Abstract: Retail prices must be kept low in order to increase the diffusion of home video game hardware. In the 1980s and 1990s, when high-performance semiconductor prices were high, the performance of the hardware was limited. Owing to hardware restrictions, Japanese video game hardware developers had to improve their ability to increase the entertainment offered by their hardware. By the 2000s, home video game hardware that was the same spec as cutting-edge PC hardware came onto the market. As a result, consumers in the European and North American markets began to demand home video game software that could take advantage of high-performance hardware. This is when European and North American home video game developers began to flourish, as their experience with video game development on the PC meant that they had the ability to develop games that took advantage of high-level hardware functionality. At the same time, Japanese home video game developers were struggling in the global market, including North America, because the development organization and capabilities that they had built before 2000 acted as core rigidity.

Keywords: product development, core rigidity, home video games
Introduction

Nintendo launched its *Family Computer* (the Japanese version of the *NES: Nintendo Entertainment System*) in 1983. Following the success of the Family Computer, Japan’s home video game market experienced rapid growth.

Following this, Japan’s home video game industry grew to be the largest in the world, and it could be seen to have a high level of international competitiveness. However, by the late 1990s, the Japanese market began to shrink. At the same time, the European and North American markets continued to experience growth, and they became the world’s key markets. Japanese businesses realized that if they wanted to continue growing, they would have to expand overseas (Shintaku & Ikuine, 2001). However, although the game software developed by Japan’s home video game companies was popular domestically, it was not popular in Europe, North America, or other overseas markets.¹

Why were home video game developers that were successful in the Japanese market unable to become competitive in the European and North American markets? Two reasons are plausible. One is that they had decided to keep their business in the Japanese market and had no intention of expanding in Europe or North America. The other is that the businesses had technical limitations that made it difficult for them to develop products for the European and North American markets. The former is a question of market strategy, and it is

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¹ During the Japanese economy’s low-growth period that has existed since the 1990s, Japanese businesses maintained their competitive advantage domestically but, for the most part, they were not particularly competitive internationally. This is known as the Galapagos syndrome, and it is viewed as a problem across the Japanese economy. Japan’s home video game companies were also said to be suffering from the Galapagos syndrome (Ikeya, 2010). For more information about the Galapagos syndrome, see Akiike and Katsumata (2018).
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difficult to discuss the propriety of management decisions. Therefore, 
this paper will discuss the latter, which is an issue of 
technology. Specifically, (1) the capabilities built up by Japan’s home 
video game developers from the 1980s through the 2000s were not 
the capabilities being sought in the genres of video game software 
that were popular overseas, and (2) developing their capabilities 
resulted in a core rigidity, so that the Japanese companies were no 
longer able to gain the capabilities needed for new genres of video 
games.

History and Overview of the Home Video Game Industry

Firstly, this paper will summarize the history and current status of 
the development of the home video game industry, and the position of 
Japanese businesses within it.

The home video game business began in the U.S. However, in 1983, 
software sales plunged during the so-called Atari shock. The Atari 
shock caused distrust in the home video game business between 
consumers and video game companies, and meant that PCs came to 
be used for video game hardware instead of game consoles (Uemura, 

At the same time, Nintendo launched its Family Computer in 
Japan in 1983 as mentioned above, leading to rapid growth in the 
home video game market. The hardware makers and video game 
companies that spearheaded the Japanese market expanded into the 
North American home video game market, which had been 
devastated by the Atari shock.

2 When a business gains a core capability that gives it a competitive 
advantage, it tends to continue using that capability. As a result, this core 
capability becomes a core rigidity, as the company becomes unable to 
adapt to environmental changes by rebuilding and integrating flexible 
capabilities (Leonard-Barton, 1992; Takahashi, 2015).
To summarize the subsequent trend of the home video game hardware market in North America, Nintendo launched the NES in North America, thereby succeeding in setting that home video game market back on a growth path and becoming the de facto standard. Because Nintendo commanded such an overwhelming market share, few European or North American companies tried to get into the hardware business. The major hardware providers in the European and North American video game hardware market were Japanese companies: Nintendo, SEGA, and Sony Computer Entertainment (SCE, now SIC) (Shintaku, 2003).³

Next, to summarize the trend of the North American home video software market, because Nintendo’s NES and other Japanese hardware had penetrated North America, it was simple for Japanese companies to localize their home video games developed for Japan and release them internationally. In the late 1980s, Japanese home video game development companies that had succeeded in the Japanese market expanded to North America. Also, with the regrowth of the North American home video game market led by the NES, North American developers of PC video games entered the home video game business (Shintaku, 2003).

It has been pointed out that there is much heterogeneity between players’ tastes in the Japanese and North American home video game markets. For example, when it comes to role playing games (RPG), Japanese players focus on the personalities and characteristics of the games’ characters and on the in-game scenarios, while North American players prefer simulations of reality (Kino, 2010; Wada, 2017). As another example, sports games are popular if they feature

³ In 2001, Microsoft launched the Xbox, marking the entrance of a North American business competing in the home video game hardware market. The Xbox and its successor, the Xbox 360, achieved poor rates of diffusion in the Japanese market. Although it achieved a certain diffusion in North America, it ranked behind SIE and Nintendo hardware (Famitsu game hakusyo, 2018).
famous professional athletes, but Japanese sports stars are less appealing in the USA; similarly, USA sports stars are less appealing in Japan. Furthermore, the sports themselves are different. While baseball and association football (soccer) are the major professional sports in Japan, the U.S. has four major popular sports: baseball, American football, basketball, and ice hockey. In addition, the video game software rental business never took off in Japan, but it experienced much greater diffusion in the USA. Accordingly, in Japan, people would buy home video games so that they could play them for a long time, while in the U.S. there was a need for games that could be rented and enjoyed over a period of several days.

Owing to these market differences, unlike in home video game hardware, where Japanese companies expanded globally to gain market share, when it came to software, Japanese video game companies gained market share in the Japanese market, while North American video game companies gained market share in the North American market (Famitsu game hakusyo 2018; Kino, 2010; Shintaku, 2003).

From the 1980s through the early 1990s, Japan’s home video game software market was on course for growth and was larger than that of North America. As a result, developing products for the Japanese market alone amounted to targeting the largest growth market in the world, so it did not pose a problem for corporate management. However, the situation changed in the late 1990s. First, the costs of developing software that fully utilize the advanced performance of home video game hardware skyrocketed. In addition, Japan’s home video game software market started to shrink (Ikuine, 2012; Wada, 2011). At the same time, the North American market continued to expand, so that by the 2000s, it outpaced that of Japan in monetary terms (Koyama, 2010). From the 2000s onwards, the gap between the growing North American market and the stagnating Japanese market continued to grow. In 1999, the home video game
software was roughly the same value in the two markets, at 365.7 billion yen in Japan and 386.4 billion yen in North America (Shintaku, 2003). As of 2017, however, Japan’s home video game software market was worth 189.4 billion yen, while that of the U.S. had risen to 450.4 billion yen, making North America the world’s largest market (Famitsu game hakusyo, 2018).^4^ Video game genres that have been popular in the North American market since the 2000s include first person shooters (FPS), third person shooters (TPS), and 3D action RPGs (Kino, 2010). These video game genres started as PC video games in the 1990s and took off from there. European and North American companies that have generated these hit games for PC include Ubisoft, Blizzard, and Electronic Arts (EA). Meanwhile, Japanese home video game developers have not come up with as many hits, with the exception of such titles as Capcom’s *Monster Hunter: World* and Nintendo’s *Legend of Zelda: Breath of the Wild*.

Looking at Japan’s domestic market, although Japanese home video game companies such as Nintendo and Square Enix lead the pack in video game software sales, several overseas home video game companies also rank in the top 10 with their FPS and TPS games (Famitsu game hakusyo, 2018).

If companies are to continue growing and achieving sales that are in line with their rising costs, they need to expand into North America and other overseas markets, and move away from doing business only in Japan (Shintaku & Ikuine, 2001).^5^

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^4^ In addition to the North American market, the European market and emerging markets were developing as well. Japan’s home video game software market totaled 194.2 billion yen in 2017 while the overseas markets totaled 1,440.6 billion yen; owing to different market estimation methods, the Japanese market size is different from the above. The Japanese market is now a mere part of the global market (2018 CESA game hakusyo, 2018).

^5^ Because the North American market has expanded so much, North American video game companies do not regard the Japanese market as
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Game Development from the 1980s to the 2000s

Changes in the development of home video games since the 2000s include the skyrocketing costs of developing software to keep pace with improvements in hardware performance (Ikuine, 2012), and the growing importance of middleware and game engines to keeping development costs down (Oomae, 2010). These changes occurred simultaneously in both Japan and the West, which means that Japanese businesses are not at an innate disadvantage. This paper focuses on game design that employs game AI, which is critical to the development of FPS, TPS, and 3D action RPGs, according to the Lead AI Researcher at Square Enix, Youichiro Miyake (Matsui, 2011).

Game AI is classified into character AI and meta-AI. Character AI refers to those programs in video games that control the behavior of characters other than the players (i.e., non-player characters, or NPCs). Meta-AI refers to programs that control the progress and positions of elements within the video game, and do not take on the identity of a character (Matsui, 2011). For example, meta-AI includes things such as programs that put reinforcements into the game when the player and NPCs are engaged in a prolonged battle.

Back when the Family Computer was launched, high-functioning chips were very expensive. Nintendo, which was primarily a hardware maker, placed their emphasis on affordability rather than attractive enough to warrant large scale investment, unlike Japanese home video game companies (Shintaku & Swartz, 2001).

Unlike the academic definition of AI, “game AI” refers to making players feel that the software is intelligent (Matsui, 2011). For example, if one enters, “Hello,” the program will say “Hello” in return. Although it’s hard to regard such a simple chatbot as “AI,” it is part of game AI. Conversely, something that happens without the player’s awareness is not game AI, even if it uses a genetic algorithm.

This is a common term used by Japanese game AI developers that has no equivalent in English (Matsui, 2011).

NPCs that are manipulated by game AI may also be called AI (Matsui, 2011).
performance in order to encourage greater diffusion of their products in the market.

As pointed out by Ikuine (2012), video game software development was limited by the performance of the hardware. When home video games were being developed in the 1980s, the limitations of image processing capabilities restricted the number of characters that could be manipulated on the screen. Additionally, the limitations on CPUs’ operating capabilities made it difficult to implement complicated game AI. Therefore, video games were made interesting by combining stage design with character AI in simple action sequences (Miyake, 2010).

Figure 1 gives a graphic representation of how behavior specified by the stage and character AI can change video games to make them more interesting. In all these cases, three enemy NPCs appear in position before the player and engage them in battle. As the three NPCs advance toward the player, they encounter an open space without any spatial impediments (1-a), or a situation where movement is hampered by a wall (1-b), cornering the player. In cases where movement is impeded by the wall, it may be easy for the player to run away from a simple advance by the NPCs (1-b) or difficult to run away because the player is surrounded on all sides (1-c).

Furthermore, even when the positions and direction of movement in the initial stage are the same as in Figure 1, adding a reflexive algorithm, such as “if the player moves to the right on the screen, the enemies shift their advance to the right side of the screen,” makes the opponents more formidable.

Despite tough limitations on hardware performance, such as CPU operating capability, memory capacity, graphics quality, and software media capacity, Japanese home video game developers designed stage structure and character AI as a set, so that the video game NPCs could be optimized to be formidable opponents. As a result, Japanese home video game developers have built a
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Development organization and the ability to integrate entire elements.

Changes in Game Development Since the 2000s

Home video game hardware became more sophisticated in its computing ability and graphic display functions with the launch of PlayStation 2 in 2000 and Xbox in 2001. Also, this hardware had larger-capacity software media and was able to provide performance that matched cutting-edge PCs. As a result, the FPS, TPS, and 3D action RPGs originally developed for PCs were also marketed for use on home video game hardware, leading to a growth in the popularity of these genres in North America and Europe.

In the development of FPS, TPS, and 3D action RPG, there was a problem that was difficult to address with the method that integrated the stage structure and character AI settings as before.

First, as the video game became bigger, the stage became wider and the number increased. These larger stages have more topographic details, and when the NPCs were put into them and character AI was added, the development cost of this work greatly increased.

Second, 3D stages made it possible to have the player and NPCs

Figure 1. Sample of stage, Game AI, and game difficulty

Note: P: Player character, N: NPC, Arrow: How NPCs move
engage in more complicated actions. It was difficult to predict the player’s behavior, set the character AI to respond to it, and achieve the appropriate level of difficulty. For example, if we look at part 1-c in Figure 1 two-dimensionally, the NPCs can be evaluated as taking action to corner players. However, if we now add the option of climbing over the wall and going to the other side to the player’s selection of available choices, dealing with the opponents becomes easy.

Accordingly, the development method of setting the stage, anticipating the player’s behavior on the stage, and setting the appropriate character AI was no longer feasible in FPS, TPS, and 3D action RPGs. For these types of video game, European and North American developers solved the problem by developing algorithms in which character AI could assess its position and incorporate that data into its decision-making process.

By developing character AI that behaves by judging the situation, costs could be kept down no matter how many stages and situations were incorporated into the game. Taking parts 1-a and 1-c in Figure 1 as examples, if an algorithm is incorporated whereby “if there is no impediment, the NPCs will advance toward the player, and if there is an impediment, it will be used to surround the player,” both situations can be handled with the development of just one program.

Furthermore, using meta-AI makes it possible to save time that would be taken up by positioning the NPCs on all stages in advance.

Using meta-AI and character AI that can assess various situations in real time requires hardware that is equipped with high-level computing capabilities. Video game developers in Europe and North America have accumulated technology to develop character AI and meta AI by developing video games for high-performance PCs in the 1990s (Matsui, 2011).

Conversely, Japanese home video game developers have had a successful experience from the 1980s to the 2000s; consequently,
they were particular about their conventional game designs, with each stage and character AI preset in advance and did not develop advanced game AI capable of assessing situations (Matsui, 2011). It seems that Japanese companies had built up their abilities by designing games that were limited by hardware performance, and it can be argued that they became stuck in a core rigidity.

In addition, Japan’s home video game market has users who are interested in traditional game designs. Even after the North American home video game market surpassed Japan’s in the 2000s, it was still possible for companies to continue doing business with old game designs by targeting domestic users, which can be viewed as a contributing factor in their not employing more advanced forms of game AI.

Discussion

Japan’s home video game industry experienced rapid growth after the success of the Family Computer. As a result, video game development capabilities improved, despite limitations on hardware functionality.

However, the home video game market went through a major retrenchment after the Atari shock in North America. As a result, PC video games experienced a growth in popularity (Uemura, Hosoi, & Nakamura, 2013). As video game developers acquired development experience with PCs, which performed better than home video game consoles, they were able to build video game development capabilities premised on the high-level hardware specs of FPS, TPS, and 3D action RPGs. As home video game consoles caught up with PCs in the 2000s, the capabilities that they had acquired for PCs became applicable to consoles, so the developers were able to gain an advantage across the home video game market.

The Atari shock caused a pullback in the North American home
video game market, but it led to a shift toward the development of PC video games, and thus the accumulation of cutting-edge technology among Japanese companies that were developing home video games. Dosi (1982) argues that the upshot of this was the enabling of a large-scale trajectory-disruptive radical innovation.

According to Ikuine (2012), the innovation pattern of home video game software is proscribed by the progress of standards in hardware performance. The differences between which software was being developed for which hardware during different time periods determined the different technologies and trajectories of the industry in Japan and the West, and we can say that these contributed to the differences in home video game developers’ capabilities in these countries.

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References


Kyoukasyo Seisaku Iinkai (Eds.), *Digital game no kyoukasyo: Shitte oku beki game gyoukai shin trend* [The textbook of digital game: New trend of video game industry which you must know] (pp. 67–74). Tokyo, Japan: Softbank Creative (in Japanese).


Shintaku, J. (2003). Hokubei game sijou no gennjou to nichibeihikaku
Wada


