaves. While all of the summer leaf veins could be applied in visual element, only 16 rainy leaves out of 28 could be used since leaf veins were quite unclear and could not be applied in the following process.

Summer Season
Visual Element : 23 Veins

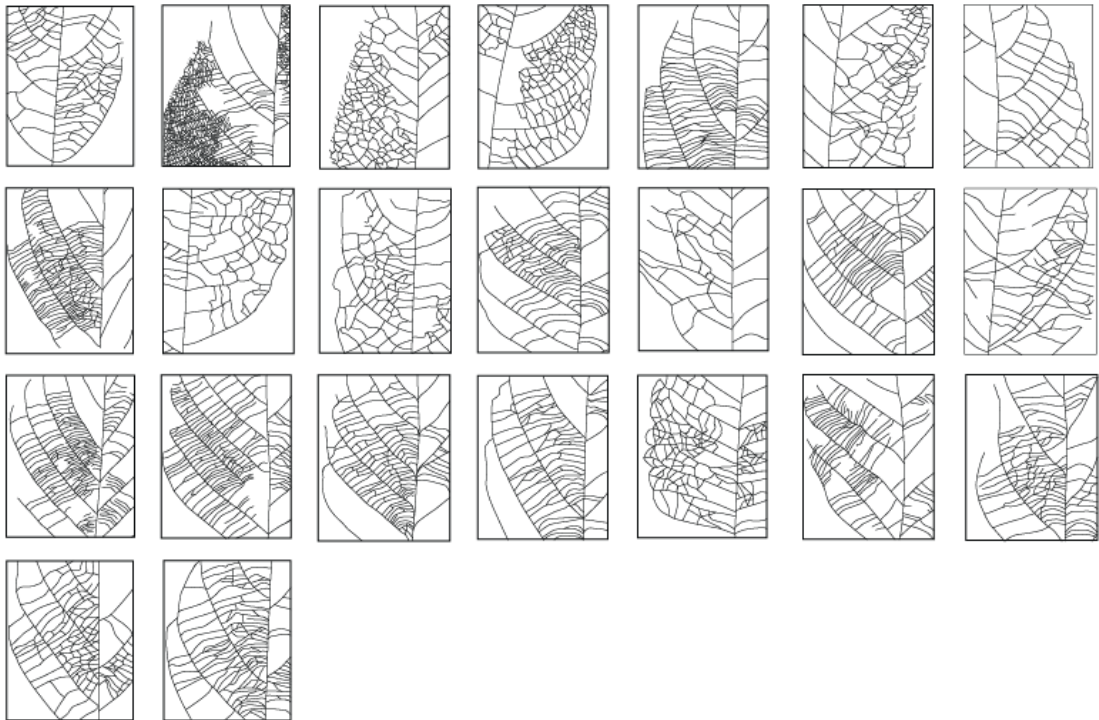


Figure 118 The illustration shows 23 leaf's veins which usable

From figure 118, it shows 23 different types of summer leaves that can be applied in artwork. According to the table, there are 23 types of leaves that already deconstruct visual elements. After the deconstruction process, detail inside each leaf were finally revealed. Somehow, one of the leaves was unable to use in the process since it lacked of necessary detail.

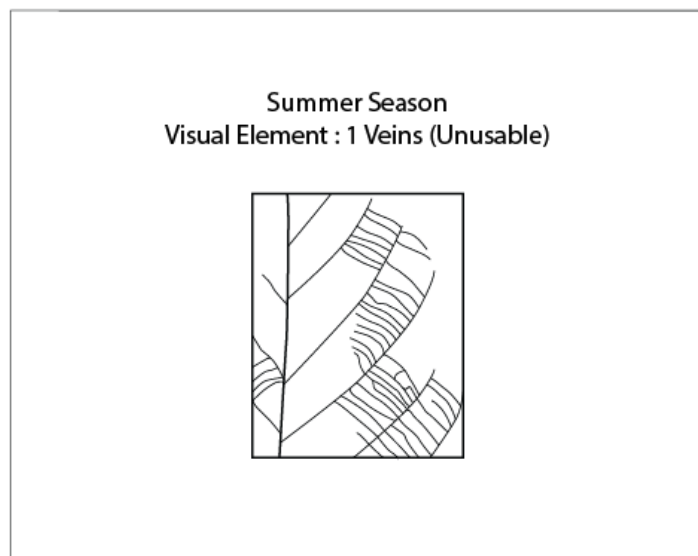


Figure 119 The data shows 1 vein that unusable

Rainy Season
Visual Element : 16 Veins

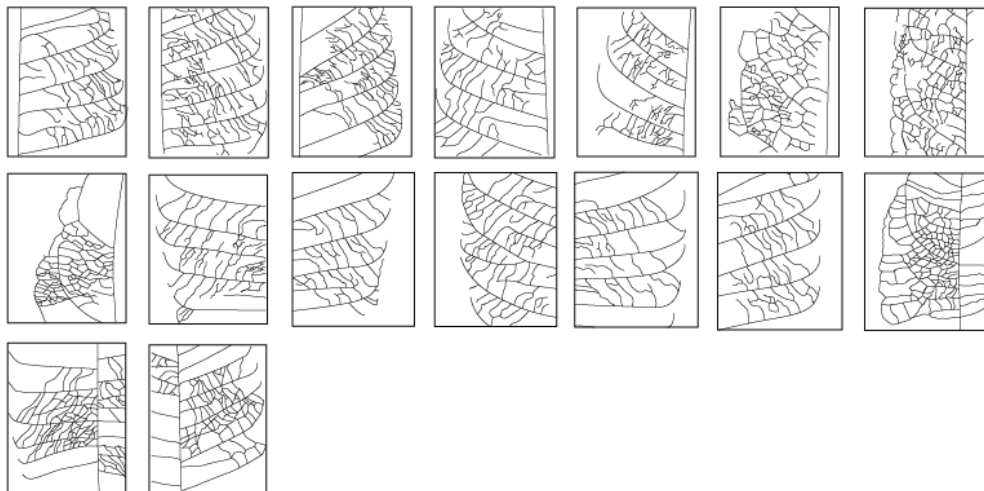


Figure 120 The data shows leaf's vein from Rainy season

According to figure 120, data collection from rainy season leaves shows that only 16 leaves could be able to use in visual element process. Due to some errors in decoding visual elements and limited yielding result., some leaves in figure 121 were unusable in the research.

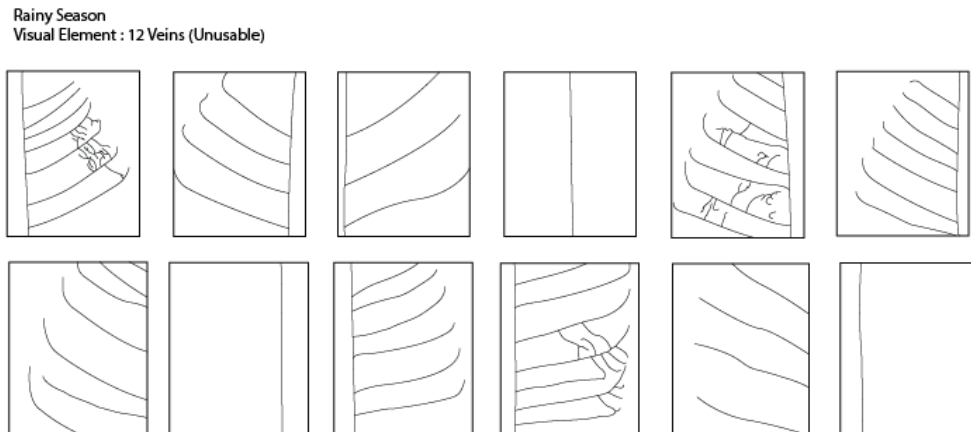


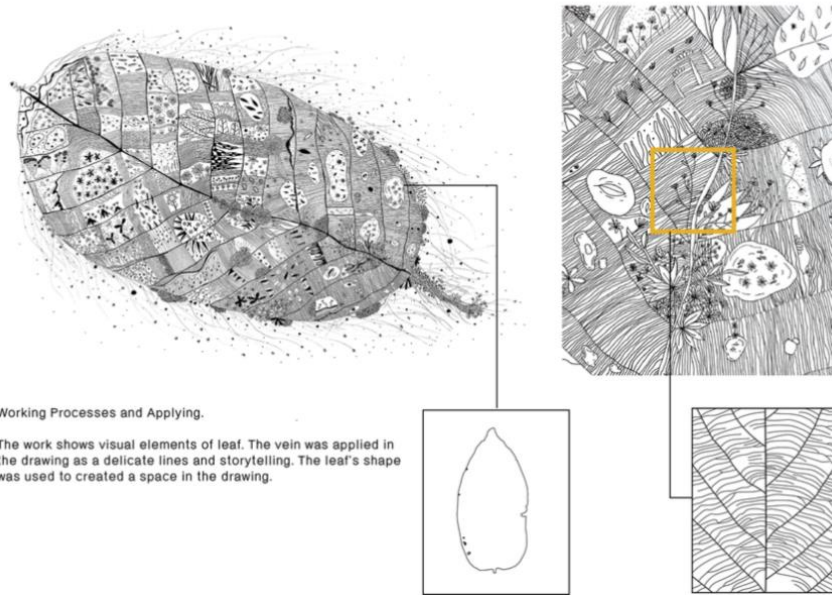
Figure 121 The table shows 12 visual elements of vein which unusable

To sum up, the collected leaves from the research area can be separated into 2 groups as below;

1. Summer group – The Summer group leaves consist of 24 leaves. According to the number, it can be divided into 23 usable leaves and 1 unusable leaf.
2. Rainy group – The Rainy group leaves consist of 28 leaves. According to the number, it can be divided into 16 usable leaves and 12 unusable leaves.

In order to examine different visual element result, leaf veinss are necessary to be carefully inspected. It is found out that summer leaves are more delicate and richer in detail. On the other hand, the rainy leaves tend to show vague detail and simple pattern.

Summer Leaf : Blooming Season



Working Processes and Applying.

The work shows visual elements of leaf. The vein was applied in the drawing as a delicate lines and storytelling. The leaf's shape was used to created a space in the drawing.

Figure 122 The illustrations shows the process of design which use leaf's vein to apply into the artwork

Rainy Leaf : Mellow Season



Working Processes and Applying.

The work shows visual elements of leaf. The vein was applied in the drawing as a delicate lines and storytelling. The leaf's shape was used to created a space in the drawing.

Figure 123 The illustrations shows the process when use visual element from leaf's vein

One concept of designing visual element came from the result of collection data. Wishing to adopt visual elements from leaf veins, the researcher had employed grid in the artwork and created a story associated with its landscape. Because of the similarity between landscape and layout, researcher could apply them in narrative story. Moreover, it was possible to notice from figure 122 and 123 that summer leaves collection played a significant role in visual elements as the conclusion below;

- Leaf veins can be applied as visual element and share the role in the artwork.
- Leaf veins can be adjusted as a pattern or a background of the artwork.
- Leaf veins can share a part of drawing or dividing spaces inside the artwork apart.

Surprisingly, the researcher has found out that different leaf veins yields different landscape during the experiment.

4.2 The result of applying Fibonacci theory and L-system in artwork

Both Fibonacci and L-system principles were adopted to conduct in the research. Fibonacci sequence was expected to be able to design artwork in the storyline. In order to accomplish the goal, the researcher had put a lot of effort in designing artwork in the storyline follow Fibonacci sequence. However, it was later found out that L-system principle was not appropriate with the research since it worked better on 3D work.

Table 2 The table shows capability of applying theory and principle to the artwork

Topic of experimentation	Fibonacci theory	L-system principle
1. Applying with 2D visual element artwork	Very good (4)	Poor (1)
2. Creating storyline in the 2D artwork	Excellent (5)	Poor (1)
3. Conducting main key visual element in the artwork	Very good (4)	Poor (1)
4. Applying special techniques such as specific computer program and motion graphic	Good (3)	Very good (4)
5. Appropriateness to the designed artwork	Very good (4)	Medium (2)

During the research experimentation, Fibonacci theory and L-system principle were employed in practice in order to seek for suitable approach to create artwork. The yielded experimentation outcome could be summed up in 5 criteria as follow;

- (1) Poor – The theory or principle cannot be applied or support the research.
- (2) Medium – The theory or principle can hardly be applied or support the research.
- (3) Good – The theory or principle can be applied or support some part of the research.
- (4) Very good – The theory or principle can be applied or support overall parts of the research.
- (5) Excellent – The theory or principle can be applied or support the research in almost every aspect.

The researcher tried to focus on finding research outcome from 5 different topics above. After the assessment, the conducted research could be concluded as below;

1. Applying with 2D visual element artwork

Since the researcher had focused on employing visual element to create 2-dimensional artwork, the research outcome eventually turned out that Fibonacci could work well with visual element. With that reason, Fibonacci was considered to be in (4) Very good criteria. L-system on the other hand could not handle the approach that it stayed in (1) Poor criteria.

2. Creating storyline in the 2D artwork

Owing to research experimentations, it was found out that Fibonacci could create (5) Excellent storyline in the artwork. However, L-system was categorized in (1) Poor criteria when it came in term of working with 2D artwork.

3. Conducting main key visual element in the artwork

The researcher had put a lot of effort to share message about nature, forest and climate change to audiences. By exploring key visual in the artwork, the researcher had evaluated that Fibonacci could work along with key visual very well that it was noted in (4) Very good criteria. Somehow, L-system could not work well with the key visual that it stayed in (1) Poor level.

4. Applying special techniques such as specific computer program and motion graphic

The researcher had combined 2 different approaches in organizing visual element, hand drawing and motion graphic. In this case, both Fibonacci and L-system were applied in the motion graphic process. The result from the experiments showed that L-system had higher ability to work with motion graphic that it got (4) Very good while Fibonacci got only (3) good.

5. Appropriateness to the designed artwork

According to the experimentation, the research outcome showed that Fibonacci seemed to be more suitable and could work on artwork better than L-system.

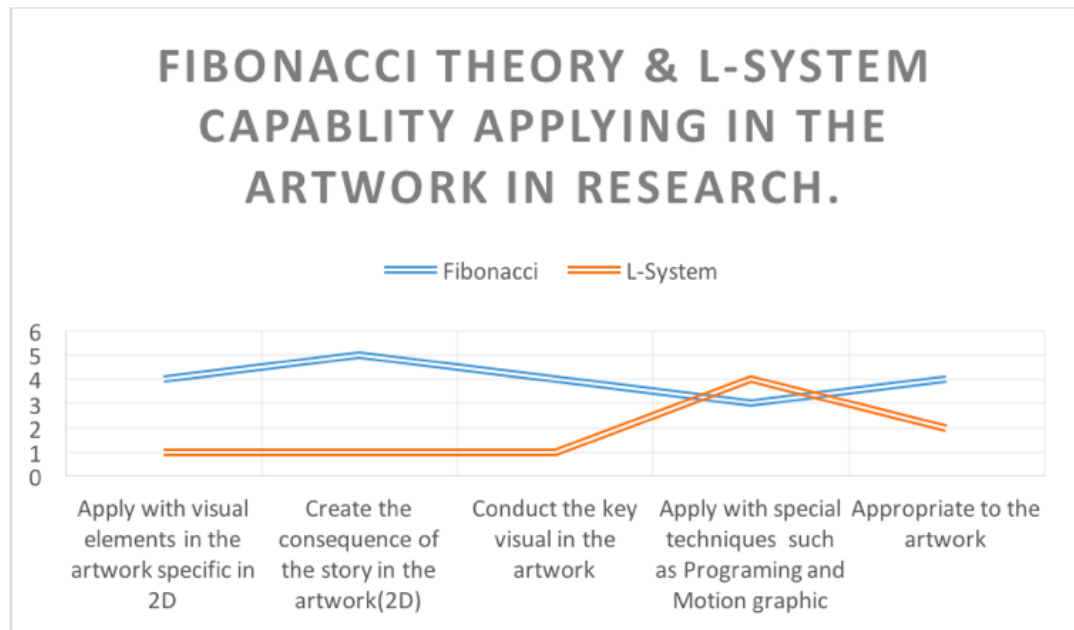


Figure 124 The diagram shows the score of Fibonacci and L-system when applied to use in the artwork

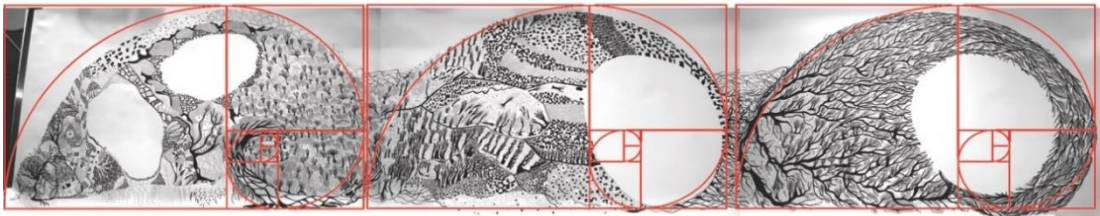


Figure 125 The pictures shows the final artwork which apply Fibonacci sequence into the final artwork

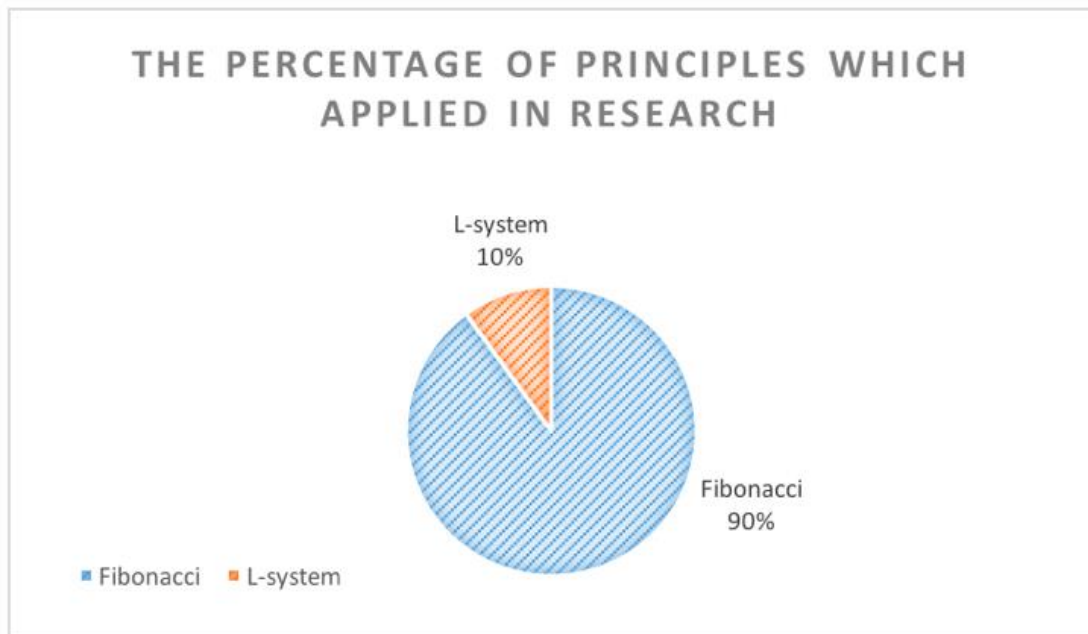


Figure 126 The pie chart show the percentage of principle which applied in research

After conducting the experimentation for several times, the researcher had found out that Fibonacci was more appropriate and practical than L-system. Therefore, Fibonacci was adopted as main principle while L-system shared only 10 percent of the final artwork. While L-system worked well on 3D work, Fibonacci was more suitable for the designed 2D artwork. Hence, the researcher mainly focused on using Fibonacci sequence in the narrative story and employed L-system in the experimentation process and at the beginning of the research.

4.3 The result of experimentation with visual elements and technical terms

Part 1 : Forest and Human

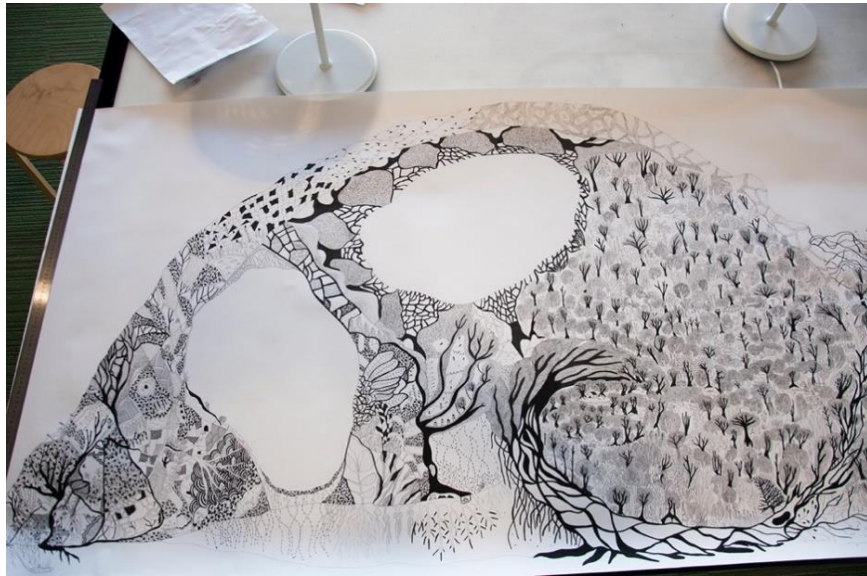


Figure 127 The picture of the final artwork which contain motion graphic and drawing

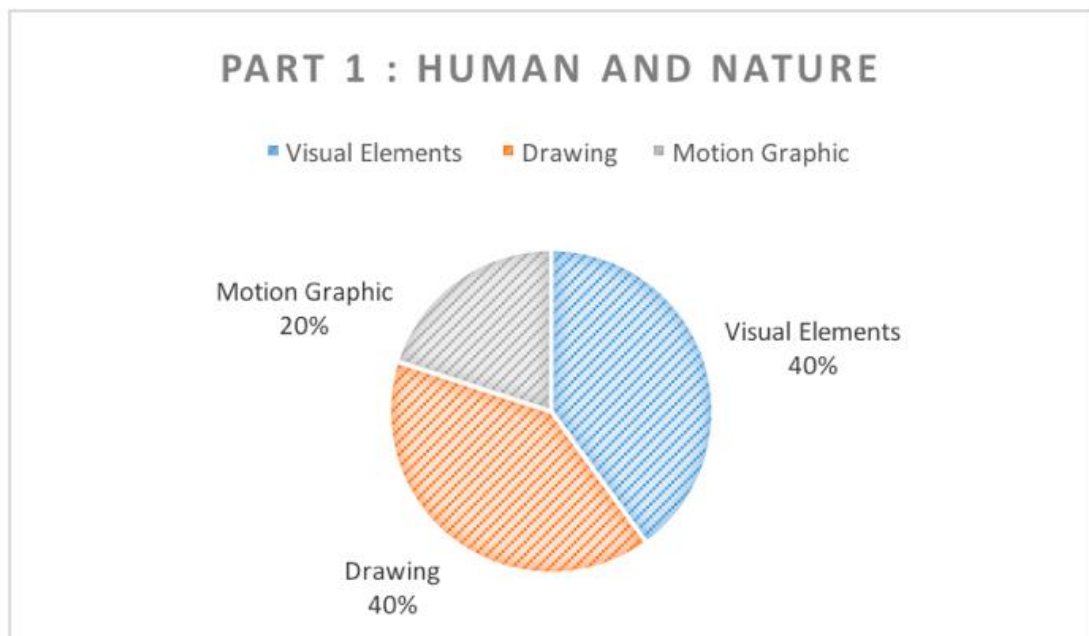


Figure 128 The pie chart shows the techniques that use to create the final artwork

It could be said that part 1 was the starter point of the whole story. Referring to the pie chart above, techniques used to create final artwork could be divided into 3 sections, drawing (40%), visual element (40%) and motion graphic (20%). In the early part of the artwork, key messages were hidden in the drawing part. Moreover, it also represented visual element moving inside the drawing. By embracing visual element with drawing, it surprisingly revealed that visual element could blend up with drawing part harmoniously. In addition, leaf veins could not only play as the layout of drawing part but it could also service as the landscape as well. The first part of the story tried to pass the hidden message about the origin of forest and human. At the beginning of life, both nature and human had similar pattern. They all started from the smallest unit, cell. This section would like to create and introduce dialogue about the importance of nature and the idea that humanity as a whole is totally dependent on nature. In the same section, there are rooms for motion graphic that share the same message as the drawing. By carefully examine details in figure 127, audiences would realize that the two spaces were made up for designed motion graphic. According to the experiment, the difficulty of combining moving image and motion graphic came from the method of how to fill up the gap between the two techniques. After testing for several times, the researcher believed that motion graphic would encourage, attract and bring more engagement among audiences.

Part 2 : Forest and Urban world



Figure 129 The pie chart shows the techniques that use to create the final artwork

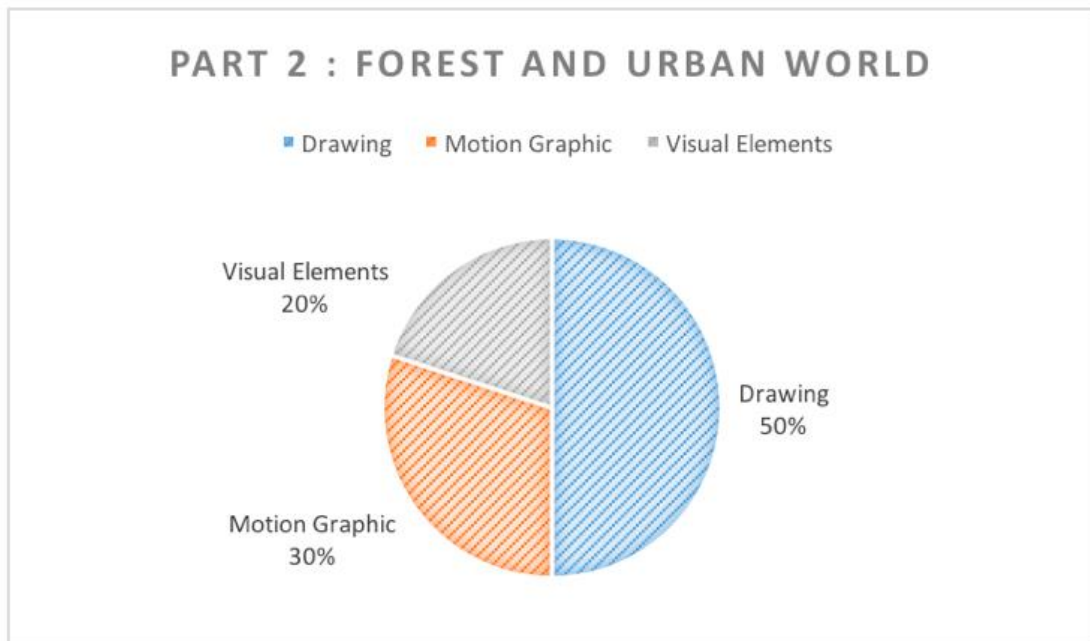


Figure 130 The pie chart shows the proportion of techniques in final artwork

According to the pie chart above, it shows that techniques applied in the 2nd part of the final artwork could be divided into 3 parts, drawing (50%), motion graphic (30%) and visual element (20%). It could be summarized that drawing shared the largest part while visual element shared the least. The other 30 percent, however, were motion graphic showing dialogue about climate change, flooding and deforestation. The story in this part tried to depict how forest could turn into city. Organic shapes and geometric shapes were used as metaphor representing as forest and city area respectively. In this part, the organic shapes would be unraveled and replaced by geometric shapes.

Part 3 : Back to nature

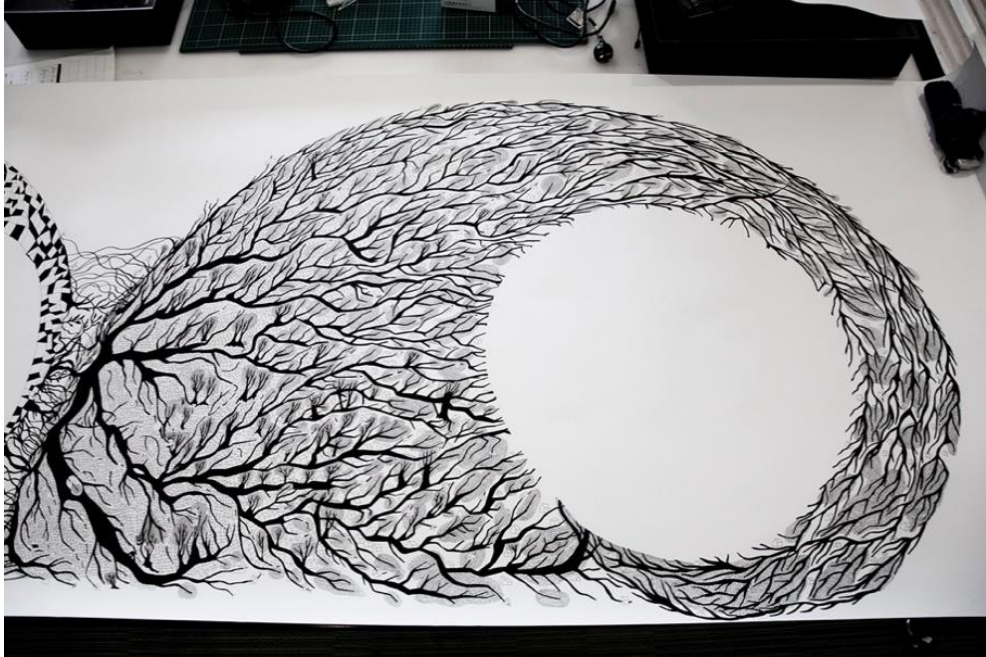


Figure 131 The picture of the artwork in third part which represent power of nature

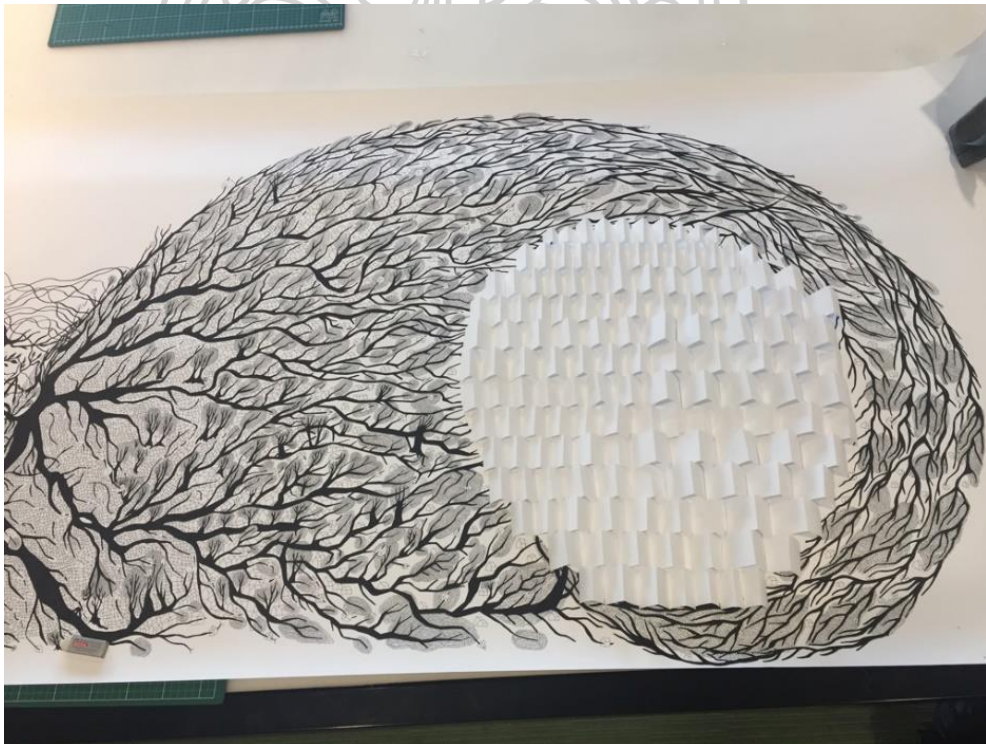


Figure 132 The picture of the artwork which include paper cut as small buildings

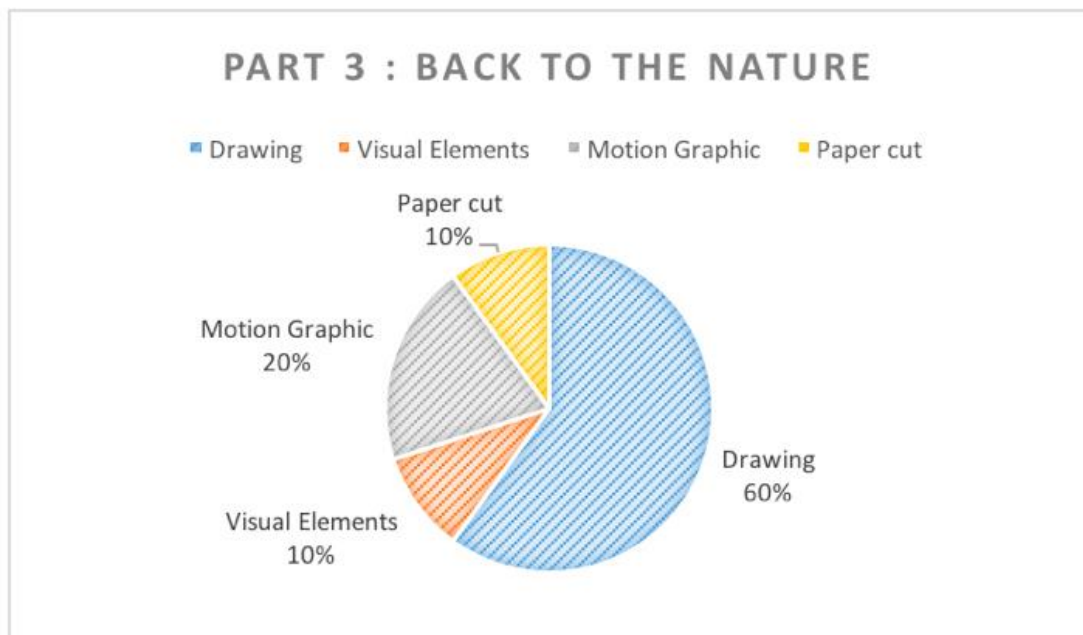


Figure 133 The pie chart shows the proportion which used in the final artwork

According to the pie chart above, it shows that techniques applied in the 3rd part of the final artwork could be divided into 4 approaches, drawing (60%), motion graphic (20%), paper cut (10%) and visual elements (10%). The last part of the storyline represented the power of nature that it would like to reclaim everything back from human. The researcher had done various forms of experimentation including paper cut techniques. The paper cut was a symbol of buildings in the city. Different from other parts, the researcher had added one more technique to visual element, small paper sculptures. However, playing motion graphic on rough surface gave less vivid result when comparing to flat surface.

4.4 Result of exhibition (Encourage environmental discussion and awareness)

The exhibition was held in a classroom in Swinburne University of Technology, Melbourne, Australia and also opened for public. The exhibition had divided the exhibited area into 4 main section as follow;

1. Drawing with motion graphics
2. Video and documentary
3. Data collection book
4. Whiteboard

The main objective of the exhibition was to raise awareness about environmental concern and brought about environmental discussion among audiences. Moreover, further information regarding to research topic was also provided. Opinion board was also provided for audiences who would like to leave their comment and opinion before leaving the exhibition room.

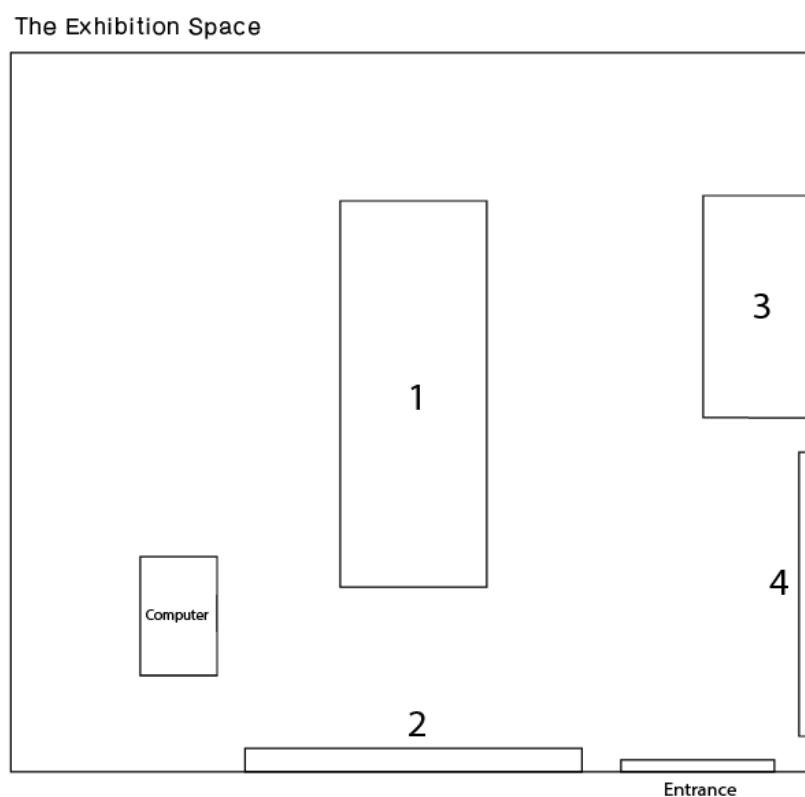


Figure 134 The floor plan of exhibition

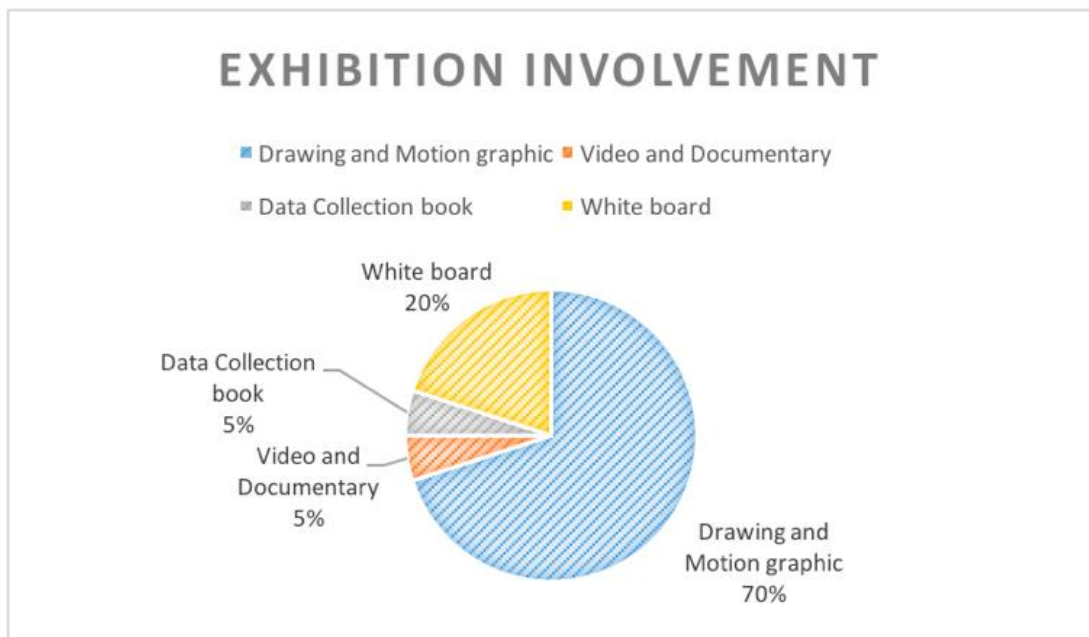


Figure 135 The charts show the percentage which an audience participate in the exhibition

Throughout 4 days, there were 41 audiences attending the exhibition. It was observed that different audience paid his/her attention and engaged with different section. The pie chart above shows the percentage of exhibition involvement among audiences. Result was provided as below;

70% - Drawing and motion graphic

20% - Whiteboard

5% - Data collection book

5% - Video and documentary

To summarize, it was clearly presented that drawing and motion graphic was the most popular section among audiences. Whiteboard, somehow, gained the second popularity. It was an important part of the exhibition since viewers could show their comments and opinions and also started conversation and discussion about environmental concern. Finally, data collection book and video and documentary shared equal 5 percent of total interest and attention.

Wishing to encourage awareness about forest, deforestation and climate change among audiences, the researcher had come up with 4 different questions relating to the exhibition as below;

1. How does climate change affect to your life?
2. What is the benefit of forest and nature?
3. Have you ever thought about integrating green space/forest with cities?
4. Does this project arouse or inspire you to sustain and conserve forest landscape?

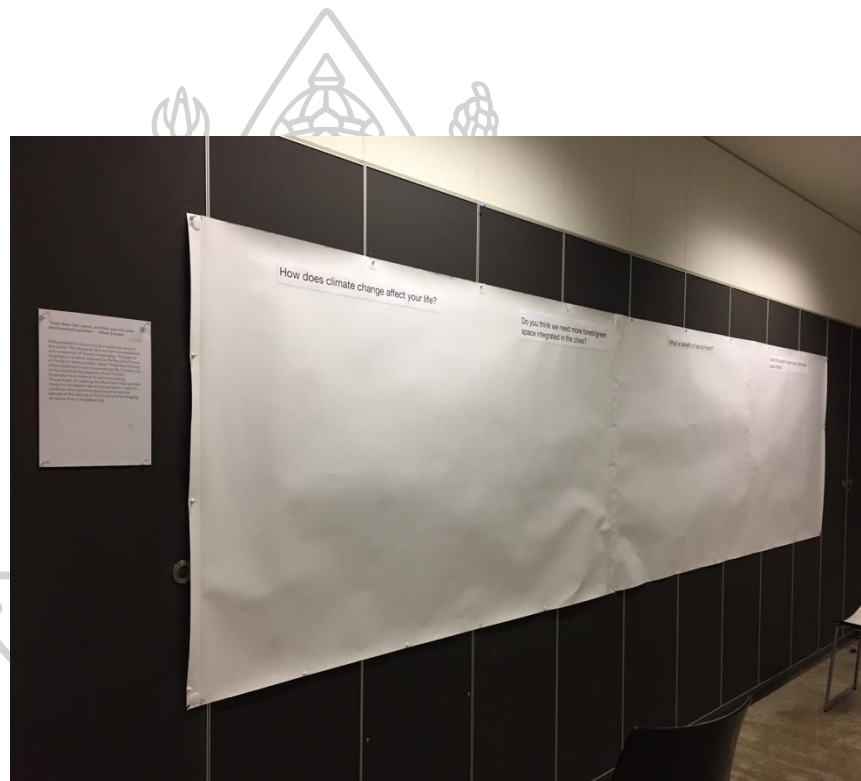


Figure 136 The picture of white board that provided to the viewers to write their comment and answer the questions about the research's questions and exhibition

According to figure 136, it provided questions that encouraged awareness among audiences attending to the exhibition. It could be said that each question had reflected their opinion and attitude toward climate change, forest, deforestation and exhibition. Result of the answer could contribute to research outcome and support some idea from the research.

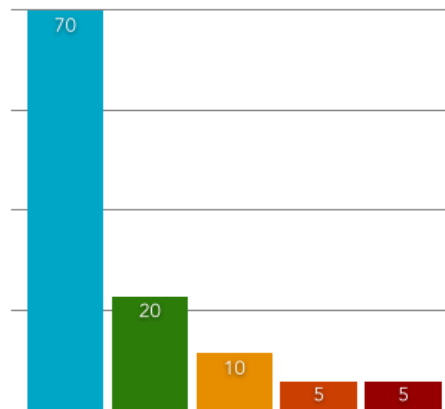
1. How does climate change affect to your life?

- Health problem
- Unpredictable weather change
- Due to the heatwave and heavy rainfall, it is hard to maintain the garden when the weather gets hotter or wetter.
- Since weather becomes more extreme, plant and natural life balance cannot help but decaying from time to time like The Great Barrier Reef. We are at risk of losing more wildlife species.
- The extreme weather results in concern about our future that it affects fresh air, pure water and livable temperature.
- Concern for latter generation, what sort of future will they have?
- Concern about scientist's warning and alarm
- Concern that government section could not take strong action toward climate change
- Concern that other people would not take serious action toward climate change
- Current weather became rather unpredictable, longer summer or winter time.
- Flooding and landslide occurred more frequency back there in Indonesia.
- Ocean marine life diversity was inevitably affected by Global warming.
- I lived in Sri Lanka and climate change really affect my daily life because it is too hot. Also, there are more frequent flood than it was in the past.
- I'm frustrated with the government because they do not take this matter seriously and effectively.
- It is too hot. Recalling from my memory, Melbourne was not this hot 10 years ago.
- I concern about future and what will happen to the next generation if we do not take serious action.
- In Thailand, there is no winter anymore due to the fluctuation of temperature.
- There are a lot of rubbish at the beach.

- There are more dying and endangered species.
- Extreme weather
- Lower penguin population
- Declining number of bees, no pollination, less food, no flowers or plants, no clean oxygen, human and animal will no longer be able to stay
- Climate change causes major flood that destroyed our home, somehow, we were the lucky ones.
- Climate change is the international concern according to the world's system (Economic, culture and social).
- Growing up in Victoria with the western privilege reduce the impact.
- Flood and heat occurred more frequently however I have not been personally impacted.
- The concern about impact of climate change was rooted deep as the future concern that one day every bad thing we have done to nature will bounce back to us.
- I concern about higher temperature. I mean the world is getting warmer, warmer and warmer.
- Summer becomes hotter and winter is milder than it used to be.
- Climate change is the unfortunate result of unconscious human development. WE have continued to destroy nature, our mother which is the source of life. It affects me at a psychological level, where I am worried whether the planet could be sustained for future generations.

After examining opinions of audiences, it could be concluded that unpredictable weather and temperature were the major concerns among people since it affected to their lives directly. Moreover, there were some people stated about other reason such as rubbish and government action.

- The result of **exhibition** (Conversation and awareness)



How does climate change affect your life? (31 Answers)

- Extreme Weather - **70%**
- Dying species of animal - **20%**
- Rubbish and Environment - **10%**
- Future and young generation - **5%**
- Health Problems - **5%**

Figure 137 The charts show the percentage which an audience answer the question

2. What is the benefit of natural forest?

- The first benefit is control templates for the second benefit is fresh air
- Reduce air pollution
- Habitat for wildlife animal
- Forest provide most of oxygen for human and animal
- Natural Forest is life
- Forest is the lungs of the world it is also a source of biodiversity without enough healthy forest all life on earth will die
- A sanctuary for wildlife
- Fresher oxygen supply, carbon regulating systems
- Temperature control
- Wildlife, the natural forest is a complete and complex eco-system which has evolved over vast periods of time. It provides fresh air, water, climate moderation. Home for wildlife and enables our human life on earth
- Animal! Fresh air, fresh water, less heat

- Giving oxygen
- Animal sanctuary
- Water production retention
- Life; oxygen, animal, plants, and it is good health
- Can benefit our wellbeing as place to relax, reduce stress
- It helps to reduce the effects of climate change
- Fresh air! Improved mental health
- It helps to protect a pollenate our environment, as well as being home

to many animals and ecosystems. It's a place for humans to reflect. Rejuvenate and appreciate

- Hiking
- Healthy and natural ecosystem
- Better quality of life for all living beings. Man-made things won't beat natural things

- The natural forest might become a perfect place for vacation, which not for just human but for animals and pets well

- They remind us we are a part of nature just like themselves.
- They balance the functions in our planet
- We enjoy then— our mental well-being
- Connect to nature

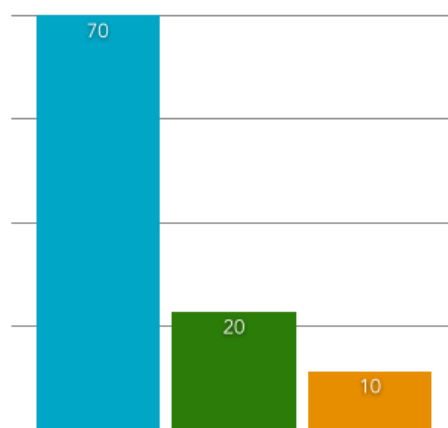
- See untouched nature
- Animals thrive in natural habitats
- Wildlife

- Wonders
- Fresh air and water
- Cleansing
- Mental health
- Health and mind well being

- Everything in the world has needs a balance. nature and forests help keep this natural balance. "Thanks" to humans are losing this. balance due to commercialization. But thanks! To these (you) beautiful people who create such project to spread awareness and rescue the forest.

The second question intends to make a clear understanding toward the importance of forest among audiences. Most of the viewer share their opinion in the same direction. According to their answers, forest is vital and crucial for both wildlife and animal sanctuary. Furthermore, forest also provides oxygen, fresh air and recreational place to all living things on earth.

- The result of **exhibition** (Conversation and awareness)



What is benefit of natural forest? (36 Answers)

- Provide the oxygen and control temperature - **70%**
- Animal Sanctuary - **20%**
- Well-Being and health - **10%**

Figure 138 The charts show the percentage which an audience answer the question about the natural forest

3. Do you think we need more forest/green space integrated in the cities?

- Yes, there are many buildings in the cities therefore cities should have green space in order to producing the fresh air for people

- We do. Even though Australia has lots of green in the city, but we still courage everyone to protect the forest. Where I came from, we barely have green park in the city. To see this, it helps us aware of the problem.

- Of course, we need green space, or it will be so boring and unhealthy

- Green space cool the city and gives people a place to go to cool off and take a break from concrete + asphalt

- Very much so, for various reasons – fresher air, oxygen, birdlife, wild life, a space to calm, relax, to gather our thoughts when we get caught up in the business of our modern lives

- Yes, we sound look at places like Singapore for inspiration

- Yes, we definitely need more green space/forest area integrated into our cities. This should mean keeping existing green space areas, and that all new areas of built environments include integrated green space from the first design stage

- Yes, encourage the corporation of more rooftop gardens to integrate green spaces into concrete, modern contractions.

- Yes! More green space should be incorporated with building vertically rooftops

- Yes, of cause. Need more trees for human and animals and for the eco-system. Need more trees on the streets so it less hot to walk in the summer days

- Yes, in cities, but also in suburbs and also, better conservation of existing green areas

- That's for sure. The city is more developed

- It would be nice to have. Councils should plan for this

- We need more space greener and greener in cities, but also more people engaged in this area

- Yes, it would reduce people's stress + encourage them to do more physical activity outside

- Yes, of cause. Deforestation bring negative impacts to the world. Bringing back greens will more likely affected the communities and life as a whole positively

- Definitely, the forest or green space in the city will not be only for us but for the animals that are trying to survive in the city as well.

- We should live in harmony with nature. We don't need cities intergrade human life with nature

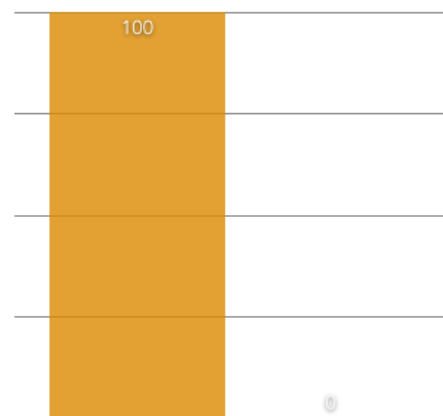
- Yes, we need more green spaces, particularly in urban areas

- We need old trees. Green/forest is not enough. It has to be the right forest

- Yes! Grow gardens up buildings to reclaim
- Sure, I love this idea of integrating green spaces into cities

It can be concluded from the third question that the entire audiences agree that green space should be provided in their town, city and urban area.

- The result of **exhibition** (Conversation and awareness)



- **Do you think we need more forest/green space integrated in the cities?**
(22 Answers)

- Yes, we need - **100%**
- No, we don't - **0%**

Figure 139 The charts show the percentage which an audience answer the question about green space in the cities

4. Does this project inspire you to save your closet forest?

- It shows relationship between human and forest. The project inspires me to save the world

- Yes, the ideas of this project inspire me to think about the value of forest

- Yes, I may not be to plant or build anymore forest, but I wouldn't destroy any

- It makes me think how everyday decisions that we make in our lives, have a cumulative effect on nature over time

- Yes, any project like this inspire me to save our nature, forest, ocean etc.

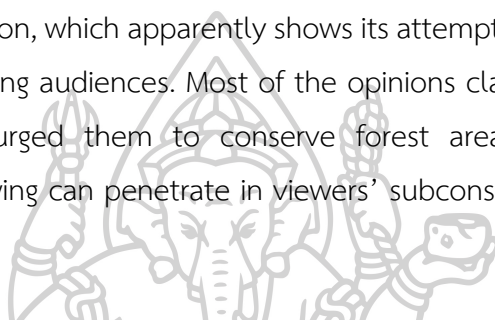
- Yes, It's beautiful
- Yes. It highlights the complexity, intricacy + beauty of the forest. It gets you thinking about what could be lost
 - yes, it shows how the forest is desperately trying to hold onto what is there. We need to be worry of what deforestation contributes to humanity
 - Reminds me of the beauty that mother earth has given us, for me to do my bit to have a lighter 'foolprint' environmentally
 - Yes, this project deepens awareness of the complexity, beauty and integrate systems within the forest inspire viewers to know more about the forest near them, and to visit them. If these forests under threat, then this project may inspire viewers to take action to save them
 - Yes, of cause. It is beautifully made. It makes you realize the importance of seeing trees and the impact of deforestation
 - Yes, it is a good reminder of what we have and are losing it made me want to have a closer look into what I've done to help preserve nature
 - It makes me think about how we communicate deforestation + effects differently
 - It encourages me to me more mindful of the conservation effects taking place in my local area
 - Impressive drawing. It shows your passionate which inspire me to save our plants
 - This project reminds me of how important of having a forest is. Not just for the benefits of it but how important it can change the quality of living for all living things in this planet. So, save the planet, save the world
 - Yes, I think human are destroying the world out of greed. We might not be able to restore the world completely, but we can bring positive changes. I will probably think about the forest more through small actions (e.g. Not littering) and probably start a small garden to start having a small green by myself
 - Yes! This is a collective human effort and we all need to do our part to look after our world
 - Inspires we are appreciated nature more

- It is necessary to save forest in our towns to build an environmentally friendly

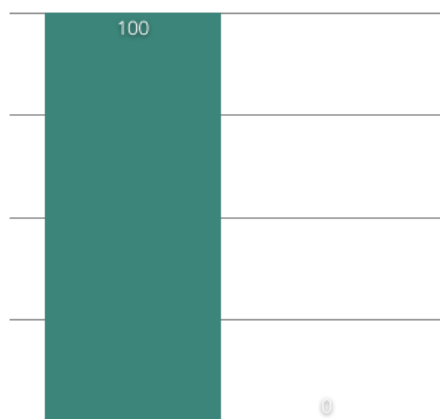
- Yes! The philosophy of de-forest ration and nature taking over is illustrated beautifully in this project

- Yes, but I do not know where the forest is. I think I should be living in a forest and maybe 300 years ago if I live here, I would be, So I am inspired to save this. Forest, of the future

It can be said that the last question directly relates to the final artwork and the whole exhibition, which apparently shows its attempt into communicating and raising awareness among audiences. Most of the opinions claimed that the exhibition really inspired and urged them to conserve forest area. Therefore, it can be summarized that drawing can penetrate in viewers' subconscious while leaving them some messages.



- The result of **exhibition** (Conversation and awareness)



- **Does this project inspire you to save your closet forest?**
(22 Answers)

- Yes, it does inspire to save the forest - **100%**
- No, it doesn't inspire to save the forest - **0%**

Figure 140 The charts show the percentage which an audience answer the question to save the closet forest

Chapter 5

Conclusion of the research

The aims of research are to contribute knowledge from studying elements from nature especially from leaves in Khao Nam Khang national park. The research attempts to collect data and producing the collection which provide sufficient information and knowledge to use in education and design platform. According to the research objectives, the result can be concluded as below;

Conclusion

5.1 To establish the significant of nature by studying elements of leaves.

The research had brought the smallest elements such as veins from leaves and developed them to use in art and design area. In addition, the research also attempts to study and understands the nature so it needs to consider deeply into the details to gather the delicate information which can provide the knowledge to develop and bring out significant of nature. The research outcome shows the result can establish the significant of the nature by bringing the aesthetic, details and information to create the artwork which communicate about forest, deforestation and climate change to the public.

5.2 To collect and analysis visual elements of leaves as a data collection.

The objective of this topic tries to analysis the visual elements from leaves and create the data collection guild book which gather the visual elements to use in other design areas or in education platform. The research reaches the goal by collecting around 40 – 50 leaves from research area and decoded all the visual elements. Therefore, all the information in data collection provide the knowledge, information and visual elements which designer, artist, student and researcher can use these data to apply in their career. Furthermore, in the analysis methods shows the processes which present the techniques, concept and ideals of research.

5.3 To create visual communication design by applying Fibonacci theory and L-system

The research attempt to experiment Fibonacci theory and L-system principle to use in design processes. Moreover, both Fibonacci and L-system were applied in visual communication design. The research examines the theories to explore the capability of Fibonacci and L-system which involve the natural ideal. Fibonacci is the most famous theory that was used in various areas, for example, mathematics, science, art, and design. Although, it is widely used in science fields yet also extensive in the art world. As we know, the Fibonacci consequence can use to manage composition as we call 'Golden ratio'. Furthermore, L-system as so-called Lindenmayer system which used in programming to predict the form of tree's growth in 3 dimensional.

L-system's principle also supports the scientist to understand the plant's structure. On the other hand, the researchers experimented with both Fibonacci and L-system together and the research discovered the results that Fibonacci more suitable to apply in visual communication design(drawing) since it can create the perfect composition for the drawing and provide the good function for narrative while L-system was used at the beginning of research yet the result was unsuitable to 2 dimensional artwork. L-system has the potential to support the basic data such as tree's structure and form despite it unfitting with a 2dimensional work. In the opposite, L-system can make the researcher understand the fundamental knowledge of growth. Eventually, the research only chooses a Fibonacci theory to exert in the final artwork and apply to use in drawing.

5.4 To build up the awareness about forest conservative and climate change to the people.

The aims of research not only study and experiment in technical terms yet including relevant visual communication design by focus on illustration. The significant of the research is created the conversation and build up awareness about forest conservative and climate change via artworks. The exhibition was set up to the public at Swinburne university of Technology, Melbourne, Australia to disseminate the knowlege. However, to build up the awareness and create conversation

need to combine with conceptual ideas and attractive techniques so the research used traditional drawing to symbolize the nature and used motion graphic to represent the technology. Those two techniques are just a tool to create the artwork, yet it has stronger concept behind the aesthetic about nature, deforestation and climate change which effect human life. In the end of visiting exhibition and observe all the artworks, the audience had a chance to give the opinions and answers the question that relevant to the research. The significant of research cannot success without people's opinions since it reflects the result of research which achived the objective.

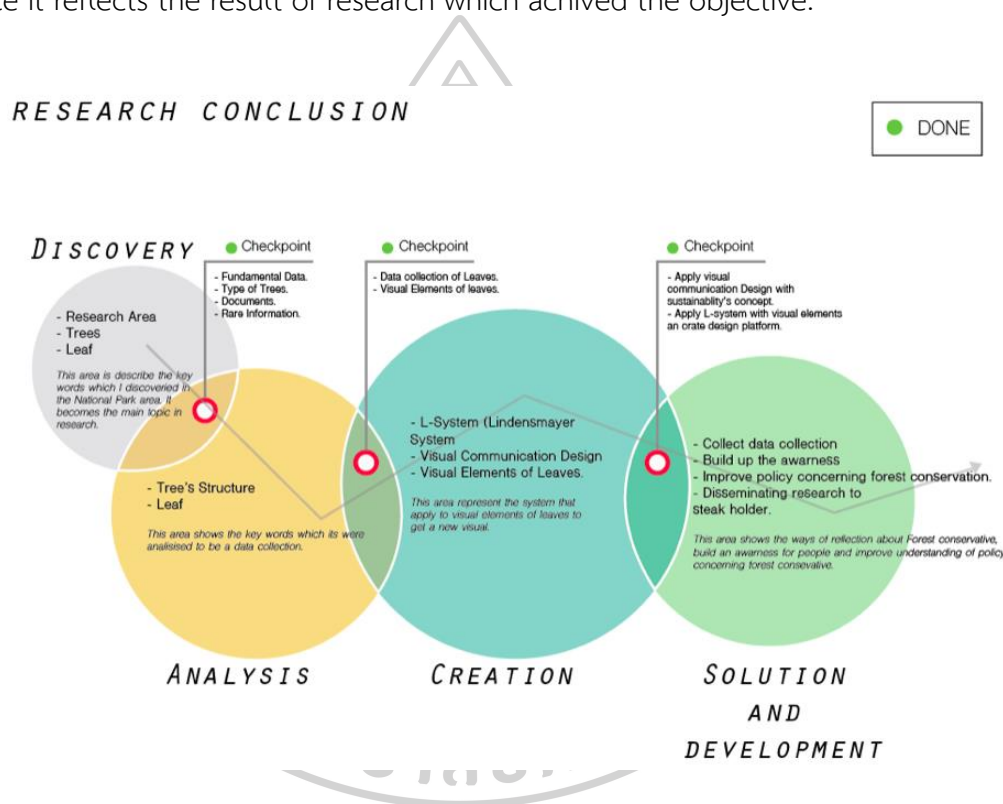


Figure 141 The diagram show the research conclusion in research

The research development in the future

1. The method of research focus on decode the visual element from nature which can apply to use in other design areas.
2. The research's results show the ability of visual communication design which can communicate the climate change issue in artistic way.

3. The research achievement not only come from the design processes yet from the key message that can convey the story of forest, deforestation and climate change which occur around the world nowadays.

4. In technical terms, research venture to get involve with new technology as motion graphic combine with traditional hand drawing to metaphor the parallel world between nature and technology which seems cannot encounter in the real the world, but it happens in the artwork.

5. The Fibonacci theory and L-system principle can apply to create design and artwork in the future.

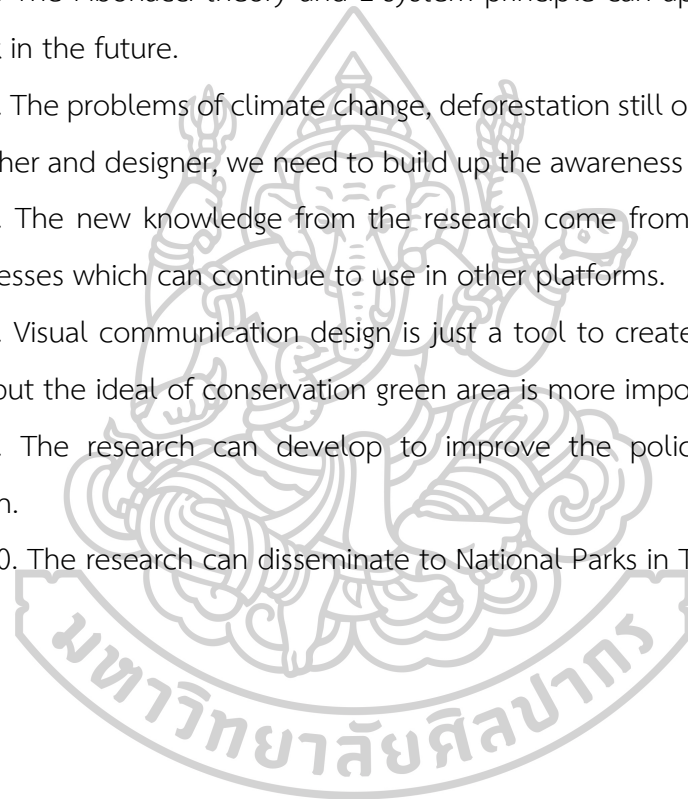
6. The problems of climate change, deforestation still occur in the world but as a researcher and designer, we need to build up the awareness to young generation.

7. The new knowledge from the research come from research processes, design processes which can continue to use in other platforms.

8. Visual communication design is just a tool to create a conversation and awareness but the ideal of conservation green area is more important.

9. The research can develop to improve the policy concerning forest conservation.

10. The research can disseminate to National Parks in Thailand.



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