A Current State and the Future Possibilities of Serious Games

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1. Introduction

Although the computer game has been one of a growing industries in Japan, the growth rate is already saturated and the future drastic recovery seems very hard. In some countries, such as the US, the Netherlands and Korea, computer game industry is regarded as one of the key issues in their national strategic policies, and those governments hold them in great account. Why they can do it, and why we don't do it in Japan? One major reason is that the computer game is regarded only as an entertainment in Japan, although the other countries notices that computer game has many potential possibilities in the market of serious games.

In this paper, we will introduce the general overview and the current state of serious games, then show how to develop serious games efficiently, and discuss the future possibilities.

2. Overview of Serious Games

The term "Serious Games" first appeared in a book written by Clark C. Apt¹⁾. In that book, he mentioned that game is effective for education and training, and named such games as Serious Games. It was written just before the computer games or video games became popular in the market. As the advancement of computer and software technologies, the contributions of computer game development companies in Japan performed a major role in the growth of computer game industries.

At the same time, the development of simulators and simulation systems for defense, space and aeronautics industries pushed the technology advancement of computer and computer games. In those fields, those systems were called Modeling and Simulation (M&S), and used for education, training, exercise support and strategic planning support.

In the years while computer game industry was rapidly growing in Japan, console game machines were in the center of the development. However, in the other countries, the targets shifted from console game machines to PCs. At the same time, there were many research laboratories which aimed to do R&D for game development technologies such as AI, CG and VR established in other countries such as the Entertainment Technology Centers in CMU or USC. In those research laboratories, the same researchers in the field of M&S and games for entertainments got together to study the most advanced computer technologies for creative industries. For an example, ICT (Institute for Creative Technology) at USC developed a game named FSW (Full Spectrum Warriors) which was aimed to be used for US Army's soldiers to do mission rehearsal before they will leave for a new battle space, but also it was sold as an entertainment game running on PCs, SONY's and MicroSoft's console games,

and it became well known as a dual-use game.

In 2004 at the GDC (Game Developers Conference), which were known as an entertainment game developer's conference started to open a "Serious Game Summit", and the name of "Serious Game" and the development become very popular in other countries.

As the above shows, the base technology of both serious and entertainment games overlaps, and both use the most advanced technologies in the field of Computer Science, Cognitive Science, Psychology, Physics, Mathematics, Arts and etc., and interdisciplinary studies are mandatory. The difference between serious and entertainment is the purpose if it's for serious or for entertainment. The term serious means if it is aimed to solve the problem in the real world or not, such as to improve the skill or knowledge, rehabilitation, medical treatments, training and exercises. Although M&S takes an important role in such field, it does not means that serious game is equal to M&S, since serious games does not always models the real world.

There are many project which employed existing entertainment games for serious purposes, and such are called "serious game projects" ²⁾ and we call it "serious uses of entertainment games" in this paper.

3. Preceding Studies

In this section, we introduce serious games that have been developed in several fields and purposes.

3.1. Advertisement for Defense and Public Policies

A variety of systems has been developed in the field of defense and they are efficiently used for tactical or commander's decision making training and exercise support ³⁾, and most of them are still called M&S.

On the other hand, the games which run on PC and used both for entertainment and serious are called serious games. FSW is one of such games, and America's Army (AA) which was developed in 2002 is also a well known serious game. AA was developed by the US Army for the purpose to promote US Army for recruitment. It is still well used serious game, and a new website is opened on Oct. 2012 for the latest version AA3.3. According to the survey held by a research company in the US, AA made the impression to the US Army better than before for the young persons between 16 to 24 years of age. The result also showed that the advertisement budget could be reduced to 0.25% among the total advertisement cost of the US Army, by introducing serious games.

Not only in the field of defense, other public organizations are developing serious games to promote their activities. The UN's WFP(World Food Programme) is the one that they have developed a serious game called Food Force (FF). The player of FF acts as an UN's staff to support and deliver food to the region where the food is being a national problem. It was developed an English version in 2005, and a Japanese game development company localized for Japanese children. In 2012, it became an facebook application and it is used worldwide.

3.2. Study and Education

A serious game designed for to be used at high school to support history classes is Making History²⁾ (MH). Players act as the presidents or prime ministers in the World War Second years, and they gather and hold the the world situation to consider the next strategies and decide the policies to overcome the situation. During this process, students can learn the modern history of the world. The difference between the other similar types of strategy game is that this game prepared instruction guide for teachers so that they can use this game in actual classes.

In Japan, correspondence course for junior high school students has been very popular, and Plus Eye (PE) is one of such services. The company which operates this PE has introduced a new game service with PE which aimed to improve and keep up the motivation of students who are doing PE. They have analyzed the usage of more than 100 thousands student, and reported the result that the utilization of PE system in 2011 has improved 1.5 to 2.0 times more comparing that of the previous year 2010⁷⁰. In this service, a student chooses an avatar in the game community, and they complete the scores through the avatars. This service both includes the characteristics of social games and serious game, and it is considered to be one of a new method for studying at home for junior high school students.

In Japan and other many countries, Brain Age (BA) is very popular not only for young persons but also for elder people for brain training type of educational game. BA was developed in Japan, and it has been expected for elderly persons to protect from the senility by activating our brains using games, but scientific papers written about the efficiency of BA has not been published. However, a paper was published in 2012 and it shows the results about the effectiveness BA used for elder persons⁶⁾. In their experiments, they have divided into two groups, and one use BA and the other use Tetris game, and did experiments to compare the performance of cognition and other functions between two groups. The results showed that BA has showed the partial effectiveness, but they also mentioned that it is too early to say the effectiveness of BA for all cognitive functions of humans.

3.3. Healthcare and Medical Treatment

In the field of healthcare for children, a game called Dance Dance Revolution (DDR) which was designed in Japan for entertainment is used at many schools for increasing the health of students^{2,3,8)}. The results of the experiments show that it was effective to keep continuing the exercise for 8 to 12 years students, and several states such as California and West Virginia, DDR is very widely used at schools.

In the field of medical treatment, two types have been developed, one is for patients and the others is for medical treatment professionals⁹. The most famous one for patient is Re-Mission (RM)¹⁰, and it is specially made for young cancer patients to improve the knowledge of the cancer,

which is helpful to cure the anxiety of cancer patients. RM is used for three months for field test, and it is reported the efficiency of RM compared to without using this game.

There are several action games for entertainment used for the improvement of the surgical skills^{2, 10)}. According to the field test report, the ratio of errors were 37% lower, and the surgical speed was 27% faster, by comparing the doctors who plays more than three hours in a week and less than that.

4. Design Process of Serious Games

As we have showed in the previous section, there are two types of development process, and the one is to use an existing entertainment game, and the other is to develop a new serious game for that purpose. Moreover, as the effective serious games are introduced, more serious games will be developed in many fields. In order to develop more serious games for new fields and new objectives, we need to have an efficient design and development process for serious games. In this section, we first introduce several existing processes, then we will introduce our original serious game design process (SGDP) that we are experimentally applying to develop several serious games.

4.1. Chris Crawford's Process

Most famous game design process is a Chris Crawford's Game Design Process (GDS)¹¹⁾, which has widely been used by entertainment games. In GDS, game design process is divided into three phases which is shown in Table 1. As the table shows, the phase 1 is for planning and research step, the phase 2 is design and development step, and the phase one is for post-mortem activities.

Phase 1	Choose a Goal	Clearly define a Goal	
	and a Topic	Selection of Topic	
	Research and	Study on that Topic	
	Preparation		
Phase 2	Design	I/O Structure	
		Game Structure	
		Program Structure	
		Evaluation of the Design	
	Development	Pre-programming	
		Programming	
		Play-testing	
Phase 3	Post-Mortem	Evaluation by Critique Evaluation by Public	

Table 1 Chris Crawford's Game Design Sequence

Chris Crawford also suggests 4 key issues for game¹¹⁾ (Representation, Interaction, Conflict and Safety), and the most game designers and developers for entertainment supports this 4 issues. However, although GDS has been effective for entertainment game developments, but it is not always applicable to the serious game developments. It is because that GDS was designed for commercial computer game development in general, and the evaluation which is done in the phase 3 is limited by the customer's or critics' evaluation. Moreover, GDS does not consider the process to evaluate the efficiency for the specific purposes of that serious game.

4.2. JIS 0160: 2012 SLCP

SLCP is a widely used software development process for large scale software system such as online transaction systems, defense and space systems and so on. It is a international standards as ISO/IEC 12207 : 2008, and it is customized for Japanese in JIS 0160: 2012. The advantage of SLCP is that it is based on a V shaped process, and the objective of the software is tested and validated at the same level of the design.



Fig. 1 Software Life Cycle Process

Although, this process is applicable to the development of serious games, and it is effective in a way that the objective of the serious game is analyzed, designed, developed, tested and validated. However, SLCP just defines the process of general purpose software, but does not consider about the game development..

4.3. IEEE Std 1516.3 FEDEP

In contrast to SLCP, FEDEP is a software development process designed for M&S in the field of defense and space. The reason that FEDEP was proposed is to reduce the cost of M&S, since the cost of those systems are very high in general¹³⁾. In order to reduce the cost, we have discussed how to utilize existing simulators by connecting through network, and we have defined an international standard called High Level Architecture (HLA). In a part of this standard, we have defined the process, and this is IEEE Std 1516.3 Federation Execution and Development Process (FEDEP)¹⁴⁾.



Fig. 2 IEEE Std 1516.3 FEDEP

As the Fig. 2 shows, the process of FEDEP starts from the phase to clarify the objective of the M&S. In each steps of this process, the design and the products are tested, and the models developed are finally validated.

It looks that this process in very similar to that of SLCP,

however, FEDEP does not define the process of software. Therefore, even when the developer uses FEDEP, they have to use another process such as SLCP.

4.4. Serious Game Design Process

As we have described above, we have to use several existing processes to develop serious game. However, using more than two processes means that the project gets very complicated and it requires more work than without using the process. In order to solve this problem, we have designed a Serious Game Design Process (SGDP), and using this process to develop several serious games to show the effectiveness of SGDP. Table 2 show the SGDP, and the Fig. 3 shows a sample format that our students are using, which are to define a user needs.

Table 2	Serious	Game	Design	Process	(SGDP)	۱
Table 2	Scribus	Game	DUSIGI	I I UCCOD		,

		8	,
Phase 1	User Needs Definition (requirements)	Define the user needs, clarify the objectives and target users of serious game	USER NEEDS DEFINITION
Phase 2	Planning	WBS, resources assignment etc.	PLANSHEET
Phase 3	User Needs Analysis	Analyze the USER NEEDS DEFINITION document, clarify the concept of that serious game and draw a major scenario to derive the primarily required function and performance.	USER NEEDS ANALYSIS
Phase 3	System Architecture Design	Draw all part of the scenario to clarify the all casts and environments, and design the conceptual model . Then, design the system structure and define the interface between subsystems.	SYSTEM ARCHITECURE
Phase 4	Software Design	Design the software.	SOFTWARE DESIGN
Phase 5	Coding and Test	Design the single module test, do coding, and test the single modules and report the results.	TEST DESIGN AND REPOTs
Phase 6	Integration and Qualification Test	Design the qualification test for the P3, integrate software, test and report the results.	QUAL. TEST DESIGN AND REPORTs
Phase 7	Deployment & Field Test	Provide manuals, deploy the serious game to the field with.	MANUALs
Phase 8	Evaluation	Evaluate if the objective the serious game is satisfied or not.	EVALUATION REPORTs



Fig. 3 A Form of User Needs Definition Sheet

5. Examples

From 2009 to 2011, we have developed several serious games by applying SGDP. Although all of them are still under development, but the prototypes of them are used in many fields for exhibition, TV programs or other special events. In the following, we will introduce the overview of them.

5.1. Commander's Decision Training

Disaster relief is an very important issued for many organizations such as the government, police, fire brigade and so on, and the commanders of them should do training for such activities. Serious game is an efficient way to do such training and exercises, and we are developing such systems ^{15,16,19}.

5.2. Education of Cooperation for Children

"Line Ho!ckey"⁽²¹⁾ is a table top game which aims to educate the importance of cooperation by experiencing a team play of a hockey type system.

5.3. Social Lubrication

It is usually not easy for most persons to communicate with unknown person. Especially at a care house for elderly persons, communication among them affects the quality of their lives. Therefore, we have targeted such place and persons, and developed two types of music tables, MU³ Table and BBQ: Brain Beats Quartet¹⁸, to support the communication among them.

5.4. Education of Language for Infants

It is known that a mother to read picture books for her infant is a good method to learn language. In order to have more efficient method for learning language, we have developed an electronic picture book system called MU^3 PictureBook, and a Peach Boy Version²⁰⁾ is being under field test for 4 years infants.

6. Conclusion

In this paper, we have introduced an overview of serious games and the conventional development process. We also showed the serious game design process (SGDP) that we have proposed and applying to develop our serious games in several fields. Although the development and the evaluation is still underway of those serious games, but some of them are being field tested for those evaluation. To show the effectiveness of those serious games, and also to evaluate the SGDP is our future works.

By showing the effectiveness of the above serious games, the importance of them will be more well understood. Then, we believe that we can make a new market of serious games, and more game developing companies can participate in that society. Moreover, as the social game for entertainment is drastically increased in a market, it might be a very good wave to develop social serious games. We are now focusing on this new field of game, and considering to apply them to education and health care professionals to reduce the medical errors.

Although a game industry has been one of a leading Japanese industries, but it is not in these years. In order to revive it, one way is to focus on a social serious game, because the social games for entertainment is drastically increasing, and serious game is required by users. As to the application field, we believe that serious games for the safety and health will be the most expected field.

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