Eight Trigrams: A level of 3D puzzle game for cultural transmission

By

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Abstract

With the development of both hardware and software, video games are evolving rapidly. Now that video games have achieved near-cinematic visuals, the market for video games is growing, and the number of players is increasing. In addition to the stunning features of video games, at the heart of serious games, they are used as a medium to spread knowledge and teach players something.

The main teaching topic in this research is a piece of knowledge in the eight trigrams, one of the traditional cultural symbols of China. The focus is on the effectiveness of using games to convey cultural knowledge. There are cultural barriers between different countries because of different histories and languages, but the spread of cultural understanding can help people from different cultures better understand each other. However, the learning of different cultures is not compulsory, because cultural knowledge from other countries will not affect people's basic life, so in most countries in the world, cultural learning does not belong to the category of primary education. Due to their worldwide presence, video games, through incorporation of cultural themes and ideas into the game, can achieve promotion of this knowledge.

Acknowledgements

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Besides my advisor, I would like to thank my thesis committee, Jennifer deWinter, and Ralph Sutter. Thank you so much for your insightful comments, encouragement, and challenging requirements.

Thanks to my roommate Roy, even he is a WPI student from the fire protection project, he was willing to test the game and found some problems repeatedly.

In particular, I would like to thank the WPI students who participated in the test due to the COVID-19.

Finally, thanks to my friends and family. At no time was I ever short of support, and I am very appreciative of all of you.

Introduction

This paper will discuss the IMGD Master Thesis Project Eight Trigrams, a 3D 3rd perspective puzzle adventure game developed for PC on Unreal Engine 4. Under the guidance of the committee, I completed the production process independently, with the assistance of UE4's official tutorials, forums, and numerous instructional videos on YouTube.

The original idea for this game came from two video games: "Tomb Raider 9" and "Age of Empires II." "Tomb Raider 9" revolves around the story of Himiko, a shamanic-queen of Yamatai-koku in Wakoku [1]. Although the game centers around her curse and immortal Japanese soldiers are fictional, I was inspired by this mysterious Japanese queen, and want to learn more about her and the history of Japan.

"Age of empires II" is a little more rigorous about this. There are many stories about famous emperors in world history in this game. "Age of empires II" is an RTS game in which the player commands battles to recreate the story. The stories in these battles are well fleshed-out, with the game's content and cutscenes nicely showing the rise and fall of historical heroes or empires. I learned a lot about world history from this game.

In this game, I learned the stories of Joan of arc, Genghis khan, attila the hun, and more. What impressed me most was Aztec's civilization. If it were not for this game, I would probably never have touched and heard about this civilization. The Aztecs were a Mesoamerican culture that flourished in central Mexico in the post-classic period from 1300 to 1521. Tribal warfare, the first quiet life, until the Spanish came panning for gold, broke everything that had been here, then the Tenochtitlan defense [2]. I was so impressed by the story that I went and looked up more information about this civilization, and to my surprise, the background and story used in "Age of empires II" were the same as what I found in the history books. In other words, what I learned in the game was correct. For me, this game not only stimulates my interest in some unknown cultural knowledge but also gives me accurate cultural understanding.

These experiences led me to think about games, whether the right cultural knowledge can be added in modern video games to deliver. Therefore, I think it is a valuable attempt to let players learn and understand some unknown cultures through games.

Screenshot of Himiko in "Tomb Raider 9"

Screenshot of Aztecs in "Age of empires II"

Literature Review

To design the game "Eight Trigrams," I researched eight trigrams, Taiji, Taoism, and the reasons why "eight trigrams" is a symbol of Chinese culture. Eight trigrams are a significant cultural proposition, and I've only chosen the propaedeutic and appropriate content to put in the game.

What are eight trigrams?

"Eight Trigrams" is an esoteric concept of ancient Chinese culture, a metaphysical, philosophical symbol composed of three groups of Yin and Yang. Its profound philosophy explains natural and social phenomena. The eight trigrams were actually the earliest symbols of written expression. [3] The unit of eight trigrams is "Yao", which is the basic expression form of time and space in Taoism[4]. "Yao" can be divided in to "Yin Yao" and "Yang Yao," they are called "Two Yi" in Taiji. Take "Two Yi" as the parameter, and do arrangement and combination, will get "Integrated Yin," "Integrated Yang," "Deficient Yin," "Deficient Yang." Then do arrangement and combination with "Four Xiang", will get "Qian"," Kun"," Xun"," Zhen"," Kan"," Li"," Gen"," Dui", these called "Eight Trigrams" [3]. This theory is the basic form of Taoism, Lao Tzu in "Tao Te Ching" said "Tao create one, one create two, two create three, three create all things" [5], is the same spirit.

What is Taoism?

Taoism is a philosophical or religious tradition of Chinese origin that emphasizes living in harmony with the Tao. The Tao is a fundamental idea in most Chinese philosophical schools; in Taoism, however, it denotes the principle that is the source, pattern, and substance of everything that exists.[6][7]

Taoism differs from Confucianism by not emphasizing rigid rituals and social order. However, it is similar in the sense that it is a teaching about the various disciplines for achieving "perfection" by becoming one with the unplanned rhythms of the universe called "the way" or "Tao."[8]

Mainly serve Daode Tianzun on as the leader. Such as Lao Tzu of the "Tao Te Ching" to cultivate the immortality realm through many different kinds of practices. The pursuit of a

Chinese religious training to become immortal, Taoist immortal, or main methods to become god can be roughly classified into five types, take sacred medicine, food, outside Dan medicine, spirit guidance, inner alchemy. And borrowed by Taoism and spell for rituals to merit such as immortal. Many of the later deities in Taoism were mostly successful practitioners or alchemists.[9]

Why could Taoism be a cultural symbol in China?

Taoism has had a profound influence on Chinese culture in the course of the centuries, and Taoists. Laozi is traditionally regarded as one of the founders of Taoism and is closely associated in this context with "original" or "primordial" Taoism.[10] Whether he actually existed is disputed;[11][12] however, the work attributed to him—the Tao Te Ching—is dated to the late 4th century BCE.[13]

Taoism originated in China, has been passed down in China for thousands of years, and is deeply rooted in Chinese culture, so the eight trigrams and Tai Chi have gradually become one of the symbols of Chinese culture.

What is the Taoism situation in contemporary China?

China is the most populous country in the world. According to statistics on the Chinese mainland, most Chinese people have no religious belief or atheism, accounting for 73.56%. Buddhists 15.87%; Taoism and Chinese folk beliefs (including local religion, ancestor worship, Confucianism, Taoism, and Buddhism) were 7.6%; Christianity (Catholic, orthodox, protestant) 2.53%, Islam 1.45%. And by law, communists were not allowed to practice any religion.[14]

Has Taoism always been important in Chinese history?

The answer is no. The influence of Taoism depends on the expectations for people and the needs of the social development of different rulers. There were some famous rulers for encouraging Taoist emperors in Chinese history, such as Emperor Qin Shi Huang, Emperor Wu of Han, Emperor Taizong of the Tang, Emperor Shizong of the Ming.[15]

What is Fuxi eight trigrams?

In Fuxi eight trigrams, the Heaven is in the higher part, and the Earth is in the lower part. The trigram Qian (Heaven) is at the top, the trigram Kun (Earth) is at the bottom (in the past, the South was located at the top in Chinese maps). The trigram Li (Fire) is located on the left, and opposite to it is the trigram Kan (Water). Zhen (Thunder) and Xun (Wind) form another pair, while being one opposite the other, the first on the bottom left next to Li while the second is next to Qian on the top right of the eight trigrams. Gen (Mountain) and Dui (Lake) form the last pair, one opposite the other, both in balance and harmony. The adjustment of the trigrams is symmetrical by creating exact contrary pairs. They symbolize the opposite forces of Yin and Yang and represent an ideal state when everything is in balance.[16]

Cultural transmission

Cultural transmission is the process through which cultural elements, in the form of attitudes, values, beliefs, and behavioral scripts, are passed onto and taught to individuals and groups.[17]

Conclusion

The purpose of the game design is to pass the culture of eight trigrams to the players. In the game, the players will solve the puzzles to restore the generation graph of eight trigrams, and use the eight trigrams to navigate in the eight trigrams maze, so that the players have a primary understanding of eight trigrams, and a mysterious background story to stimulate the players' interest in this culture, to achieve the purpose of cultural transmission.

Game Design

Overview

The game "Eight Trigrams" is mainly used to verify whether cultural knowledge about eight trigrams can be effectively transmitted and taught in the game.

1. Teaching content

As mentioned in the previous section, "eight trigrams" is a complex philosophical concept in Taoism. As a native religion of China, it has thousands of years of history and become one of the symbols of Chinese culture. However, because the local government and most Chinese citizens now believe in atheism, only a few people know about "eight trigrams" and Taoism.

One of the great functions of cultural transmission is to help people from different cultures overcome cultural barriers and communicate better. In today's China, many religious philosophies, such as Buddhism or Taoism, are highly controversial, and some may even be regarded as superstitions. Although there is freedom of religion in China, communist members are not allowed to practice it, and religion is banned in school education. As a result, very few Chinese are influenced by religious ideas today, and the Chinese themselves may not even accept the spread of Taoist ideas. There are indeed many superstitions in Taoism, but in China, it still recognizes and retains its essence, such as Tai Chi. The eight trigrams in today's Chinese culture are more a symbol to represent Chinese history and culture, rather than a widely recognized philosophy.

I hope to teach the formation rules of the eight trigrams to the players through the game and increase their cognition of this symbol. Then the eight trigrams maze is used to solidify the player's understanding of the eight trigrams pattern further. Finally, through the story background to vaguely convey the original Taoist pursuit for immortal life.

2. Eight Trigrams puzzle on the stone tablet

The puzzle is designed to teach the players how eight trigrams are formed, by understanding the puzzle on the tablet, and by reasoning to put the broken shapes in the right place to complete

the puzzle, thereby unlocking the first door into the eight trigrams maze.

Design Concept

The design of the puzzle is based on the principle of eight trigrams generation.

Derivation of the eight trigrams [18]

The theory behind this "eight trigrams" has been mentioned before and contains the underlying philosophy of Taoism. However, it is difficult for players, especially those who do not know the Chinese language, to understand this theory in a short time. But leaving aside the underlying philosophy, the mere discussion of the origin of the eight trigrams is simply a mathematical permutation.

It is painful and irregular to read the eight trigrams directly, and the purpose of the simplification is to enable the players who are entirely ignorant of the eight trigrams to quickly find out the

rules and understand the formation principle of the figure.
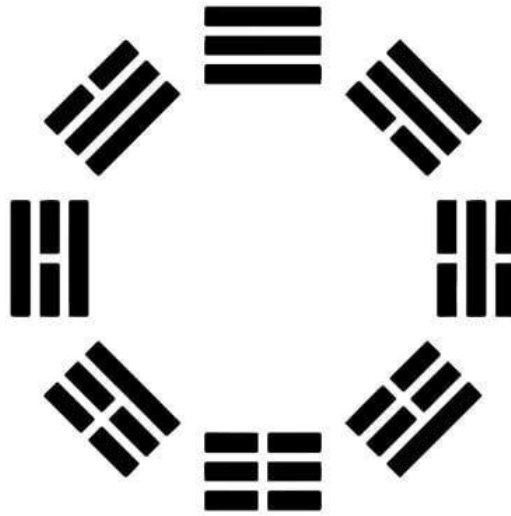
Eight trigrams graph
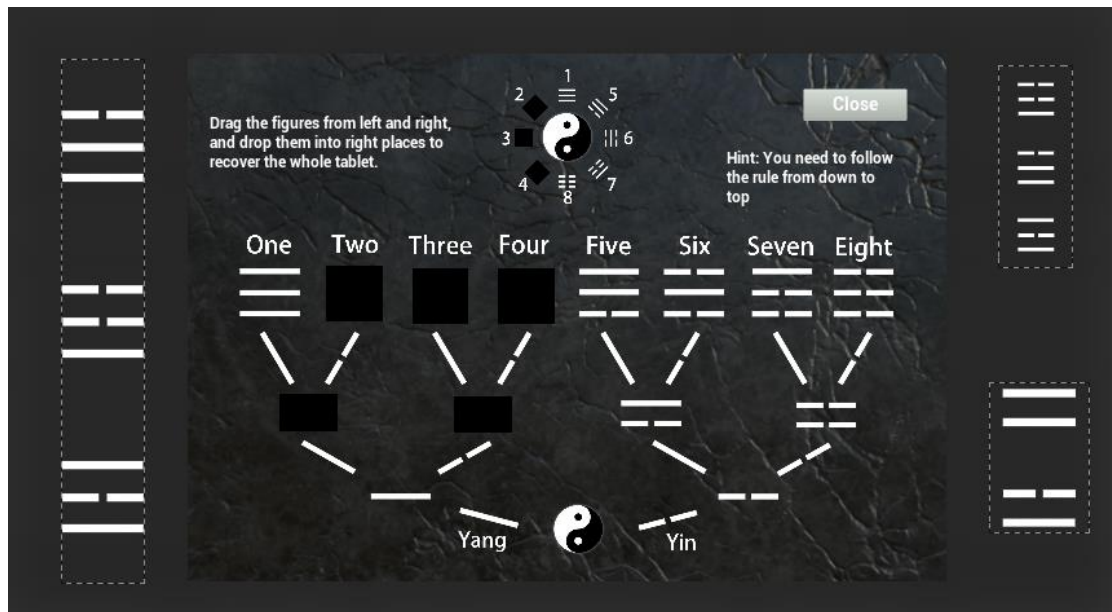
Puzzle on stone tablet in game

The damaged part of the stone tablet is the part that the player is expected to deduce by himself.

The player needs to find out the rules of the Yin part to complete the trigrams of the Yang part.

Finally, the eight trigrams on the top need to be completed according to the numbers.

There was no theory of Numbers in the early eight trigrams until the Song dynasty. In "*Plum blossom Yi numbers*," Yong Shao first combined eight trigrams with mathematics [19]. It was the addition of mathematics that made the mystery of eight trigrams and religious philosophy a lot clearer.

With the addition of Numbers, the trigrams become more regular, starting from one to eight from left to right. The eight trigrams show one at the top, eight at the bottom, and two to seven in the middle.

There is also a theory that one is the sky, sky at the top, eight is the earth, and earth at the bottom, two to seven represents the natural elements that exist in the world, such as fire, mountains, and lakes. This theory has been discussed in the former part. But to avoid confusion, this theory was removed after the game was modified.

3. Eight Trigrams Maze

After unlocking the first puzzle, the player enters the eight trigrams maze and gets a map that tells the player where to go.

Eight trigrams maze map for direction guide
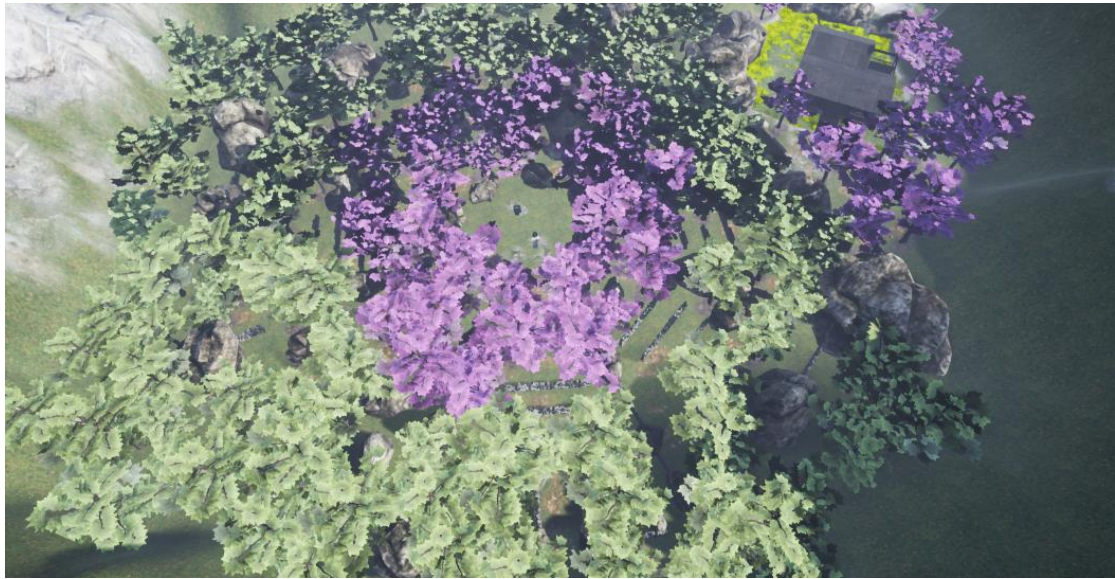
Top view of eight trigrams maze

Top view of eight trigrams maze without foliage

Design Concept

Although the legend of the first eight trigrams maze used by Zhuge Liang is a fiction, the love

for the eight trigrams maze in Chinese has been inherited. Nowadays, there are eight trigrams

mazes in many places in China, for example, the eight trigrams in Linyi city and Youli city are both have excellent designs. Also, the former once held an eight trigram maze race in the "Zhuge Liang culture and art festival." If you use the mobile map apps in the maze, you will find that even the apps are lost [20]. Therefore, tourists who do not understand the basics of the eight trigrams maze and also do not hire a guide will get lost in it and might be trapped in it for hours.

The eight trigrams maze is a maze expanded according to the shape of eight trigrams. In the labyrinth, people need to find, identify, and use the trigrams to locate their position. This simple use of eight trigrams can help players remember and understand the arrangement and order of the trigrams.

Eight trigrams maze in Linyi City [21]

Eight trigrams maze in Youli City [22]

4. Background story

A little cultural background of eight trigrams is vaguely conveyed in the background story of the game. The initial motivation of Taoist is the pursuit of immortality. But this transmission is very obscure, Christina originally went to look for the tomb, and finally found a house, and people have been living there. According to Professor Sheldon, players should be rewarded for seeing this theory and knowledge at the end of the game, the house should have been both a reward for successfully reaching the end of the level and a recap of what players have experienced to highlight the game's theme. However, due to the time and workload, the content of this part had to be cut down and changed to the current way, which was not good enough for the eight trigrams background theory delivering.

Game Flow

1. Background story at the beginning

There is a short video where the game begins to introduce the backstory. This video tells the main character, Christina, was an archaeologist and adventurer, and this was a story about her in China. Based on clues she found earlier, Christina came to the place in the game to search for the tomb of a great Chinese. The waterfall that the game's final player reaches also fits the photo in the video. The content of the story is open because there is only one level of the game to verify that the teaching goal can be achieved. In other words, the story is not integrated.

Screenshot of beginning video
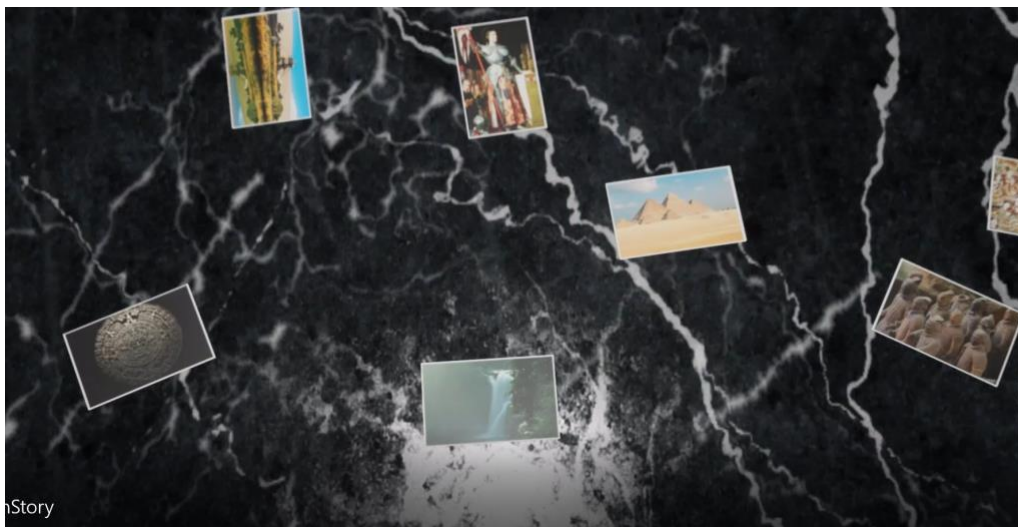
Screenshot of beginning video

2. Eight Trigrams puzzle on the stone tablet

This part has been explained earlier. Players had to open the door to enter the maze by solving the puzzle on the stone tablet.

Screenshot of stone tablet area

3. Eight Trigrams Maze

As it can be seen on the map which showed before, after entering the maze, the player needs to find the number 3 trigram according to the given map. After entering the maze, a short sequence will be triggered, in which the player is told to use trigrams that are formed by rocks to determine the direction, and these rocks are located right where the purple and green trees meet.
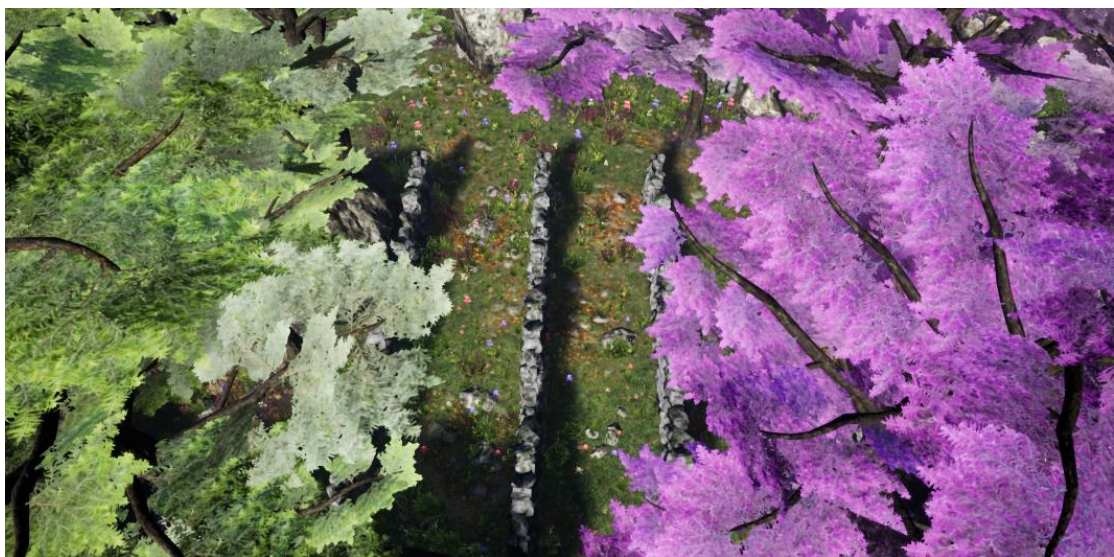
Screenshot of trigram rock under intersection of green and purple trees

Screenshot of trigram rock

The two stone columns in the middle of the maze are also hidden clues to help the player locate. The black base with the white moon, and the white base with the black ball (sun), correspond to the Taiji graph in the center of the eight trigrams. This hidden clue also helps the player locate the direction faster.
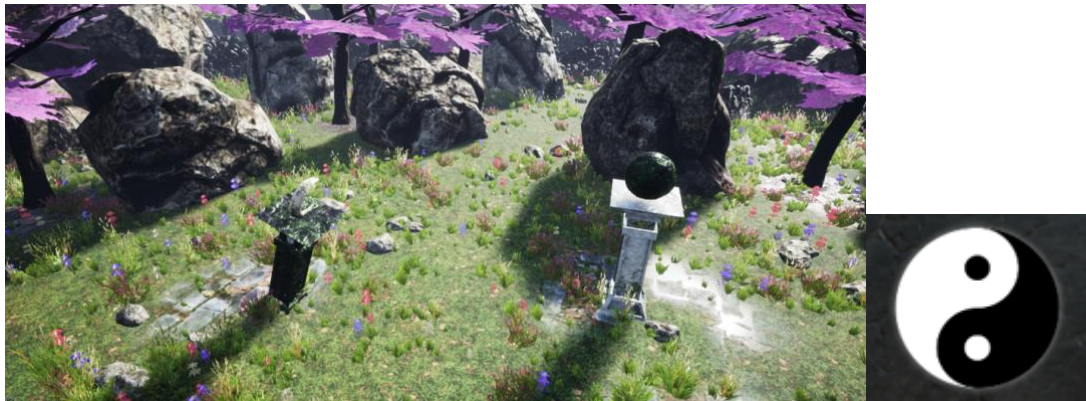
Screenshot of stone column

4. Key Puzzle

When the player finds the trigram area 3, a door can be found, and a sequence will be triggered to inform the player that a key is needed to open the door.

If the player has already found the key in the maze accidentally before he reaches the door, another sequence of opening the door will be played.

If the player does not have a key, he needs to notice the trigram below the keyhole and returns to the maze to find the trigram's area, which is number 4 trigram. Then the player will find the

key there.

Screenshot of key puzzle door

In the number four trigram area, the player will find a stone tablet and triggers a sequence. The content on the stone tablet is a sentence from the "Shaking Dragon Scriptures," which is Fengshui master Yang Junsong's masterpiece. Translated as "Searching dragons and treasures needs to look for circles of mountains. Thousands of obstacles indicate marquises live in here. "This text about Feng Shui is used to find tombs and treasure hunts of ancient Chinese dignitaries. At the back of the stone, the player will get the key.

Screenshot of stone tablet in number 4 trigram

Screenshot of key

5. Final Part

After the player opens the door in number 3 trigram, he will find a house in the final zone and triggers the last video. Instead of seeing the tomb, the player finds a wooden house, but apparently, the owner has left. Who lives here and why he hides him in the forest, Christina chooses to wait for the master to return to find out.

Screenshot of the house outside in the final zone

Screenshot of the house inside in the final zone

Game Production

Technical choice

Why Third-Perspective game?

The third-person perspective has a higher, broader, and freer view, which is required in the game because the player needs to observe trigrams from a distance.

Why 3D game?

The reason for choosing 3d games is that my drawing skills are poor, and I have never done 2d animation before, so I can't do 2d games.

Why UE4?

The reason for using ue4 instead of unity is that ue4 has a better 3rd-perspective 3d game template and related materials, which can increase my efficiency in programming.

Artistic decision

Realistic art style

The reason for choosing the realistic style is that the teaching content of the game itself is serious and real, so I hope to create a more realistic environment and art style.

Game assets production process

In order to achieve a more realistic effect, I first created the high-resolution models in ZBrush for most of the assets, then ReTypo in Maya, and bake the high-resolution model on a low-precision model and use Substance Painter to draw textures, and then finish the final processing in photoshop.

Lighting

I made light effects in ue4, adding some yellow into the color of sunlight to make the experience softer. A small amount of fog was added to enhance the mystery, and the halo reflection of sunlight on the smooth surface was added to make the sunlight more vivid.

Animation

All animations are done by hand. Mixamo was considered at first, but the character was expected to achieve some specific behaviors. In production, it took much time to manually

create the bones of the character, paint Skin Weight, and manually adjust all the animation frames.

Color choice

The color selection of most assets is trying to restore the color of real-world materials, except for some assets with specific functions. For example, the tree with purple leaves, due to there is no time to make a new model of the tree, and I hope there could be a noticeable difference to players, because players need to use the color of trees as a clue to guide them find the trigrams in the maze, so I chose to change the tree color to purple.

Text alpha

Text alpha is the Chinese word that is printed on the stone tablet in the game. In order to enhance the sense of history, the ancient Chinese calligraphy in the public domain is selected, and then the alpha channel is made and put on the stone tablet.

Game Iteration

Character

Screenshot of old version

Screenshot of current version

Change reasons

The game was originally intended to include some climbing puzzles and combat features, so a stronger male adventurer was chosen. But on the recommendation of the committee, the combat

was abandoned, they worried that the work would be too big to finish, and they were right. The character has since been reimagined as a female adventurer and an archaeologist.

Environment
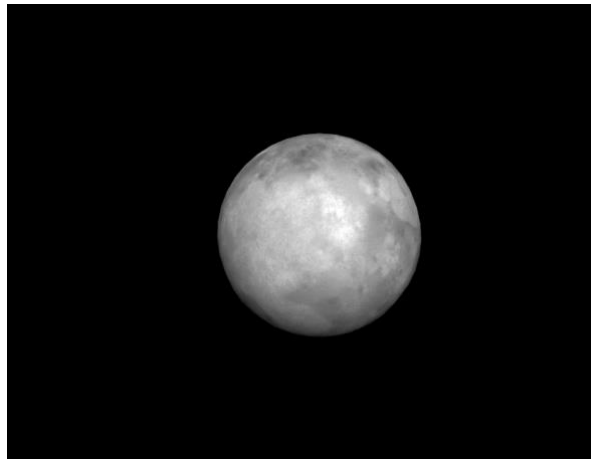
The game was originally designed to be a night scene, so the moon, torches, and Chinese-style lanterns were made, as well as puzzles about lighting objects with torches. However, in the actual production of the game, I found that the scene at night made it so hard to observe the eight trigrams maze. Moreover, due to my lack of experience, I could not adjust the light at night to be soft and comfortable enough, so that long time gaming would increase the frustration of the players. That's why I changed the environment to the daytime.

Maze Change

1. By the suggestion of Professor Sutter, the height of the stone wall was lowered to make it easier for players to observe the shape of the trigram.

2. After the roommate's initial test, the number of stone walls and boulders was drastically reduced, reducing the difficulty of the maze. Initially, the maze could only be entered from the number 1 trigram area with only one way to go to the center area, and from the center can only go to number 6 trigram, and then from number 6 trigram to number 3 trigram. This route, combined with massive boulders and stone walls, makes it extremely easy to get lost in the maze. But now the player can go directly from the center area to any trigram area.

Screenshot of old version

Screenshot of current version
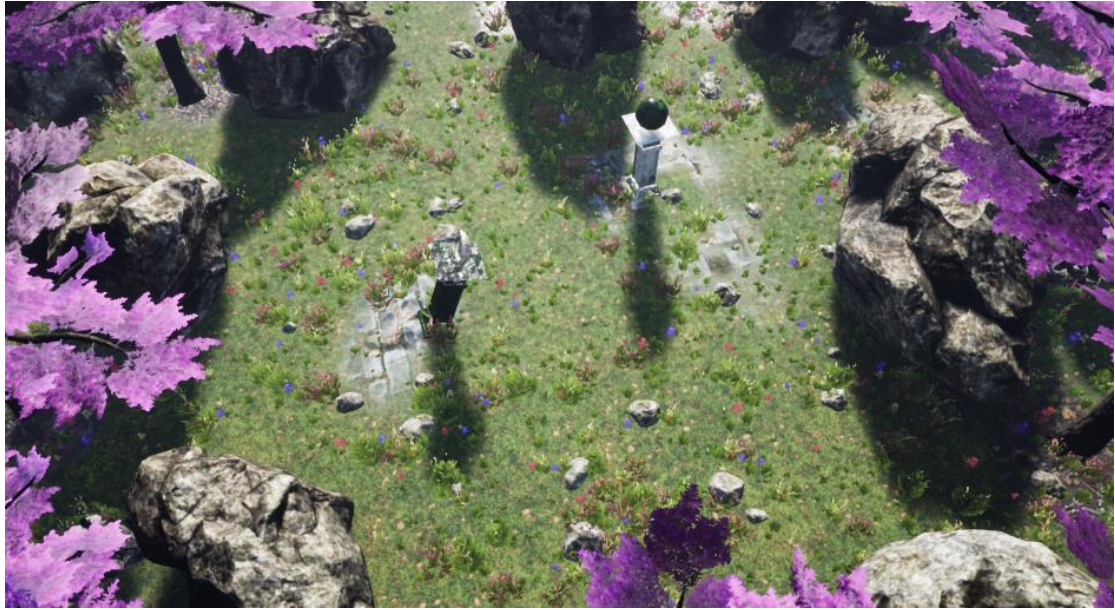
Screenshot of current version

Puzzle Change

Screenshot of old version
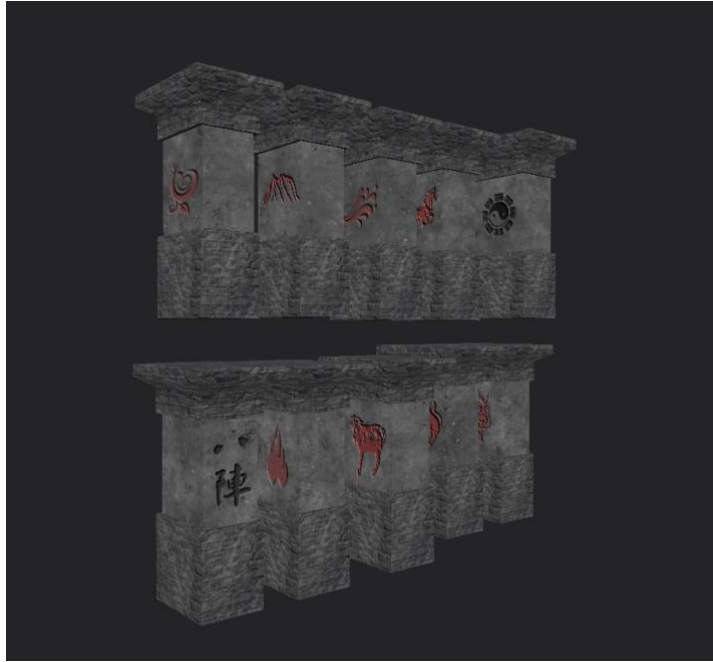
Screenshot of old version

The previous puzzle design is entirely different from the current one. In the beginning, I hope to use the eight different natural elements to represent eight trigrams as important clues, rather than teaching the derivation eight trigrams. Seven riddles are given:

1. Two bulbs, two fans, four harmers, two drills.

2. Someone with sharp horns and a white beard.

3. It can make leaves fall, and it can make flowers bloom in February. When it passes the river, it can cause huge waves. When it passes through the bamboo forest, tens of thousands of bamboo will tilt.

4. Even as small as fleas, can eat up entire grasslands.

5. Sitting is standing, standing is standing, walking is standing, lying is standing

6. It can't be seen when it is up, and it seems like thread when it is down.

7. It could be huge, which can cover the sun, it could be small which can be placed in the palm. The only door that doesn't have a riddle is the player's exit. The player has to solve the seven riddles, then eliminate the door with the seven riddles and figure out which door is not in the riddle.

But the problem is that the seven riddles do not come from history or Taoism, and the answers to the seven riddles are also theoretically wrong. The animals represented by trigrams and the natural energy represented by trigrams are not in the same theoretical system. Finding the seven

riddles in the same theoretical system is difficult. The puzzle was later dropped to help the player understand eight trigrams. The derivation of eight trigrams is chosen, which is more official, accurate, and less confusing.

Game mechanics change

The game began with a design that continuously triggered sequence as the player walked through the maze, to give the player pieces of information, requiring the player to combine them and figure out how to get out of the maze. The first part of the eight trigrams derivation puzzle is in the center of the maze. The player cannot directly operate it in the game but needs to write it down with pen and paper. The purpose is to let the player remember the formation process of the eight trigrams and find the exit in the process of recording and derivation.

But the committee's opinion was that it was not a game at all. It was too confusing and lacked interaction. At the suggestion of Professor Sheldon and Professor Sutter, the game is now divided into three areas. The first part is before entering the maze, the player interacts with the stone tablet and operates directly on the computer to make the eight trigrams. The maze is the second part, and the exit is the third part. When the player finds the exit, there is another puzzle to check whether he understands how to use eight trigrams to guide directions.

Background story Change

The backstory of the initial design is that the player finds the tomb of Zhuge Liang after exiting the maze. Zhuge Liang is believed to be the earliest founder of the eight trigrams maze. But since this theory was found to be fictitious in later research [28], the back story was changed to Christina found a house instead of a tomb. And use this story to convey the early Taoist zeal for immortality vaguely.
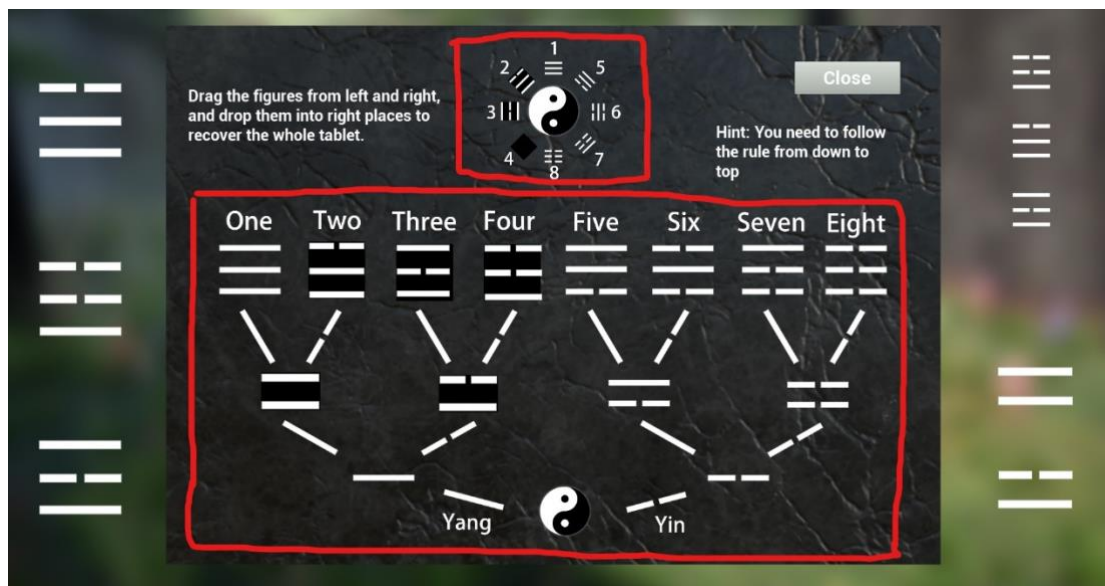
Teaching Object

The main teaching objectives are:

1. The player understands the formation rule of the eight trigrams.

2. The player understands the use of the eight trigrams for navigation and maze.

3. Players learn about the original eight trigrams functions and Taoist pursuits through the backstory.

The essential teaching goal is the first one. Players who successfully achieve the primary teaching goal should be able to draw the eight trigrams independently.

To better help the players understand and achieve the teaching objectives, the eight trigrams graph is divided into two parts to follow. The first part is how the trigrams are combined with "Yin" and "Yang," which is also the derivation of eight trigrams. The second part is how the eight trigrams are arranged numerically.

Because of time lacking, the game content of the third teaching goal has to be cut down, and now it is buried in the backstory. And if there is more game content about this part, it should be better.

Survey Part

Due to the influence of COVID-19, there are only online tests, and the behavior of each tester will not be observed. The survey mainly to test whether the players completed the teaching objectives, seven of questions are about gameplay, and six are about cultural implication.

Testers: 9 students from WPI, 7 of them from IMGD, 3 of them from Chinese (30%).

Online questionnaire

Question 1:

Purpose：Find out if the player completed the game and why they didn't.

Result:
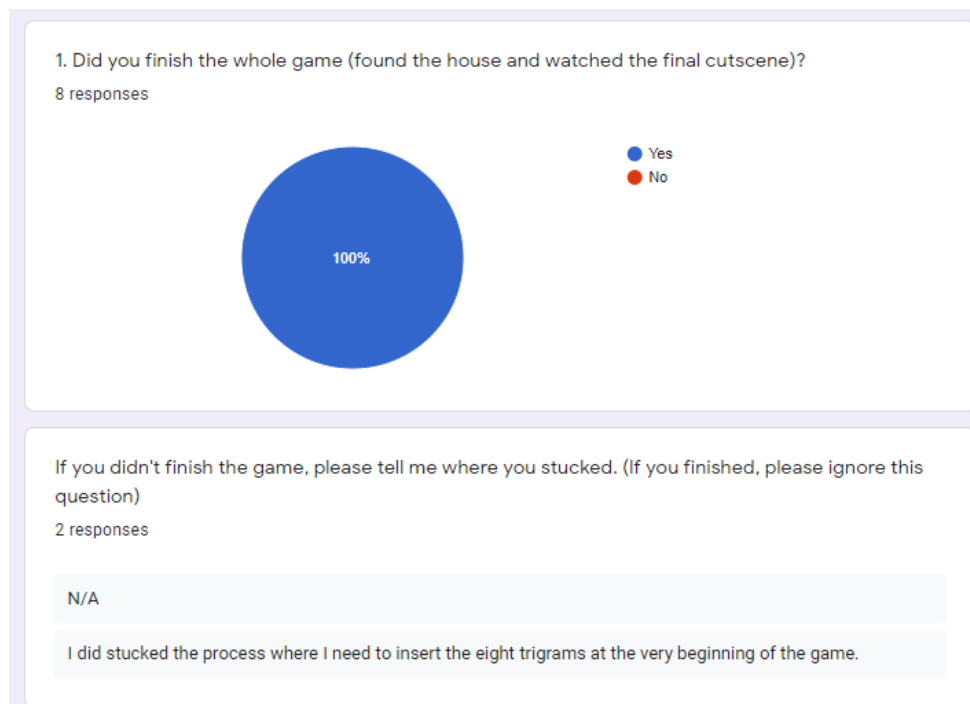
Results analysis

Only one tester got stuck when inserting eight trigrams, perhaps because he used a 4K display. Since the game does not support the 4K display, the UI will be disordered if the 4K display is used, which makes some functions ineffective.

Question 2:

2. Did you know anything about the eight trigrams before playing this game?

	1	2	3	4	5	
Not at all	○	○	○	○	○	Proficient

Purpose：It is necessary to know whether the tester knows eight trigrams before this. If the testers already know eight trigrams, the teaching purpose of the game may be invalid for them.

Result:

2. Did you know anything about the eight trigrams before playing this game?
8 responses
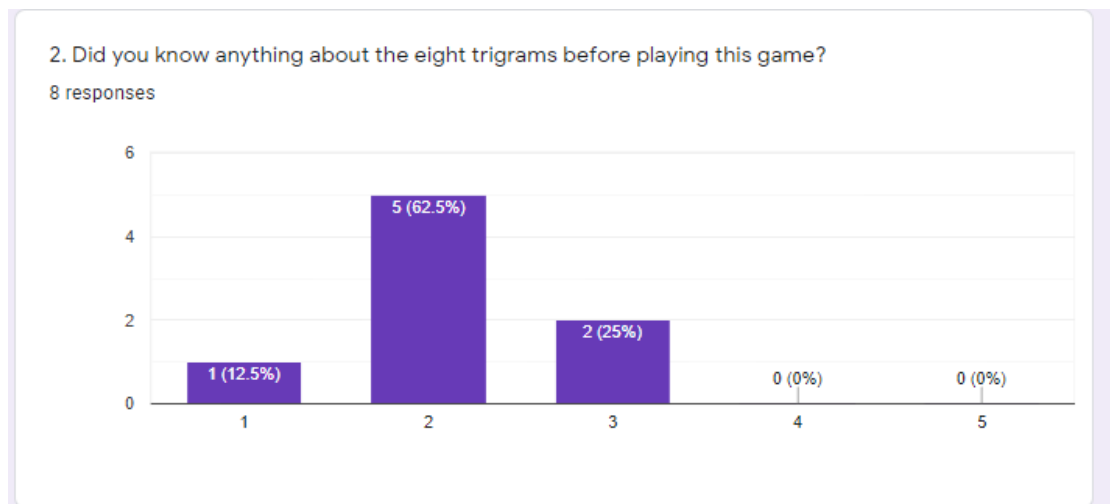
Results analysis

The results show that most of the participants had heard of eight trigrams but did not know much about them.

Question 3:

3. Which of the following countries do you think might be the birthplace of eight trigrams?

   ○ A. Japan

   ○ B. India

   ○ C. China

   ○ D. Spain

Purpose: This part of the content is hidden in the beginning video, which requires the player to pay attention to this information and realize that eight trigrams originated in China.

Result:

3. Which of the following countries do you think might be the birthplace of eight trigrams?
8 responses

● A. Japan
● B. India
● C. China
● D. Spain

100%
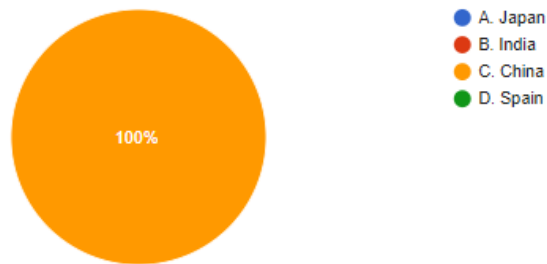
Correct answer: C

Correct proportion: 100%

Results analysis

All the testers answered this question correctly. Since there is a tester who had never heard of eight trigrams at all, it can be considered that the information successfully delivered in the game.
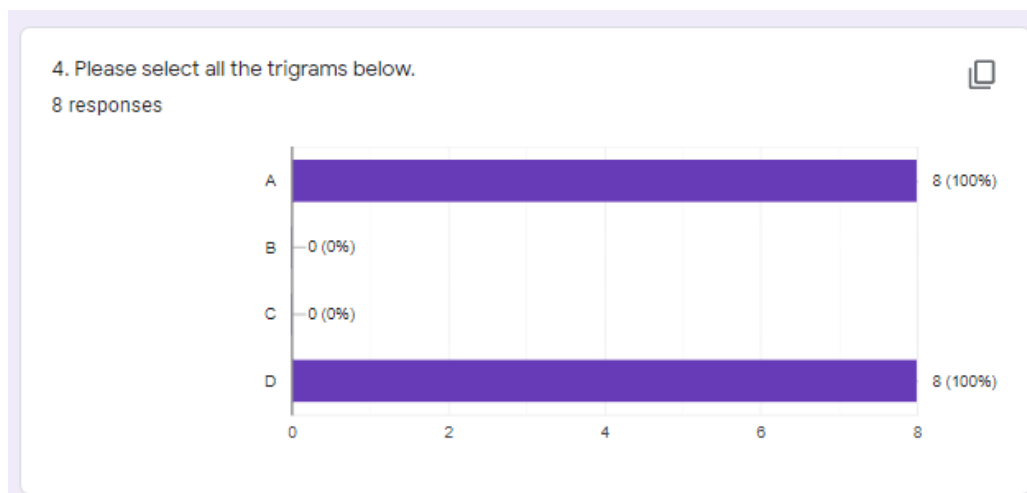
Question 4:

Purpose: Check if the player knows what is the graph of trigram through the game.

Result:

Correct answer: A,D

Correct proportion: 100%

Results analysis

All the testers successfully understood the graph of trigram.

Question 5

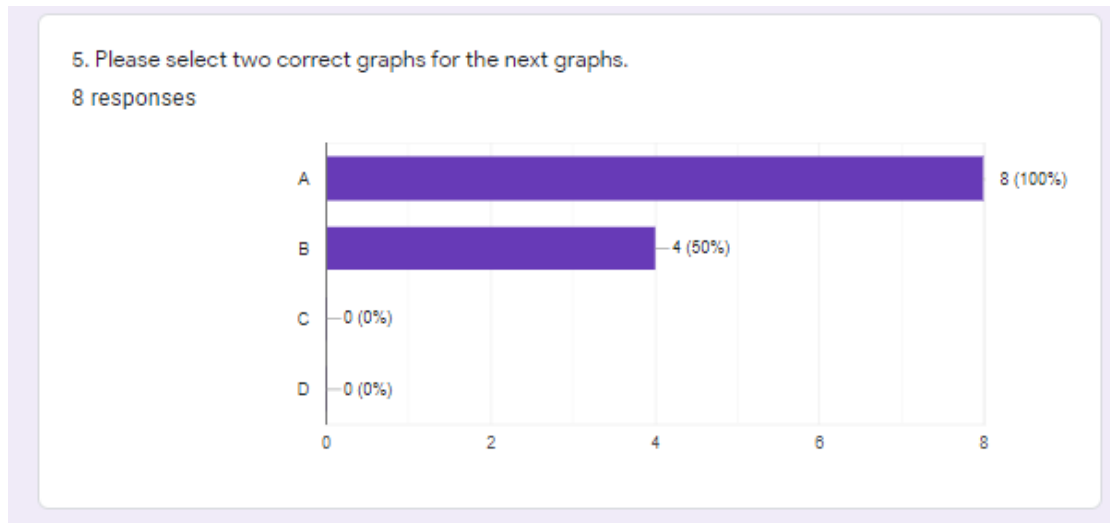5. Please select two correct graphs for the next graphs.

☐ A

☐ B

☐ C

☐ D

Purpose: The question examines whether the testers learned how eight trigrams form through the game. This question is a direct examination of the first teaching objective.

Result:

Correct Answer: A,B

Correct Proportion: 100%

Result Analysis

I made a mistake in this question because I was not familiar enough with Google form, there were two answers to this question, but I made it a multiple-choice question at the beginning. It wasn't until a tester pointed out that there should be two answers to this question that I noticed the problem and changed the question type to CheckBox.

for "5. Please select two correct graphs for the next graphs." B is also correct.

Also, the survey is a little messed up, as question 5 only allows for one answer.

Since no one chose C and D, it can be considered that they have a basic understanding of the formation principle of eight trigrams.
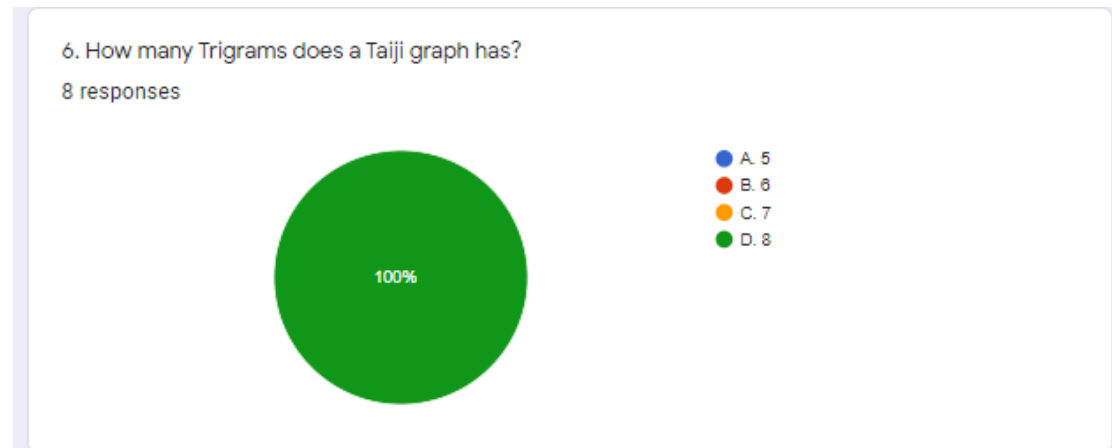
Question 6

Purpose: A simple question tests whether the player understands that trigrams are part of the

Taiji graph.

Result:

6. How many Trigrams does a Taiji graph has?

8 responses

- A. 5
- B. 6
- C. 7
- D. 8

100%

Correct Answer: D

Correct Proportion: 100%

Result Analysis

It can be considered that all testers understood the association of the Taiji graph with eight trigrams.
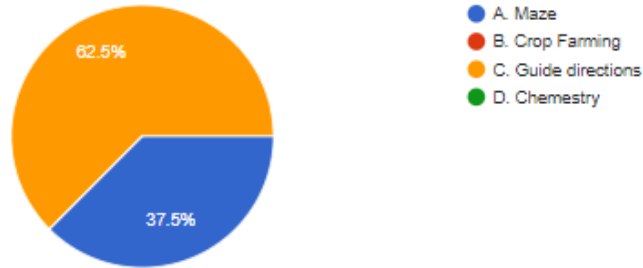
Question 7

7. For which of the following might the eight trigrams be useful

- A. Maze
- B. Crop Farming
- C. Guide directions
- D. Chemestry

Purpose: Test if the player understands part of the usage of eight trigrams in the game. Eight trigrams are very useful in practice and only a few parts involved in this game.

Result:

62.5%

37.5%

- ● A. Maze
- ● B. Crop Farming
- ● C. Guide directions
- ● D. Chemestry

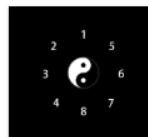**Correct Answer:** A,C

Correct Proportion: 100%

Result Analysis

I made the same mistake with this question, which should have been a CheckBox type question, but I set the question type to multiple choice. A and C are both correct answers. Since no one chose B and D, it can be considered that the players have a proper understanding of the purpose of eight trigrams in this game.

Question 8

8. Which of the following is the correct order of the eight diagrams?
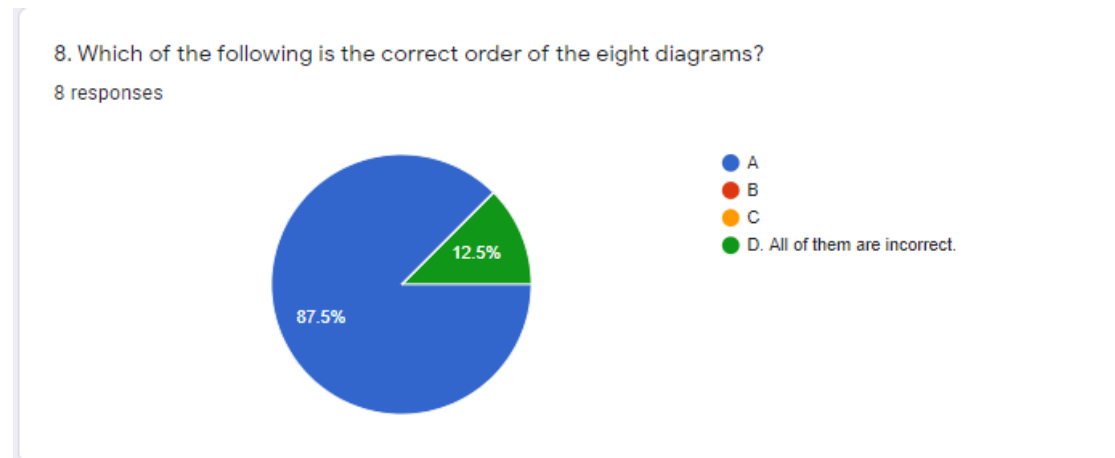
○ A

○ B

○ C

○ D. All of them are incorrect.

Purpose: This question is to examine the order of eight trigrams in the Taiji graph. Eight trigrams can be restored by understanding both the generation principle and the ranking order.

Result:

8. Which of the following is the correct order of the eight diagrams?

8 responses

- A
- B
- C
- D. All of them are incorrect.

87.5%

12.5%

Correct Answer: A

Correct Proportion: 87.5%

Result Analysis

The results show that most players learned the order of eight trigrams from the game.

Question 9

9. Based on the story of the game, the ancient Chinese people believed which of the following were uses for the eight trigrams?

○ A. Control animals

○ B. Get stronger

○ C. Eternal life

○ D. Obtain love

Purpose: This question is to test whether the player knows the initial Taoist initial pursuit, through the background story.

Result

9. Based on the story of the game, the ancient Chinese people believed which of the following were uses for the eight trigrams?

8 responses

- A. Control animals
- B. Get stronger
- C. Eternal life
- D. Obtain love

100%

Correct Answer: C

Correct Proportion: 100%

Result Analysis

The answer to this question is not directly told in the game. Players need to combine the beginning video and the ending video, the answer is a relatively obscure content. Surprisingly, all the testers understood this and chose the correct answer.

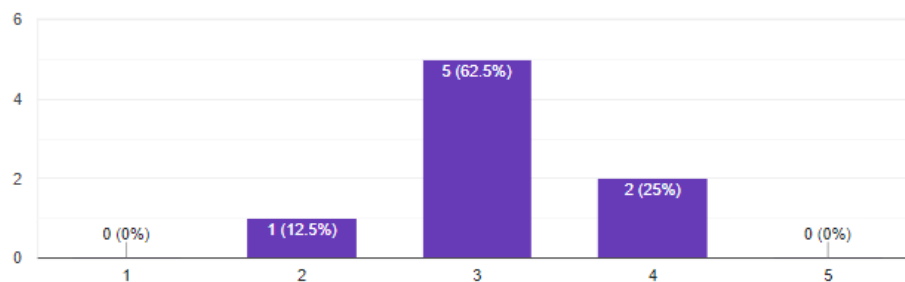**Question 10**

10. How much do you like this game?

	1	2	3	4	5	
not at all	○	○	○	○	○	very much

Purpose: Learn about the player's experience with the game.

Result:

10. How much do you like this game?

8 responses

0 (0%)   1 (12.5%)   5 (62.5%)   2 (25%)   0 (0%)

Result analysis

Judging from the results, the experience most of the testers thought the game was average.

Question 11

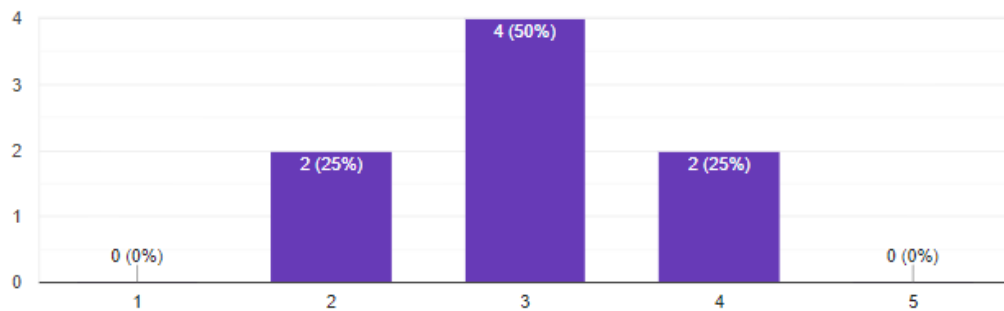11. If this level were expanded into a full game, would you want to play it?

	1	2	3	4	5	
Not at all	○	○	○	○	○	very much

Purpose: It's not a complete game, it's more like a level in the game, so it's important to know that if players are motivated to play.

Result:

11. If this level were expanded into a full game, would you want to play it?
8 responses

Result analysis

The results showed that the participants' expectations for the full game were average.

Question 12
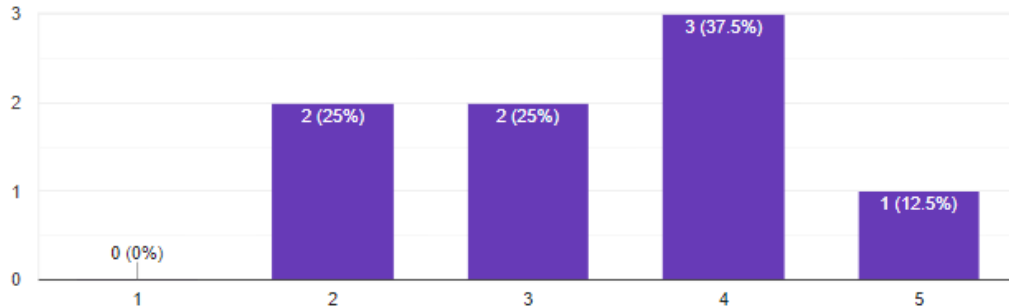
12. How difficult do you think this game is?

	1	2	3	4	5	
Very easy	○	○	○	○	○	Very hard

Purpose: Understand the player's experience with the difficulty of the game.

Result:

Result Analysis

From the result, the game difficulty is slightly hard.

Question 13

13. Please give some suggestions on how to improve this game. Thank you!

Long answer text

Result:

> Guide optimize

> Hope to have more adventure game elements and playable features

> for "5. Please select two correct graphs for the next graphs." B is also correct.
> The first thing I did when I started was press esc because I wanted to change the graphic settings. I watched the intro 3 times, I wish there was a button to skip it. I forgot which way the bars counted so at first I went to 4 to try and find the key instead of 7. I also wish there was a way to re-read things around the world.

> I feel like the game has trouble conveying both what the player should do, and its message. The hint for the trigrams puzzle is confusing; something more like "Move from the bottom to the top, adding as you go" would make more sense. Also, I didn't realize I had to add the tigrams to the circle at the very top of the puzzle, so I was wondering what I did wrong. However, solving it was quite satisfying. Out of the entire game, this was the part I enjoyed the most.

> I didn't find any hint for finding the key, so I assumed based on the Yin/Yang theme that the side opposite to the treasure should have the key. Also, when searching for the treasure and key, the stone walls on the edges of the map make it hard to see what's part of the puzzle and what is just decoration.

> The narration is a little flat, and the dialogue is grammatically incorrect/stilted. I think it would help to get somebody to proofread it and then get someone to voice the main character if possible.

> Also, I found a bug during the final cutscene. If you press S, the cutscene restarts, and if you press any movement key, you can hear the player still walking. I assume this is because the character's movement isn't locked, so I was able to walk backwards into the cutscene trigger and restart it. Also, if possible, vsync would help a lot, there was some pretty bad screen tearing.

> Also, the survey is a little messed up, as question 5 only allows for one answer. I also don't feel like I learned what I needed to to answer questions 7 and 9 right.

Analysis of the survey

Although it seems that most of the participants got the questions right, there are many shortcomings in this survey.

1. Three Chinese students were included in the nine test testers, which may make their understanding of eight trigrams higher than that of other testers.

2. All the participants were students from WPI, which means they were highly educated and had some knowledge that they probably knew before, as one of the participants mentioned that he did not need to play the game to answer questions 7-9 successfully.

3. The depth of the test is not enough, and the content examined by the questions are shallow. Although the accuracy rate of the testers is high, their deep understanding of eight trigrams is not well measured.

4. There is no adequate evaluation of the third teaching goal, which is to let player learn about the original eight trigrams functions and Taoist pursuits through the backstory. Cut down the game content weaken the teaching goal in the game.

5. Due to the influence of COVID-19, the sample of testers in the game is not enough, so the results are not objective enough.

6. It would have been better if I had asked the question, "would you like to learn more about eight trigrams after the game?"

Conclusion

According to the analysis of the survey results, several conclusions can be drawn. Eight of the nine testers successfully tested the game, and one failed to participate due to hardware issues. According to the response accuracy of questions 4, 5, 6, and 8, seven of the eight testers completed the first teaching goal, understanding the formation of eight trigrams. Based on how well the eight participants completed the game, all achieved the second teaching goal, using eight trigrams to navigate in the eight trigrams maze. According to the accuracy of question 9, all the participants completed the third teaching goal, knowing the eight trigrams functions and Taoist pursuits. To sum up, the game is effective for the completion of these teaching objectives. This result also indicates an increase in the cultural knowledge of eight trigrams among those testers. However, from the survey results, the player experience, the expectation for the whole game, and the suggestions, it can be learned that the game is lacking in content, and the game is not interesting enough.

Also, there are some other very valuable suggestions, so in future work, I can continue to improve and optimize the following content.

1. Bugfix

There are still some known bugs in the game, which will not completely interrupt the progress of the game but will bring an awful experience to the players when they appear.

2. High scene repetition

With more time for assets produce in the future, this situation can be improved.

3. Lacking playable content

The game needs to have more puzzles, gameplay. The current games are too simple to be fun. In the future, some jumping, parkour, and even combat elements can be added to make the game more interesting.

4. Insufficient teaching content

The teaching content is relatively shallow and does not contain the complex theoretical and philosophical ideas of eight trigrams, so it does not verify whether the complex cultural content can be successfully delivered in the game.

5. Language optimization.

Since English is my second language, the game would be better if someone native speaker could write the story script.

6. Better Survey

Just as the previous analysis, some questions were omitted from this survey, and the investigation of teaching objectives was not comprehensive enough, and better questions can replace some questions.

In conclusion, the first teaching goal, which is to let players understand the formation rule of the eight trigrams, is well done according to the test result in the survey (87.5% testers answer the related questions correct).

The second teaching goal, which is to let players understand the use of the eight trigrams for navigation and maze, is achieved according to the test result in the survey and how well they finished the game.

Due to time constraints, the third teaching goal about the back theory of eight trigrams, the original eight trigrams functions, and Taoist pursuits, which is very important, is not done well. At the moment, there is a little hint of back theory in the background story about this part. The third teaching goal requires more work in the future, adding new puzzles and stories to convey this part of the content.

To sum up, the game failed to verify the deep culture transfer of eight trigrams. If a team can join this project, more can be done, and complete game content can be done to deliver a deeper culture of eight trigrams.

Reference

[1] Miller, Laura (2018). "Searching for charisma Queen Himiko." Diva Nation. Berkeley: University of California Press.

[2] Díaz del Castillo, Bernal (1963). "The Conquest of New Spain." Penguin Classics. J.M. Cohen (trans.) (6th printing (1973) ed.)

[3] Fasheng Zhao. "《易传》刚柔思想的形成与易学诠释典范的转移". www.cssn.cn, Jun-12-2014

[4] Yuan Tian, Ju Qi. "易解人生". 人民文学出版. 2010

[5] Lao Tzu. "Tao Te Ching", universe part.

[6] Elizabeth Pollard; Clifford Rosenberg; Robert Tignor (16 December 2014). Worlds Together, Worlds Apart: A History of the World - From the Beginnings of Humankind to the Present. W.W. Norton. p. 164

[7] Creel (1982)

[8] Woodhead, Partridge, & Kawanmi, Linda, Christopher, & Hiroko (2016). Religions in the Modern World. New York: Routledge. p. 146.

[9] Zhihong Yuan, "当代中国道教". people.cn. Jun-9-2003

[10] Robinet (1997), p. 63

[11] Robinet (1997), p. 25

[12] Kirkland (2004), p. 62

[13] Kirkland (2004), p. 61

[14] 民政部登记的社会组织查询, 中国社会组织网

[15] Jiyu Ren,"《文史知识》经典文章回顾：道家与道教".book.ifeng.com.Jul-26-2012

[16] Wilhelm, R. & Baynes, C., (1967): "The I Ching or Book of Changes", With foreword by Carl Jung, Introduction, Bollingen Series XIX, Princeton University Press,

[17] Cavalli-Sforza, L. L., & Feldman, M. (1981). Cultural transmission and evolution: A quantitative approach. Princeton: Princeton University Press.

[18] Picture from Wikipedia

[19] Yong Shao. "梅花易数". Song dynasty.

[20] "山东有个八卦迷宫，高德地图在里面都失灵，能走出来就是再世诸葛", 司徒小镇.

[21] picture from ly.com

[22] picture from 司徒小镇景区, sohu.com.

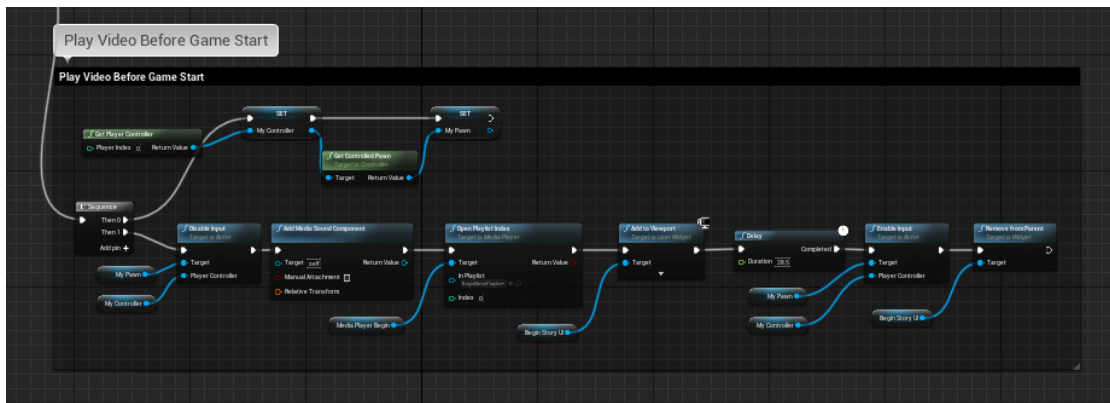# Appendix A: Technical Design Specification

Technical

Platform: PC

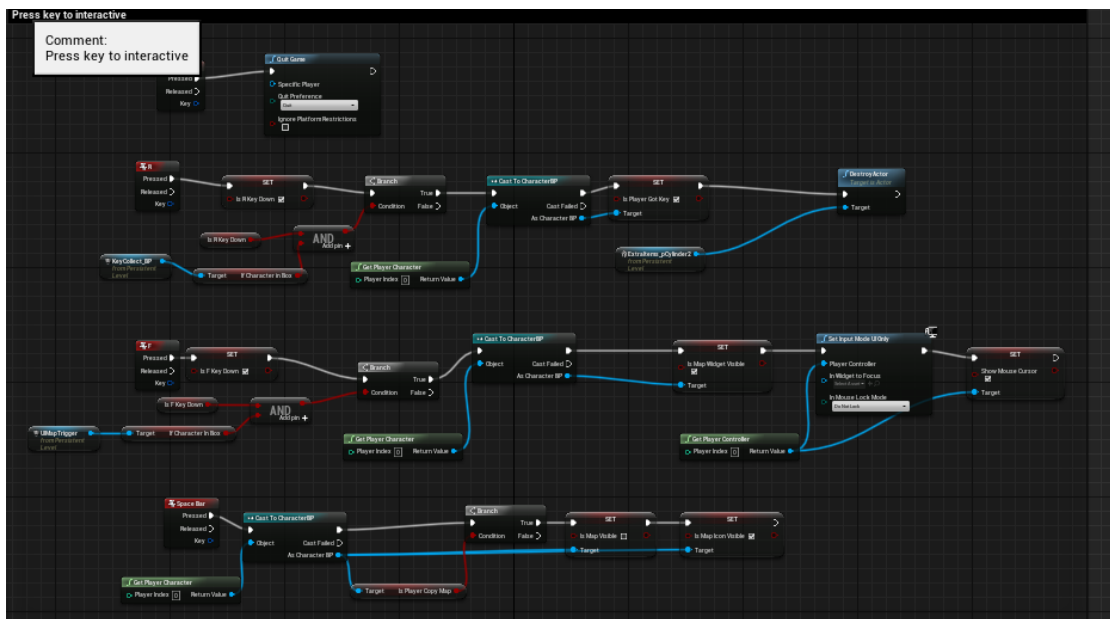Game Engine: Unreal Engine 4

Programming: Blueprints

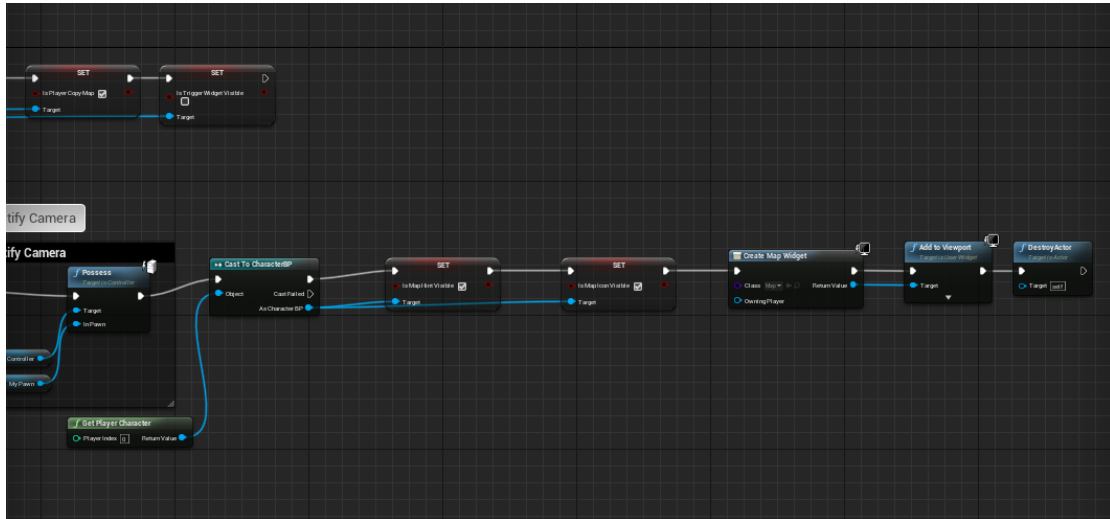Attached below are blueprints for some essential parts.

Video before game start

Explanation: This blueprint initializes the starting player and locks the player's actions for the duration of the video before the game starts.

Press keys to interactive

Explanation: This blueprint contains parts of the game that require buttons to interact with the

game world.

Initiate Sequence Player

Explanation: This section of the blueprint includes the initialization of the Sequence before each Sequence is played.

Final Door without the key

Explanation: This part of the blueprint represents what will happen if the player reaches the final area without the key.

Final door with the key

Explanation: This part of the blueprint represents what will happen if the player reaches the final area with the key.

Block background music

Explanation: This blueprint can be used to avoid background music interference when playing

the videos.

Check if puzzle answer correct

Explanation: This part of the blueprint is used to verify that the player completed the puzzle on the stone tablet correctly.

Foliage
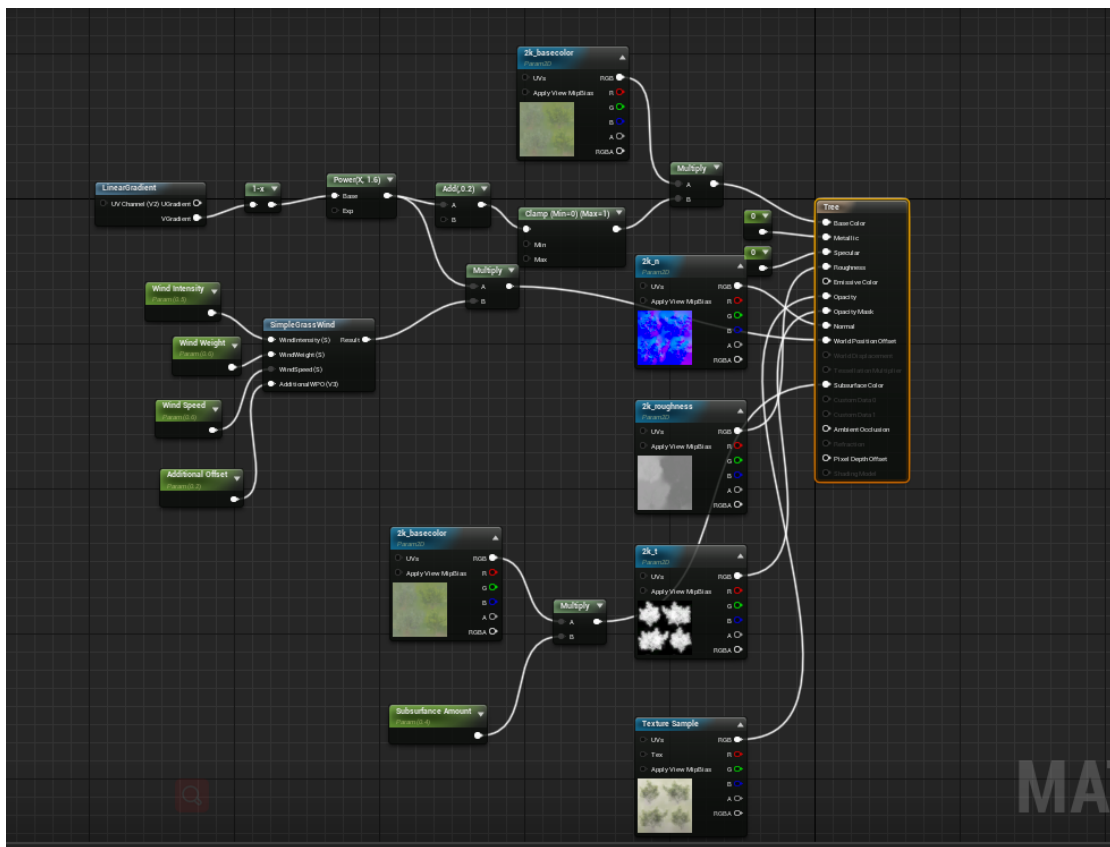
Explanation: This part of the blueprint is used to make the foliage swing, to create the feeling of the wind blowing.

Landscape painting material
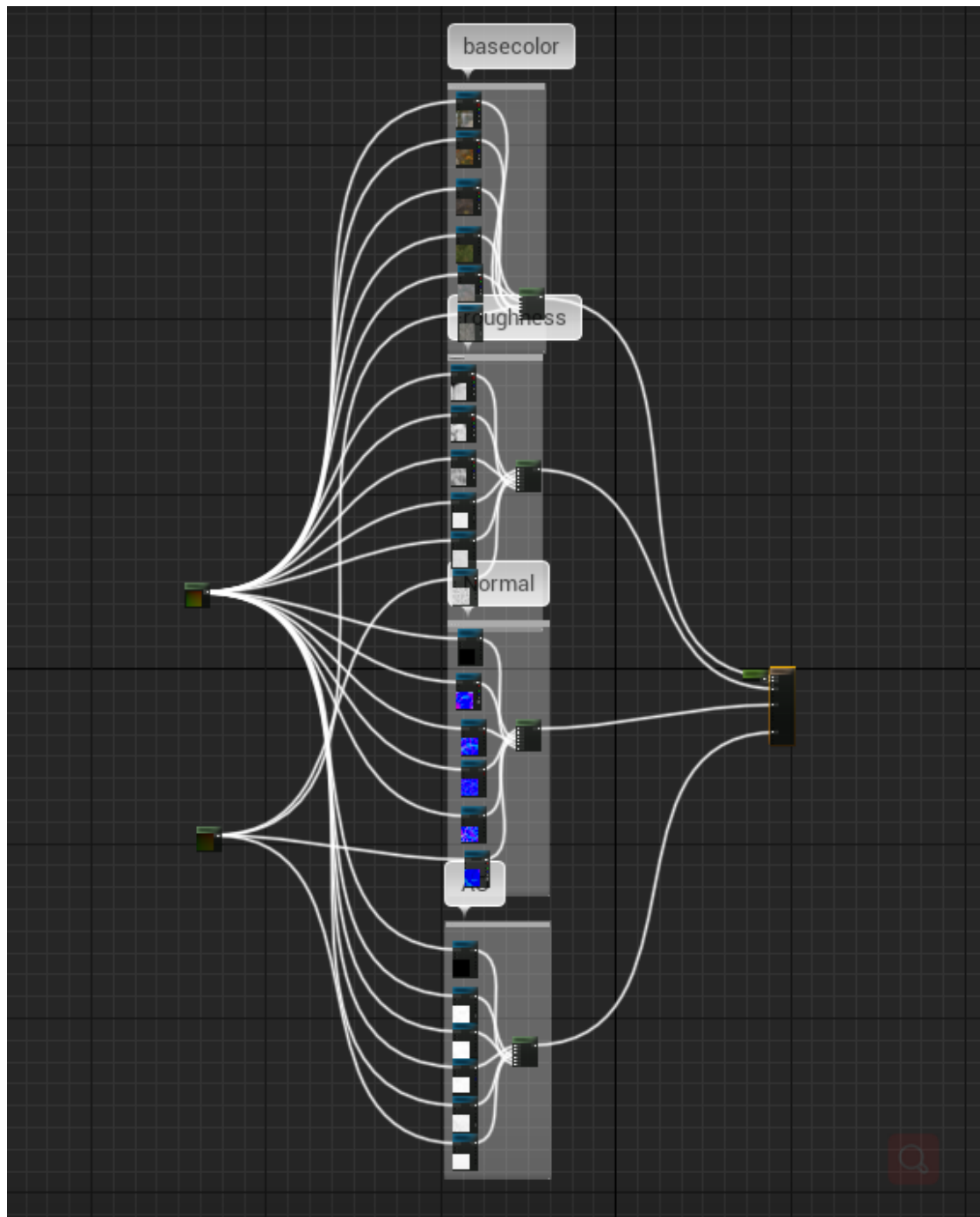
Explanation: This part of the blueprint is used to create ground textures, which can be used to overlay different terrain textures.

Appendix B: Art Design Specification

The art assets in this project are mostly self-made, some of which are attached below.

Character

Model rendering in Substance

Low-Res model in Maya
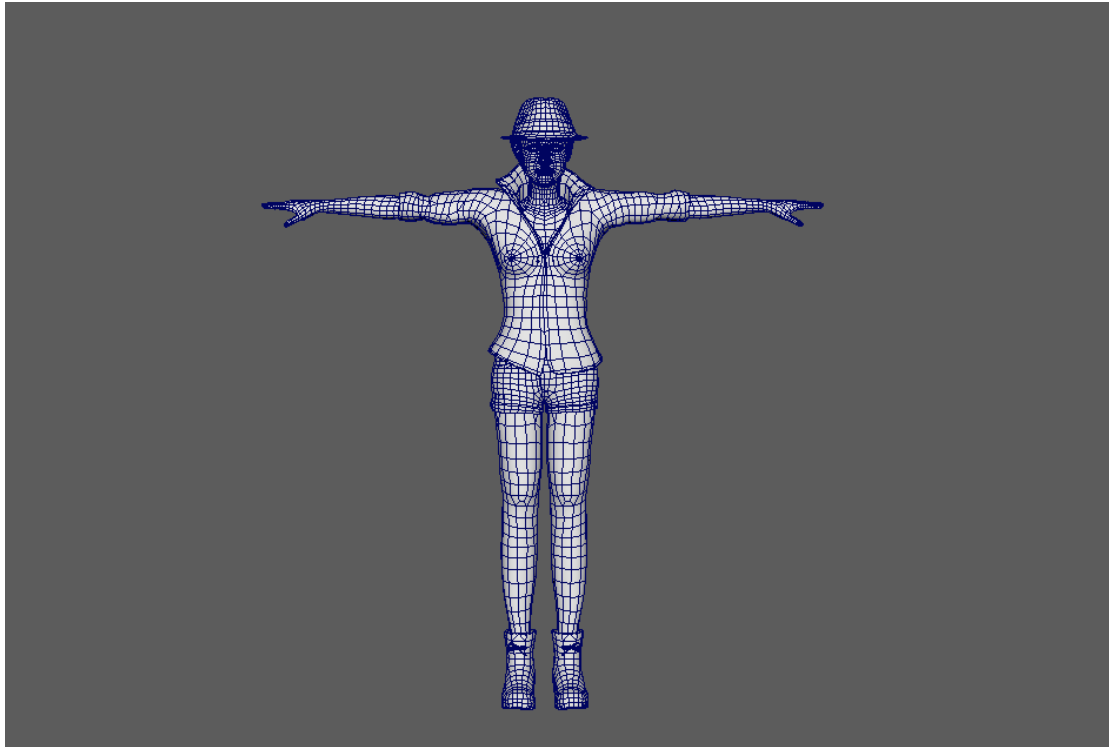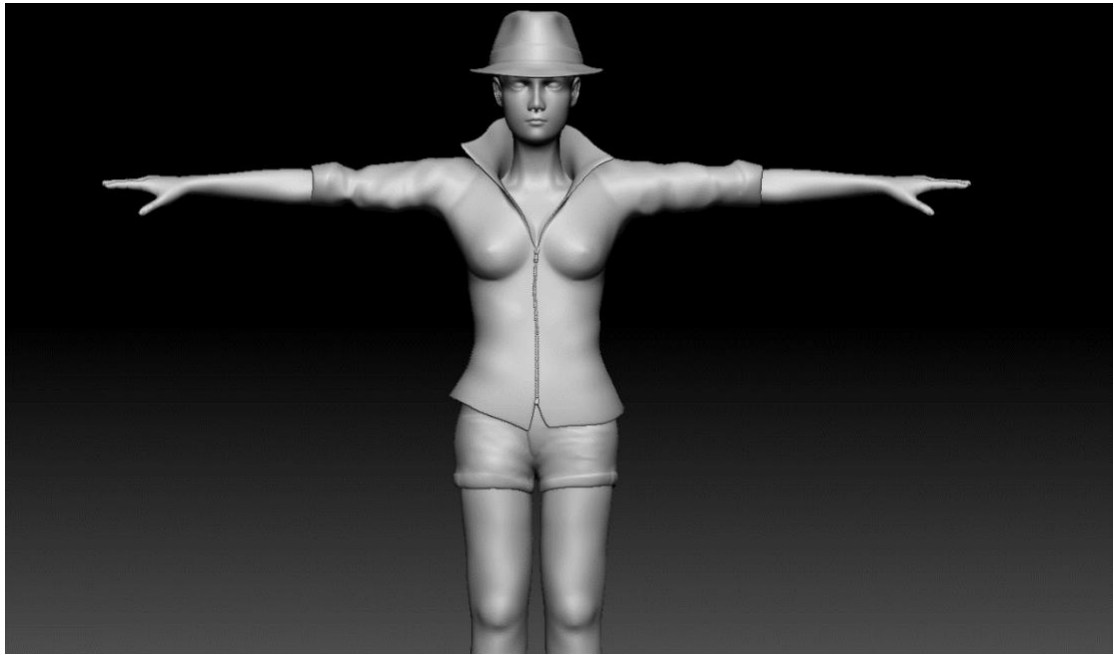
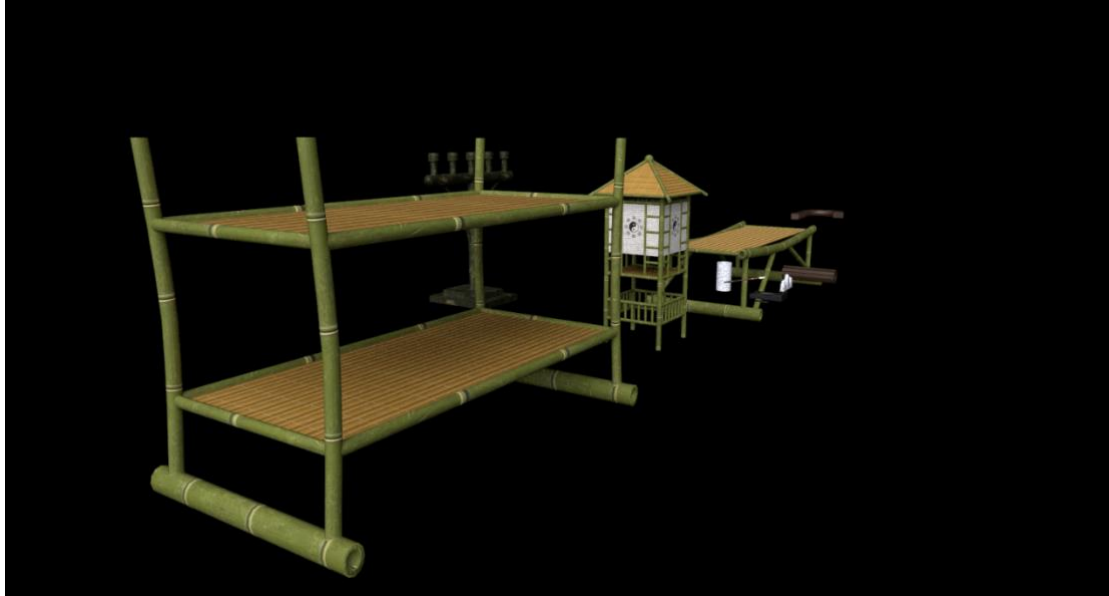Rigging & Animation in Maya
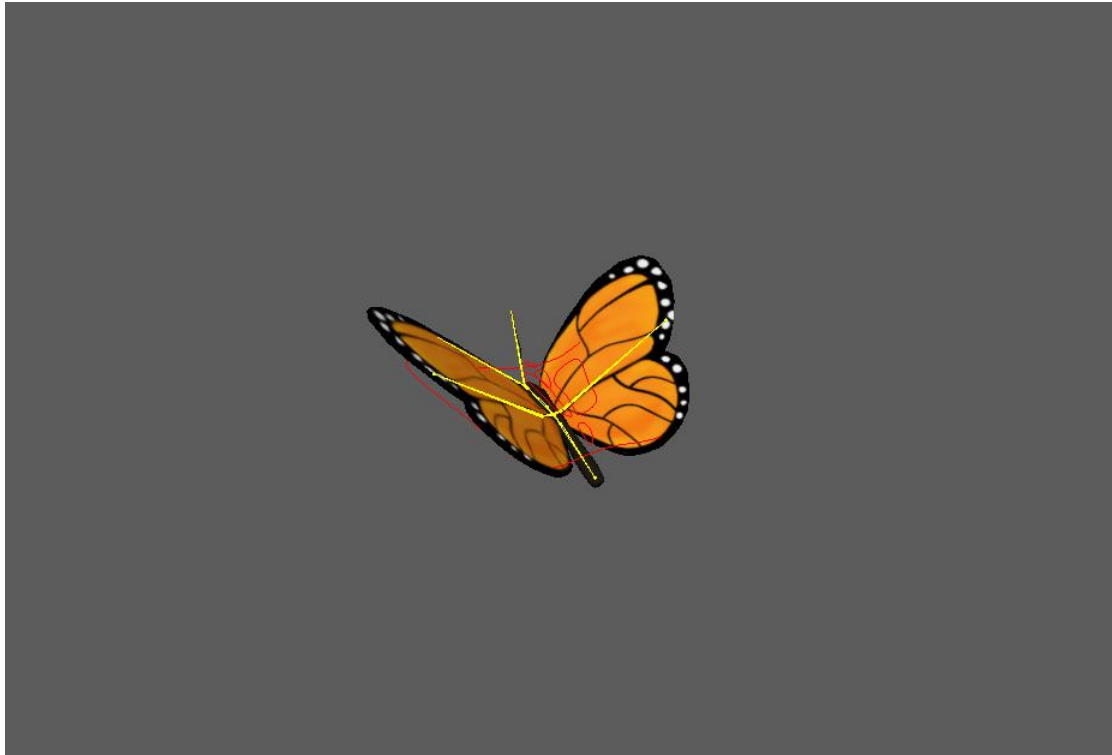
Final house render in Substance
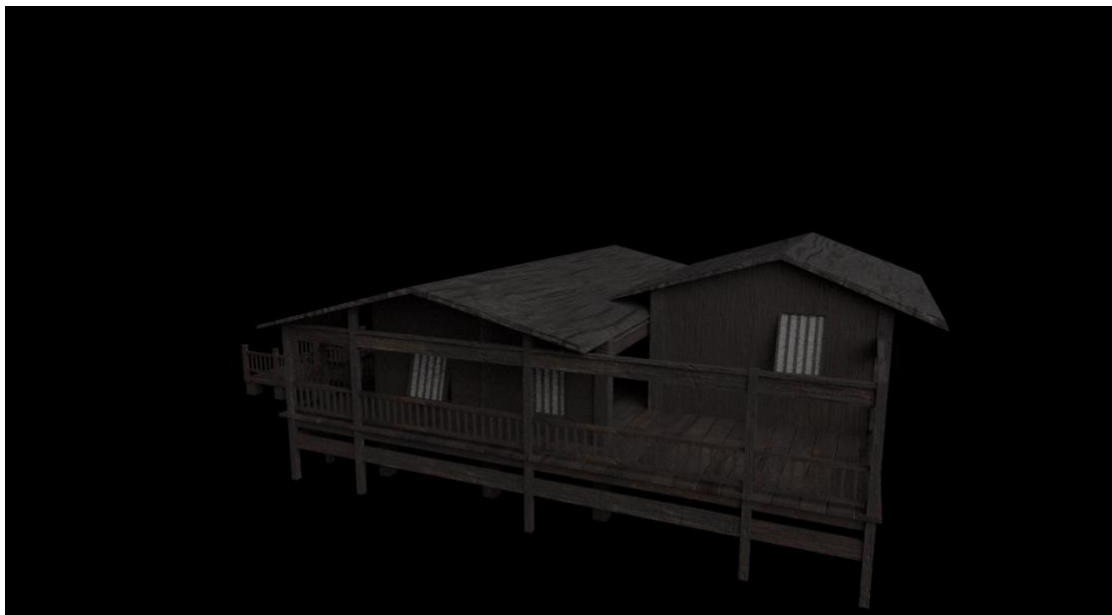
Decorative container render in Substance
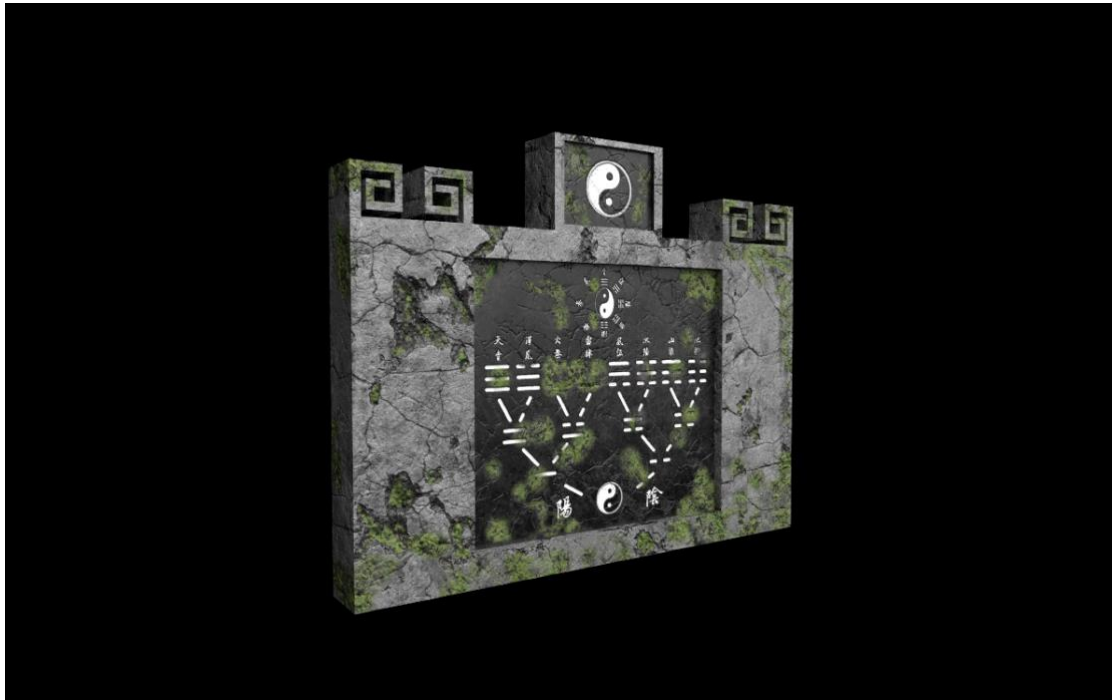

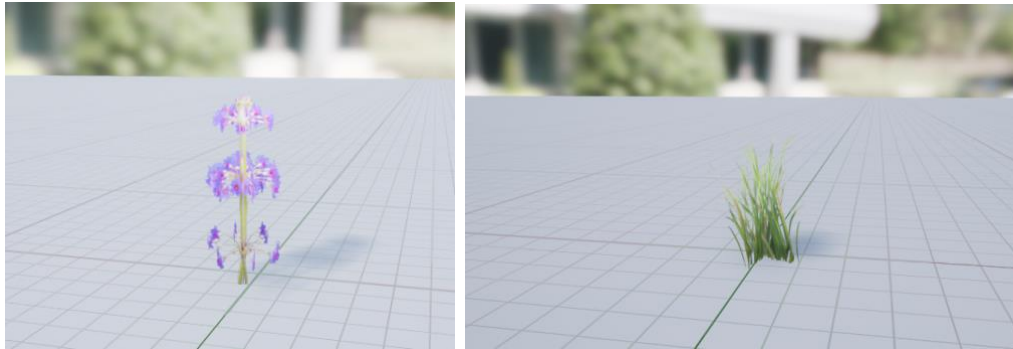Furniture render in Substance
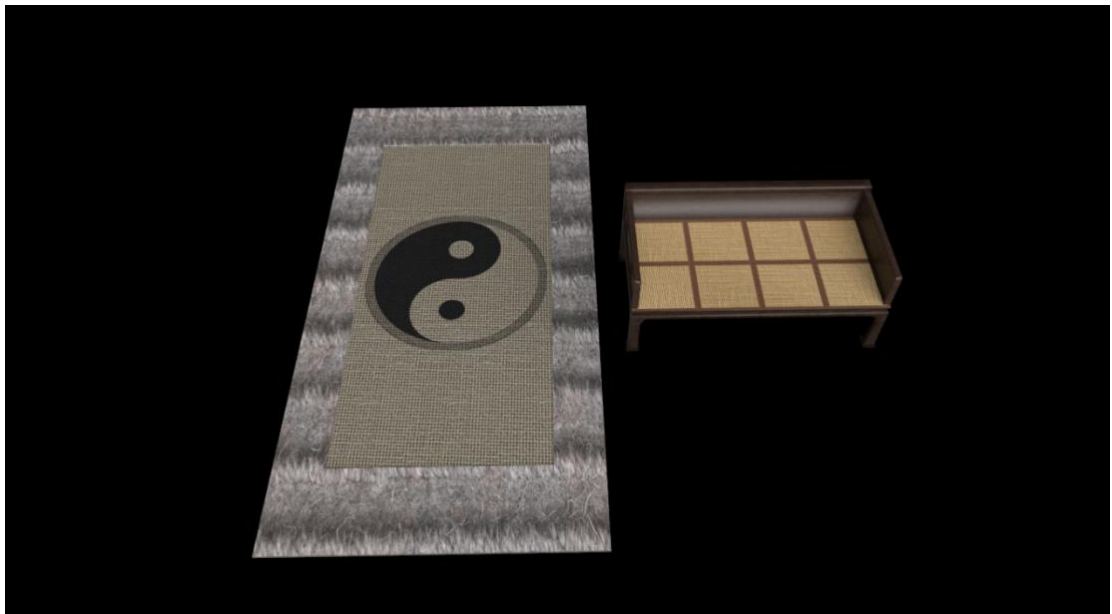
Tree with leaves in UE4

Stone tablet puzzle render in Substance

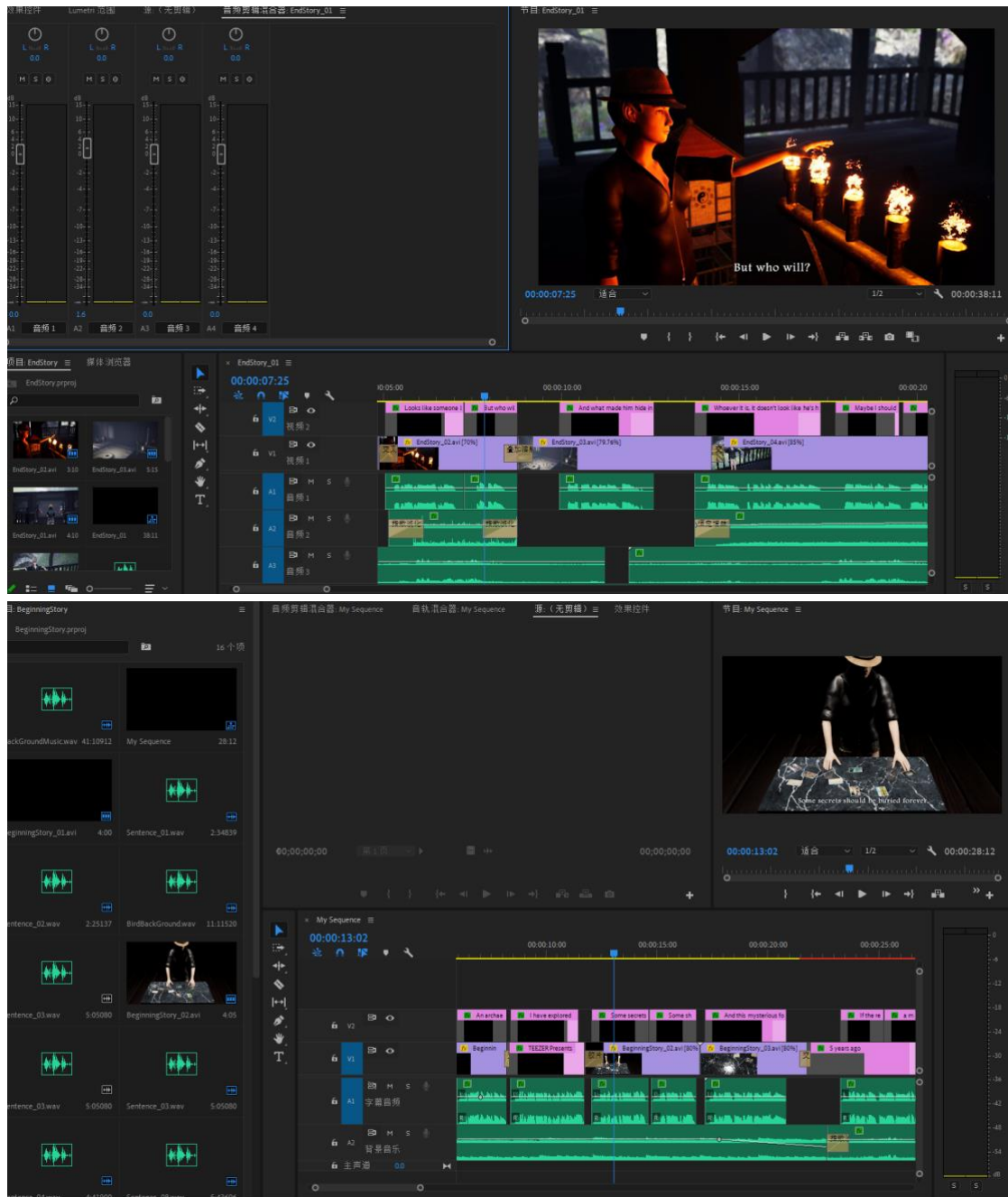

Stone tablet with key render in substance

Landscape and foliage painting

Fire FX in UE4

Appendix C: IRB approval

WORCESTER POLYTECHNIC INSTITUTE

100 INSTITUTE ROAD, WORCESTER MA 01609 USA

Institutional Review Board

FWA #00015024 - HHS #00007374

Notification of IRB Approval

Date:	26-Apr-2020
PI:	Sheldon, Charles L
Protocol Number:	IRB-20-0679
Protocol Title:	Eight Trigrams: A level of 3D puzzle game for cultural transmission
Approved Study Personnel:	Chen, Tianze~deWinter, Jennifer~Sutter, Ralph~Sheldon, Charles L~
Effective Date:	26-Apr-2020
Exemption Category:	3
Sponsor*:	

The WPI Institutional Review Board (IRB) has reviewed the materials submitted with regard to the above-mentioned protocol.We have determined that this research is exempt from further IRB review under 45 CFR § 46.104 (d). For a detailed description of the categories of exempt research, please refer to the IRB website.

The study is approved indefinitely unless terminated sooner (in writing) by yourself or the WPI IRB. Amendments or changes to the research that might alter this specific approval must be submitted to the WPI IRB for review and may require a full IRB application in order for the research to continue. You are also required to report any adverse events with regard to your study subjects or their data.

Changes to the research which might affect its exempt status must be submitted to the WPI IRB for review and approval before such changes are put into practice. A full IRB application may be required in order for the research to continue.

Please contact the IRB at irb@wpi.edu if you have any questions.