

The Evolution of DVD

ECE 571G

March 10, 1998

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**This report is dedicated to some of the (relatively) unsuccessful
or short-lived video and audio formats from the past 40 years:**

3D Television

8 -Track

ADAT

Audiopak

Betamax

CD Plus

CD Video

CD-I

Cinerama

DAT

DCC

Echomatic

EVR

Fidelipac

MiniDisc

Photo CD

Playtape

Port-a-Pak

ScoopMan

S-DAT

Selectavision

Smell-O-Vision

U-Matic

Videodisc

Introduction

The DVD (Digital Versatile Disc) is on the verge of defining history in both the computer industry and the home entertainment industry. Millions of dollars have been invested into DVD, with a lot of investors hoping it becomes the next home appliance. In order to consider where DVD will end up it will help to examine a few key questions:

- What does the scene look like *before* DVD?
- How does DVD fit into the existing scene?
- How does the technology of DVD compare?
- What will happen with DVD?

This report tries to answer those questions, by tracing the history from the turn of 20th century to the turn of the 21st and beyond. Taking a qualitative approach to how DVD will be accepted, this report will help answer some of the questions that numbers just can't answer.

It should be noted that many of the views, dates and statistics in this report are based on very North American (or more simply, American) perspectives. This was done for several reasons, but primarily because numbers and information about American culture is commonly available. However, it should be noted that this Ameri-centric view is an outdated concept, and that the world and global economies are more important now than ever before. That being said, the DVD will still sink or swim in the American market, and if it fails in the U.S., the only market that could possibly save it would be Japan.

The Evolution of the Home Market

DVD is much more than a technology. The DVD is poised to become a part of our culture. The manufacturers of home DVD players want the DVD to become the next home “appliance”. In addition to every American house having a Fridge, Stove, Stereo and Television, they will have a DVD player. Technically, the DVD is unlike any piece of equipment that has come before it, and the market forces surrounding its introduction are certainly unprecedented. In order to fully appreciate the full impact of the DVD player, and to draw comparisons between it and its’ predecessors, it will be helpful and interesting to look at the history of the home entertainment industry.

The Camera

Although it may seem bizarre to consider the Camera when examining the DVD, it cannot be ignored as an important form of media storage and home entertainment. Invented in the mid 19th century, it took many decades for the camera to penetrate the home market. Since then, the camera has remained the primary “storage” device for recording family portraits, memories, and significant events. In the 1960’s and 70’s the slide projector became a common form of “home entertainment”, but eventually slide projectors eventually took a backseat to the video camera. For years, digital cameras have been trying to make a dent in the home market, but the sales figures continue to be slow. Consumers haven’t shown much interest in adapting this particular digital technology, with little perceived benefit. Throughout the years, cameras have undergone numerous enhancements, changed standards, and incompatibilities. However, the camera has survived, and will continue to survive for a long time.

The Phonograph

The youths of today have all but forgotten the first home entertainment and distribution network: the phonograph. The phonograph revolutionized home entertainment and gave birth to what is still referred to as the “record” industry, despite the fact that records only make up a small portion of the revenues. Made popular in the early 20th century, the phonograph would dominate the home for decades. It’s interesting to point out that phonograph was a “read-only” medium, but that didn’t seem to be an issue at the time. With the birth of the record industry, new legal, copyright and licensing issues were introduced: you could purchase a licensed copy of music, and then you would have the right to replay it for your personal use. The legal concept still holds up today. The newly created record industry created many jobs, including agents, producers, and distributors. Records were originally sold and distributed in bookstores, but

eventually record stores would come into their own, both the small “mom & pop” store and the larger chains. The phonograph survived some changes to its’ standard over the years, including the introduction of stereo, and the introduction of “high density” records by slowing the rotation speeds (an interesting converse of today’s trend to increase speeds). Although there is still a small record industry, It’s generally accepted that the Compact Disc caused the death of the record.

The Motion Picture

In the year 1895, motion picture technology was invented, and a new industry was born. By the year 1929, when audio was introduced, there were movie theatres across America: Hollywood was alive and kicking. Hollywood studios and actors became famous, and it soon became obvious that there was a lot of money to be made in the industry. Like the record industry, new jobs were created to manage the theatres, studios, and the movie distribution. However, the distribution model used for the movie industry was very different from the record industry. The movie studios were able to maintain tight controls over the distribution nodes. The movie industry went through numerous changes to film standards, sizes, and audio formats. However, technology changes were much easier to control, as they only had to worry about upgrading the theatres, not the home consumer. In addition to the big budgets of the large movies, low budget “B” movies were introduced, demonstrating that money, and not necessarily quality was always the bottom line. The “adult” film industry occupied a significant segment of the market until the introduction of the VCR. Many of the ideals and methods of the motion picture industry haven’t changed for decades.

Radio

Invented in the Year 1895, the AM radio started appearing in the homes in the 1920’s. For the first time, people had two competing home entertainment devices: the phonograph and the radio. However, the two devices would turn out to complement each other well. The radio (much like today) provided information, news, sports, weather, serials and general talk in addition to playing music. The record industry cleverly used the radio as a tool to promote their records to the public, and distribution agreements were made between radio stations and record companies. The radio was the first form of entertainment to be tightly government regulated, and where advertising drove revenues.

Television

Television started appearing in homes 1939, and would revolutionize home entertainment. Unlike the cooperative relationship between the radio and record industries, there was some animosity and “competition” between the movie and television industries. In fact, motion pictures intentionally widened their screen format to thwart television. Once again, an entire new industry filled with jobs and opportunities was created. As in radio, government regulation and commercial advertising would play an important part in shaping and directing the television industry. The television industry has undergone some changes to the broadcasting standard, from the switch to colour NTSC in 1954 to the recent additions of closed captioning and stereo audio. Originally the television studios and the movie studios kept an arms-length relationship, allowing some movies to be broadcast over television airwaves. However, in the last decade the movie industry has become much more involved with television, as can be seen in the introduction of FOX, WB, and the UPN networks. The television industry and cable industry has undergone a “channel explosion” in the last couple of decades, with the introduction of specialty channels, “all-movie” pay channels, and “pay-per-view”. The movie industry has developed quite a lucrative distribution network by staggering the release of movies to pay-per-view, then to VHS, then to the movie channels, and eventually to regular television.

Magnetic Tape

In the mid 20th century, magnetic audio tapes began appearing in the home. The “reel-to-reel” machines would end up going through many formats. For the first time, people were able to record audio at home. At the time, the recording industry raised numerous legal issues with respect to copyright violations.

The Home Video Camera (film)

Eventually, the price of video cameras was lowered to the point where they could be purchased for use in the home. Home movies, displayed on home projection units would replace the slide projector as the popular way to share memories with friends and family.

The Cassette Tape.

In 1972, the cassette tape developed into the format that is still used today. The cassette tape had a significant effect on the record industry and caused the death of the 8-track. The cassette tape became the first really successful portable

entertainment medium. Although the quality of the medium was not as good as the record, it became popular because it was small, and very easy to record onto. Although it caused some dents in album sales, the record industry didn't mind, as it was seizing the opportunity to "re-sell" cassette tapes of items that had already been purchased on vinyl. This opportunity to re-release items would prove to be very lucrative for the industry, and continues to be a popular practice. It also illustrated how less popular music, unlikely to make money, would never get released on tape. The cassette tape has not changed much, with only small changes like the introduction of Dolby noise reduction and metallic tapes. The cassette will continue to be popular for a while, and the "Walkman" has taken its place in entertainment hall of fame.

PONG

In the year 1974, Pong was introduced as the first home "video game". This was the first time that the television could be used for a game centre. In 1977 the Atari 2600 was released, and became an overnight success. Once again, an entire new industry was created alongside a new piece of technology. Video game departments for existing and new companies were popping up everywhere. In addition to the console market, games were being developed for the arcades, the home computer (ie: Commodore 64) and eventually the PC. There was tremendous growth of the home game console market through until 1984, when almost all the game manufacturers and game writers reported large financial losses – the home console market "crashed". It was not until several years later, with the success of the Nintendo home console, that there was a resurrection of the home console market, now dominated by the Sony, Sega and Nintendo.

The VCR

In the year 1975 the Sony Betamax was introduced. When Sony offered to license its' technology with other manufacturers in good faith, it was surprised to discover that they weren't interested. One year later the JVC VHS was released, and the format wars had begun. Although there were numerous factors that contributed to the VHS' success, many experts (including Sony) now attribute the length of tape as the most significant factor (the one-hour Beta tape just couldn't compete). The VCR became the fastest growing appliance in history, and home consumers were thrilled with their ability to record television programs. Even the name of the device implied that recording was an integral part of the technology... the VCR. The ability to record television programs became a hot issue in copyright law. Universal Studios and Disney launched a lawsuit against Sony, raising the question of whether manufacturers of VCRs were infringing on the copyrights of producers of movies and TV programs. After the lawsuit, Universal and Disney decided that their only

recourse was to consider how to make money from VCRs. As early as 1978, movies were available on VHS, and once again, an entire new industry was born. Before long, movie rental stores were cropping up everywhere. Interesting enough, many analysts agree that one of the key factors of the VCR's success was the home "adult movie" industry, where members of society uncomfortable with public movie theaters could now watch the movies from the privacy of their own home. Some enhancements have been made to the VHS format, including surround sound, but all enhancements were carefully added to maintain backward compatibility. The "Super-VHS" format was introduced with moderate success, but failed to significantly penetrate the market.

The VCR Camera

In the late 1970's, video cameras capable of recording information straight to VCR tape were available. In 1984 the Camcorder appeared on the market, which combined the video camera and the tape recording unit. The camcorder would lead to the demise of the video camera and the home projection unit. Although many services were available to convert their existing video film onto magnetic tape, many homes have a projector and some reels of film tucked away in storage that haven't been used in years.

The Laserdisc

Although they had been around for several years, laserdiscs became commercially available in 1980. Laserdiscs first became popular as a corporate training tool, and videos were developed to train employees on a wide variety of topics. Eventually, Laserdisc players added a simple serial interface, so computers could control them to provide an "interactive" training or educational environment. For the home movie buff, the laserdisc provided a higher quality of picture and sound than their VCR. Although in America, the laserdisc has reached less than 2% of the VCR market, it gained a lot of popularity in Japan, which helped sustain the industry. Despite the low market penetration, laserdiscs have remained profitable, so they are still being sold. Movie Studios still release several movies (old and new) every month, and unlike the VCR market, the majority of laserdiscs are purchased, not rented. Laserdiscs have spawned another profitable industry with the Karaoke machine (again, very popular in Japan). There have been subtle enhancements and changes to the laserdiscs over the years, but they are mostly insignificant.

The Home Computer

The IBM PC was released in 1981. There were many earlier home computers, but the IBM PC would eventually become the home (and industry) standard.

The Audio CD.

In the year 1982 the compact disc was introduced, and the mass consumer got their first real taste of “digital” entertainment. The market moved slowly at first, but eventually CDs would become the standard for the “record” industry. Like a record, the CD was “read-only”, so although CDs would essentially replace records, the cassette market would remain strong. Audiophiles debated that the quality of records was higher than the compact disc, especially in the high frequency range. However, most consumers felt that the quality of the CD was the best. The quality of the CD was not the only contributing factor to its success: CDs were “cool”. They were shiny, looked like something taken from science fiction, and at the time they were thought to be indestructible. CDs were also very functional – you could pause, listen while you fast forwarded, and could “jump” to any song on the CD. Furthermore, they were bundled into a convenient size, and had an attractive “jewel” case. The CD was also the first viable medium to have an inexpensive “juke-box” option for the home, with Multi-CD players appearing on the market. All of these factors made the CD a hot item, from the teenager listening to “rock ‘n’ roll” to the sophisticated listener of classical music. The record industry was delighted with the CD, and the ability to “re-release” many of their existing stock on a new media format. It will be a very long time before CDs are unseated from the number one audio format. The CD has since been enhanced with a variety of standards, including the Video-CD, the Kodak Photo CD, and CD-I. With the exception of the CD-ROM, these alternate formats have remained largely unpopular, and have not made a significant impact on the home market.

The DAT

The DAT (Digital Audio Tape) bears some mention because it was heralded as the next audio format, and the logical choice to replace cassette tapes. The DAT is interesting, because it was a flop in the home industry when it was introduced in the mid 1980s (much like the follow up Digital Cassette DCC) – however, the DAT became a moderate success in the computer industry as a mass storage backup device. In addition to the computer backup industry, the DAT is still used by the recording industry and underground bootleggers, and it is often used as the source master for a CD-ROM.

The CD-ROM

In the year 1987 the CD-ROM was introduced to the computer market. The "Multimedia PC" standard was developed, and required a machine to have a CD-ROM and an audio card. Although most computers supported playing regular CD Audio from a CD-ROM drive, CD-ROM drives were used primarily to read CDs specially formatted to hold data in a structure easily read by the computer. Even if the audio CD was never developed, the computer industry would have developed some form of removable mass storage medium. In fact, if there was no audio CD, the industry would probably have gravitated towards a more sophisticated medium. However, with the popularity of the Audio CD, and the availability of established and relatively inexpensive manufacturing plants, the CD-ROM was bound to be successful. CD-ROM titles became known as "multimedia" titles, as their capacity allowed for moving pictures and audio. Although CD-ROMS supported mixed audio and data tracks, the majority of CD-ROM titles used computer-native formats, and hence the CD-ROM became nothing more than a dense (read-only) floppy disc. For its' tenure in the computer industry, the CD-ROM has proved to be of adequate capacity, but the throughput became insufficient for demanding applications. Multi-Spin CD-ROMs were developed that spun the CD faster to increase the throughput. It is quite common now to see CD-ROMS that spin over 20 times faster than regular audio CDs. Write-Once, Read Many (WORM) drives or CD-R drives have become popular in the business community, and with dropping prices, they have even penetrated the home market, although the market is still very small. To an even lesser extent, CD-RW drives (read-writeable) have become available.

How does DVD fit into Our Society?

When examining the history of the home entertainment market, it becomes very apparent that for every success story, there are numerous failures. Despite millions of investment dollars, dozens of audio and video formats have failed. What determines the success or failure of a product can be as concrete as technical merit and price – be as fickle as politics and marketing strategy – or be as unpredictable as timing and luck.

It is important to compare and contrast the DVD to the products that came before it, but it is also important to realize that each product is launched into unique circumstances. The DVD Video product is also very different from the DVD-ROM product, and it is important to consider the implications of each product separately.

The VCR

The first thing that must be emphasized is that DVD Video will not replace the VCR. It will still be a long time before people can tape their soap operas with their DVD player, and it will be an even longer time before they start recording their home movies directly onto DVD. People are not ready to give up these conveniences, and as a result, the VCR will continue to be around for a long time. The persistence of the VCR will be an interesting factor in the success of the DVD.

Audio vs. Video

The next point that must be made is that the record and video industries are very different, and people treat music and video very separately. Independent artists and more alternative artists have a much better chance of surviving in the audio industry than the video industry. Rarely does a CD have the mass demographic appeal that a “must see” movie does. Conversely, rarely does a movie have the “must have” appeal that an audio CD can. People tend to set aside time to watch a movie – with undivided attention, whereas people tend to listen to music in the background, where it can lift their spirits without distracting them from the real task at hand. As a result, music has a much higher “re-playability” factor than video, and people purchase music because of its re-playability. People also take a lot of pride in having large collections, and although this is true for movies, it is much more common for music. Regardless of how successful DVD Video is, they will never sell as many DVD videos as CDs.

There is also a big difference between video and audio hardware. The general public seems to be more comfortable with its stereos than its VCRs. When people push 'Play' on their CD player, and no music comes out, it doesn't take them long to figure out that they have to push 'CD' on the control deck. However, the number of VCRs in America that still blink "12:00" is unbelievable. Even with the simplest interface, people are going to have some trouble connecting their VCR, their DVD player and their cable converter to their televisions, let alone figuring out how to connect their direct Dolby digital to their stereo. And once connected, 10 year old Billy is going to have trouble showing Grandpa how to navigate the commands on the screen to switch between the VCR and the DVD. Now society is probably ready for the DVD, but difficult installation could damage the industry through word-of-mouth. Poorly designed or annoying menus in DVD could cause a similar backlash.

The Home Theatre

It should also be noted that the home theatre will not eliminate the movie theatre. Going to the movie theatre is still a significant event in our culture. It's not just the appeal of the large screen and the movie popcorn. People go to the theatre to be social, to go out with friends, and to go out on the town. It doesn't matter how fantastic a home theatre system is, sitting down in a house to watch a movie just isn't the same experience. However, what has developed in our society is a two-tiered system of movies. People will determine that, while one movie may warrant the cost and the trip out to the theatre, another movie won't, and so they will wait for the movie to be released to the home market.

Market Adaptability

The home market won't just adopt a new product because it is the newest and greatest. People are hesitant and cautious, and are wary of becoming victims of a fad, or falling for a "White Elephant". They are even more cautious when it comes to "enhancement" technology (as opposed to "new" technology), where they are asked to spend money to enhance or replace something that they already have. The audio industry has successfully introduced the CD as an enhancement technology, and the cassette to a lesser extent. However, the video industry has yet to have a big enhancement success story. The VCR Camera was successful, but its popularity was driven by convenience rather than enhanced technology. The laserdisc was successful, but if the DVD only achieves the popularity of laserdiscs, it will be considered a failure. It should be noted that with the popularity of the personal computer, consumers are becoming more accustomed to spending money on "enhancements" to keep up with technology. However, there is still a distinction made

in the home between spending money on computers, which are useful for business and educational purposes, and spending money on "home entertainment".

The Computer Industry

Despite the hurdles that DVD-Video may have in penetrating the home market, the DVD-ROM is going to have a much easier transition into the home computer market. With the backward compatibility of CD-ROM, and the added incentive of playing DVD Videos and future DVD ROM applications, computer users won't have a hard time adapting this new technology. There seems to be little evidence or history that would point to the failure of the DVD ROM. If anything, the evidence and history suggest that even if DVD Video completely flops, the DVD ROM will still succeed.

Momentum

From physics, we see that momentum = mass x velocity. If the DVD industry doesn't have enough velocity, then certainly there will be enough mass behind it. Never before has there been so many companies and industries involved in introducing a new technology to the market. For the first time ever, a new video technology has the backing of all the major motion pictures. The attention to copyright detail has certainly helped this endorsement. In addition, major electronics manufacturers are going to be releasing compatible players at approximately the same time. The consumer is going to have a wide variety of competitive pricing right out of the gate. Furthermore, for the first time, the key players in the computer industry are supporting the product. This extraordinary and unprecedented cooperation can be attributed to one single factor: money. It seems that everyone has realized that there is a lot of money to be made from DVD, and with cooperation, there is less risk involved.

Technical Specifications

There are a wide variety of very specific and technical features available for each of the various mediums discussed in this report. This section has been kept fairly general and has focused on the key areas of distinction.

The Physical Medium

Media	Materials	Comments
Tape Cassette and the VCR	Tape is a polymer band coated with a metal oxide, usually chromium or iron	<ul style="list-style-type: none"> • Tape can be “chewed” by player • Tape collects dust & dirt • Signal degrades after many plays
Laserdisc	Two aluminum discs encased in acrylic and glued together	<ul style="list-style-type: none"> • Could experience “Laser Rot” from either bad glue or air bubbles from the glue process
CD & DVD	Aluminum disc(s) encased in polycarbonate. For CDs, the “label” side is lacquer.	<ul style="list-style-type: none"> • Major scratches may cause uncorrectable errors

Capacity

Media	Capacity
Tape Cassette	Commonly between 60min – 100min
VCR	Commonly between 2 hours – 8 hours
Laserdisc	Constant Linear Velocity – 1 hour each side Constant Angular Velocity – ½ hour each side
CD Audio	74 minutes (although standard can be pushed to 82 min)
CD ROM	650 MB (mode 2 with less error correction can be 742 MB)
DVD Video	This is a very complicated calculation that depends on the video bit rate, the number and type of audio tracks, and many other factors. In general, the figures are quoted as 2 hours of video (and audio) per layer per side.
DVD ROM	Single Layer is 4.38 GB and a Double Layer is 7.95 GB per side

Video Quality

Media	(Approximate) TV Resolution
TV Broadcast	330x482
VCR	240x482
Laserdisc	425x482
DVD Video	500x482 (equivalent TV lines) 720x480 (Pixels)

Audio Quality

Media	Quality
Tape Cassette	Analog
VCR	Analog
Laserdisc	Several Audio Formats: <ul style="list-style-type: none"> • Analog • 44.1 kHz 16-bit Stereo Digital Audio (uncompressed) • Dolby Digital AC-3 1-5.1 Surround Sound (compressed) • DTS (same as AC-3, but with less compression)
CD Audio	44.1 kHz 16-bit Stereo Digital Audio (uncompressed)
DVD Video	Several Audio Formats: <ul style="list-style-type: none"> • (44.1 / 96) kHz (16/20/24)-bit Stereo Digital Audio (uncompressed) • Dolby Digital AC-3 1-5.1 Surround Sound (compressed) • MPEG-2 audio 1-7.1 Surround Sound (compressed) • DTS (same as AC-3, but without less compression)

Note: The notation 1-N.1 refers to anywhere from 1 to N regular channels (ie: 5 would be front left, centre, right, rear left, right) plus 1 sub-woofer for heavy bass (2-120 Hz).

How the DVD Increased Capacity from the CD-ROM

Probably the most useful comparison is to see the factors that led to the increase in capacity from the CD. Here is an interesting piece of trivia: The size (12cm) and capacity (650MB) of the CD was chosen somewhat arbitrarily, and the 74-minute length was selected because that was the approximate length of Beethoven's Ninth Symphony.

Factor	Gain	Description
Pit length	2.08	The transitions between 0s and 1s on a CD are represented on the surface of the disc as "pits". The length and width of the pits were shortened.
Tracks	2.16	Much like the grooves in a record, there are "tracks" on a CD. The distance between tracks was made smaller, or the tracks were "tightened".
Area	1.02	Although it's not that significant, the actual usable area of the CD was increased slightly.
Sub-Channels	1.06	About 67% of the CD is actually redundant information, stored in "sub-channels". The sub-channels store a variety of information, such as timing data or error correction. The DVD improved on the way it stores sub-channel information.
Error Correction	1.32	The error correction information was coded with a more efficient algorithm.
Sector Overhead	1.06	The CD also includes overhead breaking the disc into logical "sectors" of data. The overhead required for these sectors was reduced.
Dual Layer	2*	DVD supports a second "Layer" on each side of the disc. These layers are on top of each other, with the outermost layer being semi-transparent. The laser which reads the disc can be configured to read from either layer, almost* doubling the capacity. *(With dual layer discs, the information is not packed quite as tightly, so there is not a gain of 2).

Editorial Comments and Predictions

Based on the research that we have done, and our knowledge of the industry, these are our predictions for the future. In general, we believe that DVD will succeed, but probably not as much as some of the industry people hope. For the first time, the entertainment industry will be directly influenced by the home computer. We cannot stress enough that the success of the DVD in the computer will happen regardless, and will be independent of how many DVD Video players are sold.

Capacity

The DVD ROM will succeed because the computer industry has outgrown the CD-ROM. It is not uncommon now for a multimedia game to have six or more discs. Business applications often take up several CD-ROMs, and Microsoft's development libraries come in a binder full of CD-ROMs. A new, affordable, high capacity distribution medium is required, and DVD ROM will fill the gap nicely.

Price

You can walk down to the local computer store and pick up Creative Labs' full-blown DVD kit for just \$400 (Canadian). This kit includes a double speed DVD ROM player, and the necessary hardware to play DVD Video either to the computer screen or to a television, and through the computer speakers, or to a Dolby Digital surround system. Creative Labs have just announced that within a month the price will drop to \$300, and they are now selling a base version, without DVD Video playback for just \$150. What is going to keep the price down on DVD ROM units and the corresponding DVD discs is simple – the structure of the DVD is so similar to the CD-ROM. Compared to the startup costs involved with CD-ROM drive manufacturing or a disc pressing, the costs to support DVD are peanuts. With these affordable prices, soon all new computers will have DVD ROM drives as standard equipment.

Microsoft

These days you cannot look at the computer industry without considering how Microsoft is going to enter the picture. Fortunately for DVD, Microsoft is standing behind it, and it will be an integrated component of the new Windows 98 operating system due out in just a few months. In fact, DVD support for Windows 98 appears high on the feature list in press releases and product announcements. Windows 98 will be a contributing factor to the success of the DVD ROM.

The Internet

You also cannot look at the computer industry without considering how the Internet will fit into the picture. However, it is unlikely that the Internet will have much influence over the success of DVD. There will most likely be web-enabled DVD ROM applications, but they will not make nor break the DVD. Although video content is becoming more popular on-line, the quality and quantity of information over the Internet won't be competitive with DVD for a long time, if ever. The Internet may play a role in the marketing of DVD to the public, and it will help consumers collect information before they purchase a DVD player. Another area the Internet may play a role in is the distribution of DVD Videos. Instead of walking down to the corner store to purchase a DVD Video from a limited selection, consumers may choose to order their Videos from a large distributor on-line – there are already successful ventures on the Internet for both music and video.

The Television PC

Bill Gates has cited bigger, cheaper computer monitors as one of the key factors that will change the PC industry. Larger high-resolution, flat, thin screens will become affordable in a couple years. This will have a tremendous impact and help move the computer from the home office to the living room (ironically, where many of the first home-based computers started). Until HDTV becomes widespread, it may become perfectly acceptable for the family to gather around the computer screen to watch a home movie (this is practical today with 17" or larger monitors). This is where the home PC will help boost DVD Video. In homes with DVD Video capable PC hardware, the consumer is going to be much more likely to rent (or purchase) a DVD to watch at home. The consumers with this hardware will be also be the trendier consumers that will get the DVDs just for the novelty and "coolness" factor. You can almost picture one family member showing another one DVD Video on the computer, trying to justify why their computer costs so much. After some families have seen and used DVDs on their computer, they will feel much more comfortable spending the extra money to have a DVD player under the tree for Christmas.

Multimedia Applications

When the CD ROM was first introduced, it took some time before large quantities of multimedia titles started appearing. Now the market is flooded with them. In fact, many analysts are predicting that a crash similar to the one that happened to Atari and the console market in 1984. It only seems inevitable that the market is going to dry up. Computer owners

can only buy so many \$65 games. Some multimedia game companies have already started to fold. The introduction of DVD is going to cause some interesting ripples in the industry. The large and successful publishers will take the transition in stride, and will start introducing new products in the advanced format. However, the struggling game companies with sagging sales may not have the capital to invest in the tools required to deliver the higher quality game that consumers will expect for DVD. Initially, much like the introduction of CD-ROM, there may be some “shovel-ware”, where DVD titles will be quickly released with little or negligible quality improvements from their CD-ROM counterparts, but they will still sell because there won't be much DVD competition. However, once the market grows, the consumers will become more discerning, and the companies with shovel-ware and poorly crafted titles will be forced to sink or swim, and many of them will sink. However, not to worry, there will still be plenty of DVD ROM titles available in the near future.

Game Consoles

People close to the computer industry often underestimate the size and profitability of the game console market. Computer game companies will make much more money off a game developed for the Sony Playstation than one developed for a PC. In the near future, the new SEGA Katana system is going to hit the market strong, and for the first time, a console will use the Windows CE operating system. If the Katana system uses the DVD, it will be quite a boost. If the DVD catches on, then some of the other console systems could follow.

Interactive DVD

Although the CD-I system was not a commercial success, it is unfortunate that more of the system was not incorporated into DVD. While studying the DVD standard, we were surprised at how limited the interactive capabilities of the DVD are. A simple microprocessor with a small instruction set and limited memory could have added quite a bit to the DVD standard. Within the current DVD standard, interactivity has to be done through a computer, using DVD-ROM. As it is right now, Phillips is planning a DVD-I standard that will probably be unsuccessful for the same reasons CD-I wasn't popular – it will be too difficult to achieve critical mass.

The VCR

The VCR will continue to be around for a long time. The consumers like their ability to record, and their investment in purchased, recorded and home movies will make them hold onto their VCRs. DVD will cause a dip in the rental and sales

of videos, and the sales of VCR units, but the industry will continue to be strong. Because of the installed base of VCRs, the movie studios will continue to have new releases available for the VCR. The continued availability of new releases and the large availability of the classics will persuade cautious consumers to postpone a DVD purchase. However, as the "DVD" section of their local Blockbuster video becomes larger and larger, they will eventually be convinced that the DVD is a "safe" purchase.

The Laserdisc

The DVD will mark the beginning of the end of the laserdisc. There are already units out there that support both DVD and laserdisc, so laserdisc owners will be able to "ease" into DVD, but laserdisc owners have invested a lot of money into their laserdiscs, so many of them will take the transition kicking and screaming. As long as Hollywood is still making money from laserdiscs, then they will continue to produce them. However, as soon as the volumes start to put the profits in question, they will start weaning off their laserdisc production. On today's television, the laserdisc quality and DVD quality are still comparable. However, when HDTV becomes popular, the difference will become much more noticeable, and it will most likely be the death of the laserdisc. In any event, it is unlikely that a lot of money will be invested in the relatively new "MegaLaserdisc" format.

Video on Demand and Digital Satellite

From most of the reports, it doesn't appear that the DVD industry considers Video on Demand (VoD) or Digital Satellite dishes a threat. However, we don't think it would be wise to discount them yet. The Telephone Companies and Cable Companies are investing enormous amounts of money into VoD systems. Many of the Digital Satellite dishes will support VoD as well. If they can have an extensive video catalogue and provide DVD quality picture to the home viewer it could deter people from investing in DVD. VoD systems are still in pilot areas across North America, but for some urban areas they may soon become a reality. DVD will have a considerable head start on VoD, so it may not be a factor in home units, but it could effect the purchase and rental market in the future.

DivX

DivX seems to be one of the biggest threats to the success of DVD Video -- it has pulled the rug out from underneath all the work that went into DVD. Some of the studios and manufacturers have already announced that they will not

participate in DivX, and so there is going to be a format war. The failure of DivX will hinge around one factor: will the studios committed to DivX also release regular DVD versions? The questionable benefits that DivX promises will not be worth the hassle it will provide the consumer. The general public is not ready for complicated accounts and cost structures and doesn't feel comfortable hooking their DVD player into the phone. Of all countries, the Americans seem the least likely to allow this invasion of their privacy (which, ironically, is the only country that DivX will work in, because of the encryption used). Only if there are exclusive DivX-only titles will it sway the consumer market, especially if the animated Disney titles are DivX-only. Another strike against DivX is what is going to help make the DVD a success: the computer. With no PC DivX players, PC users will immediately balk at DivX, and there will be no momentum generated for the DivX videos. Hopefully DivX will fail without taking DVD Video down with it.

Adult Entertainment

The Adult Entertainment industry is always big business. It has helped contribute to the success of film, the VCR, and more recently the Internet. There are already titles available, and many more slated for release. The DVD will become a popular medium for adult movies because of the high resolution, and the "multi-angle" capabilities. Titles have even been announced with "3D" angle views, where presumably special glasses could be worn. This trendy use of alternate angles may become popular in other movie forms as well.

Old Cameras and the Photo CD

Although the Kodak Photo CD enjoyed some small success, it never really took off. It came out too late in the CD-ROM standard to become popular. However, clever entrepreneurs will be able to make some profits by utilizing the DVD as a photo CD. Imagine taking a stack of photographs into a local business, where the business would scan in all the photos, and then produce a DVD slide show with all the photos... perhaps even to a musical score. The businesses could also take existing home movies on VHS (or Super8) and digitize them and include them on a DVD – to keep costs down, they could probably get away with just using MPEG-1. As prices of DVD-R and authoring tools drop, the charge to do this conversion could become quite affordable. Services such as these may very well help contribute to the success of DVD Video.

DVD Audio

DVD Audio almost seems like an afterthought to the DVD standard. DVD Audio will not likely play an important part in the overall success of DVD. The regular CD is not going to disappear for a long time. It seems unlikely that the DVD Audio will achieve enough market base to support titles that will be DVD only, or encourage people to buy a DVD Audio player. However, the record companies may start concurrently releasing CDs and enhanced, "premium" DVDs. In order to sell the DVDs, they will most likely add bonus audio tracks, additional artwork or band information, and perhaps some live video. Large boxed sets and collections will also start appearing in DVD format (but they'll also have regular CD format). It should be noted that record companies have already released many live concerts on DVD Video format. The only thing that may make the DVD Audio format popular is DVD RAM. In fact, our recommendation to the standards committee would be to postpone the DVD Audio standard until after the DVD RAM standard. An easy to use DVD RAM device for recording Audio could do extremely well in the market, and the prospect of storing so much audio on one disk could make consumers leave their tape cassettes.

HDTV

One of the problems that will plague HDTV for many years is the hype. Consumers have been hyped and de-hyped about HDTV so much that they don't know what to expect. HDTV market penetration is still far away, and it would be premature to make too many predictions. However, it seems that with the force of the government and the FCC, HDTV will be inevitable. While HDTV is reaching its critical mass, some interesting things will occur with DVD. At one point, consumers will realize that their regular HDTV is of higher quality than their DVD. Consumers will be used to this concept, as their VCRs are of poorer quality than their regular television. However, to satisfy the need for quality, DVD2 will most likely be unveiled, with HDTV resolutions. The success of DVD2 is too hard to predict – the market will have changed so much over the next five years that anything is possible. It is most likely that if HDTV does not kill the laserdisc, then DVD2 probably will.

Conclusion

At the very least, this section should convey how many factors there will be contributing to the success of DVD – and DVD will be a success. The DVD Video will enjoy some popularity, and will help gain critical mass with the expanded DVD ROM install base. Together, the two formats will lure enough people to the world of digital video to start making the manufacturers and the publishers money. And once everyone starts making money (even if it's not as much as they had originally forecasted) then things will really start to happen. Some people may argue that critical mass has already occurred. By the end of 1997, 350,000 DVD Video units were sold in America. Although those sales figures are extraordinary, we don't think the DVD will upset the VCR as the fastest growing appliance – simply because DVD will never get the penetration that the VCR has. For an interesting comparison, in their first years 30,000 Betamax units were sold, and 65,000 8-Track units were sold – which at the time were considered phenomenal successes. It is our opinion that the indefinable “critical mass” for DVD will probably occur in 1999.

A Long Term Vision – What Comes Next?

DVD will be around for a long time. DVD ROMs will continue to be supported on computers long after they are replaced. As laser technology improves, perhaps an even higher density disc will be developed, providing backwards compatibility for all those people with “obsolete” DVD drives. With laptops and PDA continuing to grow, instead of maintaining the old DVD standard, the computer industry may choose a smaller disc size, perhaps using magnetic-optical technology. But maybe after a few more generations, there may not be a disc at all...

It almost seems ridiculous that the DVD is still based on a 19th century concept: a rotating disc. Eventually, at one point, it will become viable to stop making devices that move. Just consider all of the mechanical parts that go into spinning the disc, moving the laser, focusing the laser and reading the reflected laser. Think of all the redundant data on the DVD, necessary only because the media is moving. Think of how sensitive the arms of a hard drive are, and how susceptible they are to a “crash”.

I don't know how the technology will develop, or what will be involved, but in my mind I can picture a device no larger than a PCMCIA card that would have the capacity of several DVDs and be read-writable. Static Ram is the best term we have for it now, but I'm sure when the time comes a fancier name will be developed – for now, I'll call it a “Data Card”. Imagine a Small Video Camera where you just slide in a data card and can record hours upon hours. At home, on top of your television set would be a “Data Bank” where it can hold dozens of data cards, holding your entire music and video collection. Perhaps you can just wander down to the local record shop, plug in your “Data Card” at the nearest outlet, and receive some samples of the latest music, and a few movie trailers. Maybe you could rent or purchase a movie and have it transferred to your data card immediately. Imagine this scenario: you have to fly on the plane tomorrow, so you quickly download onto a data card last quarter's sales figures, a couple episodes of the Simpsons, the novel you are currently reading, your favourite album, the Vancouver Sun from the last few weeks, and a movie you haven't seen yet. You never know...

References

All of the information in this report is either opinion, or is based upon data obtained on the Internet. FAQ's and News services proved to be the easiest way to obtain information, but some of the more interesting information can be a little harder to find. Here is a small subset of some of the more interesting sites that were used to develop this paper:

<http://www.unik.no/~robert/hifi/dvd/>

<http://www.videodiscovery.com/vdyweb/dvd/dvdfaq.html>

<http://www.news.com>

<http://www.tacmar.com/>

<http://www.kbnet.co.uk/rleggat/photo/history/beginnin.htm>

<http://til.info.apple.com/techinfo.nsf/artnum/n17805>

<http://www.olemiss.edu/~badwf/atari2600.html>

<http://www.sponsor.net/~gchance/PongStuff/pongindex.html>

<http://www.cd-info.com/CDIC/Technology/CD-R/FAQ.html>

http://www.gen.umn.edu/faculty_staff/yahnke/film/cinema1.htm

<http://www.emiclassics.com/boheme/books.html>

<http://www.mediahistory.com/time/alltime.html>

<ftp://ftp.atd.ucar.edu/pub/dat-heads/FAQ>

<http://www.hickory.net/malco/8track/faq.txt>

<http://www.mpeg.org/MPEG/DVD/General/Glossary.html>

<http://www.ushistory.net/toc/phono.html>

http://www.appliance.com/mm/stats/html/november_1997.html

<http://www.cemacity.org/cemacity/mall/product/video/files/hstryvcr.htm>

<http://www.me.udel.edu/~mercurio/history.htm>

<http://www.cs.tut.fi/~leopold/Ld/FAQ/index.html>

<http://www.onlineinc.com/cdrompro/0296CP/res2.html>