Moving Image and Sound
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The DVD-ROM

The idea of bringing Hollywood films and others videos into one's home is nothing new. Following VHS tapes and even laser discs, the DVD-ROM promised to revolutionize the home video market with its superior sound and image quality. Physically similar to a CD-ROM, the DVD is able to store more content, including feature length films and interactive menus. This paper will focus on exploring the history of the factory made DVD-ROM, its physical characteristics, target market, and preservation issues. Furthermore, it will include information on playback devices and format advantages and disadvantages.

Back in 1986, former Warner Home Video president Warren Lieberfarb had a vision. He believed change needed to happen in the entertainment world and that although "videocassettes sales and rentals were still profitable, (…) producing a superior digital packaged product" would push the "home video industry [to] jump out ahead of digital content delivery via cable, satellite, and DSL."[1] Furthermore, storing movies on a CD-type device for sale at a reasonable price would lure costumers into buying copies of films instead of renting them, which would then

[1] "Father Of The DVD: Warren N. Lieberfarb, W'65." *Wharton Magazine*, July 1, 2007. http://whartonmagazine.com/issues/anniversary-issue/father-of-the-dvd-warren-n-lieberfarb-w%e2%80%9965-2/.

allow studios to make more profit, since "selling discs let them keep two-thirds of every dollar compared with only one-third for renting tapes."[2]

With all this in mind, Lieberfarb started to push Japanese consumer electronics makers to develop such technology. In 1993, Warner partnered up with Toshiba to "develop data compression and storage technologies needed to put full-length feature films on 5-inch optical discs,"[3] called the Super Density (SD) disc. Both companies attempted to bring Philips into the mix, since the company already held "a number of key patents related to the audio CD," but instead, it teamed up with Sony to create the Multimedia Compact Disc (MMCD).[4]

Although the two disc technologies were incompatible and could possibly recreate a Betamax versus VHS battle, both parties promised to comply with the following Hollywood requirements:

- Ability to accommodate 135 minutes of information on a single disc.
- Picture quality superior to high-end video players (i.e., laserdisc).
- Audio compatibility with surround-sound systems and with Dolby 5.1.
- Ability to accommodate three to five languages and multi-rated versions of a program on a single disc.

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[2] Kirsner, Scott. "How the Disc Was Spun." *Daily Variety* 295, no. 16 (April 24, 2007): A12–14.

[3] Kirsner, Scott. "How the Disc Was Spun,"A14.

[4] Kirsner, Scott. "How the Disc Was Spun,"A14.

- Multi-aspect ratios.
- Parental lockout
- Copy protection.[5]

In order to avoid a possible format war, Lieberfarb worked to gain support of several Hollywood studios, including Universal, and finally the computer business, who had been looking for a format to replace CD-ROMs. Companies like "Microsoft, Intel, Apple and IBM gave both sides [of the dispute] a simple ultimatum: produce a single standard, quickly, or [do not] expect any support from the computer world."[6] By 1995, both sides had finally reached a compromise. The technology would combine aspects from both formats: "[the] developers (now ten corporations large) would use Toshiba's SD disc, with its thinness and high data density, in combination with Sony's 'data coding methods,' called EFM Plus."[7] The Digital Versatile Disc (DVD) was announced at Comdex, a computer exposition, in November of that year[8] and Lieberfarb became known as the Father of the DVD.

In August of 1997, the ten initial corporations (Hitachi, Matsushita, Mitsubishi, Philips, Pioneer, Sony, Thomson Multimedia, Time Warner, Toshiba Corporation, and Victor) behind the DVD formed the DVD Forum, whose purpose was to "exchange and disseminate ideas and information about the DVD Format and

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[5] Fitzpatrick, Eileen. "Taking Stock Of DVD Rivalry." *Billboard (Archive: 1963-2000)*, May 27, 1995.

[6] Fitzpatrick, Eileen. "Taking Stock Of DVD Rivalry."

[7] Chapin, Robert. "History of DVD," September 24, 1999. http://www.miqrogroove.com/writing/history-of-dvd/.

[8] Traiman, Steve. "The Shape of Things to Come." *Billboard*, January 13, 1996.

its technical capabilities, improvements and innovations."[9] According to its website, which was last updated in 2004, the forum grew to encompass 100 members, all organizations that were involved "in activities related to DVD research, development and/or manufacturing."[10]

The Digital Versatile Disc (or Digital Video Disc) Read Only Memory, commonly referred to as DVD-ROM, consists of a 12 cm diameter with 1.2mm thickness disc, similar to a compact disc-read only memory (CD-ROM) in shape. However, the DVD-ROM has a larger storage capacity, since it is able to store "up to 13 times the data contained on a CD on one side [and if one factors] in DVD's capability to utilize both sides of a disc for data storage, [one has] an information marvel that offers 26 times the power of a Compact Disc."[11]

The DVD-ROM "can be manufactured with one or two recorded layers on each side,"[12] and has similar physical properties to a CD. Most of its surface is made out of a polycarbonate substrate layer, which "provides the disc depth necessary to maintain laser focus on the metal and data layers [and] gives the disc enough strength to remain flat."[13] Unlike R Discs, DVD-ROMs do not have a separate data

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[9] "DVD Forum's Mission." Accessed November 4, 2016. http://www.dvdforum.org/about-mission.htm.

[10] "DVD Forum's Mission."

[11] "DVD Technology FAQ." Accessed October 14, 2016. http://www.dvdforum.org/tech-faq.htm.

[12] "Disc Structure — Council on Library and Information Resources." *Council on Library and Information Resources*. Accessed October 15, 2016. https://www.clir.org/pubs/reports/pub121/sec3.html.

[13] Byers, Fred R. "Care and Handling of CDs and DVDs." Council on Library and Information Resources National Institute of Standards and Technology, October 2003. https://siarchives.si.edu/sites/default/files/pdfs/pub121.pdf.

layer. Instead "a molding machine uses a stamper to impress the pits (depressions) and lands (surface), which form the data, into the polycarbonate substrate surface."[14] Unlike those of a CD, these pits of data are:

> Smaller and rest closer together, [which] allows a shorter laser wavelength that in turn allows more data to be stored per track. The result is more efficiency in error correction and channel bit jitters. In addition, the disc has a thinner outer layer to let the reading laser pass through the extra layers with more ease.[15]

While CD drives use an infrared light with a wavelength of 780 nanometers, DVD-ROM drives and players use a visible red light laser with a wavelength of 650 and 635 nanometers.

On top of this layer, metal, usually aluminum or gold for double-sided discs, is molded, allowing the light from a laser beam to be either absorbed or reflected. This process is how the information on the DVD is read. Finally, there is an optional surface layer, which provides a surface for labels and logos. This layer is applied "over the polycarbonate substrate on a single-sided DVD" and can be:

- Thermal-printable
- Inkjet-printable
- Silkscreen-printable
- A surface that will accommodate more than one type of printing.[16]

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[14] "Disc Structure — Council on Library and Information Resources." *Council on Library and Information Resources*. Accessed October 15, 2016. https://www.clir.org/pubs/reports/pub121/sec3.html.

[15] "DVD Information." Accessed November 5, 2016. http://www.cd-info.com/dvd/.

[16] "Disc Structure — Council on Library and Information Resources." *Council on Library and Information Resources*.

As previously mentioned, double-sided DVD-ROMs can be produced with two reflective layers, which in turn provide more storage capacity than single-sided DVDs. In order for these double-sided discs to be read:

> The laser beam must pass through a semi-reflective metal layer to read data from a fully reflective layer. The outer metal layer (silicon, gold, or silver alloy) is semi-reflective; that is, it reflects back some of the laser beam and allows some of it to pass through to a fully reflective layer (aluminum) and then reflect back. Both parts are thus reflected to, and detected by, the photosensor in the laser head, which focuses on one layer at a time.[17]

Another aspect of the DVD-ROM is that once information is stored, it cannot be changed or erased. Memory-only discs record "both MPEG2 video information, super-audio signals and purely digital data."[18] The fact the DVD stores video in a digital component format results in:

> Video horizontal resolution of over 500 lines with a s/n ratio of around 65db. DVD also delivers true "RGB" video quality when using the S-video or "component video" output jacks. The result is razor sharp detail and computer quality text, without any NTSC color subcarrier crosshatch distortion. Resolution is further enhanced with "widescreen" releases that are encoded to be compatible with 16x9 TV's. 16x9 encoded DVDs have 25% better vertical resolution than "normal" widescreen encoding. This applies to on all widescreen ratios above 1.77 to 1. Viewing 16x9 encoded DVD's do not require a 16x9 TV, but the image will look slightly compressed horizontally. This can be corrected by switching the player to standard widescreen, but you loose the extra resolution. Many DVDs also offer Pan- Scan transfers, giving a choice of up to 3 aspect ratios.[19]

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[17] "Disc Structure — Council on Library and Information Resources." *Council on Library and Information Resources*.

[18] Braat, Joseph, P. Dirksen, and Augustus J.E.M. Janseen. "Diffractive Read-Out of Optical Discs." Accessed October 18, 2016. https://www.univie.ac.at/nuhag-php/janssen/data/p119.pdf, 6.

[19] "Is DVD Better Than Laser Disc?" Accessed November 20, 2016. http://www.starlaser.com/dvd-lasr.htm.

In addition, "analog information is converted into digital information, which is then encoded onto the disc from the inside edge out."[20] As mentioned previously, the technique used for encoding is known as EFM Plus, eight-to-sixteen (8/16) modulation.

The EFM Plus, or Extended Functionality Mode Plus, which was invented by Kees A. Schouhamer Immink, is yet another characteristic of the DVD-ROM that allows for better storage capacity than the one found in CDs. In this modulation system, which is a slightly different version of the CD's EFM 8/14, "an 8-bit binary information item (byte) is converted into (…) a 16-bit code word,"[21] which means that even though the translation tables DVD player's decoder chips are more complex, "the new modulation scheme requires 6 percent fewer pits and lands to convey the same amount of data."[22]

The discs also contain an error-correction system similar to but more powerful than a CD's. Called the Reed-Solomon product code, the system works by making blemishes and damage present on the disc surface "less out-of-focus," causing them to be almost completely obscured by the DVD's data pits. Since the

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[20] "What's a DVD and How Does It Work?" *Scientific American*. Accessed October 15, 2016. https://www.scientificamerican.com/article/whats-a-dvd-and-how-does/.

[21] Sannino, Roberto, and Filippo Brenna. System for decoding the EFM and EFM-plus format in optical disc (CD and DVD) read units and corresponding method of decoding. Accessed November 20, 2016. https://www.google.com/patents/US6043764.

[22] Ranada, David. "Inside DVD: How the New Disc Got Its (Very Tiny) Spots." *Stereo Review*, January 1998.

Reed-Solomon only occupies a small space on the disc, it increases the "DVD disc data density by another 16 percent."[23]

DVD-ROMs require a DVD drive to play its contents. The DVD player is made of three parts: the optical system, a disc drive mechanism, and a printed circuit board (PCB):

- Optical System: The system consists of "laser beam, lenses, prism, photo-detectors and also mirrors."
- Disc Drive Mechanism: A motor drives the disk in circular motion and a disc feed loads the disc into the player. A spindle holds the disc in place.
- Printed circuit board: Similar to other electronic circuits, it must be kept clean and dust free.[24]

As mentioned earlier, the polycarbonate substrate layer has pits, which hold the data information. These pits and subsequent smooth surfaces are read by red laser from the optical mechanism with a wavelength of 600 nanometers, which "is about 180 nanometers lesser than the wavelength of CD."[25] The laser is designed to hit a single spot, but due to the circular motion of the disc inside the player, its whole area is covered.

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[23] Ranada, David. "Inside DVD: How the New Disc Got Its (Very Tiny) Spots."

[24] "Working of DVD Player – Electronic Circuits and Diagram-Electronics Projects and Design." Accessed October 18, 2016. http://www.circuitstoday.com/working-of-dvd-player.

[25] "Working of DVD Player – Electronic Circuits and Diagram-Electronics Projects and Design."

A light sensor collects the reflected laser beams and converts "the different signals into a binary code; (…) the smooth surface is usually taken as a '0' and pits are usually taken as a '1.'"[26] The binary code is then "sent to a Digital to Analog converter, which will be setup in the PCB," where amplifiers amplify the signal and send it "to the graphic and audio systems of the computer/TV."[27]

The first DVD player was 1996's Toshiba SD-3000 and included many features, such as:

> 2X- and 8X-speed playback; frame-by-frame playback; slow motion playback; last memory playback to start playback from the position at which the playback previously stopped; title/chapter/track search to search the start of a desired title, chapter or track; repeat playback to playback only the desired title, chapter, track or portion; and memory playback to playback up to 30 desired titles, chapters and tracks in a desired sequence.[28]

All these physical characteristics allow the DVD-ROM to carry several of other features in addition to the main presentation. Among these features, one can find multilingual capabilities, since "it is possible to store a maximum of eight soundtracks, each in a different language, and subtitles in 32 languages" and multi-aspect feature, which means wide-aspect images can be compressed to 4:3 to fit a television of that ratio and still be stretched back to 16:9 for a wide screen display.[29]

Furthermore, this technology allows the user to randomly access any point of the disc, without having to rewind or go through it in its entirety to find a particular

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[26] "Working of DVD Player – Electronic Circuits and Diagram-Electronics Projects and Design."

[27] "Working of DVD Player – Electronic Circuits and Diagram-Electronics Projects and Design."

[28] "Toshiba : Press Releases 26 September, 1996." Accessed October 18, 2016. https://www.toshiba.co.jp/about/press/1996_09/pr2603.htm.

[29] "Toshiba : Press Releases 26 September, 1996."

scene or information. It is also common for a disc to contain extra footage, special commentary from those associated with the production, different angles of the same shot, and even different endings all in one disc. Educational programs such as "*Rules of the Road*, an educational program aimed at helping teens become better drivers, not only serves as a practical hands-on driver's education course, but also provides multi-angle 3-D graphic options, interactive menus and quizzes, and a virtual-driver feature."[30] All this information can be accessed several times without wear and tear, since the optical disc is read by a laser and does not make any physical contact with the pickup.[31]

The small size of the DVD and manufacturing costs were big selling points for its marketing. In fact, "[in] large quantities, DVD [cost] under $1.00 per unit to manufacture" which allowed for the retail price of less than $20.00, "while maintaining good profits for copyright holders, distributors, and dealers."[32] However, at first, the ROM disc was a product not aimed at everybody and had a very specific target market. As Gail Becker, then vice president of publicity for Warner Home Video, puts it: "In the very beginning, the early [DVD owner] profile was young men with a certain amount of income (…) But [by 1999] that time has

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[30] Pitman, Randy. "Making Room for DVD: The Tipping Point." *American Libraries*, November 2003.

[31] "How Does a DVD Work?" Accessed November 5, 2016. http://www.copy-cd.biz/technical-area/dvd-explained.jsp.

[32] "Is DVD Better Than Laser Disc?" Accessed November 20, 2016. http://www.starlaser.com/dvd-lasr.htm.

gone by and with a base of 1.4 million [DVD] units"[33] the base started to broaden. At the end of 1999, "four million U.S. households have DVD players."[34]

Of course, the DVD-ROM is not perfect and contains several disadvantages that should not be ignored. As previously mentioned, once manufacturers record information onto the DVD-ROM, it cannot be changed. In fact, "most commercially-produced DVD movies contain copy-protection mechanisms to prevent users from creating unauthorized copies of the disc."[35] In other words, if the user decides he or she needs more copies of the disc, they cannot create copies and have to buy new ones, which could be a bigger problem if the needed disc is no longer available in the market.

When it comes to international market, DVD-ROMs also produce a new problem. Due to a built-in regional lockout, playback maybe be restricted to a certain region or territory, preventing "those who live in one region from successfully viewing a DVD movie that was produced and distributed for a different region."[36] Though early players were not able to have their region changed, some

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[33] King, Susan. "As DVD Popularity Grows, So Do Extras." *Los Angeles Times*, July 15, 1999. http://articles.latimes.com/1999/jul/15/entertainment/ca-56076.

[34] Kirsner, Scott. "How the Disc Was Spun,"A14.

[35] "What Are the Disadvantages of a DVD ROM? (With Pictures)." *wiseGEEK*. Accessed November 5, 2016. http://www.wisegeek.com/what-are-the-disadvantages-of-a-dvd-rom.htm.

[36] "What Is a DVD Region Lock?" *TopTenREVIEWS*. Accessed November 5, 2016. http://www.toptenreviews.com/software/articles/what-is-dvd-region-lock/.

computer drivers, like 2003's Asus DVD-E616P1, allowed the user to change the region to play an international disc up to five times.[37] The regions are as followed:

- Region 1 - United States and Canada.
- Region 2 - Japan , Europe, South Africa , Middle East, and Greenland.
- Region 3 - S. Korea, Taiwan , Hong Kong, and Parts of Asia.
- Region 4 - Australia , New Zealand , Latin America, and Mexico.
- Region 5 - Eastern Europe , Russia , India , Africa.
- Region 6 – China.[38]

Many believe the DVD-ROM technology is not the best for archiving activities. One of the concerns for preserving a DVD-ROM is tied to the physical properties of the reflective layer. Due to the easiness of application and low costs, aluminum is used, therefore subjecting the DVD to the possibility of oxidation if exposed to moisture and oxygen. This can be a big problem since "oxidation of the aluminum diminishes its reflectivity, making the disc unreadable by the laser, and is sometimes referred to as disc 'rot,' [which] is the primary cause of ROM disc degradation from environmental influences."[39] For this reason, it is best to keep discs "in a cooler, less-humid environment and not subjected to extreme environmental changes."[40]

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[37] "DVD-E616P1 DVD-ROM Drive User Manual," June 2003. http://dlsvr04.asus.com/pub/ASUS/dvdrom/e616p1/DVD-E616P1_E13051.pdf.

[38] "What Is a DVD Region Lock?"

[39] "Disc Structure — Council on Library and Information Resources."

[40] "5. Conditions That Affect CDs and DVDs — Council on Library and Information Resources." Accessed November 5, 2016. https://www.clir.org/pubs/reports/pub121/sec5.html.

DVDs can be fragile. Physical mishandling can cause damage to the polycarbonate substrate layer, which can interfere on how the laser reads the disc. Superficial scratches might not cause much interference due to the previously mentioned "error detection and correction coding in the disc drive,"[41] but if a scratch is deep enough, information cannot be read or restored.

Another disadvantage to the DVD-ROM is that it uses compression to store data. The disc uses MPEG-2 compression, a "lossy" compression since it throws "away portions of the original information on the premise that [one cannot] really hear or see [what is] thrown away."[42] In fact, a "typical DVD compression averages 50:1, with 98% of the original data discarded."[43] This can be a problem especially if the film or video that is being recorded is of low quality. Furthermore "discs that are not mastered to exacting standards can show some compression 'artifact' distortion [which] usually show up as grey-scale distortions or 'shade rings' in otherwise soft pastel tones."[44]

Another image distortion issue common in especially first releases of factory recorded DVD-ROMs is edge enhancement. Edge enhancement, which "is a digital image processing filter that is used to make pictures look [artificially] sharper

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[41] "5. Conditions That Affect CDs and DVDs — Council on Library and Information Resources."

[42] Crawford, Walt. "MP3 Audiobooks: A New Library Medium?" *American Libraries*, August 2001, 64.

[43] Crawford, Walt. "Up to Speed on DVD." *American Libraries*, September 1999, 71.

[44] "Is DVD Better Than Laser Disc?"

than they really are,"[45] creates a halo effects around the different components of an image. Though this particular problem is more connected to Telecine operators trying to compensate for the softer pictures resulting from how transfers are made, it can greatly impact the image quality of the moving image stored in a DVD.

It took almost two decades for the DVD to be developed and by 2006, the "revenue from [discs] rentals and sales [flattened] out at around $24 billion (…) about $10 billion more, give or take, than what the entire [video business] was worth in 1997."[46] There is no doubt that this technology brought several advantages to the home video market, including its portable size, ability to store feature length films and extra content, reduced retail price, and better sound and image quality, especially when compared to the VHS tape. However, the DVD-ROM also has its downsides. The inability to re-record information on a disc, its copy protection, and regional lockout can pose issues for consumers and might impact on how they are able to use the disc. Archive institutions are also likely to run into problems when it comes to preserving these items. The aluminum present in the disc can oxidize and render the DVD unreadable or if mishandled, scratches can irreversibly damage data. Though it remained

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[45] "Ultimate Guide to 'Edge Enhancement.'" Accessed November 21, 2016. http://www.videophile.info/Guide_EE/Page_01.htm.

[46] Frankel, Daniel "DVD Timeline." *Variety*, April 23, 2007. http://variety.com/2007/digital/features/dvd-timeline-1117963613/.

popular until early 2000s, according to a report by the industry trade group the Digital Entertainment Group, "overall home entertainment revenue grew 0.2% in 2012, surpassing $18 billion [and] physical disc sales have fallen by about 30% since their 2004 peak, to some 700 million units"[47] as of 2013. Today, it is rare for someone to choose to buy this technology, since most costumers prefer the convenience of streaming and video on demand services.

[47] Hayes, Dade. "Six Reasons Why DVDs Still Make Money -- And Won't Die Anytime Soon." *Forbes*. Accessed November 22, 2016. http://www.forbes.com/sites/dadehayes/2013/07/08/six-reasons-why-dvds-still-make-money-and-wont-die-anytime-soon/.

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This page relates several environmental conditions (temperature, light, humidity etc.) that affect the DVD.

Bennett, Hugh. "DVD-ROM and CD-R." Emedia Professional 11, no. 3 (March 1998): 56. Film & Television Literature Index with Full Text, EBSCOhost (accessed November 26, 2016).
This article focuses on the major DVD drive manufacturers and how such drives differ from CD players.

Braat, Joseph, P. Dirksen, and Augustus J.E.M. Janseen. "Diffractive Read-Out of Optical Discs." Accessed October 18, 2016. https://www.univie.ac.at/nuhag-php/janssen/data/p119.pdf.
In depth look on how laser reads the data present in the pits of a CD and DVD.

Bush, Michael D. "Digital Versatile Disc (DVD): The New Medium for Interactive Video." CALICO Journal Vol. 17, no. No. 3 (2000): 453–74.
Article exploring the interactive qualities of the DVD-ROM, especially in classrooms.

Byers, Fred R. "Care and Handling of CDs and DVDs." Council on Library and Information Resources National Institute of Standards and Technology, October 2003. https://siarchives.si.edu/sites/default/files/pdfs/pub121.pdf.
Useful and practical information on how to care and handle CDs and DVDs. Also covers physical aspects of various types of DVDs.

"CD / CD-R and DVD-R RW Longevity Research - Research Projects - Preservation Science (Preservation, Library of Congress)." Web page. Library of Congress. Accessed October 15, 2016. https://www.loc.gov/preservation/scientists/projects/cd-r_dvd-r_rw_longevity.html
Research exploring CDs and DVDs longevity. It was found that DVDs last for about 30 years.

Chapin, Robert. "History of DVD," September 24, 1999. http://www.miqrogroove.com/writing/history-of-dvd/.

Details on how the DVD came about. Article especially focus on the almost format war that took place between the SD disc and MMCD disc.

"Computer Makers Ready To Introduce DVD-ROM - Entertainment Industry Magazine Archive - ProQuest." Accessed October 14, 2016. http://ezproxy.library.nyu.edu:2091/eima/docview/1506008861/5F72A4BA29C24ED9PQ/1?accountid=12768.
Article detailing how the computer industry will use the DVD-ROM to store computer games. The article also explores how people can play DVD-ROMs storing movies in their computers.

Crawford, Walt. "MP3 Audiobooks: A New Library Medium?" American Libraries, August 2001. http://www.jstor.org/stable/25645999
Short article explains how MP3 and MPEG use compression, allowing large files to be stored in DVDs and CDs.

"Up to Speed on DVD." American Libraries, September 1999. http://ezproxy.library.nyu.edu:2105/stable/25637294
Crawford describes the properties and characteristics of the DVD. He also makes the case that the DVD will be adopted by libraries as a way to store content.

Dale, Martin, and Martin Dale. "Warren Lieberfarb: The History of DVD and Cable Networks Highlights the Tremendous Value of Classic Films." Variety, October 12, 2014. http://variety.com/2014/film/global/warren-lieberfarb-the-history-of-dvd-and-cable-networks-highlights-the-tremendous-value-of-classic-films-1201328060/.
Variety interviews Warren Lieberfarb about his involvement in the history of the DVD.

"Disc Structure — Council on Library and Information Resources." Council on Library and Information Resources. Accessed October 15, 2016. https://www.clir.org/pubs/reports/pub121/sec3.html.
Webpage explains the physical makeup of the DVD and the differences between the various types of discs (DVD-R, DVD-ROM, CDs, etc.)

"DVD Forum's Mission." Accessed November 4, 2016. http://www.dvdforum.org/about-mission.htm.
Information on the DVD Forum.

"DVD Information." Accessed November 5, 2016. http://www.cd-info.com/dvd/.
Webpage contains general information on DVDs, including some of its history, storage capacity, and different types of discs.

"DVD Technology FAQ." Accessed October 14, 2016. http://www.dvdforum.org/tech-faq.htm.
Webpages with common questions about the DVD technology: how to play it, longevity, how is it different from the CD, picture quality, etc.

"DVD-E616P1 DVD-ROM Drive User Manual," June 2003. http://dlsvr04.asus.com/pub/ASUS/dvdrom/e616p1/DVD-E616P1_E13051.pdf.
User manual detailing how to operate a DVD drive.

"Fast Forward: Goodbye, CDs! - Entertainment Industry Magazine Archive - ProQuest." Accessed October 14, 2016. http://ezproxy.library.nyu.edu:2091/eima/docview/1401425691/BD7030204FA04FBEPQ/6?accountid=12768.
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This article details the initial rivalry between Toshiba/Warner and Philips/Sony.

Frankel, Daniel. "DVD Timeline." Variety, April 23, 2007. http://variety.com/2007/digital/features/dvd-timeline-1117963613/.

A very direct timeline of the DVD history. Starting with Lieberfarb in 1986 and ending in 2006 with Blu-ray and HD-DVD.

Hayes, Dade. “Six Reasons Why DVDs Still Make Money -- And Won’t Die Anytime Soon.” Forbes. Accessed November 22, 2016. http://www.forbes.com/sites/dadehayes/2013/07/08/six-reasons-why-dvds-still-make-money-and-wont-die-anytime-soon/.
Article debating the reasons why there has been a decline in DVD sales and why it is still premature to say DVDs will disappear completely.

"HD DVD VS. BLU-RAY." Shoot 49, no. 4 (February 29, 2008): 8. Film & Television Literature Index with Full Text, EBSCOhost (accessed November 26, 2016).
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Webpage detailing some of the history of the DVD and information on DVD drives.

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