

EXPLORATION OF EDUCATIONAL BUILDING WITH CULTURAL ELEMENTS USING SHAPE GRAMMAR

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EXPLORATION OF EDUCATIONAL BUILDING WITH
CULTURAL ELEMENTS USING SHAPE GRAMMAR

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THESIS SUBMITTED IN FULFILMENT OF THE DEGREE OF
COMPUTER SCIENCE(GRAPHIC AND MULTIMEDIA
TECHNOLOGY)

FACULTY OF COMPUTER SYSTEM AND SOFTWARE
ENGINEERING

2013



UNIVERSITI MALAYSIA PAHANG

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I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

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SUPERVISOR DECLARATION

I hereby declare that I have read this thesis and in my opinion this thesis/report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Computer Science ()

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Supervisor Name:

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ACKNOWLEDGMENTS

First and foremost praise be to Almighty Allah for all his blessings for giving me patience and good health throughout the duration of this Exploration of Educational Building with Cultural Elements using Shape Grammar research.

I am very fortunate to have Dr Lee Ho Cheong as my research supervisor. He has helped me a lot in my thesis writing, such as providing guidances, ideas and some resources for the shape grammar research. I would like to express my utmost gratitudes to him as he is such patience in reading my work and comment on my mistakes that I had done.

Also, I would like to express my high appreciation to my family for all their support and assistance along the way which cannot be expressed in words. Moreover, I am grateful to other colleagues, especially Tan Shu Ying and Lau Siew King who had helped me in my thesis writing process and other related work.

I would like to thank to Puan Rahmah Mokhtar, as she provides me useful guidelines and information for my final year project thesis writing. I would like to express my gracious gratitude to her.

ABSTRACT

Shape grammars are used for developing computational algorithms in production systems that generate geometric shapes. Existing researches on shape grammars in applications focus on product design, pattern generation, residential building design and architectural design. However, research on the educational building design with different aspects in functions and environments are not much addressed. This research explores the application of shape grammars in generating educational building designs with cultural, functional and artistic issues. Basic building blocks for Western, Chinese, European and Malay culture are developed to construct the educational buildings. Existing building blocks like L-shapes oriented with specific angles could be combined to form a new building concept. This new concept can uniquely represent a particular educational building characteristic. During the design process, other rules are activated to embed new shapes within the basic building block. The rules are executed to generate designs to provide students a spacious environment for study and related activities. Other concepts like pure, rational and energy saving are also expressed by the rules. The system takes into account of different requirements like costs, functions, space, culture, environment, the number of classrooms, public halls, windows and doors. For example, the urban areas in Kuala Lumpur consist of many high rise buildings, like office buildings, residential apartments and others. Under these constraints, a stylistic educational building with high scores can be generated by the system as it suits this particular set of requirements. In future, more on-site applications and surveys will be conducted to verify the advantages in using the system to explore educational building designs. Other enhancements would be the automation of the formulation and execution of the shape grammar rules by integrating artificial intelligence techniques such as fuzzy logic, neural network and genetic programming.

Keywords - Shape grammar, educational building, environmentally friendly

ABSTRAK

Bentuk tatabahasa yang digunakan untuk membangunkan algoritma pengiraan dalam sistem pengeluaran yang menghasilkan bentuk geometri. Penyelidikan yang sedia ada pada bentuk tatabahasa dalam aplikasi memberi tumpuan kepada reka bentuk produk, generasi corak, reka bentuk bangunan kediaman dan reka bentuk seni bina. Walau bagaimanapun, kajian mengenai reka bentuk bangunan pendidikan dengan aspek yang berbeza-beza fungsi dan persekitaran yang tidak banyak dicadangkan. Kajian ini meneroka penggunaan tatabahasa bentuk dalam menjana reka bentuk bangunan pendidikan dengan isu-isu budaya, fungsi, dan seni. Blok binaan asas untuk budaya Barat, Cina, Eropah dan Melayu yang dibangunkan untuk membina bangunan-bangunan pendidikan. Blok bangunan yang sedia ada seperti bentuk L yang berorientasikan dengan sudut tertentu boleh digabungkan untuk membentuk satu konsep bangunan baru. Konsep baru yang unik boleh mewakili ciri-ciri tertentu bangunan pendidikan. Semasa proses reka bentuk, kaedah-kaedah yang lain diaktifkan untuk menerapkan bentuk baru di dalam blok bangunan asas. Kaedah-kaedah yang dilaksanakan untuk menjana reka bentuk untuk menyediakan pelajar persekitaran yang luas untuk kajian dan aktiviti yang berkaitan. Konsep-konsep lain seperti penjimatan tulen, rasional dan tenaga juga dinyatakan oleh peraturan. Sistem ini mengambil kira keperluan yang berbeza seperti kos, fungsi, ruang, budaya, alam sekitar, bilangan bilik darjah, dewan, tingkap dan pintu. Sebagai contoh, kawasan bandar Kuala Lumpur yang terdiri daripada banyak bangunan tinggi, seperti bangunan pejabat, pangsapuri kediaman dan lain-lain. Di bawah kekangan ini, sebuah bangunan pendidikan gaya dengan markah yang tinggi boleh dihasilkan oleh sistem kerana ia sesuai dengan set keperluan tertentu. Pada masa hadapan, lebih banyak aplikasi di tapak dan kajian akan dilaksanakan untuk mengesahkan kelebihan dalam menggunakan sistem untuk meneroka reka bentuk bangunan pendidikan. Tambahan lain akan automasi pengubalan dan pelaksanaan peraturan tatabahasa bentuk dengan mengintegrasikan teknik kepintaran buatan seperti logik kabur, rangkaian neural dan pengaturcaraan genetik.

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CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

What is shape grammar? From our first point of view, the term seems unfamiliar to us. However, after several times of studying and interpretation, shape grammar, which was defined by Jay P.M and Jonathan C., 2006, means “a set of shape rules which can be applied in a sequence, beginning with an initial shape, to create shapes in the languages defined by the grammar.” Shape grammar is widely used in engineering field, for example; Agarwal and Cagan (1998) introduced the coffee maker grammar and Andrew I-Kang-Li (2003) explained the shape grammar used in analysing the architectural design.

Architectural design, on the contrary, is an application of diverse skills to produce an architectural form. In my country, Malaysia, the construction of educational buildings nowadays consumes a spacious area and building materials. However, the architectural design of the building is yet simple and doesn't have any special representation of meaning.

Therefore, the design for academic building with some cultural elements, like the Western, Chinese, Malay and Europe cultures by using shape grammar would be implemented as to promote the unique culture elements in our country to be nationwide. In addition, the educational building design will also include some environmental requirements and the functionality of the building in order to meet the aesthetic and sociological impact.

1.2 PROBLEM STATEMENT

There lie some problems in the implementation of shape grammars with culture elements in the design of educational building. Firstly, the shape grammar can really generate a sufficient amount of patterns, although different cultural elements are implemented. Besides that, in what way can the building design associated with environmental issues and rather than novice users, who will also be using this design software system.

1.3 OBJECTIVES

- (i) To develop educational building shape grammar with cultural and environmental friendly elements.
- (ii) To explore educational building designs under constraints of cost, function, culture, environment, space, material and location.
- (iii) To evaluate alternative educational building designs for urban planning in different cities.

1.4 SCOPE

The project scope has been identified to develop the prototype of building design as listed below:

- (i) Explore educational building designs according to specific culture and constraints.
- (ii) Program model using MEL script in Maya.
- (iii) Target users are students, architects, civil engineers and design company.

1.5 THESIS ORGANIZATION

This thesis consists of six (6) chapters. Chapter 1 discuss on the introduction to the research in exploring educational buildings with cultural elements by using shape grammars. Various techniques in constructing the shape grammars and some environmental requirements that will be used also being discussed in this chapter.

Chapter 2 describes on the literature review of shape grammar from related journal articles. Besides, various techniques used in shape grammar for different shape grammar applications were being discussed.

Chapter 3 discuss on the methodology that will be used in the exploration of educational building with culture elements using shape grammar. The techniques, analysis, the project and software methodology used for this project were being discussed.

Chapter 4 discuss about the design and implementation of this exploration of educational building with culture elements using shape grammar. The design of the interfaces, the generation of shape grammar rules and also some MEL coding will further discuss in this chapter.

Chapter 5 discuss about the results and constraints. Results such as whether this program application achieved the objectives listed earlier and discuss on the constraints met when developing this program.

Chapter 6 conclude all the works done in this research project.

CHAPTER 2

LITERATURE REVIEW

Shape grammar which was declared by Ietyn Jowers, (2006) as the “formal production system, where particular aspects design processes are represented by form and are defined according to shapes and rules applied to those shapes.” This shape grammar technique was applied in various fields, such as engineering and architectural field, computer graphic field as well as painting and sculpture. For example, shape grammar was being used to analyse the art of Tibetan Tangka paintings and to help the designers to generate and evaluate their ideas during the conceptual phase of the design process in the engineering field. Moreover, in recent years, shape grammar was used widely across computer graphic, computer game and animation. They used shape grammar in games, where they construct the structures of the buildings and also to model the artificial machine which have some human characteristics. Design, on the other hand, is a technique to produce a new paradigm of patterns through some specific requirements. For example, design an educational building with some culture and environmentally friendly elements.

The article of Harmonised Shape Grammars in Design Practise, discussed about the development of shape grammar in designing a harmonious and contextual based design objects by using the theory of Natural Language Processing. As Arus Khunket, (2011) suggest that “shape grammar is useful when applying in the architectural domain, rather than a product design domain”. The author also commented the shape grammar is useful in architectural design, but not so useful in product design pattern. On the other hand, he declared that using natural language in designing product may achieve to a harmonious and contextual design product pattern. Besides that, there are several processes involved in the natural language processing process, which consists of reasoning, factual data retrieval, and generation of an appropriate table form, graphic or natural language response. In addition, the technique of genetic algorithm, like the selection, recombination and mutation phases also being used in the production.

The technique mentioned will be used in the design of the architectural education building. For example, the initial shape pattern will change in its patterns when the rules are applied, where the shape will change in its position, either in horizontal or vertical or at any degree.

According to Liebich. (1994), he explained that “ a shape grammar includes logical rules, which act in a limited amount of elements of the same vocabulary and create a set of similar objects, based on the same syntax. These shape rules are used to produce new and alternative states of the design process. Thus, a shape grammar generates a language of design.” He interprets the techniques of constructing shape grammar rules into two, that are syntactic and semantic structures, where for syntactic structure refers to a set of language elements and a set of rewriting rules that are fully expressed ; while, for the semantic structure, is faced with task communication. In addition, artificial intelligence technique also being discussed. The knowledge based was implemented as mentioned in the paper, where it can include the links between the data on the condition side and the action side of different productions.

In the thesis, both the syntactic and semantic structures are the important elements in the design of architectural educational buildings. Besides, the vocabulary of design language should include culture and environmentally friendly elements. The semantic structure will only interchange the surface patterns of the shape without destroying its structure. For example, the replacement of rectangular to circular windows in the whole building can be achieved by changing the corresponding rules. The whole design skeleton remains as specified in the semantic structures. The environmental friendly element will also be implemented in the design of educational building using shape grammar, which will use the natural resources, such as a beam of sunlight and others instead of electricity.

There are two types of chaining, that are forward and backward chaining. Forward chaining which claimed by M. Negnevitsky, as the data driven reasoning. In the context, he claims that “this reasoning starts from the known data and proceeds forward with that data. Each time, only the topmost rule is executed. When fired, the rule adds a new fact in the database. The match-fire cycle stops when no further rules can be fired. On the other hand, backward chaining as the goal driven reasoning, which the knowledge base

has the goal (a hypothetical solution) and the inference engine attempts to search the evidence to prove it.” System such as CODE (Column Designer) has been developed to support the automation of generating the colonnade by following different orders, modules and spacing.

However, these rules based systems have a limitation in generating the emergent design. Therefore, further discussion will be needed. Due to time constraints, such technique will not be considered in the implementation.

In another study of the effects of design on automobile styling perceptions, the researchers use the software like ConceptMorph, which is a computer-aided concept design system to perform the product shape morphing and to modify the product shapes and also features by using free-hand sketches. Besides, the researchers also conducted conjoint analysis, where this method can investigate the effects of design features on the perception of automobile styling designs. During the design phase, the researchers select the design features that will be investigated, then by using conjoint analysis to compute the joint effect of the design pattern.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this methodology of the research, details about the instruments or methods used to conduct the investigation on exploration of educational building with cultural elements by using shape grammar will be discussed. This research consists of information about participants, data collection method, survey questionnaires, data analysis, the implementation of cultural elements, shape grammar rules, materials and methods used, hardware and software used, and Gantt chart.

3.1.1 Participants

A survey will be conducted among University Malaysia Pahang students and lecturers. This survey involved randomly selected third year students and some lecturers from the Faculty of Civil Engineering and Natural Resources (FKASA). A quantity of 15 questionnaires will be distributed and answering by the students and lecturers of FKASA for both genders.

3.1.2 Data Collection Method

The data collection method use in this study was aimed at exploring the design structure of the educational building with cultural elements by using the shape grammars, which will be used by the architecture students and lecturers. The data collection instrument that will be used in this study is surveying questionnaire.

3.1.3 Survey Questionnaire

A number of questions will be asked as a source to explore the design of educational building with cultural elements by using shape grammar among third year students and lecturers of FKASA. The survey consists of 10 questions and all are closed-ended questions. The closed ended-questions were multiple choice questions. These questionnaires will be handed out by me only. Questionnaire method is chosen because it is an effective, fast and convenient way to obtain the result. In PSM 1, the survey is for planning of shape grammar, while in PSM 2, the survey is for the implementation.

3.1.4 Data Analysis

All the data obtained from the survey questionnaire will be analysed by using Microsoft Excel spreadsheet in order to calculate the overall view of the respondents towards the exploration of educational building by using shape grammar. The analysed data will then be presented in value and percentage, which are in the form of histograms and pie charts. Next, the design and implementation will be made according from the result shown.

3.2 Methods and material used

In this project, the methodology is separated into two parts, which are the methodology for the system development and the methodology for the project development. Both methodologies will be discussed in the chapter below.

3.2.1 Methodology for Project Development

The figure below shows the system flow for the Shape Grammar System

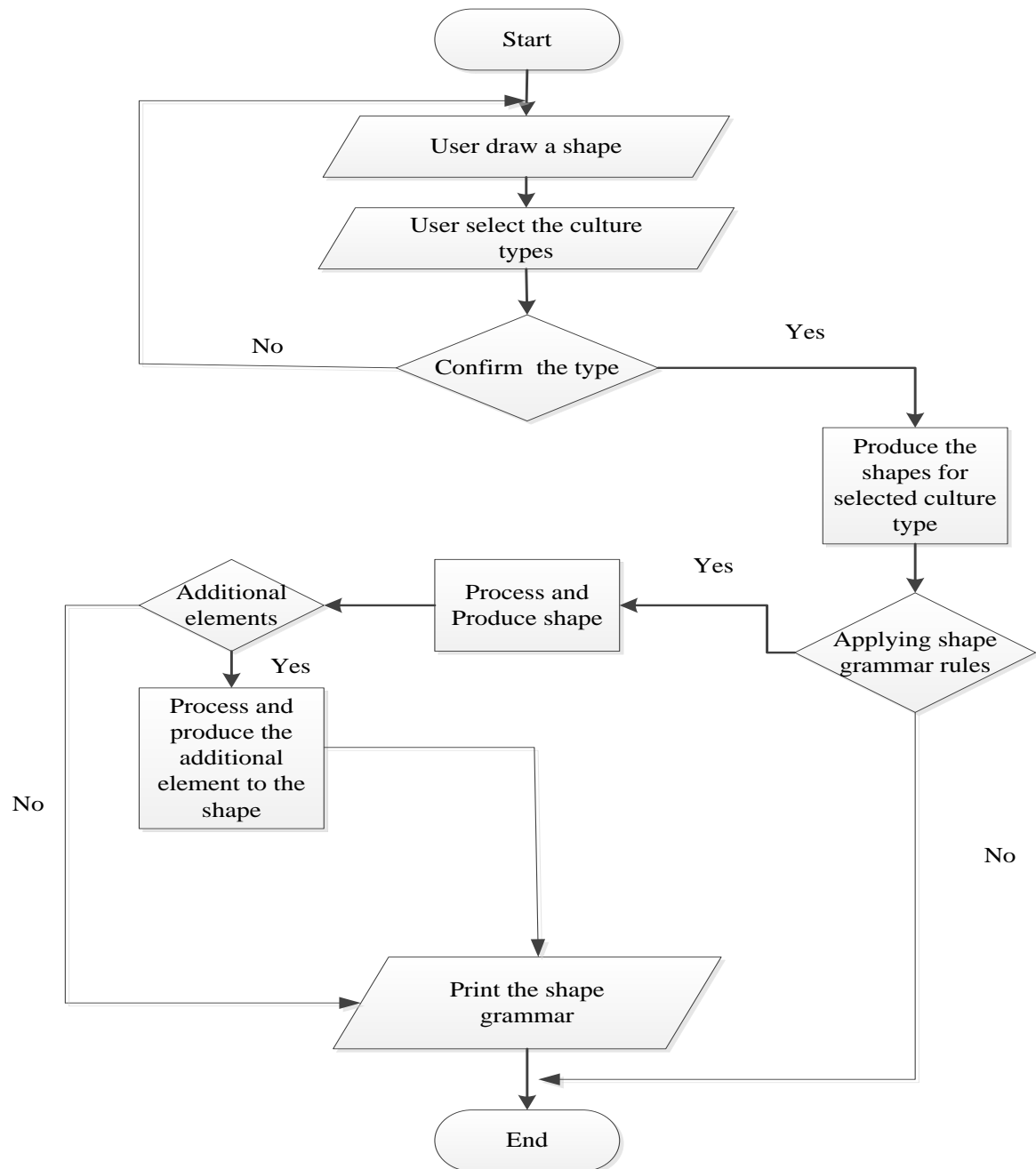


Figure 3.1: Flow of the shape grammar system

Step 1: Analysis

(4) Analysis of Educational Building

The analysis of existing educational building, such as the old educational building can be performed through the observation and also searching for the history recorded. From the observation, we get to know the details of the building design structure physically and its function. For example, the architectural structure information provides us useful information on how the building was designed.



Figure 3.2: High School Muar building

The figure 3.3 shown the educational building of High School Muar. This building was built in 1914 and was constructed according to the colonial-style.

(b) Analysis of Culture

The analysis of the culture will be performed through the study and understanding of the architectural concept and structure of a foreign country, for example, the Republic of China. These architectural concepts can be accessed from the publication of the architectural book materials, where different designer proposed their innovative ideas of culture through constructing the architectural building with different kinds of shape pattern. Furthermore, we can also searching the related information through online. Besides, we can also gather some of the requirements or opinions of the user through the distribution of survey forms. This

method also can help us to identify the user requirements more clearly on the design of educational building with cultural elements by using shape grammar.



Figure 3.3: Tiananmen Square, Beijing, China



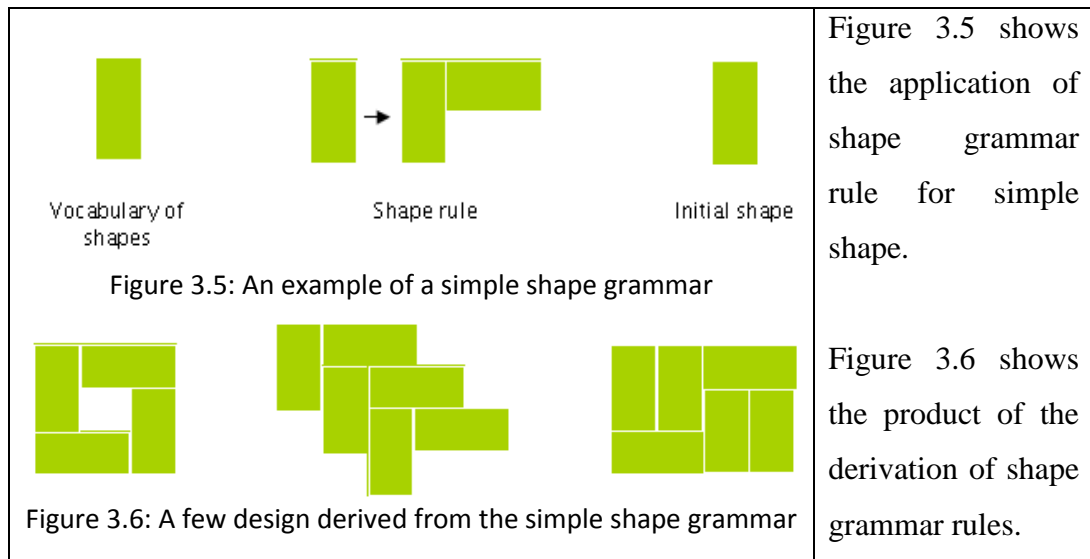
Figure 3.4: Model Animal Research Center, Nanjing, Jiangsu

The figure 3.3 and 3.4 shown about the Tiananmen Square and the research centre. From both figures, we can find some similarity, that is both architectural building used square shape in their design. Besides, the roof design in Chinese culture has some curve up shape design.

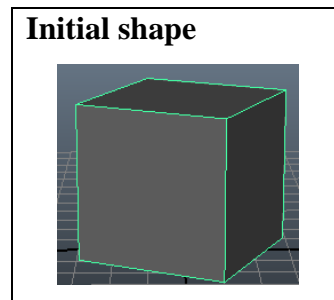
(c) Analysis of Shape Grammar

The analysis of shape grammar was conducted from studying of various related journals and research articles, such as using shape grammar in product design, pattern formation, residential design and so on. From the study, we would get to know the basic framework on how the shape grammar be functioned. For example, we can refer to Figure 3.8 below where the kindergarten building in Finland was using shape

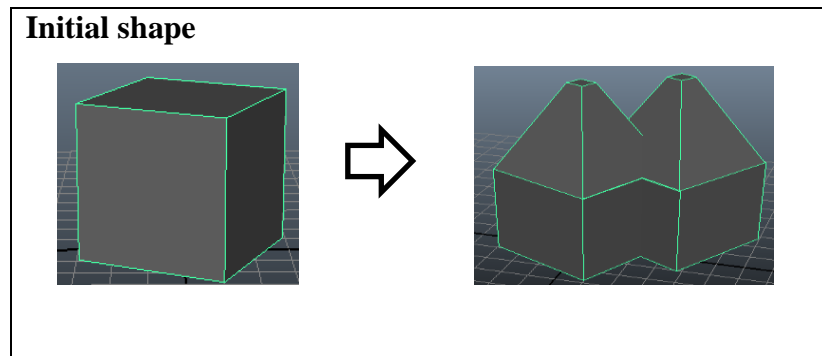
grammar technique in its building design. As a result, a modern and characteristic building was established.



- There are several logical phases in developing and using the shape grammar.
 - i. Create the shape
 - In this step, users will have to create any patterns of shape as an initial shape.



- ii. Compiling the grammar rules
 - In this step, the user will able to apply the shape grammar rule according to each of the cultural elements.



iii. Finalize for the shape grammar design

- In this step, user can save their desired shape grammar design structure.

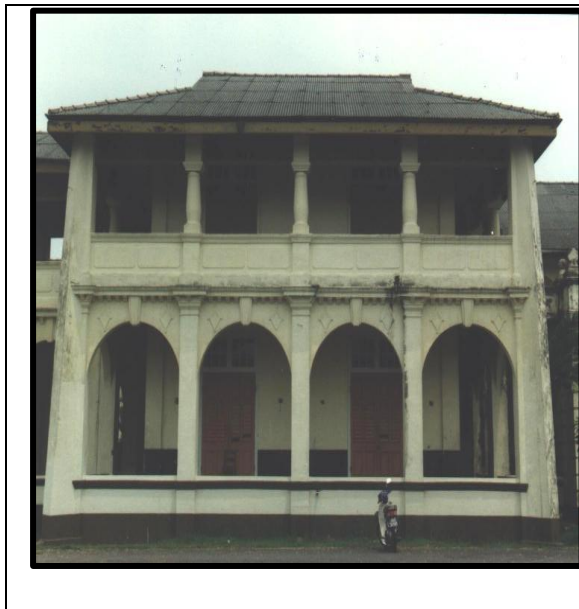


Figure 3.7: The existing educational building of High School Muar



Figure 3.8: The kindergarten building design using shape grammar in Finland.

Step 2: Design the system

(a) Design system flowchart (refer to Figure 3.1)

(b) Design the system interface

- Additional buttons are added to the Autodesk Maya 2012, that are shape grammar and culture buttons, so that user can understand easily and use. (refer to APPENDIX B)

(c) Design the system database

First step :

All the shape grammar patterns will be designed and save accordingly in each of the cultural elements in the database.

Second step :

In the user interface, an additional column of shape grammar will be added, and this additional column will enable the user to select the different cultural elements.

Third step :

The shape grammar patterns will be retrieved from the database when user selected, and then, transform the initial shape of the shape that was being selected. Finally, the user can save the design educational building model into the database in Maya binary(.mb) format for future use.

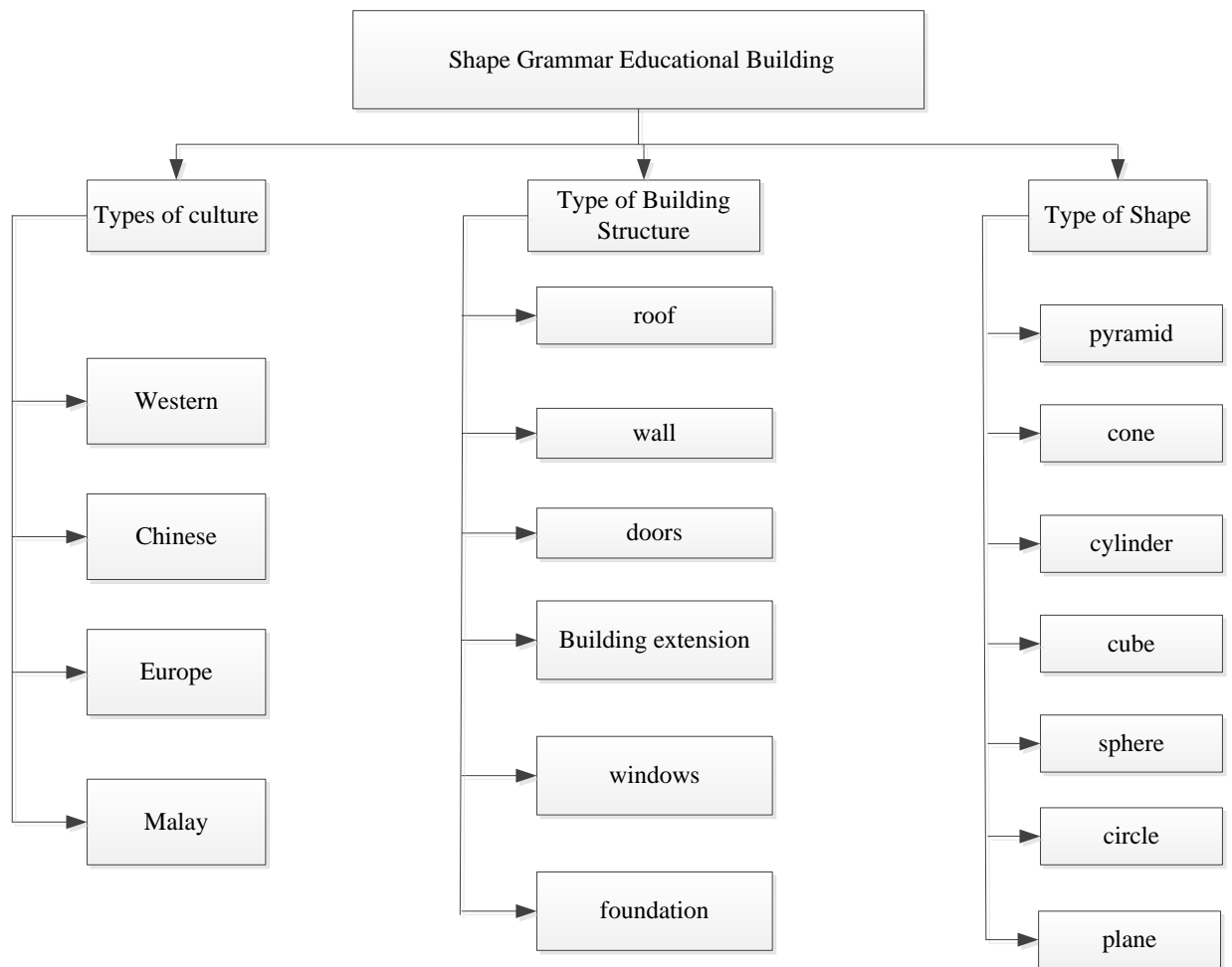


Figure 3.9 : Database Development for Shape Grammar Educational Building

(d) Design different shape patterns according to the types of cultural elements.












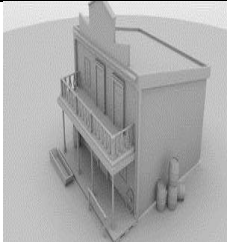

Cultural Type	Western	Chinese	Europe	Malay
Structures				
Foundation	Vary	Vary	Vary	Vary
Walls	Plane	Plane	Plane	Plane
Doors				
Windows				
Roofs				
Building Exterior				

Table 1: Different cultural element in building structure

(e) Design the building structures.

- The building structures included the foundation for the building, the walls, doors, windows, roof and the building exterior, which means exterior design for the building

Step 3: Develop the system

- (a) Review the content and design
- (b) Develop the system according to its flow and the system database function.
- (c) Develop the user interface
- (d) Develop the building models of various patterns according to the cultural elements.

Step 4: Implementation

- a) Testing the system functionality and the performance to make sure there is no error or bugs occurred in the system.

Step 5: Evaluation

- a) Evaluate the effectiveness in doing the shape grammar
- b) Summative evaluation of survey questionnaire
 - The survey will be conducted in University Malaysia Pahang.
 - Data analysis for the overall performance of the system.
 - Draw the conclusion of the survey.

3.2.2 Methodology for Software Development

The type of methodologies that I use in this project would be Addie methodology. I am choosing this Addie methodology in processing for my final year project is because Addie methodology provides a generic, systematic, step-by-step framework. This would help me to organize my work in an orderly manner, in both documentation process and in design Besides, it is designed to ensure that the learners will achieve the goals of the course with a clear understanding of the objectives, allows for the evaluation of the learner's needs, the design and development of training materials, and the evaluation of effectiveness of the training program using processes with specific measurable outcome. Besides, this Addie model also is a cost effective and saves time methodology ^[1,2].

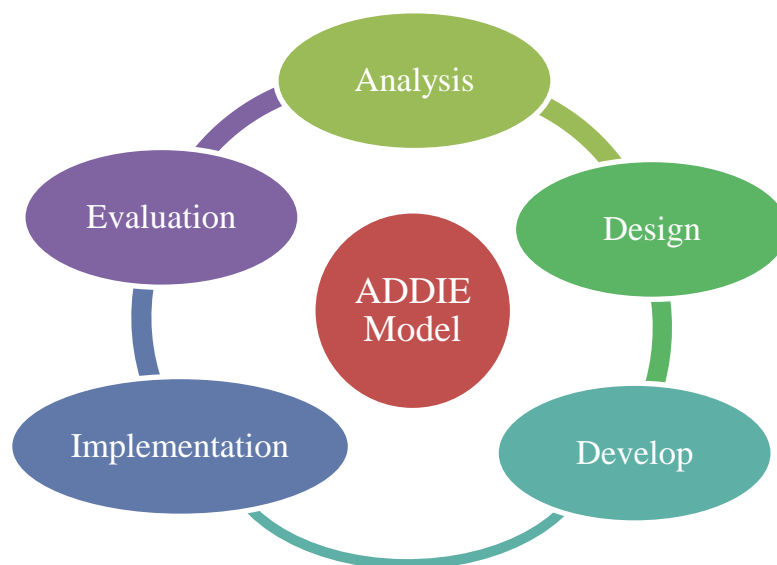


Figure 4.0: ADDIE Methodology model

In requirements phase, analysis of cultural elements in educational building design by using shape grammar will be gathered from the survey where users will make their choices for their cultural elements in educational building design. In architecture and design phase, a conceptual idea of how the system to be developed and also the user interface be presented will be sketched for clearer understanding. Next in the development phase, MEL Script which is one of the Autodesk Maya scripting language will be used for the development of the coding. Lastly is the implementation and

evaluation phase. In this phase, the students and lecturers of Civil Engineering will test on the system trial version.

3.3 Hardware and Software

Hardware Information Details		
1.	Laptop - Asus A42J	To provide a digital platform to do the tasks.
2.	Graphic Card - AMD Radeon HD 6470M	To provide the computer produce images in faster motion and better detail.

Table 2: Hardware used and its specification

Software Information Details		
1.	Autodesk Maya 2012 with 64 bits	To construct and 3D modelling the models in 3D shape.
2.	Operating System windows - Windows 7 with 64 bit	As a platform to install and run program application of Autodesk Maya 2012.

Table 3: Software used and its specification

3.4 Gantt Chart

The Gantt Chart below shows the time management and activities of this project. It helps as a guidance in performing our tasks. [Refer to APPENDIX C]

Chapter 4

DESIGN AND IMPLEMENTATION

This paper proposes the shape grammar-based system. This system able to generate 3D models of educational building by utilizing the shape grammar rules. Besides that, this system also able to simulates the exploration of educational building in different environments, such as urban and rural environments.

4.1 DESIGN

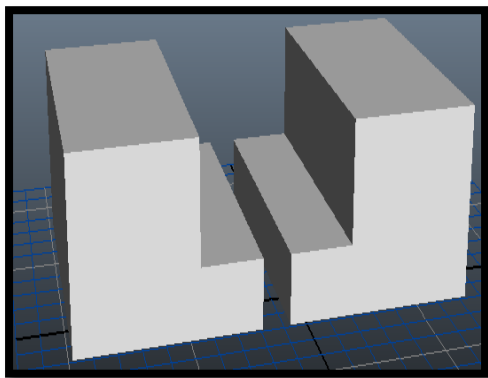


Figure 4.1: The basic building block of educational building.

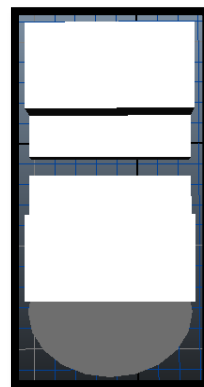


Figure 4.2: Extra place for the educational building block.

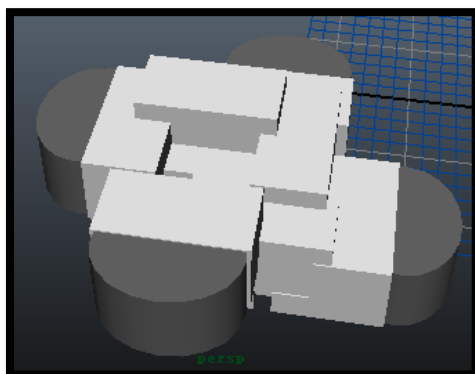


Figure 4.3: Creating of additional building blocks

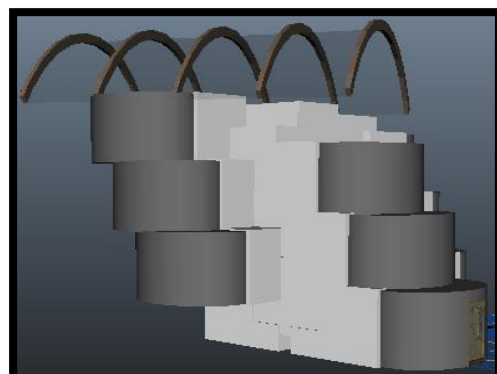


Figure 4.4: Completion by adding building blocks

4.1.1 TOPOLOGY DESIGN


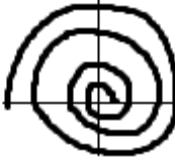



Shapes Form	Description
Square 	<ul style="list-style-type: none"> - Signifies pure and rational.
Spiral 	<ul style="list-style-type: none"> - Signifies creativity.
Star 	<ul style="list-style-type: none"> - Create urban space in the central of the star for recreational and leisure activities.
Triangle 	<ul style="list-style-type: none"> - Signifies simplicity and stability.
Rectangle 	<ul style="list-style-type: none"> - Create simple and spacious environment.

Table 4.1 Shape Form Designs

4.2 IMPLEMENTATION

The exploration of educational building has the inspiration from shapes, cultures, and also include some environmentally friendly idea. The overall concept of the building for this exploration of educational building is like a staircase, step by step in every level.

The basic building block (Figure 4.1) which was selected has the combination of two L shapes. The reason that L shape was chosen due to its meaning, learning. When both L shape was combined, means we need to have more effort in our learning path in order to success in the future.

After applying some shape grammar, a cylindrical shape was embedded in the basic block as shown in Figure 4.2. The addition of a cylindrical shape at one end of the block brings out the meaning of providing students a spacious environment for discussions and other related activities.

The concept of the pavilion is embodied in the siting of the building. The centred long pavilion enables students to travel in shorter distance and also a generous weather protected public space for students and admissions.

In addition, the concept of pure and rational is expressed by square form rotation as shown in Figure 4.3. This educational building has a total of 108 classrooms, with 2 public halls for various public activities.

The concept of energy saving concept is embodied in this exploration of the building. The light rays will penetrate through the centre of the educational building from the open top. The estimated area of the building is 605.886 meter square, 12.65 meters tall and the estimated cost of RM 272,350.00.

Table 4.13 shown is the final product of exploration of educational building.

4.2.1 DRAFT BUILDING CONCEPT

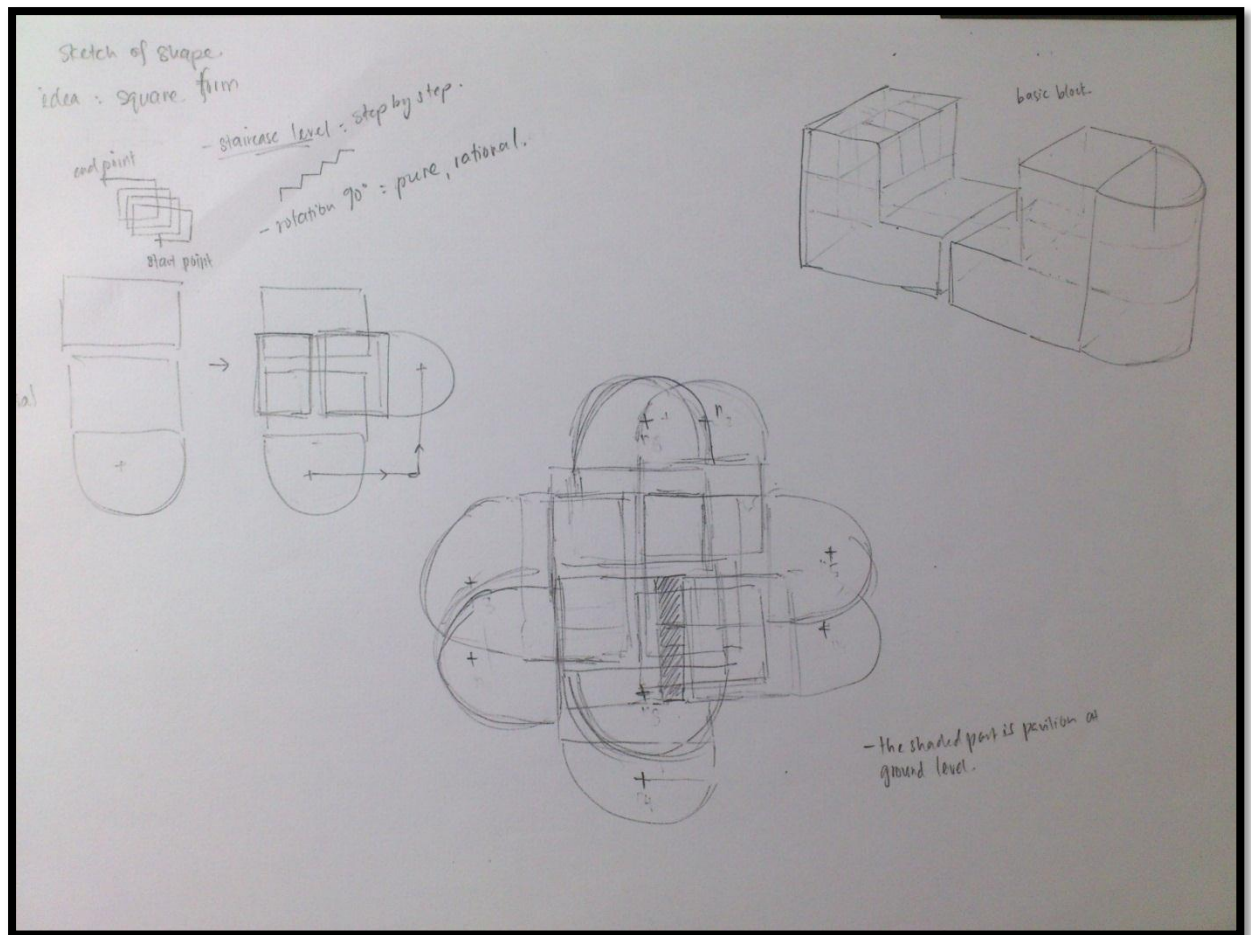


Figure 4.5 Draft concept of educational building

4.2.2 SHAPE GRAMMAR RULES

Rule 1 : Selection of different cultural types, like Chinese, Western, Europe and Malay.

For example, selecting Chinese Culture for this program.

Rule 2 : Choosing of suitable plane area, for example, plane area in 700, 1000 and 1500 square meters,


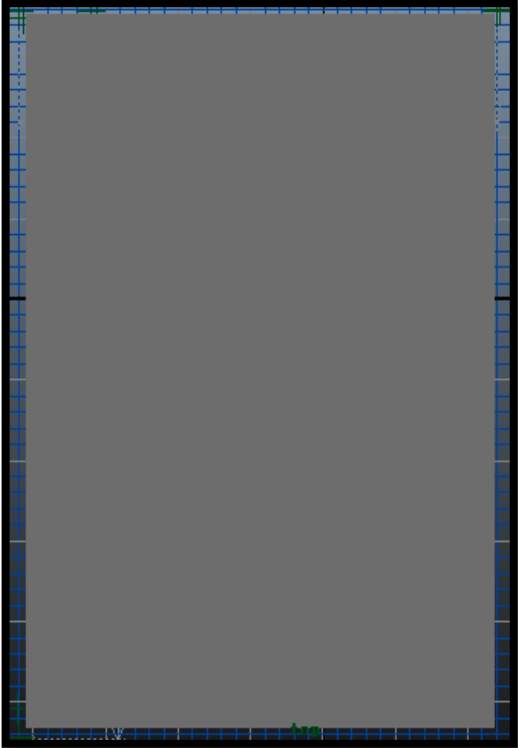
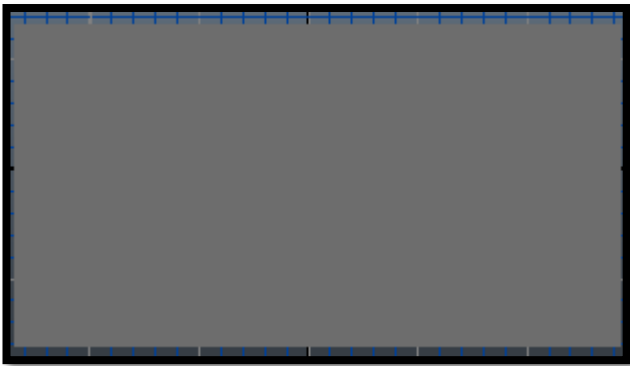
 <p>700 square meter foundation with cost of RM 10,000.</p>	 <p>1500 square meter foundation with cost of RM 20,000</p>
 <p>1000 square meter foundation with cost of RM 15,000</p>	

Table 4.2: Types of foundations

Rule 3 : Transforming the plane to estimate coordinates.

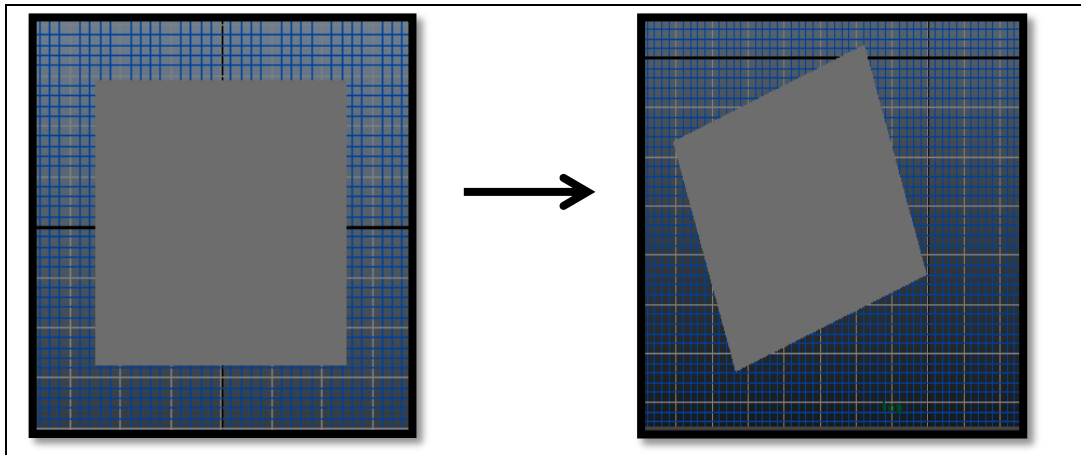


Table 4.3 : Transformation of foundation into a specified area.

Rule 4 : Selecting the basic building blocks according to suggested costs, range from RM5,000 till RM 20,000.

<p>RM5,000 – RM 10, 000</p>	<p>RM10,000 – RM 15, 000</p>	<p>RM15,000 – RM 20, 000</p>

Table 4.4 : Types of building blocks with different building materials, like bricks, composite material and glass.

Rule 5 : Applying additional space to the building. For example, adding a cylindrical shape to second building block from above to provide students additional space to conduct group discussions and other related activities.

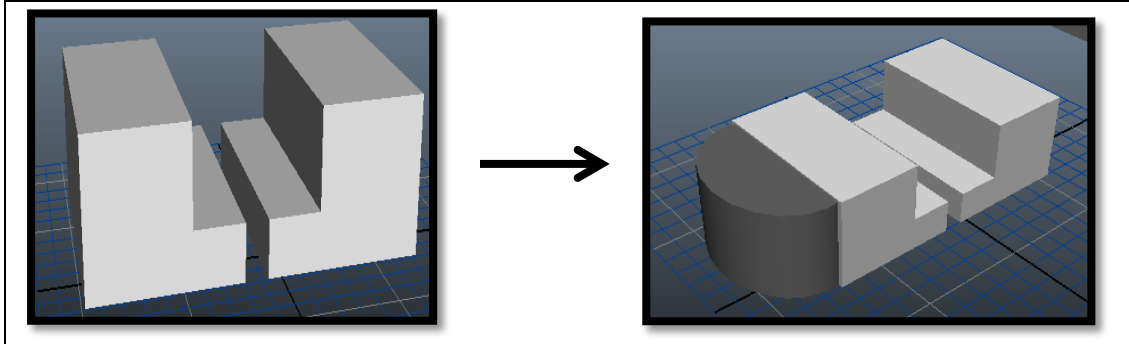


Table 4.5 : Adding of cylindrical shape

Rule 6 : Rotate the block 90 degrees to the left.

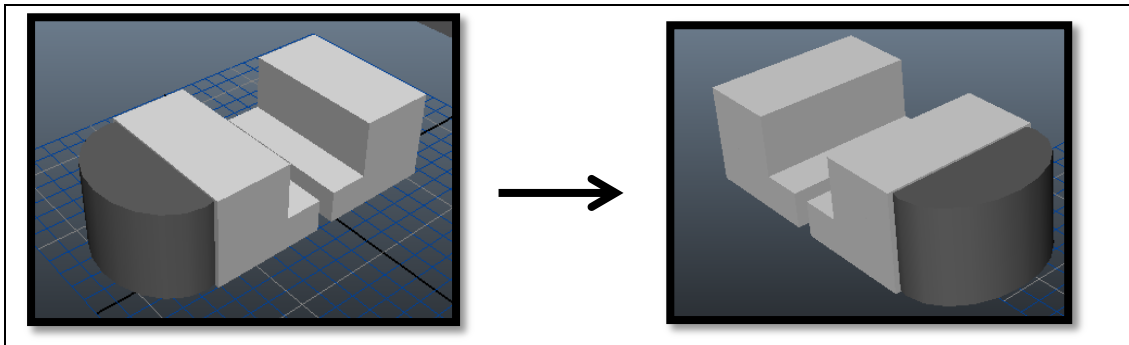


Table 4.6 : Rotation of building block

Rule 7 : Create more building blocks by rotating 90 degrees to the left and in square formation.

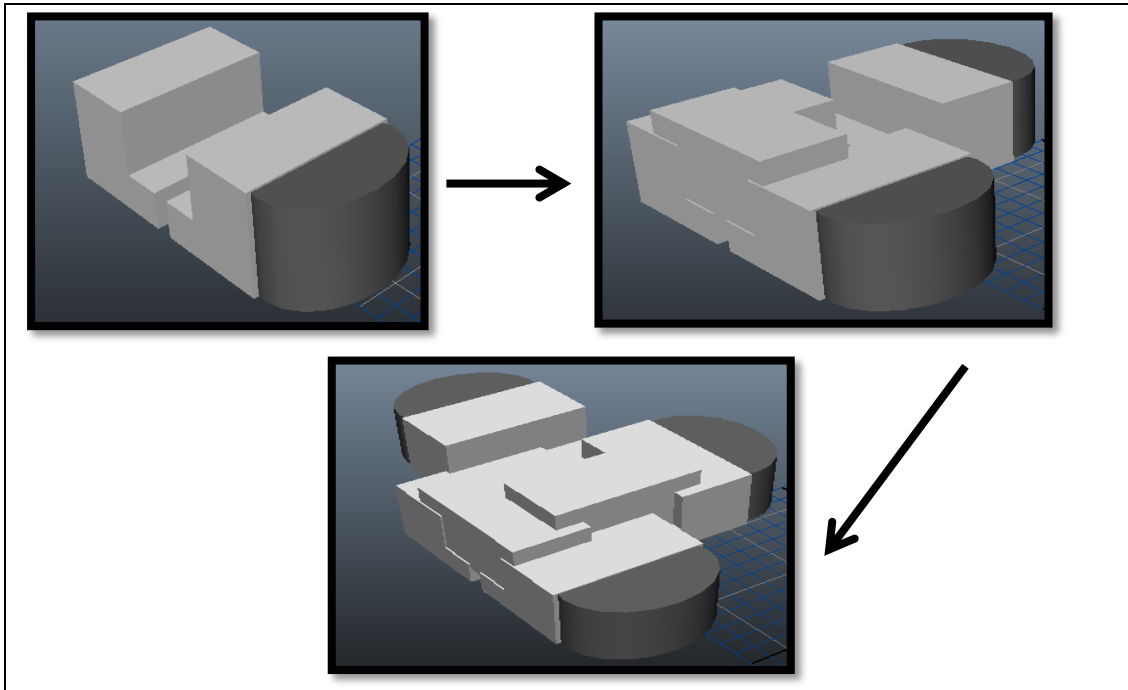


Table 4.7 : Create more building block

Rule 8 : Create the building blocks until each side has levels.

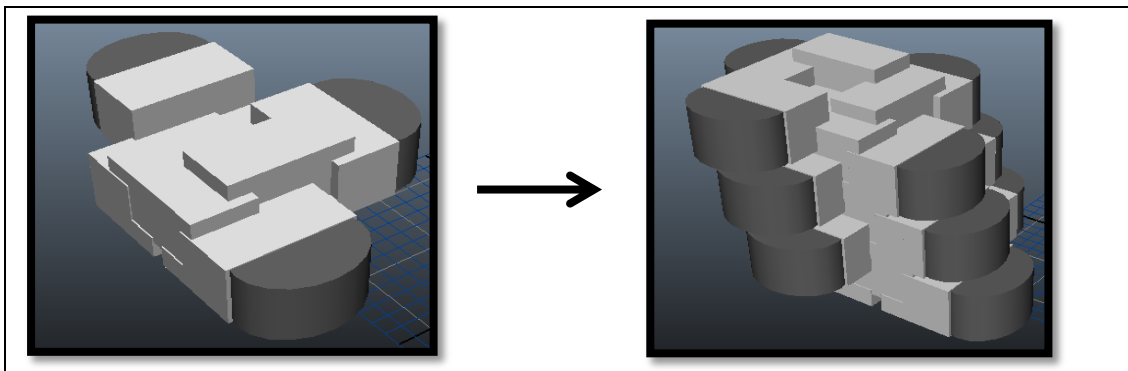


Table 4.8 : Completion of creating building blocks

4.2.3 Vocabulary elements

Rule sets need to have terminal symbols, so that at some stage the generation process can be terminated with a collection of these terminal symbols put together in the desired way. In the case of our shape grammars these terminal symbols are 3D shapes, as depicted in the table below

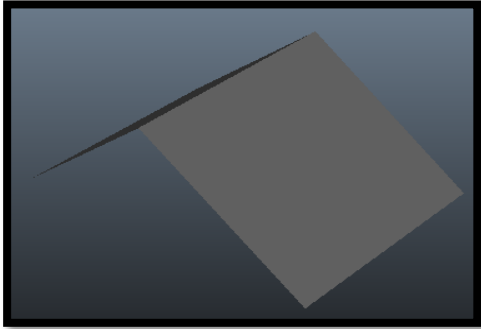
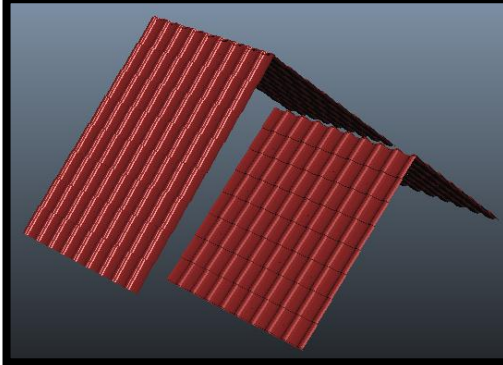
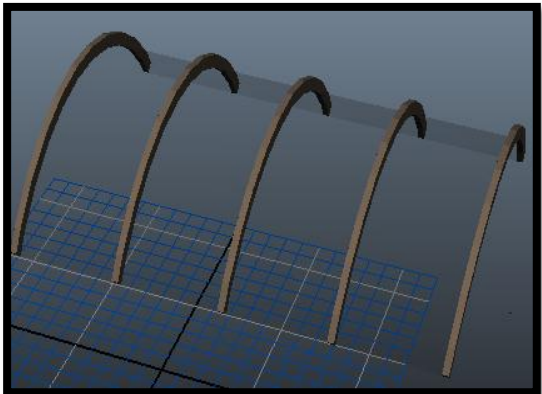
	<p>RM 5,000 – RM 10,000</p>	
	<p>RM 10,000 – RM 15,000</p>	<p>RM 15,000 – RM 20,000</p>

Table 4.9 : Roof designs

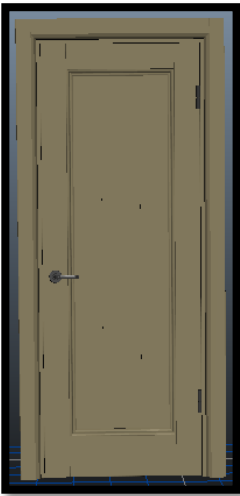
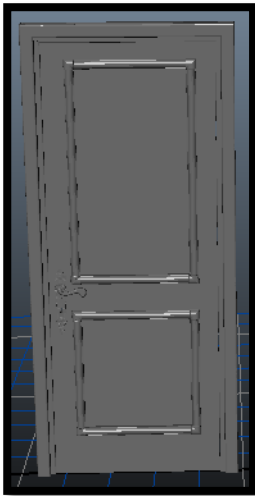
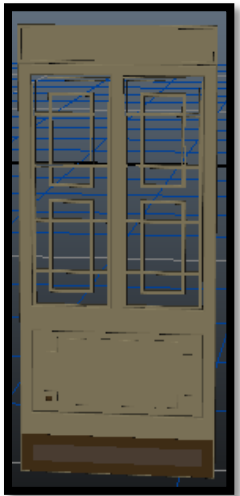
		
<p>RM 5,000 – RM 10,000</p>	<p>RM 10,000 – RM 15,000</p>	<p>RM 15,000 – RM 20,000</p>

Table 4.10 : Different design of entrance


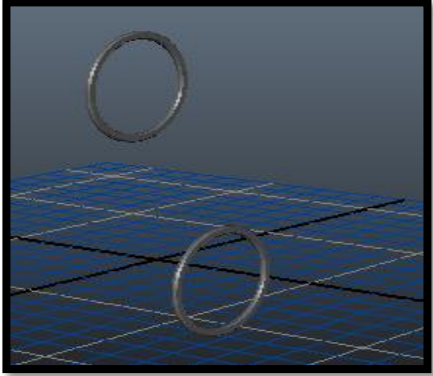
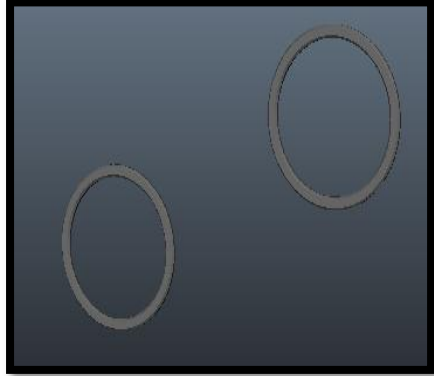
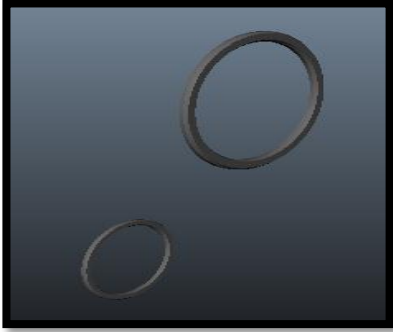
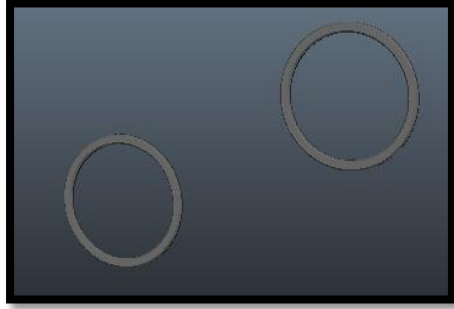
		
<p>Initial window state</p>	<p>The window at east will move upwards.</p>	<p>The window at west.</p>
		<p>The window at south.</p>
<p>The window at the north will scale from small to big..</p>		

Table 4.11 : Window designs at different direction

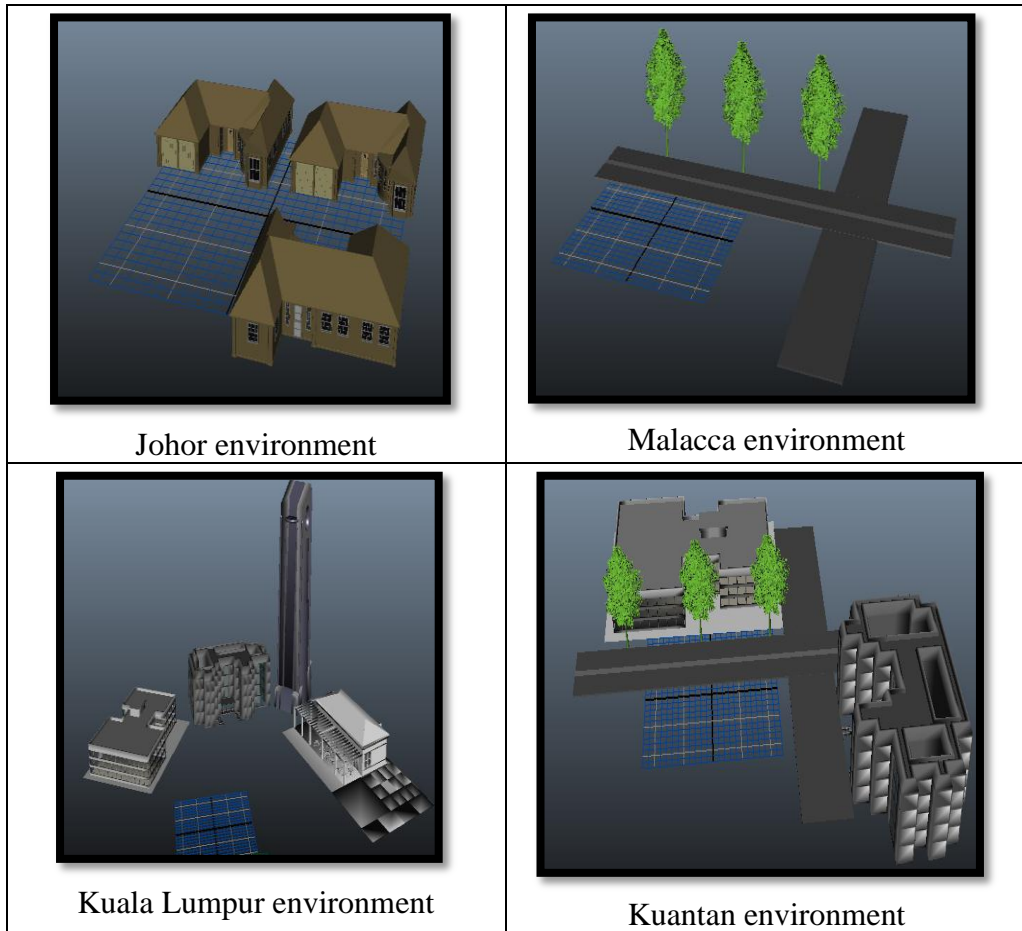


Table 4.12 Different environment location

A results in the construction of the models of the educational building as shown in the figure below. It provides view at different locations

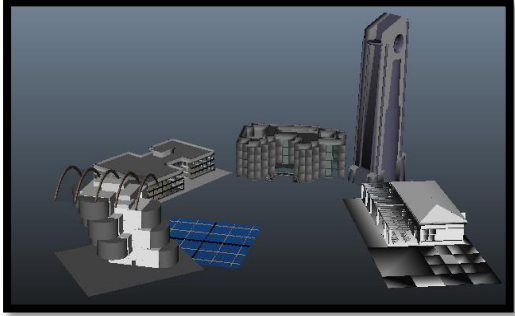
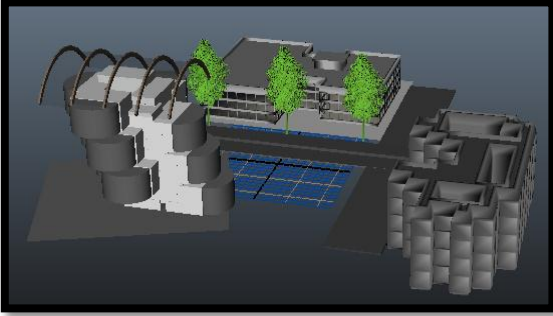
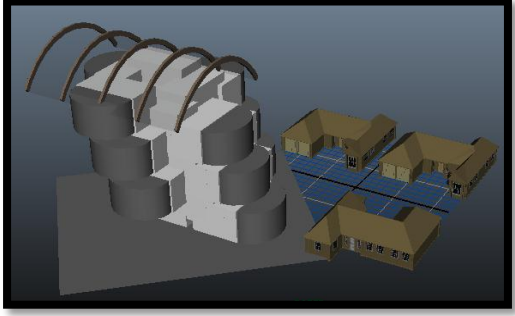
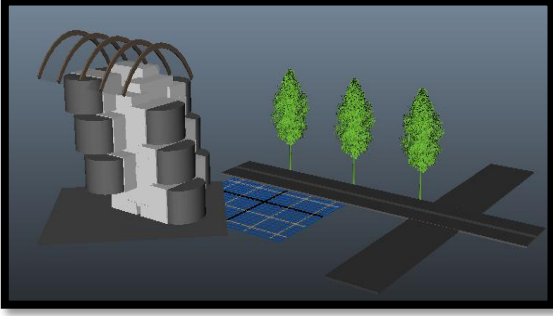
 <p data-bbox="284 539 735 607">Educational building within Kuala Lumpur environment</p>	 <p data-bbox="850 539 1337 607">Educational building within Kuantan environment</p>
 <p data-bbox="244 958 775 1025">Educational building within Johor Bahru environment</p>	 <p data-bbox="850 958 1337 1025">Educational building within Malacca environment</p>

Table 4.13 Educational building with different environment

CHAPTER 5

RESULTS AND DISCUSSION

5.1 RESULT

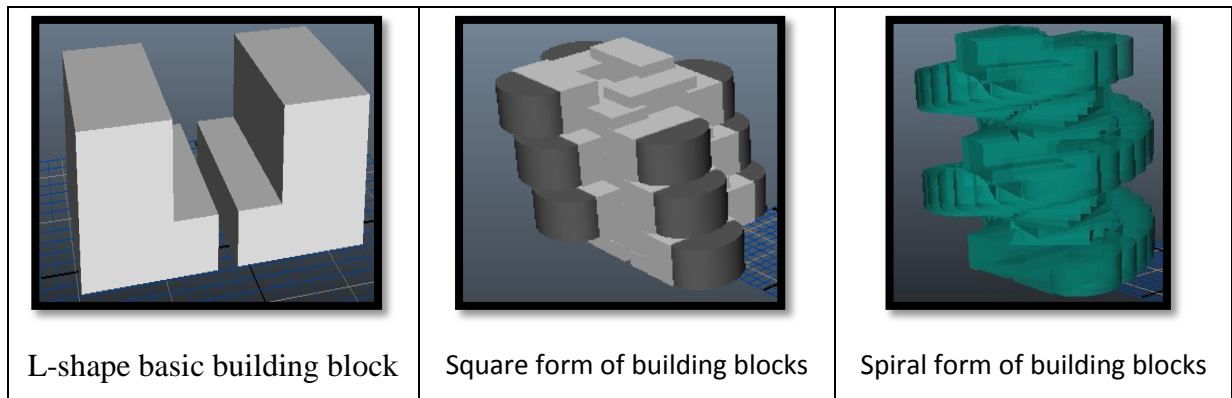
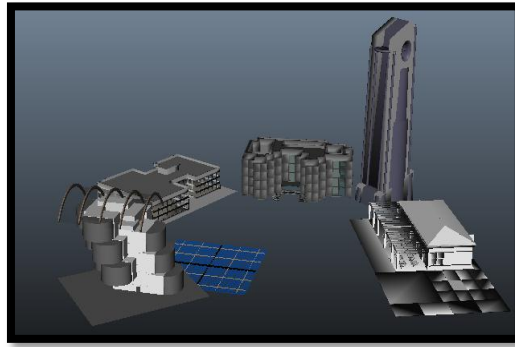


Table 5.1 Basic building block and different form of building blocks

The combination of Western and Chinese culture were implemented in this educational building, where the form used in designing the building blocks come with the “L” shape, which means of learning, whereas, the square shape form was used in the transformation of the building blocks with each angle are perpendicular, meant of pure and rational. Besides that, a spiral shape of educational building also implemented where its an expression of creativity,

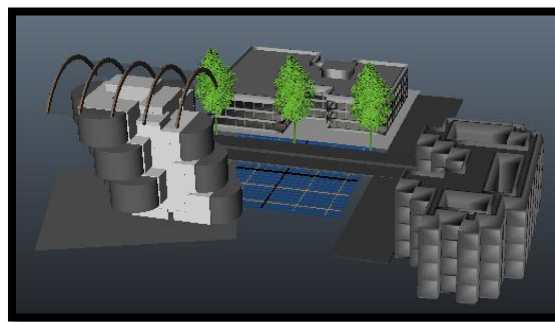
Furthermore, the exploration of educational building also concerns with its costs, building materials used, the functionality, and also environmental friendly related design. The roofing system in this exploration of educational building provides shading from direct sunlight. Besides, the atrium allows natural daylight to filter through the glass roof, this resulted the energy consumption is reduced and the daylight is maximized. The building material used must be sustainable, like composite material, where composite material are durable, lightweight, flexible in design and so on. The functionality of the educational building is providing a more spacious environment for students to carry out various activities, such as cultural night, indoor sport activities, group discussion and others.



Educational building within Kuala Lumpur environment.

Table 5.2 Kuala Lumpur Environment

We can analyse that the current exploration of educational building with shape grammar is more suitable to be located near urban areas, such as the Kuala Lumpur environment. The environment of Kuala Lumpur is with high rise buildings, like the office buildings, residential apartments and others, hence, a stylistic building would be more suitable.



Educational building within Kuantan environment

Table 5.3 Kuantan Environment

Besides that, the educational building also can be located with Kuantan environment, where on Kuantan environment, trees and buildings would produce a harmonious environment with the exploration of educational building with shape grammar.

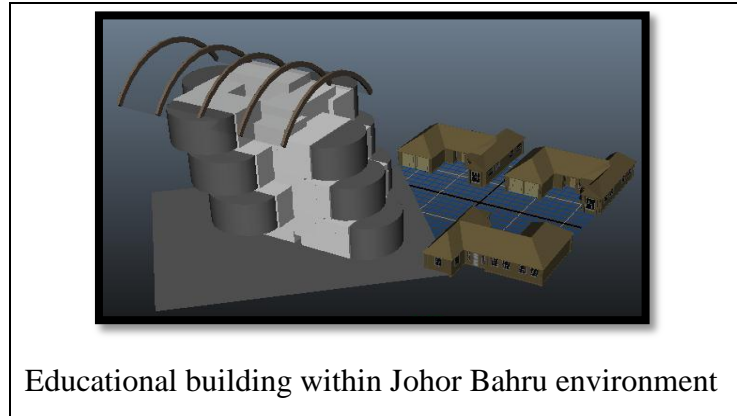


Table 5.4 Johor Bahru environment

However, for the educational building with Johor environment, it is not suitable, because the area of the educational building was quite limited, and the stylistic educational building does not match with the environment provided. As a result, if the educational building has any further plan in expanding the educational building compound, it would be difficult for the school authority in to make any further planning.

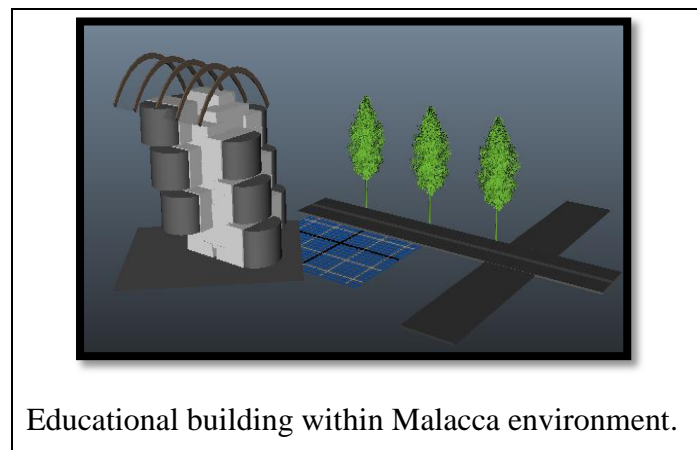


Table 5.5 Malacca Environment

Moreover, the educational building with Malacca environment where the educational building was located in a serene environment which have less transports and people travelled, hence, it would be less suitable to place the new explored educational building.

5.2 DISCUSSIONS

As a result of our approach to explore the educational building with cultural elements, we can conclude with the following observations:

Using shape grammars not only enables 3D educational building construction but also facilitates a formalization of the cultural construction principles.

If some architectural principles are defined as a set of rules, large structures like entire urban environments can be generated, where an adaptation of these structures is possible with respect to topography, existing location availability or other constraints that might be defined by integrating a GIS-system.

Variations of design could be generated as well, if the rules are defined with parameters that allow the exploration of various alternatives.

A drawback of using shape grammars is the required knowledge and skills to generate a parameter set of rules, although once this is acquired, the invested time pays off by the variety of generating buildings. In addition, the user need to have some basic skills in operating Autodesk Maya.

As there exist various approaches to architecture, for example, aesthetical composition principle, construction technique, functional aspect, we could demonstrate that they can be incorporated into a common set rule.

The developed application, Exploration of Educational Building with Culture Elements using Shape Grammar has met the objectives, which are

- (i) To develop educational building shape grammar with cultural and environmental friendly elements.
- (ii) Explore educational building designs under constraints of cost, function, culture, environment, space, material and location.
- (iii) To evaluate alternative educational building designs for urban planning in different cities.

Finally, it might also be of interest of adapting the traditional set of rules to modern Chinese architecture in order to meet the contemporary needs of living.

5.3 CONSTRAINTS

Constraints for this project are

- (i) Resource constraints
- (ii) Time constraints
- (iii) System constraints

Resource constraints

Sample resources are limited, such as the functions for declaration of variables, calling procedures and so others. In addition, the Maya Embedded Language (MEL) is a programming language which only has some common declaration method like other programming languages used.

Time constraints

The development of this program application requires ample time to complete for the whole system.

System constraints

This program applies only applicable to Autodesk Maya version 2012 and above. In addition, complex programming techniques like fuzzy rules , is difficult to be implemented.

5.4 SURVEY ANALYSIS

From the analysis of survey questionnaires, a total of 53% of students think that the overall appearance designs for the current educational building was simple, while 27% of students felt that overall appearance designs was spacious and 20% of students felt that the overall appearance designs was not attractive. Besides that, almost 93% of students don't have the interest in design own educational building, but 80% of students are interested in shape grammar evolution. The most preferable type of culture elements falls on Chinese culture, followed by Western, Malay and European. Moreover, the critical element in educational building designs that needs to be explored is the building exterior, with 40%. Next, followed by walls (27%), windows and entrance (each 13%), and foundation (7%). Have 73% of students feel that the style for the exploration of educational building is modern, they also interested in combination with different culture elements and implementation of environmental friendly building design for the exploration of educational building.

CHAPTER 6

CONCLUSION

In a nutshell, this research paper presents a new approach of shape grammar which is the exploration of educational building with cultural elements using shape grammar. In this paper, the exploration of educational building takes into the account of different requirements like costs, functions, space, culture, environment, the number of classrooms, public halls, windows and doors. Basic building blocks for Western culture, Chinese culture, European culture and Malay culture are developed to construct the educational building. With these elements include in the educational building design concept, may lead to a new building concept, which can uniquely presented the educational building characteristic. Hence, this would increase the interest in the research studies. For example, the urban areas in Kuala Lumpur consist of many high rise buildings, like the office buildings, residential apartments, and others. In future, more on site applications and surveys will be conducted to verify the advantages in using the system to explore educational building designs. Other enhancements would be the automation of the formulation and execution of the shape grammar rules by integrating artificial intelligence techniques such as fuzzy logic, neural network and genetic programming.

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APPENDIXES:

APPENDIX A

SURVEY ON EXPLORATION OF EDUCATIONAL BUILDING DESIGN WITH CULTURAL ELEMENTS USING SHAPE GRAMMAR

SECTION A: PERSONAL DETAILS

- a) Faculty:
- b) Gender: Male Female
- c) Status:

SECTION B: USER REQUIREMENTS

Please (/) tick on the respective answer.

1. What do you think of the current educational building, for example, the overall appearance design for the office building, classroom building and so on ?
 - a) Simple
 - b) Spacious
 - c) Elegant
 - d) Not attractive

2. Do you ever feel like to design your own educational building?
 - a) Yes
 - b) No

3. Do you think that the evolution of shape grammar, for example, the rectangle would change to an oval shape when applying the shape grammar rules, into different types of design structures that will be resulted an interesting and elegant building design?
 - a) Yes
 - b) No

4. Which type of cultural elements would you consider in the educational building design?
 - a) Western
 - b) Chinese
 - c) Europe
 - d) Malay

5. What do you think of cultural elements, for example, traditional Chinese window design?
 - a) The window should be in square shape
 - b) The window should be in circular shape
 - c) The window should be in rectangular shape
 - d) The window should be in oval shape

6. After the introduction of shape grammars, what kind of cultural elements you particularly like to explore by the shape grammars? You may choose more than one.
 - a) foundation
 - b) roof
 - c) walls
 - d) doors
 - e) windows
 - f) building exterior

7. In your opinion, which type of cultural elements that you consider as the most critical elements in your design, for example, the traditional Western educational building?
 - a) foundation
 - b) roof
 - c) walls
 - d) doors
 - e) windows
 - f) building exterior

8. What is the style of your educational building design?
 - a) Modern
 - b) Tropical
 - c) Futuristic
 - d) Artistic

9. Would you like to have some combination from different cultural elements for your educational building design, for example, combination of Western culture with Chinese culture?

a) Yes

b) No

10. Would you like to include some environmental friendly elements, such as green building design structure for the building design plan?

a) Yes

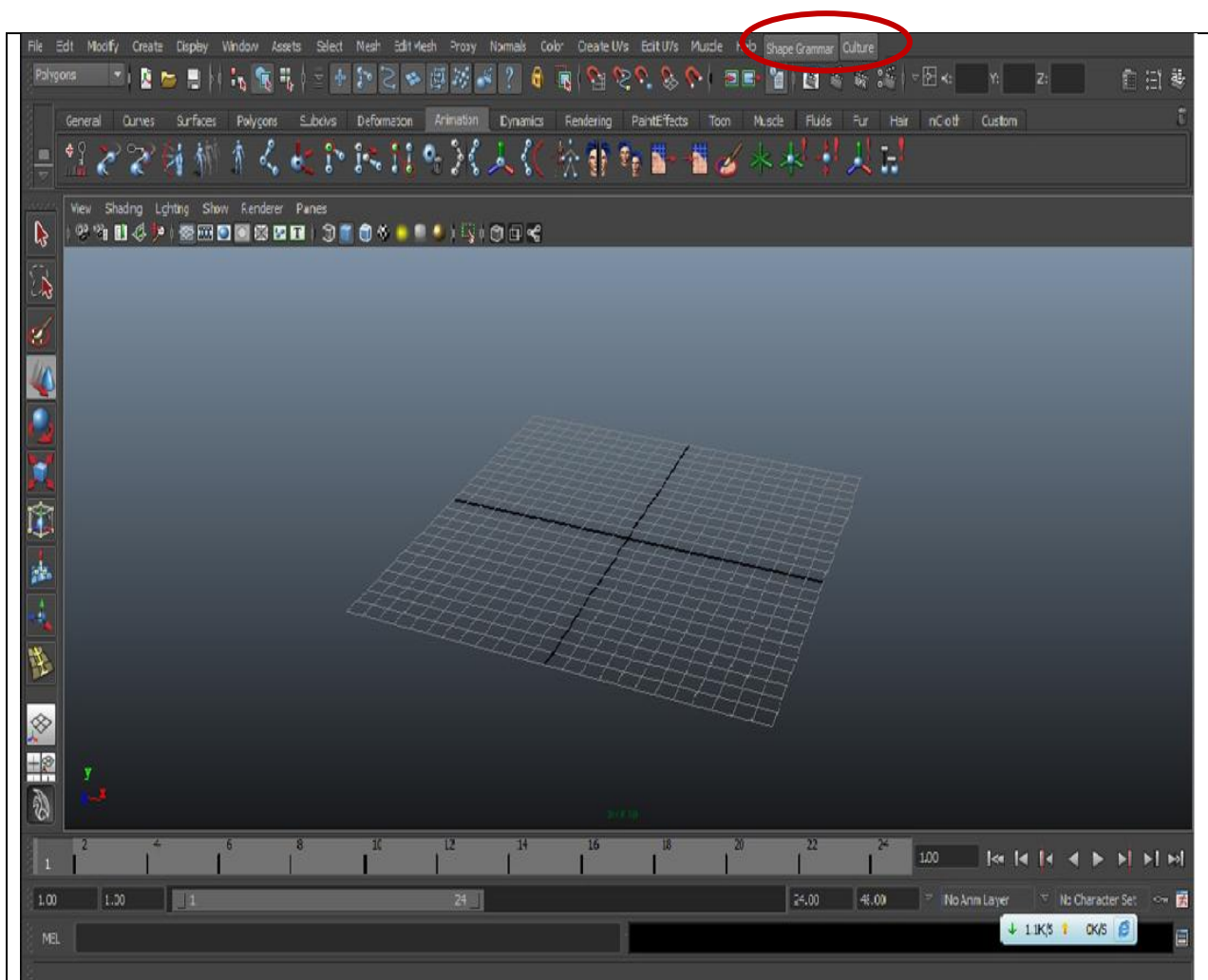
b) No

Signature,

Date:

APPENDIX B

Storyboard and user interface of the system

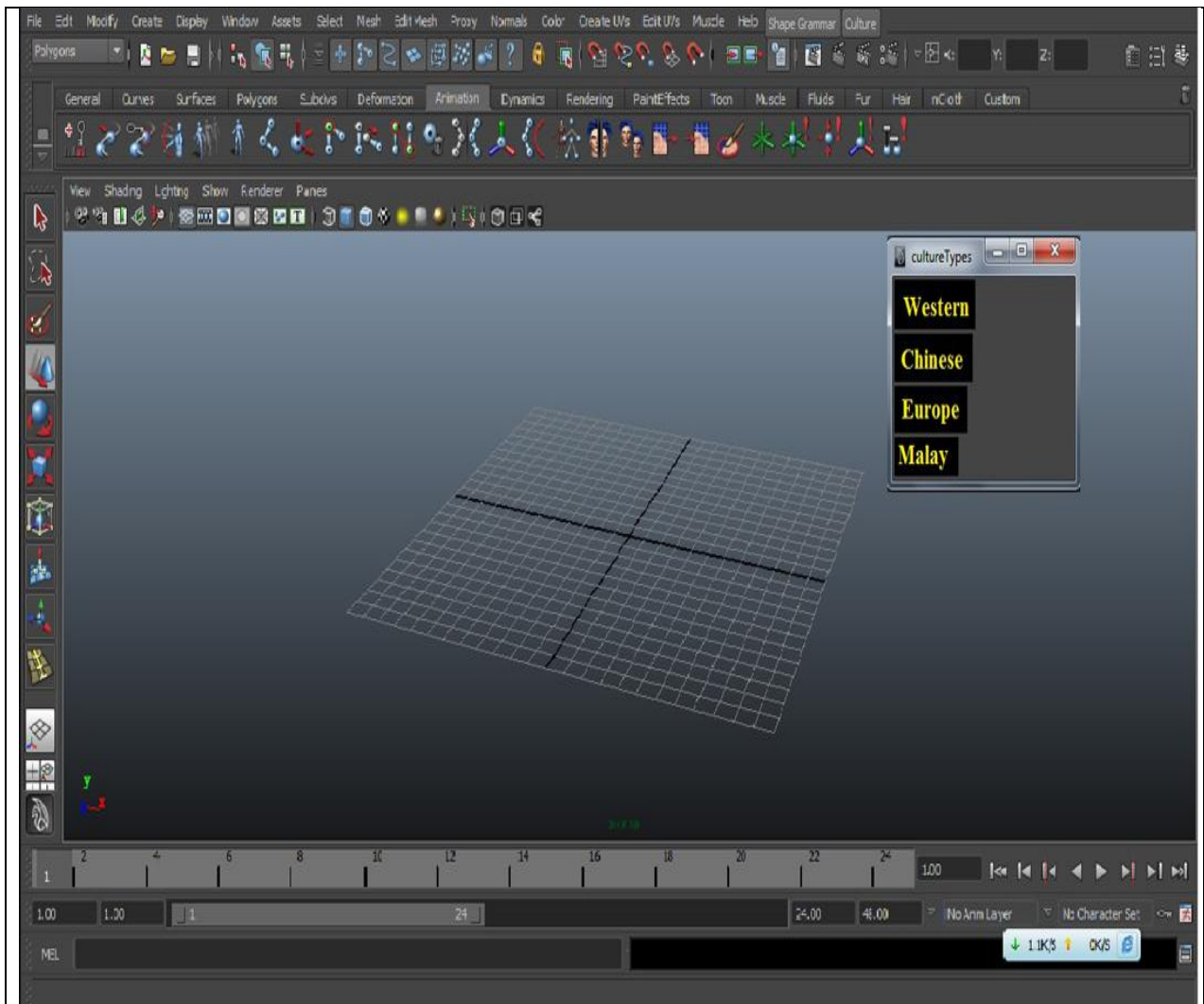


Main Interface

Button:

Shape Grammar – to perform the shape transformation

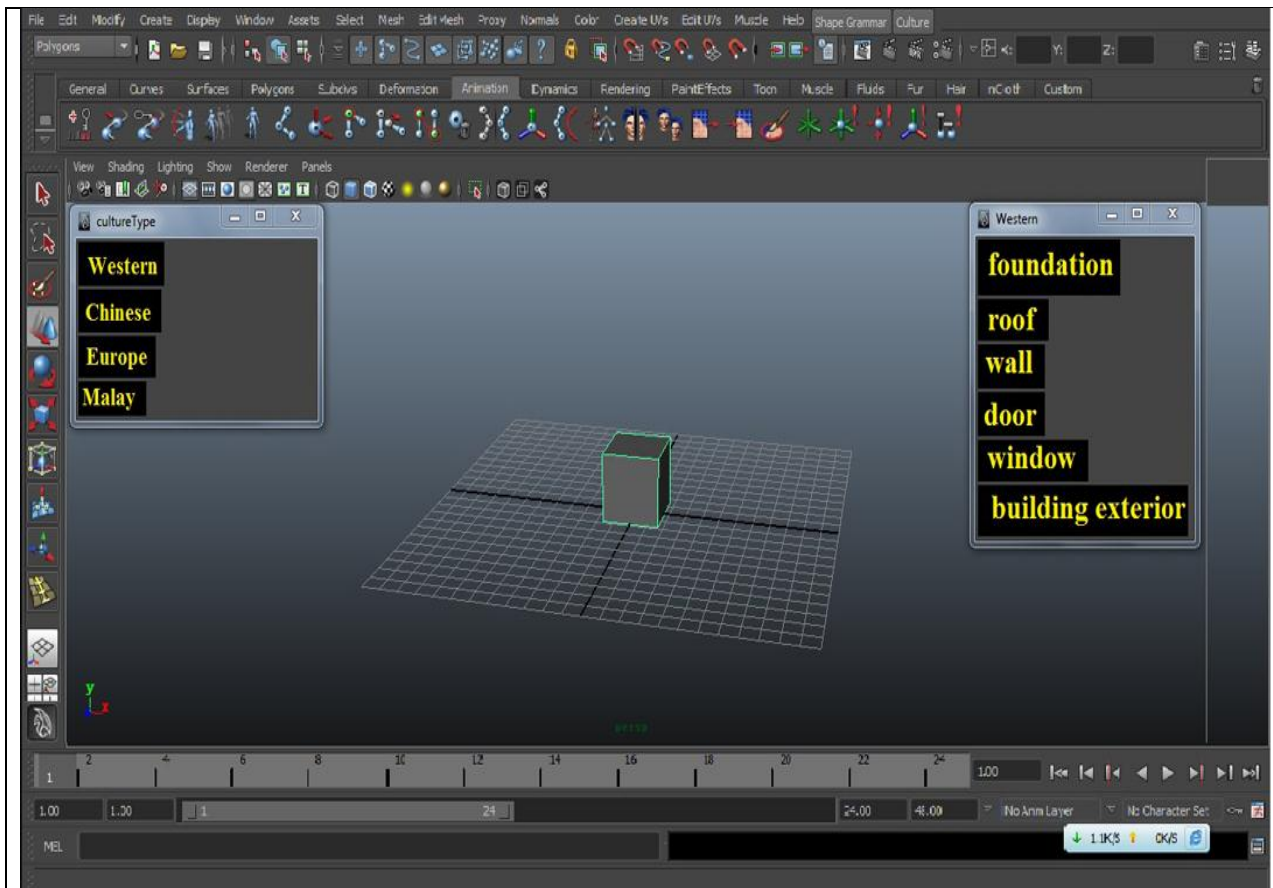
Culture – to select the types of cultural elements



Content page

Type of Cultural Elements:

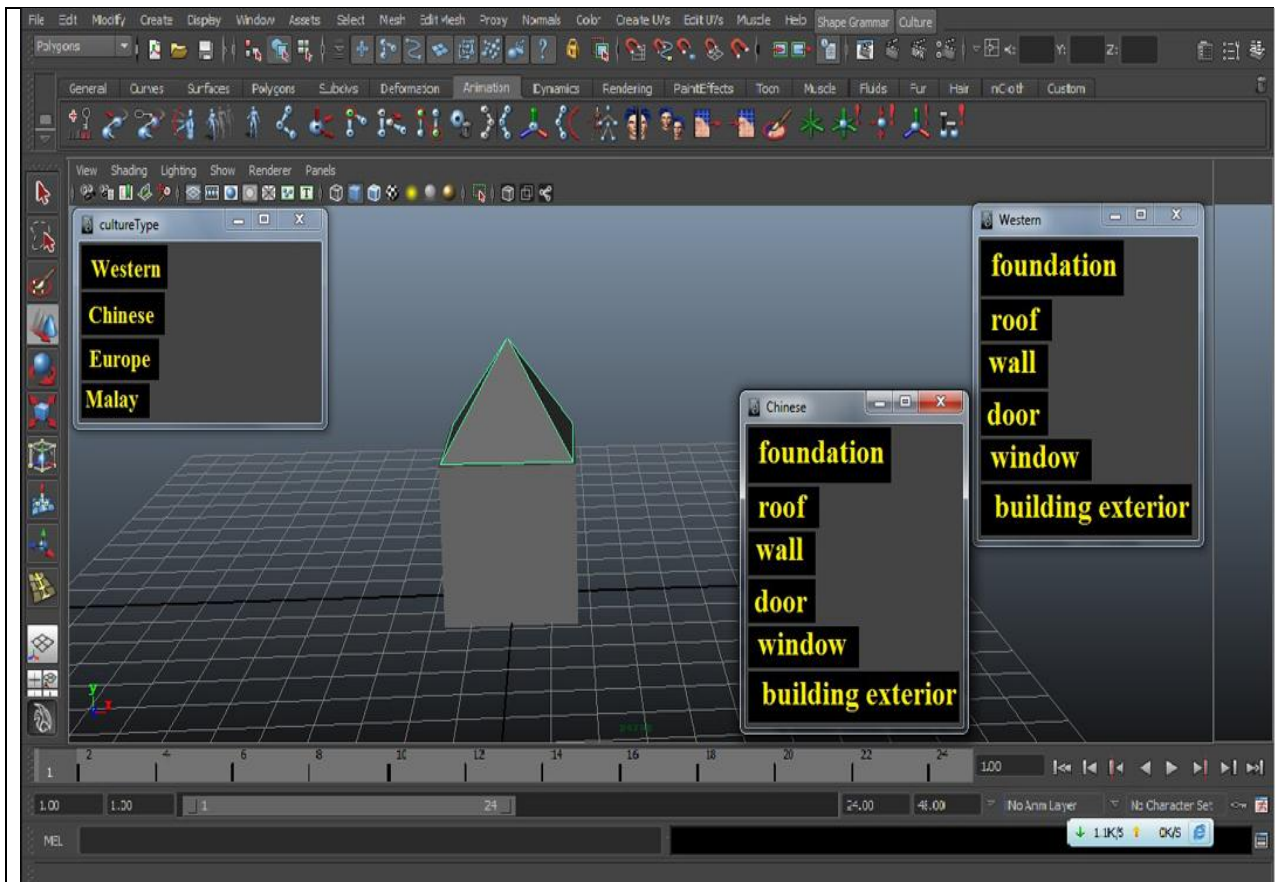
Western, Chinese, Europe, Malay



Content page

Type of building structure from Western culture

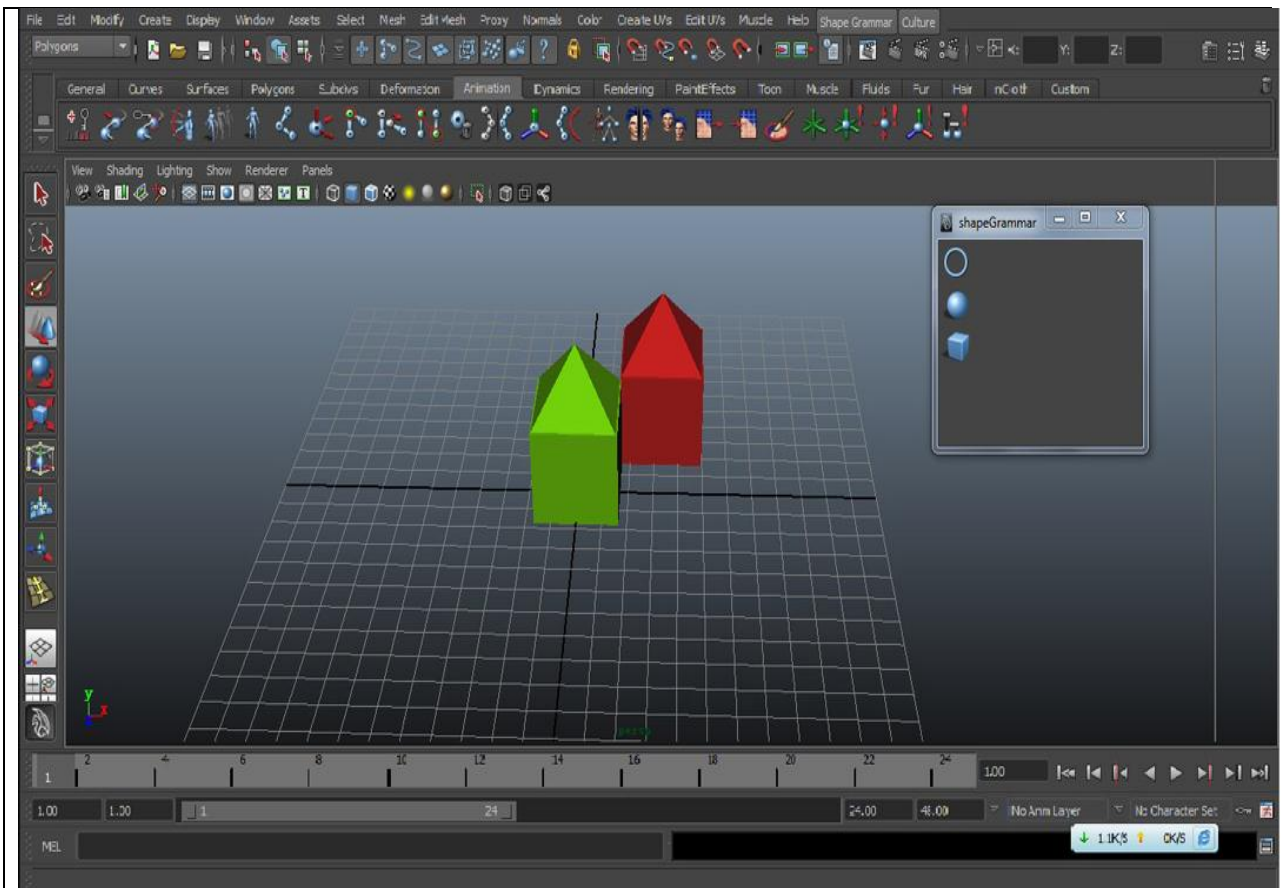
- there are six types of building structure, such as the foundation, roof, wall, door, window, and building exterior
- user can choose the types of Western culture building structure and select one from the.
- as an example, the user select the wall from the Western culture in the diagram above.



Content page

Type of building structure from Chinese culture

- user can choose the types of Chinese culture building structure and select one from the.
- as an example, the user select the wall from the Western culture and the roof element in the Chinese culture as shown in the diagram above.



Content page

Shape Grammar

-user can select the shape grammar rules from the small windows appear and decided whether they want to apply which shape grammar rules in the transformation of shape patterns. Besides, user can also select suitable colours for the shape appearance.

APPENDIX C

Gantt Chart:

