

**SM 4117 — Topics in Media Technologies II: Virtual Reality**

**Final Project**

**Virtual Reality and Computer Games**

**On their nature, relationship, design and implementation**

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21<sup>st</sup> May 2002

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## What is “Virtual Reality”?

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Before we talk about what virtual reality is, let’s clarify “what is reality?”

### What is “Reality”?

The Oxford Advanced Learner's Dictionary suggested the closest definition of “reality” for our analysis:

**real•ity** /riˈælɪti/ noun (pl. **-ies**)

**1** [U] the true situation and the problems that actually exist in life, in contrast to how you would like life to be: *She refuses to **face reality**.* ◊ *You're out of touch with reality.* ◊ *The reality is that there is not enough money to pay for this project.* ◊ *They seemed to have the perfect marriage but the reality was very different.*

**2** [C] a thing that is actually experienced or seen, in contrast to what people might imagine: *the **harsh realities of life*** ◊ *This decision reflects the realities of the political situation.* ◊ *The paperless office is still far from being a reality.* ◊ *Will time travel ever **become a reality**?*

That is, reality is what exists in our life; a thing that our human senses, consciousness and knowledge would ascertain its existence. In narrow sense, it includes the things that can be experienced by the following senses:

- Sight
- Hearing
- Smell
- Taste
- Touch

In broad sense, “reality” may also include the things which are true according to our memory, the things we were told as true, or the things which our intuition would confirm their existence.

### How is “Virtual Reality” defined?

Virtual Reality has many different meanings among people. It can be defined in many ways. Here I would list out some ways in which “Virtual Reality” is commonly defined.

#### Taxonomic Definition

Virtual Reality can be defined as a reproduced reality, replication of reality or artificial reality. It can be understood as a modeling context as below:

Reality	—>	Virtual (Artificial / Computational) Reality
Life	—>	Artificial Life
Intelligence	—>	Artificial Intelligence
Linguistics	—>	Computational Linguistics
ABC	—>	Virtual / Artificial / Computational ABC

### **Technological Definition**

A common definition of “Virtual Reality” is a computer-generated environment simulating certain kind of imaginative but realistic environment, which users can interact with using special input and output equipments such as Head Mounted Display and body suits in a three dimensional generated environment. According to Jerry Prothero, an associated researcher at the University of Washington, *“It can be defined in technological terms as a set of input devices which can stimulate a high percentage of our sensory input channels, for instance, by providing a wide visual field-of-view-and stereo sound.”* That is referring to ‘Immersive Virtual Reality’. In the paper of Jerry Isdale’s of Isdale Engineering, *“What is Virtual Reality?”*, *“There are some people to whom VR is a specific collection of technologies, that is a head mounted display, glove input device and audio, used to become immersed into a computer generated world and to interact with the environment. Some other people stretch the term to include conventional books, movies, or pure fantasy and imagination.”* That introduces certain sense of non-immersive virtual reality.

### **Psychological Definition**

With the idea of non-immersive virtual reality, a broader definition can be generated. According to Jerry Prothero, *“It (Virtual Reality) can be defined in psychological terms a pattern of sensory stimuli, which gives one an impression of being in a computer-generated space.”* Virtual Reality can be defined as physical participation in an interactive environment.

Usually all these definitions are used, without clear distinguish between them. Here for the sake of analysis, we would define “Virtual Reality” as a 3-dimentional computer-generated environment in which the users can interact with and obtain multi-sensational return from, although in future, I believe that there can be other technology replacing computer’s role to produce such environment, which facilitate a greater human immerse level.

## **What “Virtual Reality” includes?**

Base on the five human senses, virtual reality simulation would have a few basic interfaces. They are visual channel, auditory channel, haptic channel, motion interface, olfactory interface, gustatory interface, speech interface, physiological sensing control, etc. Since the language difference between human and computer, we need a lot of equipment and devices to deal with the input and output issue with computer.

These devices include Head Mounted Display, different kinds of projectors, Cave Automatic Virtual Environment, speakers, force feedback control, different kinds of smell device technology for output; and mouse, joystick, hand location system such as gloves, video tracking system, optical tracking system, pucks, body suits, and speech recognition system for human input. These are often considered as a part of virtual reality technology.

Within the projected virtual environment, there can be many environment attributes or variables such as temperature, background color, texture and theme, size, scale, viewpoint, etc. Beside, inside the computer-generated environment, there would also be characters for the users to interact with. For those characters, they would have different appearance, dressing, knowledge, personality and level of intelligence. To achieve as many different and funny characters in the virtual environment, we need a lot of different modeling methods, knowledge database and artificial intelligence. All these should also be considered as a part of virtual reality.

As long as we look at non-immersive virtual reality, we should also consider the computer language, computer graphics, computer network, tele-operation, maybe even videos, telephone, television and movies, as a part of virtual reality. That's is, anything that prevents our consciousness to think of existence and reality. What I would like to emphasis here is, virtual reality should not be limited to computer technology.

## **What is the application of “Virtual Reality”?**

After over 30 years of research and development, virtual reality is widely used in many different aspects. It is now in research level for medical treatment for cancer patients, for trial in architecture design, for preview of building interior design, for space exploration in NASA, for control of robots, for individualized education, for educational experiences, for training in military aspect, for demo in chemistry research in protein, and last but not least, for entertainment.

Gaming application is one of the most important aspects of virtual reality development.

Although we cannot see the ultimate gaming machines which we often seen in movies, we do

have games simulating many different kinds of reality in different platform. Yet, there were many different virtual reality experiences in research or demonstration level such as “The Cave” of NCSA (The National for Supercomputing Applications). In future, we can see a greater impact of virtual reality on our life.

### **Why do we need “Virtual Reality”?**

In simple, we would like to escape from reality in virtual reality. It is to satisfy our imagination, wants, unattainable hopes and desire.

Generally speaking, virtual reality can improve our living. It alters our senses to make us feel better. It may reduce our pain, sickness, ache and hunger by modifying our senses. It can make the impossibility possible and hence facilitate our lives.

### **When did “Virtual Reality” first appear?**

This is another question that would have divisive answers.

Data processing first introduced on 1642, when the first mechanical adding machine was invented. The use of electricity in data processing started on 1940s, when the vacuum tubes were used to build ENIAC. That started the computer development.

We enjoy multimedia since the introduction of IBM 1500 system computer in 1960s. Beside text and character-based graphics capability, it was capable to do voice recording and output sound, as the same time interacts with the user through keyboard and lightpen.

Virtual Reality was recognized as “birth” in 1960s, when the associated equipments was invented.

In 1965, Ivan Sutherland of MIT expressed his idea of creating virtual or imaginative worlds. In 1968, he invented Head Mounted Display. In 1969, he developed the first system to surround people in three-dimensional displays of information. After that, the concept of virtual reality began popularly used in USA in 70s and 80s, and became an emerging technology.

## What is “Computer Game”?

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Under the discussion of computer game design and implementation, we should first establish the foundation of our knowledge, that is, we should define ‘what is “game”?’

### What is “game”?

*“Games are a fundamental part of human existence. The parlance of games has insinuated itself into our language to refer to activities that are not truly games. We play along with activities we find distasteful. We play ball with those who require our cooperation. We play games when we are insincere. A willing participation is game for the enterprise. This broad penetration of gaming concepts into the entire spectrum of human experience presents us with two potential barriers to understanding games.”* (“The Art of Computer Game Design”, chapter 1)

The author of the book suggests several requirements for a game must has:

- **System**  
The collection of parts within a game would interact and affect each other in complex ways, according to the user’s actions and participation.
- **Rules**  
A game must have explicit rules which limit the users actions and responses.
- **Self-sufficient**  
A well-designed game must be closed and self-sufficient. That is, the game is internally complete without any reference, judgment and adjustment need to be made out of the rules of the game. A proper designed game precludes any possibility within the game and covers all contingencies encountered.
- **Representation**  
Games are subjectively real to the player. It represents something from the player’s private fantasy world, while it is not necessary objective to the reality.
- **Reflection to reality**  
A game creates a subjective and deliberately simplified representation of emotional reality, thus, it is at most a subset of reality. This is to provide the focus to the game.

- **Interactive**

A game represents a branching tree of sequences and allows the player to reach his own possible sequence and form his own story at each branch point. The game player is free to explore the causal relationship of sequences from many different angles. Player's interaction in game is a continuous quantity with differences in attribute of each sequence.

- **Player's Existence**

In a game play we are against the other party/parties. For computer games, we would face computer opponent. It would form an interpersonal active challenge, such that the game will acknowledge the player's existence and reacts to the player's personality and hence, the player's faces different challenges each time she plays the game.

- **Goal**

A game must have at least a goal. The players of the game are persuaded to attain the goal and actively pursuing some goal.

- **Conflict**

Conflict is fundamental to games: it was created by the goal(s) and the obstacles which prevent player(s) from easily achieving the goal(s).

- **Penalty**

The penalties for losing a game can be some loss of dignity or losing the reward that might have been gained by winning. It sounds negative to the player(s), but it is to maintain a safe way to experience reality. More accurately, no matter to the winner or loser(s) the results of a game (e.g. the harshest penalty) are always less harsh than the situation the game models.

Computer games follow the way of other ordinary games, which would generally include most of the attributes of game above. The difference between computer games and other games is that the opponents in computer games would be computer-generated character(s), with the great data processing power of computer, rather than other kinds of opponents in other games.

## **What is the function of game?**

In the most common way we identify the function of game as to educate and to entertain the player(s). I would say that it is not very accurate to say so.

Whether a game is to 'educate' its player(s) depends on the game designer. Whenever a game

is produced, there must be some new rules and simulation the player(s) can obtain from playing it. The player(s) can choose to play or not to play the game in the initial stage, and the game designer would not be the decision maker of whether the player will know more from playing the game, or whether the player plays the game or not. It is only the player(s) to make the decision for learning from the game or not by deciding to play the game or not.

Entertain is also a word with varies meanings. To be accurate, games do the following function to bring a higher satisfactory level to the players' human wants:

- **Games fulfill players' fantasy.**

Games can create fantasy world which is untrue to the players' living situation. In the environment generated in games, players can forget their problem in their real living situation. Players are highly participating in games than other media since the players take the role to select the information sequences of those games, which tends to have closer matches to the users' fantasy.

- **Games overcome social restrictions in fantasy.**

Games provide the opportunities for the players to live with breaking some social rules of reality. The players can have roles in games which are not generally accepted in reality, or do the actions which are prohibited or discouraged in real life.

- **Games prove the ability of players.**

Games have rules and limitations, which would prevent the players to achieve the games' goal(s). Since then if the player can overcome all these obstacles the game actually demonstrates the player's ability in certain aspect, whether in prowess, cleverness, quick-response or luck, for example.

- **Games can serve as social lubricants.**

No matter how the roles between different players are, game facilitates the development of human relationship among players. Through interaction, players of a game can know the others' characteristics and personalities according to their actions or moves.

- **Games exercise players.**

By interacting with different opponents, the players of a game exhaust their mental or physical power, or combination of both, according to different techniques different games require.

- **Games lead players to recognize each other.**

Players recognize other's existence and personality through the interaction in games, and are acknowledged by other players in the same way.

Computer games, in general, also serve all these function as well, with the help of computer technology.

## What is the logic of computer game?

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### How computer works?

No matter how the speed and the appearance of computers vary, the logic of computers is the same: digital. From the first electronic computer in 1944 to the computers nowadays, from the use of vacuum tubes to the application of integrated circuit, from pocket personal computers to main frame computers, the way how the information is processed is binary, in other words, 0 or 1.

With such mode of working, computer can only generates two possibilities in each process.

After the development of data processing for over hundreds years the computer now can do numerous process within a very short time, and such speed is much faster than human brain, hence, with introduce of computer games can simulate a more realistic subset of reality.

### How do we interact with computer?

We are not thinking or communicate in a binary way, therefore, we need special devices to deal with the input and output communication with computer.

Commonly we use keyboard, mouse, steering wheel, joystick and game pad to communicate with the computer games, and monitor and speaker to facilitate the output from computer games. However, unlike the games on other console platform, these devices are not specially designed for the use of computer gaming. The visual and sound element of computer games provide some realistic experience to the players, but these devices for the players to control weaken the realistic feeling of the gaming experience.

We are able to find certain special designed products for computer gaming such as 3D glasses, force feedback joysticks, etc, but they are not yet reflecting the whole reality in the game, i.e. the feeling of our five senses we can get from the game simulating environment.

### Why do we implement computer in gaming? / How do the use of computer favor gaming experiences?

There are several strength computer enjoys.

#### Responsiveness

In many ways computers can respond to player's wish of the game, such as change the length

of the time of the game, level of difficulty, intelligent level of computer opponents or even the rule of the game itself. In any attribute of a computer game can be modified, before the game start or even during the game play. The dynamic character of computer provide a far less restrictive environment for the development and modification of the game.

### **Real-time**

Even though computer requires certain length of time for data processing during the game, compare to human brain as an opponent, the speed of computer or computer opponents facilitate the shortest time the human player(s) need(s) to wait for. Computer can also make the judgment of any move faster than a human judge of the game.

### **Function of game reference**

To make sure every action of human in a game follow the rules, every game needs a referee or monitor to make the judge and maintain the order of the game. Computer reaction faster than human judges, at the same time it is more accurate and makes fewer mistakes.

### **Intelligent opponent**

It is not that computer is superior to human, but it is a fact that it processes data faster than human, hence it can generate more possibilities in each action with short time requirement in every moment of a game play, as long as there is electricity supply.

### **Limit Game Information**

Within the gaming environment in computer the game designer can easily hide the information she want to hide by not sending to the output devices of the computer. It enforces the guesswork of players towards the state of other players and the method to be the winner.

### **Offsite Multiplayer**

Computer enables the use of connection for multiple players to be the players of a same game. The maximum number of players in computer games is generally the biggest among different kinds of games. Players are no longer needed to meet together in order to form a game play in the same location.

### **Storage Capability and Capacity**

Computer can store the game state without occupying great physical space. User can save any time under the provision and availability of game record.

## **What are the limits of computer in gaming?**

However there are several limitations in computer that weakening the gaming experience.

### **Limited Input and Output Capability**

Even after the development of decades, the communication means between human and computer is still in a primitive stage. We cannot deal with smell and taste issue in a good way with computer. We cannot transmit our thought or emotion without the use of five senses or language. We need physical actions to get every job done by the computer.

What the computer output to us is also limited to sound, visual images, force feedback, temperature, and smell at most. The quality of those is also not very satisfactory.

Even if those devices are good in quality of communication, they do have limitations. We can't really act like how we control our avatars in the game using the available hardware devices, at least not in every game. The design of input and output devices of computer can deal with rectgrids quite well, as the display works on horizontal and vertical basis and the mouse/joystick works with X-Y-Z axis, which it may not be used to deal with hexgrids as well.

### **Single User Orientation**

Computer game is generally designed for one person communicates with the machine with his set of input and output devices. When there is one more person to play the game at the same time, they either have to share those devices by taking turns, or the second player has to provide herself a set of same devices. It is either a clumsy procedure or it would costs a few more money and space for the second player to play at the same time. Computer games discourage many players of the same game facing the same computer.

### **Programming**

Computer games were produced by programming the computer, and they are programmed. It is not easy to develop a computer game, as the game designer has to deal with the game requirements and computer technical aspects at the same time. It limits the possibilities of computer games, at the same time, the players are even hard to modify the rules of the game once those rules are programmed. This difficulties of computer games would not be able to solve, once when we are not able to communicate with computer in our gesture, body movement, facial expression or our language.

### **What is the relationship between computer game designers and players?**

1. Designer rules the game. Players live in the game.

A game is a system with sets of rules and regulations. It simulates reality. Rules and regulations are set by the designer. Goal of the game and penalty of losing the game are

created by the designers too. Being a good game, the designer of the game has to foresee any possibilities within the game's world of simulation. Designer has the only ability to define the winner of the game. In certain special cases the players are allowed to modify the rules of the game, but it requires the agreement of the designer, i.e. the designer leases the right of regulating the game to players. Generally speaking, players themselves choose the winner of the game according to their reaction to opponents.

2. Designer produces the means of communication. Players provide the content of communication.

It is the designer to decide the way the game computer communicates with the game players, i.e. decide what devices are used as the input and output equipment for the players to control the game and see the effects. Designer does the programming of the game to accept certain types of inputs from the players and refuse the others. Players have no way to modify these again, unless the allowance of the game designer.

While the designer limits the input and output of the game, players are those who decide what to communicate with the game/computer, with the help of the limited devices provided by the designer.

## **What are the requirements for a good computer games?**

### **Medium Specific**

Use only the idea of designing game which can be well-handled by computer. As mentioned in above chapters, computer does have certain limitations, and those limitations should be considered during the game production. Transplant of game from the other platform or media to computer should be avoided, as the game in its original platform was optimized to the technology of that platform.

### **Utilizing the Input and Output**

Computer is strong in data processing, but the input and output system of it is a weakness. The input and output devices in ordinary computer set are very limited in function, and the ability to generate realistic experience is weak too. Hence, the input and output structure in computer game is very important: it should be able to project the information the players need with the players' feeling of natural, and at the same time the use of input devices should be easy to remember and efficient. A bad design of input and output structure of a game would generate the frustration to players and make the game hard to play with.

### **Efficient rules**

Make the rules of the game simple, such that the structure of game can be simple. Define the rules carefully such that it can be applied to most cases in the game. Players do not like to be bounded by clumsy rule system which they cannot easily recall and clumsy rule system generally means a long time for process and a longer lag time to the player.

### **Make good use to what is stored**

Compare to processing time, storage time for information in computer takes far longer time. By then if the game incurs a lot of data storage, it may result a long lag time which is not favorable to players of the game and not medium-specified. With limited storage of data don't necessary means a game with less content, rather than, the content of a game should be generated by descriptive output to players and meaningful input from players.

### **Keep the game's longevity intact**

It would be a regrettable thing if the players finish the game and its life is end. It is a waste to the effort of the game designer. This can be avoid by making multiple endings for the puzzle in the game.

## **What is the relationship between computer games and virtual reality? – Common places and differences**

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Computer games and virtual reality share some same characteristics in nature, while they do have differences in many aspects.

### **Application**

The initial function of games was for self-learning. We learned from the simulating environment of game. Soon we discovered that we can make use of the simulating characteristic of game to satisfy our wants and desire, then games was used to entertain us. Computer games follow the trend that they function as education and entertaining devices.

Virtual Reality functions similarly, while the application of virtual reality is in a broader field. It is not only used for education and as entertainment, but also in many other aspects such as medical treatment and science research.

### **Motive**

While both computer games and virtual reality are used to simulate reality (in a subset or whole sense), there is little difference underneath. The motive for virtual reality is to simulate either a fake reality to fool the user(s)' senses, or a true reality to reflect the senses from the environment no matter they are favorable or harmful to the user(s). The motive for designing computer game is to simulate a preset subset of reality, which to keep the user(s) from real danger when the case in the game becomes real. In usual, the result of simulation experience in computer games is modified to a level that would not be hurting the user's five senses and physically.

### **Rules**

In the world of virtual reality and computer games, there are rules. These rules are to regulate the users' action and decide the users' experience within the environment.

In virtual reality rules are implicit. It is because explicit rules would limit the users' action (users can do anything freely in reality), and after comparing such simulating experience with reality, it would arouse the users' attention on "This is a simulation." The realistic effect of the virtual reality simulation would then be minimized.

In computer games rules are explicit. It is because the rules are to determine the winner by limiting and directing the users' action, and the decision of winner is far more important than producing a realistic simulation experience of the reality within the game.

## **Representation**

Even though both computer games and virtual reality are simulating reality, the output to the users is rather different.

Virtual Reality is a serious attempt to represent a real phenomenon in another accurately. Computer game is an artistically simplified representation of a phenomenon. Virtual Reality is a more malleable form than computer game. Only when there are some difficulties, such as limitation in technology, the Virtual Reality experience would be simplified. Computer game simplified deliberately to produce a more focus context to gain the users' attention and enhance the speed for game processing and reduce the amount of time lag. Virtual Reality tends to against any limit on the user's action throughout the whole simulation experience, which computer games limit the action of the user such that all the action of game users can be precluded by the game designer.

Hence, generally speaking Virtual Reality generates a more objective representation and Computer Games generates a more subjective and user-orientation representation to their users.

## **Level of User's Participation**

Virtual Reality modifies the user's senses to generate a realistic feeling to the user in order to satisfy the user, while computer games affect the emotion of user by the action of other opponents and users in the game play to attract user. User participates by solely body movements and senses in virtual reality, while computer game user use more intelligence to compete with other opponents in order to win beside other body physical participation demand by different computer games.

## **Data processing**

Both virtual reality and computer game emphasis the computer's processing capability, but they have different concern. Virtual reality demands a real-time processing and complexity of the environment to generate a realistic environment. Computer game, on the other hand, demands a complex processing on the intelligence of computer opponents and the shortest processing time to minimize the time lag, which would deteriorate the gaming experience if

too long.

## **Scene design**

Both virtual reality and computer game would generate a realistic environment to user, which the one in virtual reality would be open and the one of computer game would be closed. Open environment of virtual reality means the user would enjoy the greatest freedom to explore in the environment in which boundaries tend not to be set. Closed environment of computer game, on the other hand, tends to be bounded by the game designer and user tends to be unable to browse the environment as free as their preference maybe.

## **Input and output devices**

Input / output devices for virtual reality experience tend to care more on the user's senses and movements. The output devices are often form a multimedia generating set to the user of virtual reality. The environment of virtual reality would be generated in three-dimension visually, and positioning devices would be more accurate than the one used for computer gaming.

## **Function and standpoint of other users**

In the simulation experience of virtual reality and computer game, there can be other users, and these users are one of the attractive elements in those experience.

The other characters, no matter they are computer generated objects or other human users, the relationship between the user and these characters in the virtual reality experience would not be opposite, rather, these characters are preferred because in real life everyone would have interaction with other creatures, and with the existence of these characters it would generate such kind of realistic effect.

The other characters in computer games, however, are information providers or guides, or more often, opponents to the user. The relationship between these opponents and the user is opposite, as these opponents would be his/her competitors for the honor of winning. These characters, at the same time, would be the indicators of game difficulty.

## **Role of Designer**

The designer for both virtual reality and computer game is the constructor of the simulation environment, but his/her role is a little bit different.

A designer of computer game rules in the environment by attracting the players to certain goal such as winning the game or getting some bonus. He/She would be the one who decide the action flow inside the simulation.

A designer of virtual reality only defines the environment/experience. They do not necessary the one who cause the user's action flow, at the same time they may attract the user by satisfying their senses, but it would not be main motive for the user to navigate in a virtual environment.

# Design and implement of computer games and virtual reality

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Computer games and virtual reality share a similar process and routine for their production.

## Primitive Stage

Every execution of computer game and virtual reality environment has a goal behind. A goal can be a function the designer wants to provide or a purpose he/she wants to archive. A goal would help generating the solution for the problem in the latter stage of the production, as it is simply the guideline of the game production. A goal can be teaching addition for a children educational game, or reducing the pain of the patient for a virtual environment for medical treatment.

After the goal being established, the designer can select the topic of the game. The topic is the way to express the goal of the game. The condition and events within the topic will communicate the abstract goal, and hence, topic subordinates the goal of the computer game. There can be many ways to express the idea of the goal, and only some can be applied to the game while other should be swept away. This is also important in the production of virtual environment.

## Research Stage

After the goal and topic are clearly defined, research on the topic would be a necessary process to immerse the designer in the topic. Research is important and it accumulates the designer's experience on the topic, no matter in a production of computer game or virtual environment. For example, if we choose to produce the experience of traveling on the MTR train in a virtual reality, we need to research this topic by having a real travel on MTR, collecting the information on how the MTR operates and how a MTR train runs, how is the environment inside the MTR system in different session within a day, the speed, acceleration and the break of the train, together with the information on the train passengers.

In such stage the designer would know whether the topic selected would provide varies of implementation ideas for the game. All ideas or information can be loose, and should be stored until the next stage: design. This stage would take long time, as it deserves.

## Design Stage

After weeks or months of research, one would have clear idea of the game's ideals. Design

stage can be started with sufficient information. Input and output structure, game structure and program structure should be the three things the designer has to figure out in this stage. It is because the limitations on computer input and output devices, limitations in computer resources and its management and the importance game structure to the players satisfaction. Decisions such as the basic rules, the amount of information the players can have, the level of intelligence of the computer opponents, relationships between opponents, the way the players awarded when someone is win, the increase on difficulty when the players become advanced, the allocation of computer resources on storage and processing, the treatment of input data, the way how devices are function and exhausted and the environment and players represented, should be deal with in this stage. Such kinds of concern would also be considered in the production of virtual environment, with the action of user(s) clearly defined and detailed. In the example of MTR simulation, the user's action in the whole process, feeling in the train apartment, the action and appearance of other passenger, the jolting geometry of the train, the sound the user can hear and the facilities in the train apartment should be systematically arranged and packaged to the virtual environment.

After all those elements documented, the whole design can be evaluated by examination on the stability of game structure. Consider the case how would the attributes or values in the game be treated when they reach their boundary or maximum value. By thinking of these extreme cases it avoids many troubles in the programming and debugging stage. For the production of virtual environment, these extreme cases can be the boundaries of the environment, multiple execute of behaviors or overlapping behavior attributes.

## **Programming Stage**

It is the easiest stage in the production, unless the designer has the difficulties of acquiring not enough programming knowledge. Programming is to write down the rules, actions, behaviors, appearances and representations of different objects in the language the computer uses, and associate the behaviors and actions to input devices and the effects to output devices.

Writing the documentation can be a job of programming stage, since all the information requires to be documented in the documentation is finalized and ready-for-use in this stage.

The job for virtual environment production in this stage is similar to computer games', while the designer of virtual environment may spend more effort on dealing with behaviors generating or input and output devices, and less effort on sorting the command lines of rules.

## **Playtesting and debugging**

Playtesting is correcting the mistakes we made on the game design, and debugging is correcting the mistakes we made on programming. Both are important in both computer games and virtual environment production, as those mistakes would deficit or even destroy the simulation experience and level of participation of the users/players if they are not solved. Leaving these mistakes in the virtual environment may even leave life threatening dangerous toward the players, as virtual reality communicates with our five senses.

### **Implement Stage**

When the production finished, we simply let our target users use our product. Implementation of computer game is far simpler than virtual reality, as games can be played once the users meet the computer speed requirement and have the devices required by the game, but virtual reality need more specification to the users, the using location and the application. This is to control the effect of the experience to the users.

After all these, the designer can sit aside and wait for the response and comment of his/her product.

## Conclusion

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Computer games and virtual reality share the similar characteristics on their nature and production process. They generate simulation of environments of human lives and provide satisfaction to human beings. Both live with the introduction of computer and are limited or expanded by the characters of computer technology. They have similar model during production, concern on similar design techniques and ideals.

By their function, we may say computer games are certain kind of virtual environment generated for entertainment and self-education purpose. Here I would question: even though there are different types of computer applications, would the initial, original and primitive function of all those applications is, to simulate human life?

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