Product Development Strategy for LG Electronics in Optical Storage-based Consumer Electronics

by

SUNG HWAN KIM

M.S., Seoul National University, 1990
B.S., Seoul National University, 1988

Submitted to the Alfred P. Sloan School of Management
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at the

Massachusetts Institute of Technology

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Signature of author .................................................................

MIT Sloan School of Management
May 7, 2004

Certified by.................................................................

James M. Utterback,
David J. McGrath, Jr. Professor of Management and Innovation, MIT Sloan
Thesis Supervisor

Accepted by.................................................................

David Weber
Director, MIT Sloan Management of Technology Program
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ABSTRACT

With the dawning of the digital era, many home electronic products are emerging. One of the fastest growing and most wide-spread products in the market is the DVD player. Few digital products have achieved as fast a market penetration, and with as rapid a price drop, as the DVD player.

This thesis touches on the product development strategy for my company, LG Electronics, in terms of short-range and mid (long)-range plan, specifically on means to sustain and keep the profit margin reasonable in spite of the current competitive market situation.

The system dynamics tool is used as a method of analysis and assessment on the current DVD player market situation. Based on the results of the analysis, I propose the following strategies, in terms of products and technologies, for LG Electronics to maintain sustainable growth in the industry. Firstly, in terms of mid-range plan, the company should broaden its DVD product scope and make profit by adding value. Secondly, in terms of long-range plan, the company should draw a big picture for further growth by taking into account the development of new disruptive technologies and products in the industry.

Thesis Supervisor: James M. Utterback
Title: Professor of Management and Innovation Chair
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I. Introduction

1. Overview

The rapid rise of DVD (Digital Versatile Disc) in the past five to six years has surprised many people involved in this industry regardless of whether they are firm executives or market observers. At its launch in 1997, there was widespread skepticism about whether consumers would buy new high-priced product that could only playback expensive pre-recorded discs. Some people expected that DVD players might establish the small niche market that complemented VHS recorders that dominated home video industry at that time.

However, market observers failed to forecast a number of significant changes in the market. The first thing they did not recognize was that film studios had a clear strategic focus for the development of DVD, so the technology had industry support from the start. The second thing they did not expect was that the price of players and discs declined more rapidly than almost any previous comparable technology or product. The lowest street selling price for a DVD player in the U.S. is below $40 as of Q1, 2004, compared to more than $500 five or six years ago.

Apart from the fact that DVD technology could catch the imagination and interest of consumers and establish a market successfully in the digital era, one of the most important factors is that DVD has enjoyed the most rapid rise of any consumer electronics technology ever introduced. Since its introduction in 1997, the DVD technology has, unlike previous analog technology, encouraged and facilitated other industries such as computer industry and entertainment industry. In other words, the DVD market is no longer limited to home
entertainment playback boxes - it is being combined with increasing numbers of products: computers, portable devices, gaming consoles, and vehicle DVD - DVD is everywhere. On top of that, DVD players have played a role as a market enhancer in producing a ripple effect in the home theater category as consumers upgraded their TVs and their sound systems, as well as digital TVs.

While the abrupt falling of average selling price for the hardware coming from fierce competition among hardware manufactures and a variety of films on DVD released by studios have played a significant role in activating the market, the profit margin for hardware manufacturers as well as core component suppliers has been drastically declining. As a result, most of the major players such as Japanese, Korean and Taiwanese firms in this industry are getting into hot water in the sense that revenues coming from DVD players would start to decline in two or three years, even before they can make enough money to collect their huge investment in research and development.

By this reason, many major players have been making efforts to shift their product portfolio to the direction of increasing the ratio of DVD recorders to DVD players. The falling price for DVD recorders will trigger customer needs to convert DVD players to DVD recorders sooner or later. This thesis provides a discussion on market dynamics in the DVD industry, as well as product development strategy for LG Electronics.
2. Objective of Thesis

As the DVD player market is becoming more competitive than ever before, especially with the participation of many small Chinese firms that have price competitiveness, the profit of DVD player manufactures has been sharply declining. LG Electronics, like other major players, is being driven to the wall in terms of revenue and profit margin, and thus has a burden to overcome this tough situation.

In this thesis, I would like to analyze and assess the current DVD industry using the system dynamics tool and verify which factors are dominant and how they drive the commoditization process in the market. After I review the current DVD market, in an effort to find a way how LG Electronics can increase its revenue and keep reasonable profit margin in spite of the current competitive market situation, I am going to introduce some related literatures and frameworks which I will be using to suggest a product and technology development strategy for the company post-DVD player market.

In particular, my thesis is aiming to suggest some clues to the following questions:

- How can hardware manufacturers reorganize profit pool in DVD market value chain?
- Will the relationship between DVD players and DVD recorders be competitive, predator-prey, or symbiotic?
- Which standard for DVD recorders will be dominant and how royalty issues can affect DVD market evolution?
- Is it possible for High Definition DVD to penetrate the market?
II. OPTICAL STORAGE TECHNOLOGY AND MARKET

1. Technological Trends in Optical Storage Industry

Spurred on by its flexibility and affordability, and networkability the technology offers, optical storage technology has continued to grow at an incredible pace since it was introduced. When Sony and Philips invented the Compact Disc (CD) in the early 1980s, even they couldn't have imagined what a versatile carrier of information it would become. Launched in 1982, the audio CD's durability, random access features and audio quality made it incredibly successful, capturing the majority of the market within a few years. In a sense, this evolving technology owes much of its success to the standardization of the CD (Compact Disc) by Philips and Sony. Because this standard has been universally accepted, the CD market has been on a steady growth path over the past two decades. Along the way, the technology has evolved from CD read-only capabilities (CD-ROM), to CD-Recordable (CD-R) and the CD-Rewritable (CD-RW) format, followed by DVD-ROM and DVD-Rewritable, most recently, HD (High Density) DVD using blue laser. As Fig.II-1 indicates, optical storage technology has increased its storage capacities, but also has expanded its application products ranging from computer industry to consumer electronics, and then broadcasting area.

Despite the success of the compact disc, there has been a clear need for a higher capacity format to meet additional application requirements. DVD, the Digital Versatile Disc, is a high capacity CD-size disc for video, multimedia, games and audio applications. Capacities for the read-only disc range from 4.7GB to 17.1GB. The high quality of video and audio has helped DVD-Video to compete very effectively with VHS for pre-recorded video titles,
Fig. II-1 Optical Storage Technology Evolution
and statistics show that DVD is growing faster than any other digital consumer electronics format in the USA and Europe. PCs with DVD capability are also selling, but multimedia and games applications of DVD have been slow to start. The advent of new games consoles using DVD is also helping to stimulate further sales. Let me briefly summarize the characteristics of DVD as follows.

1.1 DVD History (From CD to DVD)

The introduction of DVD technology is very similar to that of CD technology. In both cases, the complexity surrounding the introduction of the new technology was largely due to coordination issues. However, the key players in the DVD arena seem to have learned from experience and organized to maximize value in the industry. The Philips CD standard was wildly successful, driving sales of electronics and media for both consumer and business applications. However, the CD standard was originally designed for audio and proved inadequate for a variety of other applications. The movie industry was particularly frustrated by CD’s limited capacity. Capacity issues were beginning to emerge in the software industry as the size and complexity of applications increased.

In January 1993, “Nimbus demonstrated a red book audio disc at the Medim show in Cannes, France.” The double density disk was played on a standard CD audio player with a digital out, and the video image was displayed on a NTSC television. In December 1994, Philips and Sony announced a joint proposal for MMCD (Multimedia CD), which would be a single-sided, dual layered disk “Targeted at the professional electronic publishing and computer market.” Shortly thereafter, Time Warner and Toshiba announced a joint
proposal for SD (Super Disc); a similar technology targeted the entertainment industry. In August 1995, these rivals reached a compromise and basic specifications for a unified DVD technology were released three months later. DVD now is the result of an agreement by both camps on a single standard to meet the requirements of all the various industries involved. The major milestones are listed in Table II-1.

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
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<tbody>
<tr>
<td>1994</td>
<td>Hollywood ad hoc committee defined features for movies on 'CD'.</td>
</tr>
<tr>
<td>1995</td>
<td>Agreement on a single standard format called DVD.</td>
</tr>
<tr>
<td>1996</td>
<td>DVD-ROM and DVD-Video specifications version 1.0 published</td>
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<td></td>
<td>Digital copy protection scheme (CSS) agreed</td>
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<td></td>
<td>First DVD-Video players sold in Tokyo (November)</td>
</tr>
<tr>
<td>1997</td>
<td>Launch of DVD in USA (August)</td>
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<td></td>
<td>DVD Consortium becomes DVD Forum, expands membership and holds first General DVD Forum Meeting with 120 members</td>
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<tr>
<td>1998</td>
<td>DVD-Video version 1.1 and DVD-ROM version 1.01 specifications issued.</td>
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<tr>
<td></td>
<td>DVD Forum adopts DVD-RW as another re-writable format</td>
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<tr>
<td></td>
<td>7 new members of DVD Forum Steering Committee making 17 in all</td>
</tr>
<tr>
<td></td>
<td>DVD Forum publishes DVD-Audio specification version 0.9</td>
</tr>
<tr>
<td></td>
<td>Full launch of DVD in Europe. 1m DVD-Video players sold in USA</td>
</tr>
<tr>
<td></td>
<td>4.7 GB DVD-R and DVD-RAM version 1.9 specifications released</td>
</tr>
<tr>
<td></td>
<td>1999 DVD-Audio (1.0), DVD-Video Recording (0.9 &amp; 1.0), DVD-RW (0.9) and DVD-RAM (2.0) specifications published.</td>
</tr>
<tr>
<td>2000</td>
<td>CPPM copy protection for DVD-Audio agreed</td>
</tr>
<tr>
<td></td>
<td>DVD-Audio players launched in USA (July)</td>
</tr>
<tr>
<td></td>
<td>First DVD-Audio discs in USA (November)</td>
</tr>
<tr>
<td></td>
<td>DVD-RW Part 2 (1.0), DVD-R for Authoring (2.0), DVD-R for General (2.0) and DVD Stream Recording (0.9) specifications published.</td>
</tr>
<tr>
<td>2001</td>
<td>DVD-Audio players &amp; discs available in Europe and elsewhere</td>
</tr>
<tr>
<td></td>
<td>DVD Video Recorders launched in Europe etc</td>
</tr>
<tr>
<td></td>
<td>Guidelines for IEEE 1394 transmission for DVD-Video/Audio issued.</td>
</tr>
<tr>
<td></td>
<td>DVD Video Recorders launched in Europe etc</td>
</tr>
<tr>
<td></td>
<td>DVD-Multi (1.0), DVD Stream Recording (1.0), DVD-Audio (1.2) and DVD Video Recording (1.1) specifications published.</td>
</tr>
<tr>
<td>2002</td>
<td>WG-11 created to study future blue laser format</td>
</tr>
<tr>
<td></td>
<td>DVD-Audio recording specification ver 0.9 issued</td>
</tr>
<tr>
<td></td>
<td>Hybrid DVD-Audio format approved by DVD Forum</td>
</tr>
<tr>
<td>2003</td>
<td>DVD Forum rejects hybrid DVD-Audio format</td>
</tr>
<tr>
<td></td>
<td>DVD Forum selects 0.6mm HD DVD, shelves 0.1mm</td>
</tr>
<tr>
<td></td>
<td>DVD Forum releases iDVD specifications</td>
</tr>
</tbody>
</table>

Table II-1. DVD Milestones
1.2 DVD Features

DVD is an “application family of optical disk formats for read-only, recordable and rewriteable applications.” DVD originally stood for Digital Video Disc but now means Digital Versatile Disc. DVD was “designed from the outset for video, audio, and multimedia, not just audio.” The more flexible file system (UDF) can and has been compiled into a collection of application specification sub-formats (DVD-ROM, DVD-RAM, DVD-R, DVD-RW, DVD-Video, and DVD-Audio). It’s worthwhile to note that digital and analogy copy protection is built into the DVD-Video standard. DVD technology also allows for both single and dual layer disks as well as both single and double sided disks. As a result, a single DVD is capable of storing the data from 25 CDs. Finally, DVD technology boasts backward compatibility with CDs. DVD players can play CDs, which means that consumers and businesses won’t have to replace their software and media libraries when they purchase a DVD player.

The superior features of the DVD platform are important because they provide incentives for adoption by consumers, content providers, and electronics manufacturers. DVD was clearly designed to be a more flexible platform with a wider range of possible applications including video and multimedia. This added flexibility combined with built in copy protection made the technology accessible and appealing to a wider range of content providers. Furthermore, backward compatibility makes the standard more appealing to consumers and the possibility for a variety of contents expands the range and volume of products that electronics manufacturers can sell.
DVD is a multi-application family of optical disc formats for read-only, recordable and re-writable applications. The main features of the DVD formats are:

- Backward compatibility with current CD media. All DVD hardwares will play audio CDs and CD-ROMs and most will play CD-Rs and CD-RWs.
- Physical dimensions are identical to the compact disc but each disc comprises two 0.6 mm thick substrates, bonded together.
- Single-layer/dual-layer and single/double sided options are available.
- Up to 4.7 GB read-only capacity per layer, 8.5 GB per side maximum.
- Designed from the outset for video, audio and multimedia, not just audio.
- All formats use a common file system (UDF).
- Digital and analog copy protection for DVD-Video and DVD-Audio built into the standard.
- Recordable and re-writable versions are part of the family.

1.3 DVD Applications

Despite the success of the compact disc there has been a clear need for a higher capacity format to meet additional application requirements.

- DVD-Video, which was launched in 1997 in the USA, has become the most successful of all the DVD formats, as it has proved to be an ideal vehicle for distributing video content from the movie industry. It can store a full-length movie in high quality video with surround sound audio on a disc the same size as a CD. DVD now accounts for the majority of video sales in the USA and Europe.
• DVD-ROM is beginning to replace the CD-ROM and provide a new high capacity disc format for the computer industry. New PCs are now provided with DVD drives instead of CD drives. The entertainment industry has developed new games consoles (e.g. Sony's PS2 and Microsoft's X-Box) which incorporate DVD-ROM drives for more sophisticated and realistic games applications.

• DVD-Audio, which was launched in 2000, is slowly gathering momentum to become the format for very high quality, surround sound music, offering the music industry new revenue opportunities.

• Recordable formats such as DVD-RAM, DVD-RW and DVD-R are now being extensively used in PCs for computer backup and short runs of DVDs and in standalone products such as video recorders and camcorders.

DVD-Video and DVD-ROM hardware and software have been available since 1997. DVD-Audio was launched in 2000. DVD writers and DVD video recorders are now available at affordable prices.

2. Standards Evolution in Optical Storage Technology

DVD is poised to revolutionize both the home electronics and computer industries. DVD has the look and feel of today’s familiar audio CDs and CD-ROM discs (4.75-inch/120mm) that store music and computer software. Since its formal introduction in early 1997, DVD has gone on to become the most successful consumer electronics format in history – outpacing Laser Disc, VHS, the Compact Disc and Direct Satellite television.

When DVD was developed in the mid-1990s, the primary objective was to provide content
owners (Hollywood studios) with a higher quality home video alternative to VHS and Laserdisc to compete for consumer attention against growing video-on-demand and cable television options. To entice consumers to purchase new DVD players and – more importantly – new software, the consumer electronics manufacturers worked with a Hollywood advisory committee to determine an ideal set of value-added features for the new medium. With better-quality video and audio, multiple language streams for audio and subtitles for easier title distribution, copy protection and simple interactivity, the new DVD format was destined to be a consumer hit.

Originally named “Digital Video Disk,” then “Digital Versatile Disk,” the format is now simply and officially “DVD” with no three-word-equivalent. DVD has become an industry standard thanks to the efforts of some leading companies who wanted to avoid a replay of the VCR marketing war between proponents of the VHS and Beta formats.

2.1 DVD-ROM / DVD-Video Format

Taking a quick look at physical features, like CD-ROM, the DVD format is read by an infrared laser focused through a protective plastic layer onto the disc’s reflective layer. (The transparent layer is 1.2mm thick on a CDROM, but only 0.6mm on a DVD-ROM.) The beam reflects off pits burned into the reflective layer by the recording laser and is passed through optics to the pickup. The laser beam utilized on a CD-ROM player has a wavelength of 780 nanometers (0.78 millionth of a meter). DVD players employ a laser with a wavelength of 650 nanometers, designed to read through the thinner 0.6mm transparent layer. This makes it possible to focus on smaller pits of digital data, about half
the physical size of pits on a CD-ROM —effectively doubling the density of pits on a DVD-ROM. More data is squeezed onto the disc by recording tracks closer together and closer to the center hole, as well as improving the error-correcting decoding algorithms. The result is a single-sided DVD that holds seven times as much data as a CD-ROM. The transfer rate is more than 2000 kB per second, or roughly equivalent to a 14X-speed CD-ROM. This improved capacity and performance make it ideal for video-intensive multimedia applications. DVD discs come in capacities of 4.7, 8.5, 9.4 and 17GB. Most of the early discs will be single-sided, but the specification includes dual-layered and double-side versions that define the four levels of storage capacity. DVD data is read by a variable-focus laser; on dual layered discs, a lens shifts the beam’s focus from the pits on the outer layer to the pits on the inner layer.

2.2 DVD-recordable / DVD-rewritable Formats

Part of the appeal of DVD is the versatility of the technology. There is a DVD format to fit virtually every computer-storage, professional, and consumer-recording application, from broadcast production to data backup to personal digital video recording. With all of this versatility has come a level of confusion over the variety of DVD recordable and rewritable formats in terms of affordability, compatibility, performance, and longevity.

Currently, there are eight formats in the DVD family, all based on a set of international standard specifications: DVD-ROM, DVD Video, and DVD Audio, which are read-only formats of pre-recorded content; DVD-R and DVD+R, write-once formats; DVD-RAM, a rewritable format for both A/V and computer applications that allows data to be rewritten
about 100,000 times; and DVD-RW and DVD+RW, rewritable formats for A/V and data applications that also allow discs to be rewritten up to 1,000 times. As I have already explained basic DVD standards above, here is an overview of the DVD recordable and rewritable media formats.

**DVD-R**

The “R” in DVD-R stands for recordable or, simply put, “write one time.” DVD-R is the next generation of CD-R. Think of it as the larger-capacity brother of CD-R. DVD-R is a write-once, single-sided optical disc. It has the same physical size as a CD-R (12cm), but has higher data and track densities that give it about seven times the storage capacity of a standard 650MB CD-R. DVD-R’s current capacity is 4.7GB with a single-sided disc and 9.4GB using a double-sided disc. DVD-R is very similar to CD-R in that both use a dye-based material and lasers to write and store their data. Both are permanent, write-once formats. CD-R and DVD-R also share another important feature—compatibility. Like the read compatibility for CD-R provided by CD-ROM drives, DVD-R can be read back in most DVD-ROM drives or video players in the market, making it an ideal solution for high-capacity data, video, or audio distribution.

**DVD-RW**

DVD-RW is one of the two re-writable formats endorsed by the DVD Forum, along with DVD-RAM. It has a capacity of 4.7GB, is recorded sequentially like a CD-R, but unlike a CD-R, it can be overwritten 1,000 times using phase change material instead of organic dye material. DVD-RW has a data storage life of at least 30 years. It is basically the rewritable cousin of the DVD-R format from Pioneer. DVD-RW is very similar to CD-RW, just like DVD-R is similar to CD-R. DVD-RW discs can be read in DVD-ROM and DVD Video.
players. DVD-RW can also be used as an authoring tool for DVD titles.

**DVD-RAM**

DVD-RAM is a high-performance, rewritable/rerecordable, optical disc that enables information to be read, written, erased, and rewritten again. It acts similar to a floppy disc, where programs can be run from it, data can be stored, or files can be written and deleted. Current DVD-RAM capacity is 4.7GB for a single-sided disc and 9.4GB for a double-sided disc. DVD-RAM is differentiated from other DVD formats by several design features. First, DVD-RAM media is random access like a hard disk. This enables DVD-RAM to retrieve data faster than the other available formats (current DVD RAM transfer rate is 22.16Mbps, twice the standard DVD speed). Second, DVD-RAM discs can be rewritten up to 100,000 times. Finally, DVD-RAM boasts a sophisticated ECC error correction scheme that makes it ideal for data applications. Recently, smaller-sized DVD-RAM and DVD-R discs were developed for video camcorder applications. The DVD-RAM video camcorder disc is a 2.8GB mini-sized DVD (8cm) with a recording capacity of 60 minutes. A standard-sized DVD-RAM disc is 12cm and has a recording capacity of 120 minutes using standard-quality recording. The 1.5GB mini DVD-R disc provides 30 minutes of recording time. These mini DVD discs are used in Hitachi’s new DVD camcorder and can be played back in Hitachi, Panasonic, Toshiba, and several other brands of DVD video players. Even if, however, DVD-RAM format has some strong points mentioned above, compared with other rewritable format, it has a vulnerable weak point that discs recorded by DVD-RAM format cannot be played back by a majority of existing DVD-ROMs and DVD players.

**DVD+R**
DVD+R is the write-once version of the DVD+RW format that has been developed in cooperation by Hewlett-Packard, Mitsubishi Chemical, Philips, Ricoh, Sony, and Yamaha. It currently has a single sided capacity of 4.7GB and is capable of storing up to 2 hours of MPEG-2 video. DVD+R and DVD-R share similarities in that they are both write-once formats with single-sided capacities of 4.7GB, both need finalization after recording, and both can be used for either data storage or video applications. The major difference is that they are not interchangeable when it comes to recording. Because each format writes information to its corresponding disc differently, DVD+R discs must be recorded in a +R computer drive or video recorder, and DVD-R discs must be recorded in a -R computer drive or video recorder. Once recorded, they share similar playback compatibility, and both will play back in a majority of existing DVD-Video players.

**DVD+RW**

DVD+RW is a rewritable DVD format that has been developed in cooperation by Hewlett-Packard, Mitsubishi Chemical, Philips, Ricoh, Sony, and Yamaha, the primary supporting companies of the DVD+RW Alliance. It currently has a single-sided capacity of 4.7GB and a double-sided capacity of 9.4GB on a 12cm disc. The DVD+RW format can record either sequentially or randomly because it supports both CAV (constant angular velocity) and CLV (constant linear velocity) recording. With CAV recording, the speed of the disc remains constant, regardless of where the data is physically being recorded to the disc. This constant rotation speed of the disc enables fast random access, making DVD+RW suitable for random data recording. With CLV recording, the speed of the disc decreases as data are being written to it. The data are written to the disc in a spiral fashion, beginning at the
center hub and spiraling outward towards the edge of the disc. By slowing the rotation speed of the disc as the data is being written to it further and further from the center, a constant data transfer rate is maintained. This constant transfer rate makes DVD+RW suitable for real-time video recording, too. Three DVD recording formats are summarized in Table II-2.

<table>
<thead>
<tr>
<th></th>
<th>DVD-RAM</th>
<th>DVD-RW</th>
<th>DVD+RW</th>
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<tbody>
<tr>
<td>Forum/standard</td>
<td>DVD Forum/TCG-WG6</td>
<td>RWPPi</td>
<td>DVD+RW Alliance</td>
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<td>Year announced</td>
<td>1999</td>
<td>2Q00</td>
<td>4Q00</td>
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<tr>
<td>Supported by</td>
<td>Matsushita, Toshiba, Hitachi</td>
<td>Pioneer, JVC, Samsung, Sharp, Sony</td>
<td>Philips, Ricoh, HP, Dell, Sony, STMicroelectronics</td>
</tr>
<tr>
<td>Strengths</td>
<td>Software searching</td>
<td>Pick-up head control</td>
<td>Efficient pick-up heads</td>
</tr>
<tr>
<td>Weakness</td>
<td>Incompatible with DVD-ROM, DVD-player</td>
<td>Weaker rewritable</td>
<td>Weaker pick-up head control</td>
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<tr>
<td>Status</td>
<td>Most popular in Japan</td>
<td>N/A</td>
<td>Most popular in Europe</td>
</tr>
<tr>
<td>Trend</td>
<td>Market share declining</td>
<td>Move towards dual solution</td>
<td>Market share increasing</td>
</tr>
</tbody>
</table>

**Table II-2 Comparison on three DVD recorder/recorderable**

Even though there are three rewritable DVD formats available in DVD recorders and two write once formats both for PC and consumer electronics application, the discussion in this thesis relates only to DVD recorders that are connected to TV sets, not rewritable DVD drives which are used with PCs. Each of the formats has different features that manufacturers are touting as the best way to record video.

### 2.3 Next Generation DVD

The 4.7 GB capacity of DVD recorders is only enough to record approximately one hour of TV programming at standard definition quality. To compete with the 6 hours of
programming that can be stored on a VHS tape, a variable bit rate system is used that can
double the length of the time for recording, albeit at VHS tape resolution. These recording
options are similar to the standard play and extended play of VHS today. Currently, there is
no way to record HDTV programming, in its high definition form, on a DVD. A two-hour
high-definition movie recording, using MPEG-2 compression will require a capacity of at
least 15 GB. In order to pack more data onto the same size disc, the pits on the disc must be
smaller. The laser wavelength necessary to read a 15 GB disc can be no larger than 430
nanometers so that it can distinguish between the smaller pits. The red lasers used today
have a wavelength of 650 nm. Since blue and purple lasers have a wavelength of less than
430 nanometers, a move down the color spectrum in laser technology is necessary for the

<table>
<thead>
<tr>
<th>Format</th>
<th>Blu-ray Disc</th>
<th>HD-DVD</th>
<th>HD DVD -9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recording Capacity</td>
<td>ROM</td>
<td>Max 27GB(S/L)</td>
<td>15GB(S/L)</td>
</tr>
<tr>
<td></td>
<td>RW</td>
<td>Max 27GB(S/L)</td>
<td>20GB(S/L)</td>
</tr>
<tr>
<td>Laser Wave Length</td>
<td>405nm</td>
<td>405nm</td>
<td>650nm</td>
</tr>
<tr>
<td>Substrate Thickness (mm)</td>
<td>0.1</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Numerical Aperture</td>
<td>0.85</td>
<td>0.65</td>
<td>0.6</td>
</tr>
<tr>
<td>Data Transfer Rate (Mbps)</td>
<td>36</td>
<td>36</td>
<td>7</td>
</tr>
<tr>
<td>Recording Format</td>
<td>Video</td>
<td>MPEG2</td>
<td>MPEG4(AVC)</td>
</tr>
<tr>
<td></td>
<td>Stream for NTSC</td>
<td>MPEG2 TS</td>
<td>MPEG2 TS(?)</td>
</tr>
<tr>
<td></td>
<td>Tracking Format</td>
<td>Groove Only</td>
<td>Land &amp; Groove</td>
</tr>
</tbody>
</table>

Table II-3 Next Generation DVD formats

next-generation of optical storage. There are a number of companies who are developing
blue laser pickups. Nichia Chemical Industries, a privately owned Japanese firm, has
announced that they have a commercially available violet light laser.
Moreover, with the proliferation of high-definition and the FCC (Federal Communications Commission)'s HDTV mandate only a few years away, new high-density optical disc formats are beginning to take shape. As is always the case, multiple formats—in this case, three that are all capable of delivering DVD-length HD content—are vying to become the standard, and two of them have powerful backers. One format, Blu-ray, is based on blue/violet lasers and supported by Sony, Matsushita, Philips, LG Electronics, Hitachi, Samsung, Sharp, Pioneer, Thomson, TDK, and Mitsubishi (some of them are DVD Forum members who developed the format outside the Forum). Recently Dell and Hewlett-Packard are joined Blu-ray camp as IT companies. Another format, HD-DVD, approved by the DVD Forum, is blue laser-based. Toshiba and NEC are HD-DVD format proponents with many DVD forum member companies. The other group backed by Time Warner is proposing HD/DVD-9, which uses the current red lasers with more efficient video compression such as H.264 or Windows Media 9. As a high-resolution standard, there is another format; called EVD, is being developed in China even if it may be a local standard for China. Table II-3 shows briefly summarized features for each HD formats.

3. Market Trends and Competition

3.1 Market Trends

As DVD players become more and more commoditized, they have been touted as the fastest selling consumer electronics products for a couple of years. According to the Arlington, Va.-based Consumer Electronics Association (CEA), DVD player sales increased 49% between 2000 and 2001, added 39% in 2002, and were expected to increase
another 49% in 2003. The Los Angeles-based DVD Entertainment Group (DEG) reported that DVD software shipments increased almost 100% for between 2000 and 2001 and rose another 88% in 2002. CD players, which were introduced in 1983, had only reached 12.4% household penetration in their first six years of availability. Additionally, the DEG reported that DVD player penetration might reach more than 50% of U.S. households by the end of 2003; according to the CEA, CD players took more than 10 years to reach that level.

Top vendors leading the market include Sony, Panasonic Pioneer, LG, Samsung, Funai, Apex, and Toshiba. The DVD market is now going through unprecedented growth and adoption, particularly within the US. It is estimated that DVD player unit shipments grew to 98 million in 2003. In 2004, worldwide shipments will reach about 105 million before beginning to decline in 2005. By 2007, shipments will have dropped to close to 83 million. The total market will then begin its decline in 2005, though the portable and automotive segments will continue to grow (Fig.II-2). DVD set-top box players

![Bar Chart: Worldwide DVD Unit Shipments (Units in Millions)](chart.png)

*Source: In-Stat/MDR, 1/04*

*Fig. II-2 Worldwide DVD Unit Shipments (Units in Millions)*
have boomed in sales due to the price-elasticity of this segment driven by the reduction in the average selling price. The average selling price of DVD set-top-box players fell from $504 in July 1998 to $129 in major retail outlets in December 2002 with some units going for as low as $39 in early 2004, as many Chinese firms that have cost competitiveness jumped into the market. However, as is shown in Fig.II-3, average selling price for DVD players are much higher than that for DVD set-top-box players due to the number of shipments of higher-priced automotive, DVD+VCR, portable, and HTiB (Home Theater in a Box) systems. Even if it is likely to fall further, the market price for set-top-box DVD players would reach its limit soon.

![DVD players (US)](image)

**Fig.II-3 DVD players Average Selling Prices, LG data (2004)**

Together with this incredible fall in prices during such a short period, other important factors that also influenced market penetration are the rapid increase in DVD titles available, and the integration of additional information about the movie onto the DVD disc, which gives the consumer access to information not usually available with a VHS tape. The first feature films on DVD appeared in Japan in December 1996 (The Assassin, Blade
Runner, Eraser, and The Fugitive from Warner Home Video). In the U.S. Warner Brothers US launched DVD titles on March 24, 1997, but the launch was limited to seven cities. Nevertheless, almost 19,000 discs, a number much greater than that expected by the studio, were purchased in the first two weeks of the U.S. By December 1997, over 1 million DVD discs were shipped while the number of titles climbed up to 530. Today, all movies that appear in theaters are released on DVD as well as on VHS. By the end of 2002 there were about 23,000 titles available in the U.S. Due to the late response from the video rental market — it was September, 1999 when Blockbuster began DVD rentals in 500 stores — growth of DVD rentals was slower compared to the growth of sell-through sales. But also the rental market transited quickly to the DVD and DVD rentals outpaced videocassette rentals for the first time in June 2003 (The Washington Times, June 21, 2003) Fig.II-4 shows how rapidly DVD title sales revenue has increased.

![Graph showing growth in DVD sales](image)

**Fig.II-4 A torrent of DVD Title Sales**

On the other hand, DVD recorders are still quite expensive for many households. Therefore, continued price declines will be necessary to encourage consumers to buy DVD recorders
instead of VCRs. Since DVD recorders were offered by Wal-mart for the first time for mass market in the US in 2003, the price for a DVD recorder has been continuously declining, and then expected the price will have been below $199 at the end of 2004. The price for a DVD recorder in other regions such as Europe, Japan shows similar trends in declining. The average selling price for a DVD recorder in Fig.II-5 is quite higher than that for I mentioned above because it is estimated across the entire category, including higher priced models that include hard drives.

![Fig.II-5 DVD recorders Average Selling Prices, LG data (2004)](image)

3.2 With competition DVD products are becoming commodities

With the dawning of the digital era, there is no clearer evidence of the global power shift in consumer electronics than in the video hardware industry. For more than twenty years in the past, Japanese consumer giants such as Sony and Panasonic continuously dominated VCRs. These companies dominated DVD players in the first few years after they introduced them commercially in a similar way with a few Korean firms. During the past
couple of years, however, virtually all DVD player manufacturing has moved to China and Taiwan. That is because, in contrast to VCRs, virtually all of the core ICs and the components for a DVD player are readily available from a variety of U.S. and Taiwanese companies. VCR production requires complex assembly of a lot of electromechanical and electronic parts. Moreover, VCRs uses only the most basic semiconductor technology, again easily sourced by internal supply, and therefore easily vertically integrated. As a result, it was virtually impossible for Chinese or Taiwanese firms to match the quality of Japanese and Korean VCRs. By contrast, there are about 80% fewer moving parts in a DVD player and the critical components have multiple sources, uniform quality, and global availability. By this reason, manufacturing has shifted to regions with low-cost labor.

Fig.II-6 shows the causal loop diagram for the general DVD player. R1, a positive reinforcing loop, represents increases in DVD player sales as the customer awareness is enhanced by the word of mouth effect. R2 indicates that as sales go up with huge volume of products, unit cost drops due to economy of scale, and then price falls, enticing customers to purchase products. In a similar reinforcing feedback loop, R3 shows that overall market demand increases as the awareness of customer gets higher as a result of advertisements either through broadcasting or media. R4 and R5 are reinforcing feedback loops that are dominant as the modulization and standardization enable even small and midsize firms to jump into DVD market readily.

The balancing loops that control the whole market dynamics are B1 and B2 in the Fig.II-6. Theoretically, if all potential customers, that is, all households, purchase a DVD player, DVD player market gets saturated. However, as the selling price falls and there are more
choices for customers to buy more than one DVD player or replace old one in terms of product variety with high performance and new features, the number of DVD players that each household has can be steadily increased. Another balancing loop explains the behavior of commoditization. As sales increase and unit cost decreases due to economy of scale, unit cost for product declines and then profits go up, enticing new entrants to jump into the market. An increase in the number of DVD player manufacturers causes fierce competition in terms of price, and therefore; revenues and profits for each firm decrease. In summary,

Fig.II-6 DVD player market Dynamics (1)
product commoditization coming from standardization and modulization enabled new entrants to join the market without technological difficulties, causing fierce price competition among the firms.
Another critical determinant that has triggered the rapid increase in demand for DVD players is complementary goods like DVD titles. Indirect network effects arise when the benefit of using a product increases in the use of a complementary set of goods. Typical examples of products exhibiting indirect network effects are computers that have complementary software and CD-players that are complementary with CD titles. The indirect network between DVD players and DVD titles has been exactly following the footprint of CD players and their software. As is shown in Fig.II-7, the positive feedback loop R1 operates fairly quickly in a way that, as the installed base (the number of people or
households that have a DVD player) increases, third parties that make movies like Hollywood studios increase their DVD title release. Increase in available DVD titles facilitates DVD player market and vice versa. In a similar way, another reinforcing loop that increases DVD player market is the growth of DVD rental stores. Not only are sell-through sales for DVD titles very popular, but also the rental market transited quickly to the DVD and DVD rentals, outpacing videocassette rentals for the first time in the US in June 2003 (The Washington Times, June 21, 2003). The negative feedback loop B1 shows that other substitutes for DVD set-top-box players such as PCs and game consoles that have DVD-ROM drive play a role in decreasing demands for set-top-box players even if the whole DVD market grows.

4. Some Issues Related to DVD players/recorders

4.1 DVD Royalties

As I mentioned above, the price for a DVD player has been sharply falling - well-known brand products are selling below $80 as of the end of 2003 in the US market. With the increase in DVD player sales, mounting bills for DVD-related royalties collected by major DVD intellectual property holders are expected to have a negative impact on sales of many DVD players made by those who do not have DVD standard patents. This is because DVD player manufacturers need to license all of the sets of patents for a complete solution. As Table II-3 indicates, the royalties for DVD players are excessive enough to be a significant portion of the price of a player as DVD player prices have dropped.
<table>
<thead>
<tr>
<th>DVD players</th>
<th>DVD recorders</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6C</strong>&lt;br&gt;(Hitachi, JVC, Matsushita, Mitsubishi, Time Warner, Toshiba)</td>
<td>4% of the net selling price of the player or $6.00 whichever is greater. Additional $4 for DVD-Video playback.</td>
</tr>
<tr>
<td>$4.50 is standard, $3.50 to those who comply with the Reward Program</td>
<td>4% of the net selling price of the player or $6.00 whichever is greater. Additional $4 for DVD-Video playback.</td>
</tr>
<tr>
<td>Video CD decoding is an additional $1.25, $0.75 for those in good standing.</td>
<td>DVD+R/+RW only $6.50 DVD+R/+RW with DVD-Video $8.00 DVD-RW only $6.50 DVD-R/-RW with DVD-Video $8.00 Video CD decoding is an additional $1.25, $0.75 for those in good standing.</td>
</tr>
</tbody>
</table>

| Thomson | $1.00 |
| MPEG LA | $2.50 for each DVD player or recorder |
| Dolby | Less than $1.00 |
| SACD* | $1.50 |
| MP3 | Decode ability is $0.75 |
| Macrovision | Less than $1.00 |
| **Total** | $12.00 to $21.00 | $17 minimum |

Source: Licensing Authorities and In-Stat/MDR, 1/04, * SACD: Super Audio CD

Table II-4 DVD player & recorders License/Royalty Fees per each in US dollar

Taking into account the fact that current royalty fees for DVD players are around $12 as is shown in Table II-4, Chinese DVD manufacturers, in particular, balk at paying such a large amount. Until recently, Chinese manufacturers have ignored the requirement of paying royalty fees from patent holders as long as they could. However, they are now facing high pressure to pay royalty fees from patent holders as China became part of the World Trade Organization in 2003. Apart from many Chinese manufacturers, as far as DVD players are concerned, even if major Korean manufacturers have some patents that can be used as a cross licensing deal against major patent pools, the number of patents owned by Korean manufacturers are not enough to significantly reduce the huge royalty burden. Accordingly,
future market share and profits for DVD players who have few or no DVD patents will be largely dependent on how effectively they can cope with royalty issue. The reason I do not raise any royalty issue on DVD recorders here is not because it is not important, but because it will be touched on again in Chapter IV.

4.2 Standard Issue for DVD recorders

When the idea of recordable DVD was first announced, people were delighted that there was a technology that would allow them not only to store Gigabytes (GB) of information but also to record TV programs on a disc as big as a CD. However, if customers go to the market for a DVD recorder nowadays, they will have to choose between multiple recording formats. Because of that mess, consumers have been unwilling to adopt a certain technology that is in competition with other technologies. The reason is simple. It comes down to money coming from royalties that they can collect from their technology license.

While most PC DVD recorder drives are now multi-format, most set-top DVD-Video recorders are still either DVD+R/RW, DVD-R/RW or DVD-RAM. The important issues for DVD recorder formats include compatibility, performance and longevity. Many early DVD players cannot playback contents on DVD recordable media. In terms of performance, some can rewrite more than 100,000 times while others can rewrite only as much as 1,000 times. These format issues for DVD recorders are closely related to exploding product sales and market domination. I would like to touch on this DVD recorder format issues in relation to my company’s strategy in Chapter IV.
4.3 Do DVD players and DVD recorders become either competitive, predator-prey, or symbiotic?

It seems that DVD players have been successfully and rapidly replacing VCRs so far. In fact, many consumers have essentially set aside their VCRs, replacing them with DVD players to watch movies. However, up until a couple of years ago, one thing was missing from the DVD player that VCRs had—a record button. Let’s imagine the situation that people can record TV programs from a TV, and store pictures, or contents that they have taken from a digital camera or a camcorder directly onto a DVD disk with digital quality that never degrades over time or the number of copies the way VCRs do. With the advent of DVD recorders, consumers can now chronicle their favorite TV shows, watch it at a time they like or better yet, record their once-in-a-lifetime, precious memories with a simple touch of a button.

When it comes to DVD recorders, complicated copyright issues seemed an imminent barrier to be solved because movie studios regarded DVD recorders as a big threat in the sense that piracy of digital contents can cause damage to their income on a scale unparalleled by piracy of analog contents. However, as far as consumers are fast realizing the ease of use and sheer value of capturing digital content on a reliable DVD disk, DVD devices are now moving from being just a player to a recorder regardless of the desires of movie studios. Consequently, DVD recorders will penetrate DVD market and increase the absolute market volume. In other words, DVD recorders and players may become partly predator-prey relationship, but as the market volume increases, there may be some demands for low-end second or third DVD device in a household, just as was the case with
VCRs. That means even if DVD recorders replace or partly cannibalize DVD players, both DVD players and recorders will coexist for quite a long time.

III. Related Literature Review and Framework

1. Technology S-curve and Value Networks

According to Christensen⁴, the technology S-curve suggests that the magnitude of a product’s performance improvement in a given time period or a given amount of engineering effort is likely to differ as technologies mature. In the early stages of a technology, the rate of progress in performance will be relatively slow. As the technology becomes better understood, controlled and diffused, the rate of technology improvement will be accelerated. But in its mature stages, as is shown in Fig.III-1, the technology will asymptotically approach a natural or physical limit such that ever greater periods of time or inputs of engineering effort will be required to achieve improvements.

![Fig. III-1 The S-curves of VCRs and DVD Players](image-url)
For example, since it was introduced by Sony in 1975, even if there was confusion due to competitive VCR formats (Betamax and VHS), the VCR became the fastest growing appliance in history, and home consumers were thrilled with their ability to record television programs. At first, the VCR was positioned as a home recording device, primarily for time shifting. However, as a result of increase in the number of prerecorded video titles available, VCR sales skyrocketed dramatically due to this external network effect. By the early 2000, it was estimated that approximately 85% of US households had at least one VCR (Fig.III-2). The evolution of this new disruptive technology can be exactly explained by Christensen’s theory. Over the next 5 years, as important technology advancements such as front-loading, remote controls and hi-fi stereo were added, the sales were accelerated and then VCR became one of the most important consumer electronics inventions since the television. Even if the performance of VCRs has been continuously improving until the end of 1990s, performance over time/effort has decreased as the S-curve for VCRs approached the mature stage.

![Bar Chart](source: U.S Census Bureau (2000a, 2000b).

**Fig. III-2 Percentage of US Households**

When DVD players were first introduced into the market, some people expected that the
DVD player might establish a small niche market which complemented the dominant VCR, since the DVD had high price and there was a lack of movie titles available for DVD players. Few predicted how quickly the price of DVD players would fall and how actively content makers would increase the number of their movies on DVD discs released. The market penetration of DVD players followed the S-curve that Christensen suggested in the same way that VCRs did. Even if the performance over cost was initially not satisfactory due to the DVD players’ high price, the performance over cost significantly improved as the market took off. Play-only decks were introduced as the first type of DVD, and are the most mature of the DVD device categories profiled here. Play-only decks offer consumers basic DVD playback functionality, often in combination with such features as CD-Audio, MP3, DVD-Audio and SACD (Super Audio CD) support, digital photo viewing capability, progressive scan, and/or multi-disc changers. The relationship between DVD players and DVD recorders is expected to behave quite differently from that between VCRs and DVD players. I am going to talk about that a little bit in Chapter IV.

2. Product Platform and Dominant Design

Successful firms in the highly competitive industries had much in common. Their product offerings were focused but not narrow, their approaches to innovation systematic and disciplined, and their development of product designs and supporting technologies highly creative. They preempt incursions into their markets by routinely introducing successions of new models that not only represent greater product differentiation, but also provide valuable feedback to designers and engineers that serve to advance technical frontiers and reduce costs.
A competitive environment in which world-class companies routinely render obsolete their own products and processes with the systematic and focused introduction of new ones and nurture fledgling efforts to bring new technologies to market-by issuing a succession of product models-demands a renewed understanding of and commitment to the notion of strategic product planning. Such planning must be coherent and disciplined, but not rigid. It must exploit standards and design tools, tap the creativity of industrial designers, and coordinate to achieve the requisite manufacturing flexibility and agility [29].

![Fig. III-3 Product Family Geology](image)

According to the report of Booz-Allen Hamilton's 1968, "Product Cycle," which refers to the activities that span the time involved in the development and commercialization of new products, is composed of six distinct stages: exploration, screening, business analysis, development, testing, and commercialization. The corporate memory which can be obtained by analyzing past product learning cycle, whether it was successful or not, is an effective way of helping assess new project decisions for the new product development.

Even if the strategic value of a product platform can only be recognized if its performance is measured, documented, and presented to management, the concept of product families and platform is a considerably good way of organizing a firm's projects to develop and expand its product scope.[Meyer, M., and Utterback J., op. cit.]

The relationship among product family, product platforms, and follow-on is depicted Fig.III-3 [20]. One product family can have several product platforms within it and each product platform within the family can spin off a multitude of follow-on products. "Product family" is a family of products that can be drawn from a common foundation of technologies, components, and corporate resources. From a market perspective, product families address a common market segment.

Sony's walkman is a good example of outstanding product family management. Sony's strategy employed a judicious mix of design projects, ranging from large team efforts that produced major new model "platforms" to minor tweaking of existing designs. Throughout, Sony followed a disciplined and creative approach to focus its subfamilies on clear design goals and target models to distinct market segments. Sony supported its design efforts with continuous innovation in features and capabilities, as well as key investments in flexible manufacturing [20].
“Product platforms” form the organizational backbone and technological foundation of the product family. They are tailored to address specific niches within the marketplace addressed by the family. Each platform within a product family provides a base architecture. The architecture consists of a set of subsystems and technologies drawn from the family pool (see Fig.III-4). From this base, follow-on products can be quickly developed and commercialized into the marketplace. It is not too much to say the importance of follow-on or derivative products in the sense that sometimes they go down a bomb in the market much more than expected.

Fig.III-4 Platform Extensions and Renewals

Sanderson and Uzumeri [29] have viewed product platforms as the implementation of “virtual designs” that serve as the basis for a series of “product realization.” Each significant improvement of a product platform leads to a new generation of follow-on products. The product family therefore evolves based on both the renewal of its underlying platform, and the specific product offerings generated from successive platforms.

A platform renewal, which defines a totally new platform within the product family, occurs when the architecture of the product design is changed to incorporate major new subsystems and new subsystem interfaces. Timely platform renewal has been essential to Intel’s great success in CPU chip. A very important point we can get is that a firm must seek to continuously renew its base product architectures to achieve sustained commercial success. In other words, successful product development planning under the product family framework is in the management of the linkages between follow-ons, between platforms, and between families. [18]
The first DVD player was composed of twelve discrete ICs to enable DVD playback mainly because hardware developers had to ensure quality by using ICs that had already been available in the market. As the technology enhanced and the market for DVD players grew, many functions have been integrated, and therefore; there are only two or one chip, plus memories, and the audio DAC (Digital Analog Converter) remains nowadays. Fig.III-5 and Fig.III-6 show the hardware integration trends in a DVD player.

Fig.III-5 DVD player Block Diagram(1)

Fig.III-6 DVD player Block Diagram (2)
The evolution of platforms for a DVD player has had a huge impact on the market competition between well-known big firms and small size manufacturers. The more chips and components that are being integrated, the smaller the size and the cheaper the price for DVD players become. Since the front-end and back-end ICs of a DVD player were integrated in the second half of 2003, this integration has enabled a single board to be used at a lower price. As the technology for DVD play-only decks matures in terms of standardization and modulization, Figure III-6 is becoming a dominant design if we exclude simple mechanical parts and exterior design.

Chip providers have been lowering technology barrier for small firms that do not have R&D (Research and Development) resources to enter the market by providing not only integrated ICs but also a reference design, manufacturing kit, and the required software or firmware. In this sense, the evolution of platform that is more improved and simplified made it easier for many small Chinese firms to jump into the DVD player market without R&D resources, unlike Japanese and Korean manufacturers. As was not the case with analog products in the past, ironically, digital technology based on standardization and modulization lowers the market barrier as the technology matures, causing many competitors to enter the market without investing much money in developing products. This commoditization is pressurizing top tier manufacturers to move to the next cutting edge product.
3. Value Chain in DVD Industry & Profit Pool Migration

3.1 The Value Chain in DVD Industry

Taking into account the whole DVD industry, in terms of revenues and profits, its value chain can be divided into several activities. As Fig.III-7 indicates, one is DVD hardware manufacturing activity that integrates key components such as DSP&MPEG chips, optical pick-up heads, and other components into the whole system including firmwares by system manufacturers. Another crucial activity is DVD title manufacturing conducted by movie makers and disc manufacturers. The other parties are DVD patent holders who own standard patents and DVD rental service providers.

![INDUSTRY VALUE CHAIN](image)

**Fig.III-7 The DVD Industry Value Chain**

As is often the case in which the interfaces between components and subsystems are clearly defined, once a modular architecture and industry standards have been established, the integration of modularized components under the standard is no longer a competitive advantage to a company. In this sense, the power shift in DVD players (hardware) from Japanese and Korean firms to Chinese manufacturers shows a good example. As products
became more mature due to their standardization and modularization, even top tier manufacturers began to take advantage of DVD manufacturing kits provided by several chip makers with a view to shifting their R&D resources to the next cutting edge product.

At the early stage of the DVD industry, the operating margin of several key component makers and top tier DVD player manufacturers was fairly high. Hollywood studios were not so much interested in DVD title business because the DVD market size at that time was not big enough to entice them. However, as a result of sharply dropping DVD-player selling price due to the fierce competition among DVD player manufacturers, Hollywood studios began to be interested in DVD market. The increasing number of DVD titles brought a virtuous cycle effect to the DVD industry. The more the DVD titles were created, the more people purchased DVD players, and vice versa.

3.2 The DVD Industry Profit-Pool Lens

A profit pool can be defined as the total profits earned in an industry at all points along the industry’s value chain. Although the concept is simple, the structure of a profit pool is usually quite complex. The pool will be deeper in some segments of the value chain than in others, and depths will vary within an individual segment as well. Segment profitability may, for example, vary widely by customer group, product category, geographic market, or distribution channel. Moreover, the pattern of profit concentration in an industry is often very different from the pattern of revenue concentration [24].

From a revenue point of view, DVD manufacturers and DVD title distributors like Hollywood studios dominate the industry, accounting for almost 60% of sales. Revenue from the purchase and rental of DVDs increased more than 40% to $16.3 billion, according to research by Video Business, with the average DVD player household buying 16.5 DVD titles in 2003. On the other hand, the revenue of DVD hardware manufacturers increased
around 11.3% to $12.1 billion during the same time period, which was calculated from

Fig.III-8 The DVD Industry’s Profit Pool

DVD player shipments in Fig.II-2 and average selling price in Fig.II-3, being surpassed by
the revenues of DVD titles. Moreover, in terms of profits, most top tier DVD player
manufacturers made extremely small or no profit by selling their products. Of course, for
Hollywood studios, their profit margins have been decreasing due to the increase in piracy
and the falling of prices for DVD titles. However, the impact of falling prices on DVD
hardware manufacturers, coming from fierce competition, is much more serious than that
of film studios. Fig.III-8 shows a snapshot of current profit pool dominated by DVD title
distributors. The total revenue of the DVD industry has amazingly increased - DVD movie
business is by far the most profitable activity in the value chain; on the other hand, other
value chain activities are characterized by weak profitability. In other words, they account
for a significantly smaller share of the profit pool than they do of the revenue pool.

By seeing how the pool’s shape has changed- where profits have increased or diminished,
who’s been gaining or losing profits- we can often infer which competitive, economic, and
other forces have been shaping the industry’s profit structure. Moreover, knowing the distribution of profits along the value chain provides you with the broadest view of profit trends in your industry. Such a view is essential for identifying structural shifts that could influence the profits available to you and your competitors in the future. It is important to note, however, that profits concentrate not just in particular value-chain activities but also in particular product types, customer segments, distribution channels, and geographic regions [25].

As long as only playable DVD player market is concerned, the profit pool in Fig.III-8 does not seem to be changed a lot over time. DVD hardware manufactures, especially top tier players including LG Electronics, have to find a way in which they can reorganize current profit pool and increase not only their revenues but also profits. I will talk about the reorganization of current profit pool associated with the short-term strategy for my company in Chapter IV.

4. Strategic Alliance (HLDS (Hitachi LG Data Storage) Case Study)

4.1 Background

Despite the great potential for conflict, many companies successfully diversify and grow via joint ventures. As Killing points out, when projects get larger, technology more expensive, and the cost of failure too large to be borne alone, joint venturing becomes increasingly important [13]. In other words, the complexity of R&D projects and fierce competition in the global market are important drivers that require cooperation, especially for small and medium-sized firms.

Hlavacek et al. and Robert [12] believe one class of joint venture to be of particular interest—”new style” joint ventures in which large and small companies join forces to create a new entry in the market place. In these efforts of “mutual pursuit,” usually without the formality of joint venture company, the small company provides the technology, the large company provides marketing capability, and the venture is synergistic for both parties. However, even large integrated firms are often not willing or able to perform the necessary amount of R&D and to cope with the uncertainty associated with radical environment changes. In standard-oriented market, Shapiro and Varian suggested winning strategies
with making allies, preemption, and control of customer’s expectation. In addition, they identified seven key competitive assets that were control over an installed base of users, intellectual property rights, ability to innovate, first mover advantage, manufacturing capability, strength in complements, and brand name and reputation.

At the time LG Electronics was taking into account joint venture in the late 1990s, the optical storage market was undergoing a major change in terms of the type of media used, with CD giving way to DVD, and read-only formats to recordable or rewritable types. This market transition from CD to DVD triggered many optical storage firms to intensify their R&D in order to survive the increasing international competition. LG Electronics had had a leading edge position through worldwide market share No.1 with major product such as CD-ROM and CD-RW drives in this market since 1998, even without the ownership of key patents related to standard. However, unlike CD-ROM drive market, it did not look easy for those companies such as LG Electronics and other Taiwan companies who had poor technologies and few patents associated with new standards to keep their leading positions due to royalty fees increasing rapidly when optical storage drive makers migrate to DVD rewritable drives. Therefore, profit margins will largely depend on how heavy royalty burdens they have to bear and how fast prices fall.

On the other hand, Hitachi was trying to focus its business with new standard such as DVD-ROM and DVD-RAM drives following the CD-ROM and CD-RW drive market that was not any more profitable at that time. It had expected the DVD drive to be dominant after a short transition period. However, the optical drive market did not move from CD to DVD as fast as it had anticipated. The portion of DVD-ROM in PC market in 1999 was just only 10.5%, compared to that of CD-ROM of 80%. Anyhow, as long as CD-ROM market is concerned, LG Electronics has maintained the high rank, especially No.1 in CD-
ROM drives for desktop PC since 1998, but it has relatively low positioning in the DVD market. By contrast, Hitachi has very poor positioning in the CD-ROM market but it has been leading the DVD-ROM market - ranked No.1 between 1998 and 1999 (See Table III-1).

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</tr>
<tr>
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<td>NEC</td>
<td>Aopen</td>
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<td>Others</td>
</tr>
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</tr>
<tr>
<td>11</td>
<td>others</td>
<td>Others</td>
<td>Others</td>
<td>Others</td>
<td>Others</td>
<td></td>
</tr>
</tbody>
</table>

Source: Gartner Group M/S Data (Desktop PC only)

**Table III-1. CD-ROM/DVD-ROM Drive Market Share for Desktop PC (Worldwide)**

Probably due to this background, the two companies decided to establish a joint venture company in November 2000. This joint venture, named Hitachi-LG Data Storage Inc. (shortly HLDS), aimed at becoming one of the world’s leading vendors of optical disk drives by combining Hitachi’s strengths in the area of DVD-ROM and DVD-RAM technology with LG Electronics’ world-class competitive manufacturing technology of CD-ROM and CD-RW drives.
4.2 Performance of the Joint Venture

With the establishment of the new joint venture, LG Electronics and Hitachi were able to respond to the latest trends of the optical storage industry more efficiently and to move toward high-density products that require high technology such as Combo (DVD-ROM and CD-RW in one deck) and DVD-RAM. Through these efforts, the two companies would be able to improve their standing as the global top players. The combination of LG Electronics’ competitive advantages such as manufacturing technology, price competitiveness coming from relatively low labor cost and high throughputs, and global marketing power with Hitachi’s world-class product development capability for the next generation technology standard would offer the new joint venture a stable foundation to lead the current as well as future digital storage market.

One of the most important advantages for LG is that it could be free from the toughest issue in terms of DVD royalty, which is around 10% per net sale price, by sharing Hitachi’s intellectual property rights related to DVD standards. Another large benefit in terms of business operation brought by this joint venture is that LG could ship all goods from its existing product lines to the joint venture and thus secured a stable sales channel.

For Hitachi, it was able to use its technological strength for early development of new products and thus strengthen its position as a market leader. In addition to shipping all its product volume to the joint venture, Hitachi was able to leverage LG Electronics’ production technology and marketing power for earlier commercialization of its world-class products that were aggressively targeting global markets. Table III-2 shows the
synergies of this joint venture have made so far, in terms of how effectively and competitively cope with its competitors in the battle field of optical storage that is strongly driven by standards.

<table>
<thead>
<tr>
<th></th>
<th>LGE</th>
<th>Hitachi</th>
<th>Joint Venture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control over an installed base of users</td>
<td></td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>Intellectual property rights</td>
<td>O</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>Ability to innovate</td>
<td></td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>First-mover advantage</td>
<td></td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>Manufacturing capability</td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Strength in complements</td>
<td>O</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>Brand name and reputation</td>
<td>O</td>
<td></td>
<td>●</td>
</tr>
</tbody>
</table>

**O**: Good, **●**: Very Good

Table III-2. The synergy effects of joint venture

By establishing this joint venture, both companies could directly sell the latest products developed by the joint venture under its own names, thereby securing opportunities for additional sales. One of the earliest successes was the world’s first Multi DVD-rewritable drive, developed in late 2001, which can record and playback ranging from DVD-RAM, DVD-RW to CD-R/CD-RW format. Another successful example that was also the world’s first was the Super-Multi rewritable DVD drive, developed in mid-2003, which supported all existing DVD recording formats. These two leading-edge optical drives were not only compatible with existing DVD writers but also came with a price tag that was lower than existing DVD writers and therefore quickly took over that market segment.

From this alliance, the two companies could reduce procurement and development costs involved in response to diversifying product requirements, as well as share their resources in terms of economy of scale and scope, resulting in more competitive products having better performance and cost advantage. As Table III-3 indicates, HLDS has achieved robust
market leadership and increased its market share continuously that enabled it to dominate the market since it was established.

<table>
<thead>
<tr>
<th></th>
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<th>2002</th>
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<td></td>
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<td>Share(%)</td>
<td>Shipments(m)</td>
<td>Share(%)</td>
<td>Shipments(m)</td>
<td>Share(%)</td>
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<tr>
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<td><strong>17.6</strong></td>
<td>38.1</td>
<td><strong>23.1</strong></td>
<td>49.3</td>
<td><strong>26</strong></td>
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<td>9.8</td>
<td>19.3</td>
<td>11.7</td>
<td>32.2</td>
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<td>23</td>
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<td>28.3</td>
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<td>2.7</td>
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<td>6</td>
<td>3.6</td>
<td>3.5</td>
<td>1.8</td>
</tr>
<tr>
<td>Sony</td>
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<td>4.2</td>
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</tr>
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<td>1.8</td>
<td>1.1</td>
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<tr>
<td>Total</td>
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<td>164.9</td>
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<td>189.4</td>
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<td></td>
<td>NA</td>
<td>-8.1</td>
<td></td>
<td>14.8</td>
</tr>
</tbody>
</table>

Source: IDC, 2003

**Table III-3. Worldwide Optical Storage Drive Shipment: by vendor**

In summary, the joint venture between LG Electronics and Hitachi has been very successful and meaningful so far. By combining strengths of the two companies and providing cutting-edge products, they are leading the world optical storage market on the basis of synergies made by consolidating mutual strengths through global partnership. In this sense, this joint venture is a kind of realization of new business paradigm to target global digital market which was difficult to imagine earlier in the analog era.

5. Organization for Product Family Development and Renewal

According to Meyer, Marc H. and Alvin H. Lehnerd, unlike people's expectation, senior management who are responsible for older established big firms would seldom organize
their companies in ways that assure that product portfolios are kept alive and vibrant. More often, they fail to notice the importance of taking steps to renewals that need as high priority as current business do in terms of absorbing energy and resources. Meyer, Marc H. and Alvin H. Lehnerd\textsuperscript{18} place emphasis on how to approach to this organizational problem.

Experience indicates that successful innovation through teams has three ingredients: ownership, empowerment, and consistency. Ownership is control - a charter to make the decisions required by the task. Empowerment provides teams with the time and resources necessary to do the job. Consistency means that ownership and empowerment are granted for the full term of a project, form conceptualization until such time as the concept has either succeeded or failed in the market [18].

- Provide Ownership at each and Every Level

Within product families, ownership must be provided to teams developing each product platform and its respective derivative products. From an organizational perspective, that means the corporation should "look like the things it seeks to make. As Morris, a management consultant, and Ferguson, a technological entrepreneur, noted, "Organizational architecture and decision-making" should "mirror technical architecture." [18]

A platform-based organization resembles James B. Quinn's "spider's web" organization, as shown in Fig.III-9. In this figure, platform teams are networked to derivative product teams and to one another. As new platforms are brought on line, derivative product teams are formed. Naturally, each team must have a clear charter that, among other things, assigns boundaries for its work and prevents conflicts with other teams. In this way each team is clearly focused. [18]

![Fig.III-9 Spider's web organization for product family development and renewal](image-url)
- **Avoid the Square Peg Syndrome**
  While it would seem logical for companies to organize in ways that reflect the products or services they are trying to make, it does not always happen. One large manufacturer we know had developed a core business in films and cameras with an organizational structure of functional smokestacks (R&D, manufacturing, and distribution). Such an organization was well suited to the company’s traditional high-volume commodity products. Facing a decline in that core business, however, senior management started initiatives to create systems that were essentially low-volume, high-value-added products requiring the integration of numerous peripheral technologies, computers, and software. As a result of those initiatives were driven through the existing functional organization, not surprisingly, few successful systems were ever created. That was because the top functional managers reflected the types of engineering, manufacturing, and distribution with which they felt comfortable.

- **Avoid Pseudo-Ownership**
  Pseudo-ownership is a condition in which teams believe they have the authority to make critical decisions, when in fact others have reserved that authority for themselves. Pseudo-ownership is typically revealed at the interfaces of the project and the corporate functions that assist it: R&D, design, test and evaluation, marketing, cataloguing, product service, quality control, and purchasing. Each function has its rules and procedures and assumes authority over all decisions within its own jurisdiction. Each serving function seizes temporary control.

However, sometimes, if current platform team and next platform team belong to same group or segment, most priorities to budgets and resources are given to current platform team due to managements’ short-term concern on profits. As in the Microsoft example, continuous coordination and communication are required between team leaders to synchronize the activities of platform teams and product teams [18]. In other words, in terms of ownership for a new platform development, organizational architecture and decision-making should mirror technical architecture.
IV. RECOMMENDED DEVELOPMENT STRATEGY FOR LGE

1. Short-Range Strategy

1.1 Reorganization of the Profit Pool

According to Michael E. Porter\textsuperscript{19}, at the broadest level, firm success is a function of two areas: the attractiveness of the industry in which the firm competes and its relative position in that industry. Firm profitability can be decomposed into an industry effect and a positioning effect. Some firm successes come almost wholly from the industry in which they compete; most of their rivals are successful, too! The distinction between industry structure and relative position is important because, among other things, the firm can choose strategies that will improve one while harming the other.

When it comes to current DVD industry, nobody makes profits no matter who they are, as long as they are hardware companies such as component suppliers and DVD player system manufacturers, even DVD title distributors. One thing that a DVD player is particularly different from other products is that even far before the market reaches saturation point, the technology life cycle is getting into mature phase. That is to say that though there still remains ample room for market growth for a DVD player, strong pressure on profit margin coming from price competition will be continued due to low technology barrier enabling new entrants that have no R&D resources to join this market. In this sense, first-tier players including LG Electronics necessarily need to find a new breakthrough to increase both revenues and profits. Fundamentally, however, the value chain for DVD industry shown in Fig.III-7 is too strong to be destroyed easily. Therefore, in a way to reorganize profit pool,
first-tier players have to put in more efforts to shift their product lines from a DVD player to a DVD recorder, which is more profitable, before DVD player market becomes saturated.

1.2 How fast can DVD recorders penetrate the market?

As I stated in Chapter II.4.3, there is a high possibility that even if DVD recorders replace or partly cannibalize DVD players, both products will coexist for quite a long time. This is because it will take time to settle down some crucial drivers that may affect the market penetration for DVD recorders. One of the important issues is the price of a DVD recorder. Narrowing the price gap between play-only DVD player and DVD recorder will be necessary to encourage consumers to buy DVD recorders instead of DVD players. In addition, as DVD recorders of all form factors become more affordable, a steadily growing percentage of mass market consumers will choose recorders over play-only devices. Focusing on the development of DVD recorder devices will allow hardware manufacturers to avoid undue exposure to the highly commoditized play-only markets. According to market forecasting in Fig.II, the reference price for a DVD recorder to trigger its demand is expected to be below $199 at the end of 2004 or the early of 2005.

Another issue that plays a key role in increasing in demand for a DVD recorder is standard. There are three rewritable DVD formats and two write once formats available in DVD recorders. Each format has different features that I have already explained in detail in Chapter II.2. As for consumers, the choice of which DVD format to use is, to a large extent, an application-centric decision. Both write-once formats, which are DVD-R and DVD+R, are quite attractive for transferring home videos from tapes or digital camcorders to DVD discs using associated editing and authoring applications. From the standpoint of Consumer
Electronics application, not PC application, let me briefly compare three rewritable formats in terms of user convenience.

DVD-RAM that was originally created for data storage applications, which need high speed and excellent error-correction technology, are suited for data backup and archiving. DVD-RAM format enables users to record one program while viewing a previously recorded program. Or a viewer can begin watching an earlier part of a program that has not finished its recording. Both of these functions can be done without a hard drive. However, one of the most serious weak points that DVD-RAM format has is lack of backward compatibility. That means DVD-RAM disc recorded by DVD-RAM format cannot be played back by most of current installed base of DVD players and DVD-ROM drives. Even if DVD-RAM supporters such as Matsushita (Panasonic), Toshiba, and Hitachi are aggressively marketing to make their format dominant, this compatibility problem may drag their feet to be dominant in the market. DVD-RW format developed by Pioneer enables sequential rewriting and has similar parameters to the record-once DVD-R specification.

Unlike DVD-RAM, DVD-RW has no sector or defect management capability. And it is not possible to watch a video recording until the recording is completely finished because DVD-RW uses a linear recording method. However, in terms of backward compatibility, DVD-RW format allows most current DVD players to read the discs. DVD+RW format backed by Philips along with some alliances was most recently completed recording format outside DVD Forum which determines DVD standards and facilitate DVD products. Even
though detailed specification of DVD+RW is a little bit different from that of DVD-RW, by and large, DVD+RW and DVD-RW are quite similar technology in terms of Consumer Electronics application considering user benefits.

Taking into account the current market situation and comparing pros and cons of each DVD recording format, it is unlikely for one single format to be dominant in a short period of time as it was the case with VHS and Betamax standard war. Because neither of three standards is highly differentiated, nor are network effects strong, incompatible standards can coexist for a quite long time. For consumers, one clue to making the right decision is to adopt an application-focused approach to selecting the best DVD format for the job. Easing the customer’s confusion over the recordable DVD standards is another key determinant of the growth in the DVD recorder market. This conclusion gives a hint for LG Electronics to take its right decision for standards to be a market leader. Fig.IV-1 shows that hardware manufacturers should strive to shorten the transition time $T$ that needs to replace the demand for DVD players with that for DVD recorders.
1.3 Other factors that accelerate DVD recorder market growth

As was not the case with DVD players, DVD title is no more a gating factor for a DVD recorder adoption. Aside from the price and standard issue, other important factors that may have an impact on the market growth for DVD recorders are its complementary products such as digital TVs and camcorders. One of the drivers that make DVD recorders attractive is digital TVs. In the US, the FCC (Federal Communications Commission) has mandated that ATSC (Advanced Television Systems Committee) tuners be integrated into every device with an NTSC tuner by July 2007. That means all DVD recorders have NTSC (National Television System Committee) tuners. Those who have not digital TV STBs (set-
top-boxes) or want to record TV programs onto DVD in place of VCRs seem to be potential customers for DVD recorders. As digital broadcasting expands in other areas such as Europe, Japan, and Korea, it will stimulate demands for DVD recorders which have integrated digital tuners whether they are terrestrial or satellite.

Another complementary product for DVD recorders is an installed base of digital camcorders. DVD recorders seem to be more popular with those who own a digital camcorder and wish to preserve their recordings over a long period of time or are replacing their old worn out VCR. According to a market survey, "DVD recorders are more attractive for the person who either needs a new VCR anyway, but doesn't have a library of VHS tapes, or for somebody who has a digital camcorder and wants to digitally dump the information from the camcorder onto DVDs." Many advantages of a DVD disc ranging from random accessibility, data reliability to excellent preservability without deterioration over a long period of time entice people to purchase DVD recorders. In this sense, camcorders could be strong complementary products for DVD recorders.

1.4 Mapping out short-term strategies for LG Electronics

As I mentioned in Chapter IV.1.1, firm success is a function of the attractiveness of the industry in which the firm competes and its relative position in that industry. The first priority for DVD recorder manufacturers is how quickly they can grow the market in order to increase their revenues and profits. That is because the demands for DVD recorders are heavily dependent on the affordable price, which is assumed to be below $199. As one of the first tier players who want both DVD recorder market growth and its market share, LG
Electronics has to focus on how to create competitive advantages in terms of cost. I would like to recommend some strategies to ensure world-leading cost competitiveness in support of profitable growth.

1.4.1 Alliance or Joint Venture for the market leadership

In addition to the functions required for DVD playback, a DVD recorder, which is largely composed of two parts called front-end and back-end in Fig.IV-2, needs more ICs to handle recording function and interfaces to be connected to external input/output devices such as TVs and camcorders. The front-end part, which is sometimes called a loader, is almost the same as a DVD recordable drive for PC in terms of functionality. Due to its advanced technology integrating many chips into one or two, a DVD player has no division between front-end and back-end, enabling many small firms to produce DVD players by just integrating several modularized components. When it comes to a DVD recorder, however, it has quite a long way to go to be as simple as current DVD player is. Moreover, since the number of firms that can produce loaders are restricted, the material cost for a loader takes a high percentile of the whole material cost for a DVD recorder, and the technology barrier to integrate system is still quite high, only a few firms have been producing DVD recorders so far, compared with the situation for DVD players that there are over 200 firms. That is to say, unlike in the era of play-only DVD players, several difficulties such as yield , the level of precision needed for optical pickups, and the hurdle presented by the software needed for recording on DVD recorders make it difficult for second or third-tier firms to enter DVD recorder market for the time being.
Despite taking into account this technological situation, it is expected that the time window for first tier players like LG Electronics to ensure its leadership in the DVD recorder market is at most two years. The approach I recommend for LG is to take advantage of an alliance or joint venture just as it did for the optical disk drive (for PC) business arena (i.e. the formation of HLDS), as was mentioned in Chapter III.4. In order to make matters simpler, the expansion of business coverage of HLDS from only optical disk drives for PC application to the whole optical storage businesses including consumer electronics seems to be the most appropriate way to form alliance. The other way is to establish a new joint venture dedicated to consumer electronics between LG Electronics and Hitachi. Either way will do as long as there are resulting synergies, but the first option seems to be more efficient in terms of alliance-making. Let me talk a little bit about the benefits which LG Electronics can get from taking advantage of HLDS or making a new alliance with Hitachi.
Benefits from alliance or Joint Venture

As Fig.IV-3 indicates, the industry value chain for a DVD recorder is fairly different from that for a DVD player in the sense that, unlike a DVD player, the front-end part (let me call this a loader hereafter) plays a crucial role in securing cost-based advantages for a DVD recorder because it reaches as high as 40 percent of the whole hardware cost as of the end

INDUSTRY VALUE CHAIN

Patent Holders

Front-End providers

DSP IC
Optical pick-up
Other Front-End components

System manufacturers

MPEG IC
Other Back-End components

End Users

Movie makers
Disc manufacturers
DVD title distributors (Direct Sales)

Rental Service
Retailers

Blank DVD disc manufacturer

Fig.IV-3 The Value Chain of DVD Recorder Industry

do 2003. This means that the cost competitiveness of a DVD recorder largely relies on a loader, all else being equal. Harking back to Chapter III.4.2, HLDS has achieved robust global market leadership by increasing its market share, as a global No.1 player, in optical disk drive market since it was established. There are some advantages that LG Electronics can take by vertically integrating a DVD recorder internally.

First, LG Electronics can lower the cost of a loader for a DVD recorder by internalizing it from economies of scales that HLDS is reaping massively, compared with that of outside suppliers. As I touched on in Chapter III.1.4, a loader for a DVD recorder has the same
function as a DVD recordable drive for PCs does. That is to say, a loader can be easily provided by HLDS, which is producing huge volume of DVD recordable drives for PCs, keeping number one market share position, and therefore having excellent bargaining power over its suppliers.

Second, one thing worthwhile to note for DVD recorders in terms of technology is that while there was no need with DVD players to keep up with the increases in DVD-ROM drive speeds that took place in the PCs, the advantage for moving to higher speeds in DVD recorders is that it allows a recording on the hard drive to be archived on a DVD disc at a faster rate than real-time. In addition, video can be transferred from camcorders or VCRs at faster than real-time rates as well. When it comes to drive speeds, whether they are CD recordable or DVD recordable drives, HLDS has been keeping product leadership one step ahead of its competitors. Accordingly, time-to-market for DVD recordable drives will act as a competitive advantage over other competitors. Since it is expected that the technological speed limit for a DVD recordable drive is 16X, HLDS can have its product leadership to the speed limit for a DVD recordable drive. DVD recorder manufacturers may use up to 16X drives as well.

Third, as far as royalty payments for DVD recorders are concerned, LG Electronics can largely reduce the burden of royalties by extending HLDS's business coverage or establishing a new joint venture between the two companies. That is because Hitachi, which is one of the 6C members, owns 51% of HLDS shares and therefore, it can negotiate cross-license deal with other patent holders. Even if LG Electronics has some standard
patents associated with a DVD recorder, they are not enough for the company to offset its payments to other patent holders through cross-license agreements. As shown in Fig.II-4, apart from initial payment, at least $18 is required for a DVD recorder. Royalty payments will become increasingly burdensome as the price of a DVD recorder falls, resulting in a critical barrier to securing cost advantage.

1.4.2 DVD recorder Format

A single standard generates greater network effects and cost less than multiple standards. However, manufacturers do not want monopolized standard because having a standard controlled by a single firm leads to monopolistic pricing. As was the case with DVD playback standard, MMCD (Multimedia Compact Disk) camp and SD (Super Density) camp could reach agreement on a single standard format that combines the best technologies of MMCD and SD. As a result, the read technology allows all DVD products (players and disks) to possess the same level of network externalities in a region to communicate. Unlike the read technology, however, given the encoding standards, the method of actually writing the DVDs does not possess great network externalities. That is one of the crucial reasons why concerned parties failed to elicit one single format for the write technology.

In terms of format adoption, during the past years, even though each of three format proponents had been grappling with one another in DVD recorder market, none of the formats became dominant. Moreover, as I mentioned in Chapter IV.1.2, as far as DVD recorder formats are concerned, it does not seem that any one single format will become
dominant in the foreseeable future. That is because, unlike the old VHS versus Betamax war which involved hardware incompatibility and products were thus mutually exclusive, DVD recorders share the same hardware specs, hence a recorder can adopt more than one format. Anyway, this format confusion issue, along with the price, is considered one of the important barriers that have kept DVD recorder market from growing as fast as it had been expected. In a way to avoid format confusion, some DVD recorder manufacturers have started to introduce “dual format” recorders. For example, Toshiba announced that all of its future DVD recorders would combine DVD-RAM with DVD-RW, and Sony shipped its first dual format DVD+RW/-RW recorder in the US market in the second half of 2003.

In an effort to compete with these competitors, the most reasonable choice I would like to recommend for LG Electronics is to take the next level by offering all-format DVD recorder that can support all three recorder formats as soon as possible. Fortunately, in pursuit of avoiding format confusion and offering greater versatility, HLDS (by the name of LG in the US) introduced and began to sell “Super-Multi” drives that can write all formats available in the fourth quarter of 2003. It is neither difficult, nor does take a long time for LG Electronics to develop an all-format DVD recorder if it takes advantage of a “Super-Multi” drive as a loader. There are two benefits LG Electronics can expect by launching all-format DVD recorders. One is that the company can take an initiative in DVD recorder market by providing its customers with convenience associated with format selection. The other is that the company can aggressively market its products on the basis of cost competitiveness coming from joint venture, resulting in increased brand awareness. The second step LG Electronics can take is to make a new architecture or platform for a
DVD recorder as simple as that for the current DVD player by integrating its components and functions to maintain its cost competitiveness, which puts it one step ahead of its competitors.

1.4.3 Complementary Products and its Organization for Development

As I stated above in Chapter IV.1.3, apart from DVD titles to playback, there are two complementary goods that help boost DVD recorder sales. One of the two is the camcorder, whether analog or digital. As LG Electronics is not doing camcorder business now, it cannot establish any positive strategy for DVD recorders to enhance their sales directly associated with a camcorder. As long as a digital TV is concerned, however, there is something worthwhile to note for the company in terms of making synergy with DVD recorders.

According to market survey\textsuperscript{28}, over the next decade, it is expected that digital TV penetration would be increasing from less than 5% in 2003 to more than 50% by 2010. The FCC now requires that 50% of TVs 36 inches and larger have integrated digital capability by July 2004 and 100% a year later. The rule ultimately states that all new 13-inch+ TVs sold after July 1, 2007 must comply. The FCC’s September Plug and Play ruling should provide additional fuel for digital TV growth. Table IV-1 shows market prospect for digital TVs by 2007. One of the core business divisions that LG Electronics has is Digital Display & Media Company, which is providing cutting-edge digital display products including plasma TVs, LCD TVs and monitors, and digital high-definition televisions (HD TVs). Taking into account rapid growth of digital TV and DVD recorder market, LG Electronics
needs to put in its effort to make synergies between the two products on the basis of its core competences.

<table>
<thead>
<tr>
<th>GLOBAL UNITS (K)</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANALOG TVs</td>
<td>130,854</td>
<td>129,981</td>
<td>128,000</td>
<td>125,000</td>
<td>122,000</td>
<td>115,000</td>
<td>100,000</td>
</tr>
<tr>
<td>ANALOG STBs</td>
<td>3,173</td>
<td>2,080</td>
<td>1,600</td>
<td>1,400</td>
<td>1,100</td>
<td>900</td>
<td>500</td>
</tr>
<tr>
<td>DTVs with TUNERS</td>
<td>1,595</td>
<td>2,306</td>
<td>3,100</td>
<td>6,000</td>
<td>11,000</td>
<td>18,000</td>
<td>30,000</td>
</tr>
<tr>
<td>DIGITAL DISPLAYS</td>
<td>5,748</td>
<td>7,080</td>
<td>8,500</td>
<td>12,000</td>
<td>15,000</td>
<td>19,000</td>
<td>23,000</td>
</tr>
<tr>
<td>SD DIGITAL STBs</td>
<td>36,800</td>
<td>38,707</td>
<td>42,000</td>
<td>51,000</td>
<td>63,000</td>
<td>80,000</td>
<td>100,000</td>
</tr>
<tr>
<td>HD DIGITAL STBs</td>
<td>1,200</td>
<td>1,600</td>
<td>3,000</td>
<td>6,000</td>
<td>10,000</td>
<td>15,000</td>
<td>22,000</td>
</tr>
<tr>
<td>GLOBAL TVs</td>
<td>179,370</td>
<td>181,851</td>
<td>186,200</td>
<td>201,400</td>
<td>222,100</td>
<td>247,900</td>
<td>275,500</td>
</tr>
<tr>
<td>TOTAL DIGITAL</td>
<td>44,143</td>
<td>48,093</td>
<td>53,600</td>
<td>69,000</td>
<td>89,000</td>
<td>117,000</td>
<td>153,000</td>
</tr>
<tr>
<td>ADVANCED DIGITAL</td>
<td>8,543</td>
<td>11,083</td>
<td>14,600</td>
<td>24,000</td>
<td>36,000</td>
<td>52,000</td>
<td>75,000</td>
</tr>
</tbody>
</table>

Source: CIBC World Markets Corp

Table IV-1. Digital TV Estimates

DVD recorders are fairly attractive recording equipment to those who have or want to purchase digital TVs in the sense that they can record some TV programs they need onto DVD discs in place of VHS tapes. In a way to correspond to this customer demand, the combination of a digital TV and a DVD recorder would be a good value-added product. Even if the combination of the two products needs a new platform, unlike the simple combination of an analog TV and a VCR, integration of the two products can be a strong competitive advantage for LG Electronics because there are only a small number of firms that can produce both digital TVs and DVD recorders. Moreover, some components such as MPEG decoder and Micom can be shared to reduce the material cost of the combination product; otherwise they should be used for each device. On top of it, there can be many combination products that provide a variety of value-added functions like the same PVR (Personal Video Recorder) using built-in hard disk drive and EPG (Electronic Program Guide) as TiVo is providing its service that charges a lump-sum or monthly payment.
Another point I would like to stress is how efficiently LG Electronics manages its R&D organizations to develop new platform products which are sometimes called digital convergence products. Though they are all corporate research labs in the company, two organizations for optical storage and digital TV are doing their R&D activities separately. In the past, there has been little demand for combination products between the two organizations. With the dawning of the digital era, however, the demand for combination or convergence is steadily increasing not only for IT but also for Consumer Electronics products. Accordingly, a new organization for this kind of combination product between a DVD recorder and a digital TV, which has a new platform, is required across the two organizations no matter how big it is. As the platform-based organization resembling James B. Quinn’s “spider’s web” organization in Chapter III.5 indicates, basic three ingredients - ownership, empowerment, and consistency - should be committed for a new organization.

1.4.4 Making Alliance with External Complementors

According to Annabelle Gawer & Michael A. Cusumano, at the birth of many industries, a few firms develop all or almost all the components necessary to make the products. As industries evolve, what generally happens is that specialized firms emerge to develop certain components of the larger puzzle. An increasing number of industries today consist of different firms that each develops one component of a big jigsaw puzzle. Economists refer to these industries as “de-integrate.” This evolution has also been happening in the DVD industry, where vertically integrated first tier players are being pushed by second or third tier firms that could easily integrate core modules supplied by component specialists. This commoditization process makes it difficult for leading firms to differentiate their
products from those of second tier companies except for the price. Therefore, it is worth noting that the firm’s product has limited value when used alone but gains in value when used along with complements. I mentioned about some in-house or outside the company’ complementary products that LG Electronics can make the most of to increase its DVD recorder sales in terms of hardware. Though it may take some time, however, the company cannot escape the commoditization game as far as hardware is concerned. To overcome this fundamental problem and create more profits from the value chain, the company needs to think about more positive strategies, which play a large role in increasing its competitive advantages and profitability, by combining some external complementary services with its hardwares.

One of the strategies LG Electronics can take is to make alliance with service firms, whoever they are cable or satellite broadcasting companies, to provide customers with differentiated products that can record digital TV programs. In other words, subscribers who pay some extra charge can record digital TV programs that they want by DVD set-top-box recorders with the exclusive authentication function that is provided by LG Electronics and allows users to record some digital programs. This business model seems to be reasonable in the sense that cable companies control access to 70% of homes in the US and that not all digital programs are expected to be able to copy or record by any DVD recorder due to the Hollywood’s (the video content owners and developers) insistence on better digital rights management (DRM) standards.
Another strategy that the company can take into account is to provide far differentiated products that have network enabled capability. As DVD devices evolve and mature, there is also an increased desire to connect DVD appliances to the Internet, as well as other consumer electronics devices in the home. With the explosion of the Internet, consumers are increasingly streaming all types of audio and video files into the connected home and want devices, including their DVD players or recorders, to be able to handle all the different media formats emerging today. Moreover, Wireline and wireless home networking technologies, which are being supported by Ethernet and 802.11b, can be integrated into DVD devices. The addition of home networking technology enables consumers to stream compressed audio, digital photos, and in some cases video files, among other file types, from a PC’s hard drive to a home entertainment center. If these applications are available through DVD devices, a variety of alliance or partnership can be considered by LG Electronics. One example is that movie studios can distribute their contents electronically through the Internet enabled DVD recorders provided by the company without disc replication process and distribution channel that need fairly amount of cost. Of course, more robust copy protection scheme should be implemented by LG Electronics to ensure that contents can only be downloaded or recorded on a disc for authenticated subscribers. In addition, combining hard disk drive into DVD recorders makes it possible for users to enjoy a wide range of functions such as time-shifting, video editing, audio jukebox and photo album applications with their large TV screens and excellent audio systems in their cozy living rooms. In a sense, DVD recorders with these functions are going to be measured against TiVo and ReplayTV for user friendliness in the
sense that CE manufacturers can add some of the TiVo features to their products without requiring the consumers to have a subscription.

1.4.5 Product development strategy for DVD players

According to the CEA, even if DVD player penetration was expected to reach more than 50% of U.S. households by the end of 2003, the market demand for a DVD player still seems to have huge growth potential, especially in the rest of the world that have recently begun to increase in demands. Taking into consideration this market situation, the DVD player market is not yet done. It seems that the market for DVD players is about to hit a second inflection point, starting in 2004, driven by the availability of low-cost (sub $300) and easy-to-use DVD recorders. I want to make some comments on how efficiently LG Electronics can manage its DVD player business in light of the fierce competition from Chinese players which have cost advantages.

Royalty Reduction through Alliance or Joint Venture

In the case of a DVD recorder, either an alliance or joint venture with Hitachi, or extending its business coverage of HLDS to reduce royalty payments, can have a tremendous impact on the cost competitiveness. This is because as DVD player prices have dropped, as I stated in Chapter II.4.1, royalties are now becoming a significant portion of the price of a player. Taking the situation that current royalty fees for DVD players are around $12 into consideration, royalty reduction through alliance may considerably help LG Electronics secure cost advantage over Chinese DVD manufacturers.
Shift to Value-Added DVD Products

Unlike a DVD set-top box player, even if the market portion for other form factors such as portable DVD, automotive DVD, and universal DVD, which can playback both DVD-Video and DVD-Audio, is quite small, the profitability for these value-added DVD products is still high and the market is steadily growing. One thing LG Electronics has to keep in mind is how efficiently it evolves product platforms for these high-end DVD products as well as their follow-on products. If the price for a portable DVD player without LCD screen reaches sub $100 within two years, it will become enough competitive to replace CD players in terms of user benefit that can playback DVD as well as most of audio formats.

Another emerging category with similar product platform with a portable DVD is automotive application products, which may be the overhead LCD drop-down monitors with integrated DVD playback systems or in-dash DVD players that can be also used for car navigation systems. As the number of SUVs and navigation system-equipped cars increases, market will be continuously increasing. In an effort to embody this automotive DVD market, LG Electronics has begun to make alliance with one of the biggest Korean motor companies recently. In addition, in order to reap economies of scale for automotive DVDs, the company should expand its alliance with other foreign giant motor firms, aiming at not only before market but also aftermarket.

However, one thing that LG Electronics has to keep in mind is that even if a variety of combinations look very attractive in terms of technology, they have a possibility of being
small niche products in the market. This is partly because, generally, combinations causes
the product price to increase quite a lot, and many consumers may not be interested in some
functions that need high awareness of technology to use, and partly because, unlike IT
products, when it comes to consumer electronics products, low price and easy manipulation
of products are important drivers to increase in consumer demands.

As for simple DVD set-top-box players, it is very difficult for LG Electronics to take
appropriate strategy based on product differentiation since competition is based primarily
on price. Even though price competition is significantly fierce in simple DVD set-top-box
players, it does not mean the company must get out of the low-end product business right
now. That is because continuous operation can absorb the huge amount of fixed cost and
operation cost for the time being. In the short term, moving operation facilities offshore can
be one of the quick and dirty alternatives to reduce its operating cost, in the long run; the
company should get out of the low-end product business and then shift its focus wholly to
upmarket products.

2. Mid (Long)-Term Strategy

2.1 High Definition Optical Storage Technology

As I briefly stated in the Chapter II.2.3, the 4.7 GB capacity of DVD recorders is not
enough to record more than one hour of TV programs at even standard definition quality,
not to mention at high definition. Even if a HDD (hard disk drive) has a recording capacity
more than 100 GB, taking into account the fact that a HDD is not a removable medium,
there is no way to record HDTV programs, in its high definition form, on an optical disc for
distribution or backup. At least 15 GB is required for a two-hour high-definition movie recording, even using MPEG-2 compression. The higher the demand for a large screen HDTV, the higher resolution is needed in tandem with its screen size in order not to deteriorate its picture quality. I am going to talk a little about how LG Electronics should prepare next generation technologies and products to keep its leadership in optical storage-based consumer electronics industry.

2.1.1 Strategic Approach to Dominant Standard and Alliance

According to Fernando F. Suarez\textsuperscript{8}, when a technological field in which two or more alternative technological trajectories compete for dominance, the technology dominance process can be described as five milestones. He said that each milestone marks the start of a new phase in the dominance battle, and each phase is characterized by different dynamics that in turn make some of the factors associated with dominance more relevant than others. Fig.IV-4 shows the timeline suggested by the different milestones in the technology dominance process, where:

- $T_O$ denotes the beginning of a technological field with an organization pioneering applied R&D;
- $T_P$ denotes the time when the first working prototype emerges;
- $T_I$ denotes the time of the first launching of a commercial product;
- $T_F$ denotes the time when a clear early front-runner appears; and
- $T_D$ denotes the time when one of the alternative designs becomes dominant.

The different milestones shed light on the process that unfolds in an industry whereby one particular technological trajectory becomes dominant.
Fig. IV-4. Five milestones in the process of technological dominance

As Fernando F. Suarez³ mentioned, the five milestones in a dominance process define phases that have different characteristics. In particular, success in each phase seems to respond to a different mix of firm and environmental-level factors. In the Fig. IV-5, each phase has been associated with the factors that tend to have the strongest effect. Of course, each situation will not necessarily conform precisely to the pattern described in five phases: some factors may also have an effect in adjacent phases to the ones suggested in the figure.

<table>
<thead>
<tr>
<th>Factor Type</th>
<th>Dominance Factor</th>
<th>Phase I</th>
<th>Phase II</th>
<th>Phase III</th>
<th>Phase IV</th>
<th>Phase V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm Level</td>
<td>Technological superiority</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Credibility/complementary Assets</td>
<td>*** ***</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Installed base</td>
<td>*** ***</td>
<td>***</td>
<td>***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strategic maneuvering</td>
<td>***</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Environmental Level</td>
<td>Regulation</td>
<td>***</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Network effects and switching cost</td>
<td>*** ***</td>
<td>***</td>
<td>***</td>
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</tr>
<tr>
<td></td>
<td>Regime of Appropriability</td>
<td>***</td>
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</tr>
<tr>
<td></td>
<td>Characteristics of the technology field</td>
<td>***</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Fig. IV-5   Key factors of success at each stage of the dominance process

New format competition for the next generation DVD seems to follow the above dominance process. Even if there are three high definition technologies competing for the next generation DVD as shown in Table II-3 which summarizes detailed features for each
format, substantially, there are only two competing camps with blue laser-based HD (High Definition) recording technology. This is because the other format, which is called HD-DVD9 backed by Time Warner, is using current red laser technology and has relatively poor technological specification to meet HD picture quality. Moreover, it has only a few supporters when compared with the other two camps. Let me touch on the progress that two major camps have been making so far.

Blu-ray, also known as Blu-ray Disc (BD) is the name of one of the next generation optical disc formats jointly developed by thirteen leading consumer electronics and IT companies (Hitachi, LG, Mitsubishi, Panasonic, Pioneer, Philips, Samsung, Sharp, Sony, TDK, Thomson, HP and Dell). This format was developed to enable recording, rewriting and playback of high-definition television (HDTV), which is not possible with today’s VCRs or DVD recorders. BD makes it possible to record over two hours of HDTV programs, or more than 13 hours of SDTV (Standard Definition TV) contents on a 27GB disc. There are also plans for higher capacity discs that are expected to hold up to 54GB of data using dual layer recording technology. In terms of recording format which is both for AV and PC application, BD seems to be now in the phase III stage in the above Fig.IV-4 and Fig.IV-5. BD recording format has already been completed and some companies have already demonstrated their prototypes during past two years. On top of that, Sony has been shipping its first commercial model since last year in Japan. In addition, Panasonic and LG Electronics are going to launch their commercial products in the first and second half of 2004. Even if the price for commercial products is quite high due to several reasons, BD format can be considered to be in the phase III of the dominance process. BD camp is now
putting in many efforts to make its format a de facto standard by releasing commercial products much faster than its competitors, aiming at increasing its installment base. As long as the dominance process for a new format is concerned, BD camp has been getting ahead of other camps so far.

Meanwhile, another format called HD-DVD, which was partially approved by DVD Forum that has been determining and promoting current DVD format so far, is also blue laser-based and supported by Toshiba and NEC along with many DVD forum members. Toshiba and NEC demonstrated their HD-DVD player prototype in January at Consumer Electronics Show. Specifications for HD-DVD Read-Only Disc Version 0.9 were approved by the DVD Forum Steering Committee in November, 2003. As the spec name suggests, the approval covers only the "read-only" DVD disc. Taking into account this progress going, though HD-DVD camp demonstrated its prototype in Jan 2004, the dominance progress for its format seems to be now in the phase I in the above figures.

In a preparation for taking initiatives in the next generation HD technology, LG Electronics has been collaborating with other BD members for a couple of years. As far as HD standard is concerned, what I would like to recommend for the company is to firmly maintain its collaboration and make contributions to BD camp for some reasons.

First, LG Electronics, one of the original BD members, has been deeply involved in establishing BD standard technologies that are quite different from those of current DVD since BD camp was first announced in the early of 2002 by nine members. Because the
company has been running the gauntlet from high royalty burdens since it started doing DVD business, to become one of the original members of BD camp has a significant meaning to itself. Since the company was not an original member that had participated in the DVD forum for DVD format discussion from the beginning, it could not secure enough standard patents to negotiate cross-license deal with other patent holders to be free from royalty payments. In this sense, it is considerably important for LG Electronics to take the leadership of BD format that makes the company to have a chance to reflect its technologies on standard patent pool from the beginning. Basically, the company is aiming at zero royalty payments for the next generation DVD business to make more profits and compete with its strong competitors without royalty handicap.

Second, BD standard is fairly getting ahead of the other camp, HD-DVD led by Toshiba and NEC, in terms of technical feasibility and the degree of commercialization progress. Apart from technological superiority or inferiority, Blu-ray Disc recorder is currently available to consumers even if the price is fairly high, while HD-DVD camp has not yet established even its technology specification. One of the reasons BD camp could take steps much faster than HD-DVD camp is that BD is not open to anyone who wants to join, unlike current DVD forum. As some people pointed out, one of the most critical reasons that made the commercialization schedule for current DVD delayed was that it took too much time to finalize its specification to coordinate interests of many parties involved. In this sense, the restricted number of members consisting of BD camp made it possible to speed up its making decisions to establish standards and commercialization. Even if the number of BD members is quite small, the fact that most major consumer electronics firms
such as Panasonic, Sony, and Philips and IT companies such as HP and Dell joined in this
camp could raise the possibility that BD format would be a de facto standard in the near
future.

2.1.2 Market Penetration Strategy

From the Fig. IV-5, a third milestone in the dominance process is the launching of the first
commercial product, which for the first time, directly connects a technology coming out of
the lab to customers. Typically, the first product in the market is too expensive for the mass
market and is therefore aimed at early adopters or the high-end users of the market. As was
the case for DVD players, DVD titles have had a huge impact on the sales in DVD players
as complimentary products. As the same token, HD movie titles are indispensable for HD
products to be penetrated in the market. Regardless of which HD format camps they belong
to, most hardware manufacturers are hopeful that the movie studios will begin releasing
HD DVD movies. However, DVD has been very good so far for the studios and they are
reluctant to mess with success. As for the movie studios, when DVD movie sales revenues
begin to decline, they will jump in to HD DVD market. And as long as a dominant single
format does not exist, they may also be reluctant to release HD DVD contents due to
format confusion.

First, taking into account these situations mentioned above, what I would like to
recommend for LG Electronics is how efficiently and quickly it could reach the critical
mass of installed base to take off in the market and then make a virtuous cycle between the
price decline and the increase in demand. The early market, although typically a relatively
small one when compared to the mass market, helps a particular design become an early
"forerunner." This happened with Ampex's design that dominated the emerging VCR industry for almost 10 years (Rosenbloom and Cusumano, 1987), and with Apple Computers that dominated the emerging personal computer industry for several years after the introduction of the Apple I in 1976. Even if the early market is expected to be small due to its high price and restricted application, LG Electronics had better launch its commercial products earlier than other competitors for several reasons as follows. One of the reasons I think is that early market release for HD products will be a good opportunity for the company to show off its technology leadership and raise its brand awareness. In some ways, even if there has been little difference in product quality between top-brand companies and LG Electronics, the company could not charge the price of its products as high as that of top-brand products due to its weak branding. Another reason is that since a line up investment for HD products, which may rather than be called by a pilot line, does not require as much cost as an entirely new product does, the cost for mass production is not worthwhile to be taken seriously. Moreover, Sony's huge investment in HD disc manufacturing facilities helps reduce the burden of the company to prepare for HD discs. In summary, there seems to be little serious damage for LG Electronics to release its commercial HD products early to the market.

Second, another strategy I recommend is to make the most of complementary goods that are expected to play a significant role in driving HD recorder sales. One of the keys to success for HD products will be partially determined by the availability of prerecorded content from the movie studios. While the movie studios are salivating at the thought of getting consumers to buy their favorite movies all over again in HD, they are concerned
with copy protection. Since BD technology is providing much more robust copy protection schemes than those for current DVD, there is quite a high possibility that movie studios move on to the HD market earlier than expected. One of the movie studios, Columbia TriStar, believes that DVD disc revenue will begin to decline around 2006 or 2007 (2004 In-Stat/MDR). Moreover, since Sony, one of the strongest BD members, owns a studio, it may release BD contents, which may encourage other studios to follow suit. In this sense, LG Electronics has to make efforts to encourage movie studios to jump into the HD market through BD camp activities. Another complementary product is HDTV that I mentioned in Chapter IV.1.4.3. Even if a current DVD recorder can record HDTV programs, it cannot retain HD picture quality when recording. The FCC’s regulation that requires digital tuner integration into every device by 2007 helps increase in HDTV sales, resulting in the increase in demand for HD recorders. When it comes to a HDTV, LG Electronics is one of the leading companies that have strong technologies and patents associated with ATSC broadcast standard. A new digital TV platform that integrates an ATSC tuner and a HD recorder will give a significant benefit in terms of cost reduction due to sharing some core components between the two devices. The other complementary product, a digital camcorder, can partially drive HD recorders even if the company cannot take any positive action because it is not doing camcorder business. Camcorder manufacturers are now working to push HD resolutions down to consumer-level cameras by proposing the HDV (High definition Digital Video) standard for the recording of HD resolution video on DV (Digital Video)-format cassette tapes.

Third, in a preparation for late advent of HD recorder market, LG Electronics had better take gradual steps to increase in demand for HD recorders. Looking back on a decade of

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progress, consumer interest in HDTV is now on the rise, yet it’s hardly as fervent as the early interest in color TV. Even if it offers dramatically higher quality video and audio than standard TV, a HDTV has not quite caught on with mainstream consumers for some of the same reasons that held back color TV sales for more than a decade such as high price, limited programs in color, and some initial confusion in technological standards. By the same token, it is less clear that HD technology will represent a sufficiently valuable innovation to encourage consumers to upgrade from existing red laser-based devices. Basically, HD technology has been developing by device manufacturers with a view to offering a way to escape the increasingly commoditized red-laser DVD market. Accordingly, in order to reduce this growing pain and make vague market prospect clear, one of the strategies that LG Electronics can think is to promote a HD recorder as a high-end model of current DVD recorders. This strategy is aiming to avoid consumers’ format confusion for HD recorders. As the high-end model that is backward compatible with DVD devices penetrates the market little by little, HD recorders may replace current DVD devices before they get saturated, even though it may take quite a long time.

When it comes to make alliances with external complementors that raise the product value of LG Electronics, the same strategies that I mentioned in Chapter IV.1.4.4 should be taken into account in terms of making synergies between hardware and its application services.

2.2 Other Disruptive Storage Technologies

So far, I have introduced some technology and product development strategies which are focused on the optical disk technologies for LG Electronics. Over the 50GB threshold, however, the system will be close to the optical diffraction limit, and new other techniques
have to be applied. When it comes to consumer electronics industry, it is not likely for new disruptive storage technologies to get their commercial start in the near future. This is because consumer electronics products such as VCRs and DVD players/recorders are too strongly connected by their network effect and complementary products to be destroyed. By this reason, even if the recording capacity is much higher than that of optical storage devices, hard disk drive application products have not yet become a mainstream regardless of form-factor size in the consumer electronics market. As is often the case, however, there still remains a possibility that a new disruptive technology can quickly develop into a competitive threat, and then dramatically transforming the marketplace. One of the promising candidates for the future data storage technology that are not limited by the diffraction theory, which confines the recording capacity of optical storage technology less than 50 GB, is near-field recording (NFR) technology. Another prominent candidate is holographic optical storage data technology. Holographic memory is a form of three-dimensional distributed data storage that enables high capacity recording using a modulated laser beam (the data beam) and an unmodulated laser beam (the reference beam). Interference between the two causes various interference patterns, which are the basis of this technology. These techniques are not perfected yet, but soon they may be the basis of the future of data storage and processing. In order for LG Electronics to avoid being attacked by unexpected competitors with these new technologies, it has to keep an eye on these technologies and put in enough efforts to be ready for starting commercialization earlier than its competitors when the market is likely to take off.
V. Conclusion

We have entered the era of Digital Darwinism where a variety of digital technologies and products appears, evolves, and any combination of features and functions can be built. One of the representative digital products that have appeared in the consumer electronics market is the DVD player. As DVD players become more and more mainstream, how will vendors differentiate their products and how large are those opportunities? Unfortunately, for those who are hardware manufacturers regardless of whether or not they are first-tier players, a DVD player is no more a profitable product due to its de-integration, resulting in commoditization and fierce price competition. LG Electronics, like other first tier players, needs to find another breakthrough to create revenues and profits to maintain its leadership in this industry. My recommendations for the company in this thesis to overcome this tough situation and sustain its technology and market leadership in the optical storage-based consumer electronics are categorized into two parts in terms of time horizon.

In the short term, LG Electronics needs to reorganize the value chain for DVD industry in two ways: secure its competitive advantages in terms of reducing hardware costs, and combine external complementary services with its hardwares in terms of raising its product value. One of the strategies the company can take to increase its product leadership for a DVD recorder is vertical integration by making alliance with Hitachi or simply expanding current HLDS’s business coverage to consumer electronics area. The vertical integration of a DVD recorder by making alliance will bring two competitive advantages to the company; one is to reduce its product costs from internal supply of core components and royalty payments to patent holders. The decrease in royalty payments will prove to be significant
cost savings since the price of a DVD recorder is expected to fall rapidly. In an effort to increase its product value in the value chain as a more positive strategy, LG Electronics can make partnership with external complementors such as cable TV service providers and satellite broadcasting companies. There may be two types of business models with these external complementors; one is simply to provide users with DVD recorders that can record some digital programs with a specified copy protection scheme under a certain authentication of broadcasting service providers, and the other is to launch content downloadable DVD set-top-box recorders, which have network enabled capability through the Internet, providing users great benefits in term of offering easy purchase process and a lower price for movies.

In the mid (long) term, LG Electronics can think about two aspects of the next generation HD technology; one is its approaching strategy to a dominant format and the other is its market penetration plan. First, what I want to recommend for the company is to solidly maintain its collaboration relationship with the BD camp in terms of establishing de facto standards. One of the crucial benefits the company can get from joining and making contribution to the BD camp is that it can position itself as one of the major patent holders for HD technologies, resulting in freedom from royalty burdens. In addition, the company is more likely to raise its brand awareness as one of the first movers by jumping on the bandwagon of the dominant format. Second, the appropriate market penetration plan for the company is to release its commercial product earlier than its competitors. The company should launch its HD devices as high-end DVD recorder models in order to eliminate format confusion, which is a potential problem for buyers. In addition, so as to leverage its
product value, the company should develop its internal complementary products or combine external complementary services to its hardware. Apart from these current business strategies, in order for LG Electronics not to be overtaken by new disruptive technologies, it should pay attention to the emergence of promising new technologies.
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