Village Zhenggezhuang
Changping, Beijing 100000
(501)555-7346

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Mr. Li Wendong
Beijing University of Posts and Telecommunications
Village Zhenggezhuang
Changping, Beijing 100000

R&D Reports of
Nintendo's New Game Console- Game Boy

Dear Manager:

I am very grad and grateful to been chosen to do this research and development job for Nintendo's Game Console-Game Boy.

This report will give my research results of strategic fit, technique details, market research and department description. I put a conclusion as the end of my report.

I hope that my report can give you a brief understanding about Game boy, a classical game console.

If there are some mistakes and shortcomings, please point out and tell me. Thank you for your reading and help.

Sincerely,

Ding Xijia

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Introduction

In the 1980s, with the development of economy and technical progress, human living standards have been greatly improved, which could be proved by the rapidly growth of various consoles. But the early consoles, such as arcade or video game consoles, were not very cheap or portable, which might cause inconvenience to customers. Under this background, the Nintendo, who always puts players' happiness in the first place, developed and launched a new product Game Boy, a very portable and inexpensive handheld game console, which also opened a new era. This report shows the process of development and the innovation of technology which are the reason of Game Boy becoming the best handheld game console.

Strategic Fit

After 1987, NEC and SEGA, two Japan companies who produce games and game consoles, enter the field of TV games in large scale, making Nintendo losing its market share. Nintendo felt a deep threat in the field of household game consoles. Hiroshi Yamauchi, the present of Nintendo at that time, was worried about that the product of the company is simplification. He realized that the development of the second economy pillar of Nintendo is imminent. After recognizing the importance of revolution, the company made A series of strategic plans to get into whole new market in order to replace the position household game consoles had in the company. To sum up in a word, the reestablishment of a pillar industry of the company is inventing Game Boy.

Yokoi Gunpei, the first development minister of Nintendo at that time, thought constantly of developing portable game consoles. He directed the first development department developed portable consoles which can replace game disks freely. This was a whole new idea at that time. In order to achieve the goal, Nintendo must allocate resources. It involves all aspects of the relationship of power in the company. Yokoi Gunpei must persuade the administrator use the resource on future products rather than existing products. Fortunately, Yokoi Gunpei and the present of Nintendo, Hiroshi Yamauchi, had an amicable personal friendship. Thus the cooperation of the two is quite smooth. Finally the revolutionary portable game console was named Game Boy, and a legend began. The development of Game Boy followed out the corporate philosophy, which was short and thin. For this reason, Game Boy had advantages of high cost performance, high endurance and low cost. But due to the cost, the quality of screen was not so good. Both advantages and disadvantages will be discussed below in the part of Technical Details. Game Boy was also followed the corporate culture. The culture of Nintendo was standing against violence and pornography and developing all-age games. And most games of Game Boy were in this type, such as *Super Mario Land* and *Tetris.* Nowadays, there are oceans of vulgar games in the market, but Nintendo still holds the precious social responsibility and business ethics.

Nintendo had successfully found out a balance between operating efficiency and bold innovation. At the same time of developing Game Boy, Nintendo did not give up the household game console

market. Nintendo accepted the fact of losing market share and tried to adapt to the new market environment.

In conclusion, Game Boy is a product with iconic trademark of Nintendo.

Technical Details

2.1: Technical Detailed Information and Feature

As the technical research and development team of Nintendo, in this section, we will show you about the technical features and the detailed information of our new product-Game Boy. (Realboy, 2013)

2.1.1: CPU

Based on the technology of microchip and the control of the cost, we decide to use an 8-bit CPU-SHARP LR35902 to be the centre control unit of our product, we do not choose the Intel 8080 and the Zilog Z80. The Intel 8080 was the second 8-bit microprocessor designed and manufactured by Intel and it is sometimes been labeled "the first truly usable microprocessor", it is widely used for calculators, cash registers, computer terminals, industrial robots and other applications. The Zilog Z80 is an 8-bit microprocessor designed by Zilog. It was widely used both in desktop and embedded computer designs as well as for military purposes. Because this CPU is a custom-built one which is specialized for our product. The clock frequency of our Clocked at 4.2MHz (4194304Hz). It is faster than the Intel 8080's 2.0MHz and the Zilog Z80's 2.5MHz. This CPU is adopt the special instruction extender from the Z80 and it retained just the Intel 8080's register set and the registers added by the Z80 were left out, that is to say, this CPU is a hybrid between the Intel 8080 and the Zilog Z80. We choose this CPU to satisfy the both the performance and the cost.

Fig.1: The CPU- SHARP LR35902 for Game boy

2.1.2: RAM

The system RAM of our product is 8 kB internal S-RAM which can be extended up to 32 kB. As for the system RAM, this area consists of two permanently-mapped banks internal to the Game Boy, it was used by the games to store temporary data. The Video RAM is 8 kB internal, this special memory was used to hold the pixels to display on the screen. The choice of the RAM is based on the CPU we choose, only in this way can make our entertainment system be more efficient. (FH-Karlsruhe, 2013)

2.1.3: Display

We decide to use a 2.6 inches reflective STN LCD with 160 × 144 pixels to be the screen of our product. STN is a super-twisted nomadic display, and LCD is a type of monochrome passive-matrix liquid crystal display.The reason we choose this kind of display device is this kind of screen has low cost for the product, in order to control the price of the product to let it be accepted by more customers, we choose the reflective STN LCD without backlight, although it is not convenient for the users to play it in the night, it will also provide a good display effect in daily use.

Fig.2: The display effect of the 2.6 inches reflective STN LCD (Flickr, 2011)

2.1.4: Buttons and Knobs

The Game Boy has four operation buttons labelled: "A" which means accept, "B" which means back "SELECT", and "START", it also has a D-pad to control the direction when the user are playing with our product. A D-pad (short for directional pad; also known as a Control Pad) is a flat, usually thumb-operated four-way directional control with one button on each point, found on nearly all modern video game console gamepads and game controllers. There is a volume control knob on the right side of the product and another knob on the left side to adjust the contrast. At the top of the Game Boy, there is an on-off switch and a slot for the Game Boy cartridges are located.

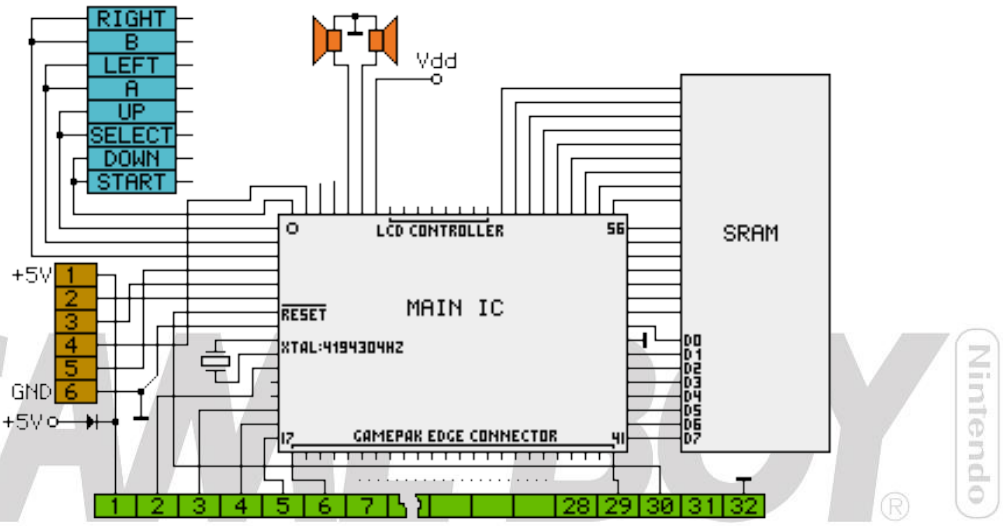

Fig.3: The logic connection between the components of Game Boy

2.1.5: I/O Connectors

Our product has optional input/output connectors. We are going to set the left side of the system with an external 3.5mm x 1.35mm DC power supply jack which allows users to use an external rechargeable battery pack or AC adapter instead of four AA batteries. Our device requires 6V DC of at least 150 mA current. Another connector is a 3.5 mm stereo headphone jack which allows users to listen to the audio with the bundled headphones. On the right side of the device, we offer a port which allows the users to connect their Game Boy to another Game Boy system by a link cable, provided both users are playing the same game. (Vidgame.net, 2014)

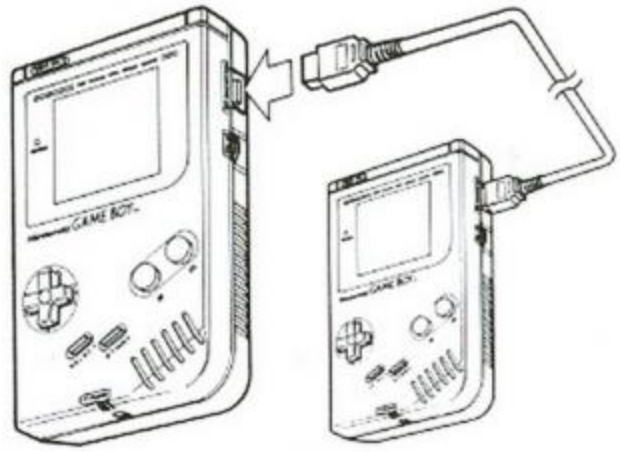

Fig.4: The link cable for two Game Boys.

2.1.6: Parameter Specification

CPU:	*8-bit SHARP LR35902 CPU running at 4.194304MHz*
BUS architecture:	*8-bit data-BUS, 16-bit address-BUS*
RAM:	*8kB internal can be extended to up to 32kB external*
Video RAM:	*8kB internal*
ROM:	*16kBit, 32kBit, 64kBit, 128kBit... up to 4MBit cartridges are known.*
Sound:	*4 channels. Each of which can be mapped either to the left or to the right or to both speakers.*
Video:	*Display: Reflective LCD 160x144 dots (physically)* *Colors: 4 shades of gray* *Sprites: 40 sprites 8x8 / 8x16*
Communication:	*One serial port. Up to 4 GameBoy™ can be connected together using these ports. Baud rate and protocol are not fully documented.*
Power:	*Classic: 6 Volts, 0.7 Watts, 4 AA Batteries - 35 hours* *Pocket: 3 Volts, 0,9 Watts, 2 AAA Batteries - about 25 hours*

Table.1: The parameter specification for the Game Boy

2.1.7: Product Feature

We mentioned that we offer a port which allows the users to connect their Game Boy to another Game Boy system by a link cable, provided both users are playing the same game. This process can make more fun between different players and it is the biggest feature compared with former product. The media which store the game we used is the ROM cartridge, the biggest feature of this

kind of storage is that it contains battery-fed volatile memory for game saves. The ROM cartridge is a removable enclosure containing read-only memory devices designed to be connected to a consumer electronics device. ROM cartridges can be used to load software such as video games, or other application programs. The progress of the game will be preserved, user will not have to play from the beginning of the game every time they play it. (IGN, 2009)

Fig.5: The storage media of the software for Game Boy

2.2 Detailed Project Plan for the Next Year

Through the analysis of detailed technology information, we have got the specification of Gameboy. Next, we will make the plan for the next year.

2.2.1 Detail Design

According to consideration, we choose DFM strategy to reduce the manufacturing costs during the whole developing process. As most of the precise calculations are being done at detail design stage, we'll generate a comprehensive analysis here in 5 steps. First, we estimate the manufacturing costs by analyzing the whole process. Second, we reduce the costs of components. For some components, we redesign them to eliminate the processing steps. Then we choose the appropriate economic scale for the part process. Finally, we standardize components and processes when necessary. Third,

we reduce the costs of assembly following the rules: minimize parts count, encourage modular assembly etc. The last two steps, we will reduce the costs of supporting production and consider the impact of DFM decisions on other factors respectively. In order to make it more clearly, we use the Gantt chart to show our plan for the detail design.

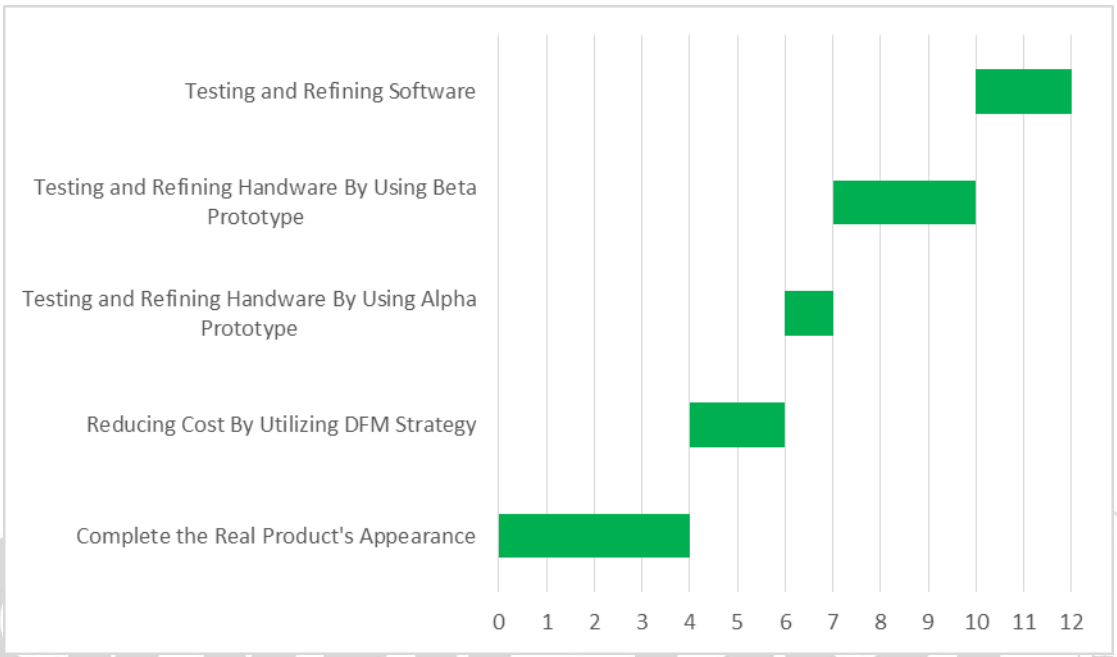

Fig.6: The Gantt chart for the Next 12 Months

2.2.2 Testing and Refinement

After the detail design stage, we will begin testing and refining of our product. At first will use the alpha prototypes to get access to whether it can work as intended and satisfy the key customer needs. That is to say, we would build models that look similar to and perform the basic functions of the product. However, the models are not necessarily fabricated with the actual processes to be used in production. Second, we will use the beta prototype to find out the bugs in our products. The first step is to make sure that our product's hardware is in good condition. Consequently, we must make sure our product make no mistakes to guarantee the safety. Also, the necessary software is also intended to be refined. This process is pretty crucial for our product, if anything wrong with this part, the next steps that the product is supposed to do totally can't be done. The product would be out of use.

Development Schedule

Phases	Time Required	Tasks	Milestones
Concept Development	Finished	Identifying Opportunities and Selecting the Best Planning	Acquiring a Specific Concept Model
System- level Design	Finished	Decomposition into Functional and Physical Elements	Identifying the Components and Physical Sketches
		Product architecture	Establishing a System- level Architecture of the Product
Detail Design	4 Months	Completing the Real Product's Appearance	Getting the Real Product's Main Body
	2 Months	Reducing Cost by Utilizing DFM Strategy	Minimize the Product's Cost
Testing and Refinement	1 Months	Testing and Refining Hardware by Using Alpha Prototype	Working as Intended
	3 Months	Testing and Refining Hardware by using Beta Prototype	Accessing Reliability Debugging
	2 Months	Testing and Refining Software	Realizing Every Raised Concept

Table.2: Development Schedule for Game Boy

2.2.3 Department Responsibility

	Detail design	Testing and refinement	Production ramp-up
Market group	Make the investigation to know about the customer's need.	Analyze the feedback from the people who have used the product.	Make the marketing strategies for the product and prepare for marketing promotion.
Design group	Make a plan and complete the design.	1. Test the quality of the product. 2. Test the function of the product.	Improve the product in different way to match the customer' need.
Technique group	Make the prototypes	Refine the product according the instructions of design team.	Refine the quality of the product.

Table.3: Department Responsibility for our group member

Market Research

3.1 Customers' demands & wants

It is significant to grab our customers' needs. Know what they desire, and then, create a perfect fusion, making by their demands and our spirits, to occupy their heart, to make our own miracle.

At the beginning, we inspected the video game consoles' development recent years . We find the mainstream video game consoles have carved up the market. If we still persist in updating our video game consoles or developing a new one, we cannot have a remarkable surmount, since the electronic hardware technology limit our imagines. There is no any possibility to beat our rival, such as SONY and SEGA.

Therefore, we think we should raise our handheld game console. This month, when we were on the way to the company, we saw that the people on the bus were boring. Some adult males might look newspaper, but others were idling. That is the golden time to push our handheld game console (HGC).

In 1979, the first HGC came to our eyes. That is Microvision. However, Microvision is not successful. Here is the negative comment: "*Today the Microvision is considered somewhat rare, and to find a working model is even more difficult. The Microvision suffers over time with substantial screen rot and the liquid crystals in the screen often leak. In addition the controls and buttons also suffer from damage and often times don't work.*" (Gamester81, 2013) Similarly, our Game & Watch (Developed in 1980) is also not good. There are too little games to enjoy for players, because the games are inserted in the consoles.

Meanwhile, a handheld console called Lynx is developing. Fortunately, it and previous HCG have a common shortcoming ---- High power consumption. What a funny design. As a HCG, the most important factor is "cruising power" ---- Powerful battery. Indeed, beautiful graphics, unbelievable picture quality is very fascinating, but less than 2 hours playing time will make players upset. Finally, we advance our idea ---- Game Boy.

We think Game Boy will stun the HCG market. After testing, we have the following data: *"The original Game Boy boasted anywhere from 10 to 30 hours of battery life on four AA batteries, according to different sources (the more generous estimates came from Nintendo itself at launch)."* (Edwards, 2009)

We use the cassettes as games carriers. Our consoles' game's data and save files can be written in the carriers. Thus we not only decrease our cost on the storage, but also support other game companies write games on our platform. In addition, our new HCG supports multi-players. Now that video game consoles support two players. Game Boy why not?

At the end of this section, we give a SWOT analysis to conclude the Game Boy's advantages and disadvantages.

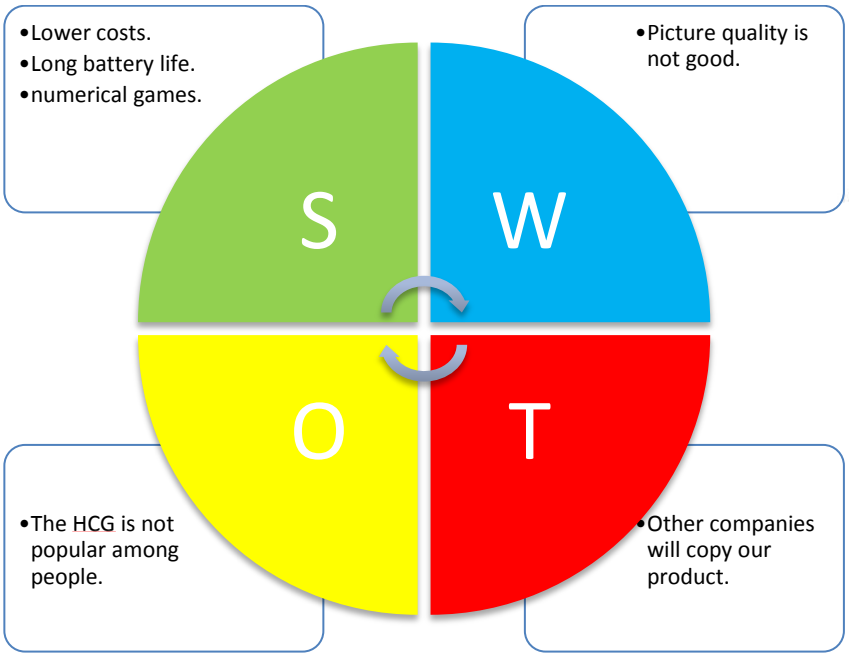

Fig 7: The SWOT analysis of Gameboy.

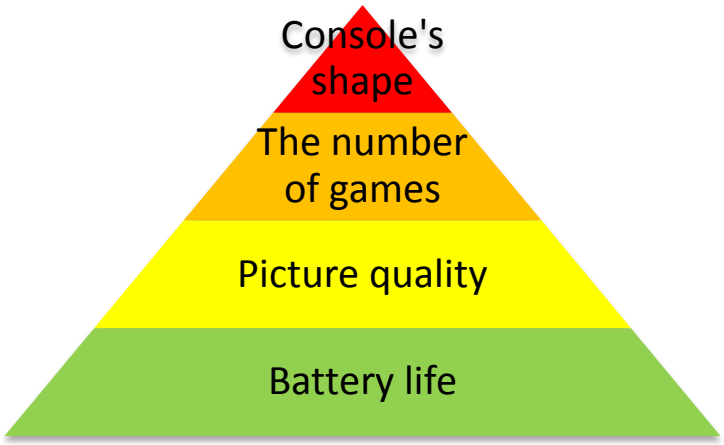

Fig 8: The customers demands pyramid level.

3.2 Customer Dividends

After survey, we think that the new handheld game console can perfectly satisfy most of the demand of users. This product has a bright future**.**

3.2.1 Target Market

Our main target market is the young generation. As we all know, the young people are the main force of the society and most of them have hard work every day, besides, the huge life pressure is on their shoulder. With our product, on the way to work when they are taking public transportation, they can play for a while to relax their mind and release the pressure. What is more, our handheld game console is mainly focus on endurance rather than delicate pictures or powerful computing ability. It is important that student's population is one of our target markets.[4] We knew that our student fans hope we can launch low-end game console because of their situation that they have no incomes but pocket money given by parents. For these reason, the price of our product is not high, which means that even middle school student have ability to afford to buy Game Boy. Our Game Boy, a new kind of high cost performance game console, will be very popular in students. In addition, due to the comparing between teenagers, our products will spread at a very high speed if the Game Boy is really attractive.

As for games, we investigated that there is a game named Tetris is welcomed by the majority of game player, so we decide to port the game to our Game Boy, making this game become one of the promotion power.

3.2.2 Lead customers

For our Game Boy, leader customers are those game fanciers who always concerned about the updating, selling and even stop producing of game consoles and some pivotal pundits of game console industry. Let them enjoy our Game Boy. And ask them to advertise our products in some

game magazine. In this way, many potential buyers may be attracted to buy our Game Boy. (AFP-JIJI, 2014)

About those game fanciers, we must win their hearts. To some extent, their propaganda influence is more necessary than those reviewers because they analysis from players' point of view rather than engineers' angle. Thus, praise from game fanciers wins more users for us. We all agree that bright spots are needed to gain their approval, which is the key to catch their eyes. (BBC, 2001)

Description of the Department

General designer：Yokoi Gunpei (Digg, 2000)
As the general designer of the Game Boy, Yokoi Gunpei has wealth of design experience and sensitive market insight. He planned and leaded the design of Game & Watch, and acquired huge success. Besides, as the leader of the project, he has a remarkable leadership so that he can greatly arouse the enthusiasm of members. In this project, he fully analyzed the demand of the market, contrasted the merits of the similar product in their competitors and combined cost supplier price and their own price positioning to provide a perfectly feasible scheme for Game Boy.

Development director: Lzushi Takehiro (CVG, 2003)
He graduated from Doshisha University and belong to the first development department in Nintendo now. He participated in design and development of SNES product with rich product design experience and excellent innovation ability. Besides, he can fully combine advanced technology with the product to meet the needs of the product.

Video game developer: Yoshio Sakamoto (Kohler, 2010)
He is an excellent video game developer. His first projects at Nintendo were the design of pixel art for the Game & Watch handheld Donkey Kong, and the arcade game Donkey Kong Jr.

Graphic designer：Matsuoka Hiroshi (Nintendo, 2003)
He graduated from Kyoto University and belong to the first development department in Nintendo now. He participated “METROID” stage background graphic design. Also, he has rich experience in graphic design and painting skills.

Sound designer: Tanaka Hirkazu (Greening, 2013)
He is an excellent musician and composer with fund music theory besides sound designer. He belonged to the first development department in Nintendo. He participated sound designer for many games, such as “Donkey kong” series, “Wrecking Crew” and so on.

Concept designer：Makoto Kando (Kano, 2000)
He is one of the original designers in Nintendo’s creative department. He designed toys and board games before working on the Nintendo Beam Gun series. He eventually became one of the lead designer of the Game & Watch series. Also, he has the rich experience on concept design.

Conclusion

In recent years, with the increasing life pressure, entertainment has become more and more important in our daily life. People, including young and old, children and adults, have the demand of relax their mind. That is why we want to invent our whole new product, Game Boy.

Findings:

1.This is a brand new product, which suits for all. There will be various types of games on our Game Boy because Nintendo had cooperated with many game producers.

2.There will be various types of games on our Game Boy because Nintendo had cooperated with many game producers.

3. Game Boy did not need to use any new but immature technology to maintain the high endurance and low price.

4.We had many successful products before, such as Game&Watch and FC, which build up good reputation for Nintendo. When Game Boy is released on the market, the leader customer will Come in great numbers and cause chain reaction. So we do not have to worry about the sales volume.

Recommendations

1.Our Game Boy has many innovations that its competitors do not have. For example, the cross key design is one of the greatest invention that other companies must imitate.

2.Nintendo needed revolution and transformation. The development of Game Boy is positive attempt.

3.Game Boy focus on the keywords “portable” and “high cost performance”. Even a teenager can buy one with his pocket money and then put it into his pocket. As a comparison, the competitors of Nintendo use the new technology, colour LCD, which greatly shorten the battery endurance and increase the cost. Thus, in our target market, the teenage population, we are the leader of the market.

4.As for technology details, our Game Boy has many innovations that its competitors do not have. For example, the cross key design is one of the greatest invention that other companies must imitate.

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