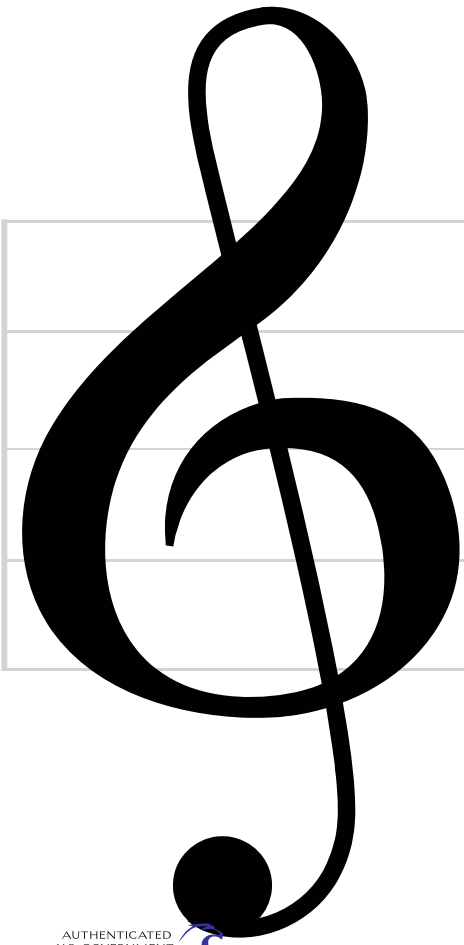
For The Record

How Format Wars Have Shaped Recording History



Modern technology and culture may find themselves in closest harmony revolving around the phonograph record. Reflections on the twentieth century conjure images that include the spotted dog Nipper peering quizzically into a Victrola, ecstatic teenagers at sock hops, and psychedelic album covers. Our cultural icons include Elvis, the Beatles, and Madonna. We live in an age when we are encouraged to "spin up", "get on track", and "stay in the groove"—language from the age of the gramophone.

The recording industry has supplied the lifeblood of popular entertainment for over a century, opening a window on the World's dreams, thoughts, and memories and preserving them for future generations. Technologies invented in the 1800s have made popular entertainment easily accessible from every corner of the planet. The phonograph record lies at the heart of those technologies, in one format or another. With so much power to shape culture, it is no wonder that the recording industry has been a battlefield for entrepreneurs who seek to profit from it.

Only a few years ago, "records" were thought of as the black, vinyl platters that spun out hit songs by the Bee Gees and symphonies by Beethoven. Vinyl records have since yielded to cassette tapes, Compact Discs, and Flash drives. Their ancestors include piano rolls, organettes, and music boxes. Recording formats have come and gone with regularity over the years—some slipping quietly into obscurity, others managing to define entire generations. The days of the gramophone record may be past, but the importance of recording popular culture and the entertainment that shapes it will never be lost.

The public's insatiable desire to be informed and entertained has inspired countless technological advances. Whether the recording technology of the day is papyrus or the iPod, it reflects from every facet of society. Accountants, doctors, engineers, teachers, military generals, priests, and bureaucrats inevitably find practical applications for recorded information. Practicality might drive the research necessary to pioneer new technologies, but entertainment can determine the direction those technologies take.

The quest to supply an incessant demand for richer, more rewarding media experiences continues to motivate entrepreneurs to come up with the next revolutionary media format. The cycle of invention, adoption, and obsolescence has repeated itself countless times throughout history, in ever tightening gyres. Today's pace of invention is measured by the stopwatch of Moore's Law, with cutting-edge technologies making their way to the recycle bin in a matter of months.

Recording media have been among the most visible technologies to pass quickly into obsolescence. Victrolas, cassette players, and video tape recorders clutter attics and garages worldwide. These modern antiques merge with the generations of popular recording formats that preceded them, and they are just as sure to be joined by many formats to come.

Winning the title of "best format" often comes with more than a little bit of luck and the willingness to put up a hard fight. Despite the difficulty of dispatching the prevailing technological format from its throne, and the inevitability of some day becoming equally archaic, each contending format is zealously defended by its inventors, investors, and early adopters. Few challengers can be winners in the Format Wars. Fewer still are remembered as champions.

Inventors who survive the Format Wars will go to great lengths to protect their secrets—and their profits. In modern times, patents are used to lay claim to the latest technological trend, and lawsuits are filed to challenge infringements. In millennia past, priesthoods preserved the mysteries of the oracle, and death could befall someone who might expose them.

Recording in High Definition

A format war seems to flare up every decade or so, and it can be a matter of years before an uncontested winner is declared. The new millennium ushered in one especially significant contest, to determine who will reign over the coming era of high-definition (HD) media.

The DVD Forum, caretakers of the prevailing laser recording format, had appointed HD DVD as the rightful successor to DVD—the current media king. Sony, who had been relegated to the sidelines in past battles, saw an opportunity for a coupe by getting to market first with Blu-ray, the company's laser disc contender.

Five years of intense fighting pitted Sony's Blu-ray camp against Toshiba and its allies championing HD DVD. To the surprise of many, on 12 February 2008, Toshiba raised the white flag and conceded defeat. As the dust settles on the laser disc battlefield, the outlook for a new generation of high-definition media storage has become clearer. Blu-ray stands as heir apparent in a long line of popular recording formats.

The current format champion may not wear the crown for long, if history is any indicator. New challengers are already lining up in the wings for a shot at the title, and they, in turn, will take up their positions on the battlefront of the Format Wars. Before we look to the conflicts that lie ahead, it can be enlightening to peer back into the past.

Checking the Records

Entertainment plays a major role in determining the prevailing format for recording information. Humans possess an innate passion for amusement, which has spawned technologies for creating music albums, movies, and video games.

The influence of the entertainment industry has reached extraordinary proportions in modern times. MP3s, video players, and game systems are considered essential equipment among a generation accustomed to immediate and unlimited access to wireless jukeboxes, cinemas, and arcades. But the obsession for songs, plays, and games did not recently evolve—it is tightly woven through human experience, from before history can account for it.

Ancient Artifacts

Music has been at the heart of human entertainment, perhaps for tens of thousands of years. Some of the earliest human technologies were developed for the sole purpose of making music. Prehistoric artisans crafted flutes from reeds and lutes from gourds. As technologies for creating music evolved, so did the desire to record what was played.

Musicians enjoyed a place of honor in early civilizations. Melodies performed during religious rituals were handed down orally as part of the priestly mysteries. By the time of the Golden Age of Greece, prizes were heaped on winning musicians at the Ancient Olympic Games. Some of the songs performed by choruses 2,500 years ago can still be sung today, reconstructed from fragments of ancient sheet music. Greek composers used a special notation system to record their melodies on papyrus. The sheet music they created may represent the first recording format for music.

The Greek engineering skills were preserved by Roman and Ottoman conquerors. Clockworks, invented by the Greeks, were combined with mechanical and hydraulic engines to create increasingly complex and even programmable machines. Some of these devices were designed to play musical instruments. Courtesans from Baghdad to Bologna were routinely treated to elaborately orchestrated displays that included boatloads of robot musicians and singing mechanical knights—all playing recorded music.

Skilled engineers crafted mechanical devices to mystify and entertain audiences for several centuries following the fall of the Greek Empire. Such automata became popular amusements, especially during

10,000 BC and Before
Memorization: In prehistoric times, melodies for songs and instruments were passed from one generation to the next by memorization.

100 BC
Clockworks: The Antikythera mechanism, crafted in the second century BC, was a programmable clockwork computer.

1200
Automata: Gears rigged to pull cables and trip levers were used to animate a variety of different contraptions, since at least the first century AD.

450 BC
Sheet music: Musicians in ancient Greece created the first copies of sheet music by adding musical notation to lyrics written on papyrus.

the Renaissance. Leonardo da Vinci was among the many artisans commissioned to create the cable-and-pulley-driven contraptions that would play back the music and actions recorded into them. The concept behind da Vinci wiring up an automaton's performance and a computer programmer writing code are essentially the same—only the materials and scale differ.

The Birth of the Modern Recording Industry

By the end of the Renaissance, recorded music had found its way into mechanical clocks, musical toys, and snuff boxes. The automata that had entertained audiences during much of Western history evolved into the barrel organ, ushering in an era of popular recorded music.

Barrel Organs

Barrel organs brought musical performances once reserved for wealthy urbanites to fairgrounds and street corners of small towns across Europe. Scores for elaborate tunes would be encoded with metal pins hammered onto the surface of a wooden drum, called the barrel. An organ grinder then turned a crank that was fastened to the barrel, causing the pins to pass over levers attached to pneumatic valves. When a valve was open, forced air would pass though a corresponding organ pipe to produce the desired note.

Several different tunes could be recorded on a single barrel by staggering the arrangements of the pins. To select another tune, the musician simply shifted the barrel forward or back to align a set of pins with the corresponding set of valves. Operating a barrel organ was primarily an engineering exercise. The music had already been created by the recording artist who wielded the hammer to set the pins in the barrel.

Player Pianos

By the late nineteenth century, the barrel organ had evolved into the player piano. Instead of using pins to open and close pneumatic valves, holes in a paper scroll allowed air to pass directly through corresponding valves. Mechanical amplifiers lifted the relatively heavy hammers sufficiently to strike the piano keys, without requiring so much force that the paper roll would be ripped apart by the forced air.

Successive improvements in the design of the player piano led to sophisticated recording processes that not only sped up production time for making piano rolls, but also provided subtly accurate recordings of individual performances. Accomplished concert pianists eventually agreed to have their performances recorded for posterity—and for profit. Competing piano companies and independent publishers began recording hundreds of classical tunes, popular ballads, and commissioned pieces for the piano.

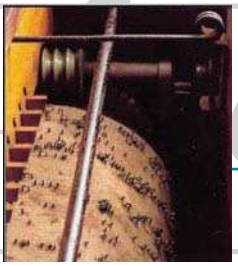
By the early 1900s, piano rolls in a variety of formats and materials flooded the music market. The availability of inexpensive piano rolls brought professional-quality musical performances into homes and social centers around the world. Player pianos were turning up in the parlors of back-country farm houses and small town saloons as well as in fashionable sitting rooms and concert halls.

Perforated rolls of paper were not the only medium for recording music at the turn of the nineteenth century, however. A revolutionary technology patented by Thomas Edison would soon replace the player piano as the family entertainment center and usher in the modern era of recorded entertainment.

Recording Cylinders

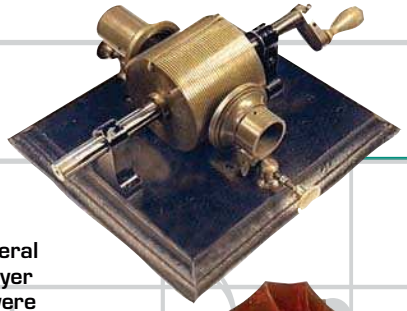
Edison had made his now-famous recording of "Mary had a little lamb" on a tinfoil covered cylinder in 1877. Early models of Edison's "talking machine" were sold mostly as office dictation machines under the Ediphone label. A home version of the talking machine, along with a limited number of prerecorded two- and later four-minute cylinders, was trademarked as the Phonograph.

Edison's talking machines attracted only a small audience. Attempts to miniaturize the recorded cylinders to make talking dolls also failed, due partly to the fragility of the tinfoil recording medium. Edison soon lost interest in his talking machine, turning his attention to the task of inventing the electric light. He even allowed the British



1400
Barrel organ: By the fifteenth century, the roller used in music boxes to pluck notes when metal pins passed by was adapted to create the barrel organ. The barrels used in cathedrals could be as large as 10 feet in diameter.

1876
Piano roll: Several pneumatic player instruments were exhibited at the Centennial Exposition of 1876 in Philadelphia, launching the earliest versions of the player piano



1877
Tinfoil cylinder: Thomas Edison introduced the phonograph in 1877. The first working talking machine was indented primarily for taking dictation.

1886
Wax cylinder: The Graphophone used engraved recordings on wax coated cylinders, making a significant improvement to the embossed cylinders used in the phonograph.

patent on the phonograph to expire in 1885, thinking the invention was a failure.

Although Edison had given up on promoting the phonograph, some of his rivals foresaw the potential for a machine designed to play recorded music. Charles Sumner Tainter partnered with Alexander Graham Bell and his cousin Chichester Bell to market an improved version of the phonograph. They jokingly called their invention the "Graphophone"—a play on the Edison trademarked name. Using prize money A. G. Bell had won for his invention of the photophone, the three young inventors established Volta Laboratory in Washington, D.C., and set to work building an improved talking machine.

Tainter and the Bells made numerous revisions to Edison's design, which they carefully documented to protect the several patents they had been awarded. The three men were so concerned that Edison would take credit for their inventions that, in 1881, they sealed a detailed account of their research in a box they deposited in the confidential archives of the Smithsonian Institution.

After several years of refining the graphophone, Tainter had managed to overcome many of the phonograph's shortcomings. Most significantly, Tainter developed a better recording medium by hardening the coating on the cylinder with carnauba wax and refining the etching process.

Against Tainter's better judgment, the American Graphophone Company approached Edison's representatives in May 1887, to propose the possible merger of the two companies. Tainter's associates demonstrated the advantages of the graphophone, including the improved wax cylinder. The merger offer was rebuffed, and, as Tainter had predicted, Edison immediately set out to develop a wax replacement for the phonograph's tinfoil cylinder.

By November of the same year, Edison filed a competing patent for a wax cylinder. Due to Tainter's carefully documented research, the courts upheld his patent claim. But by then, the wax cylinder was already destined to be a victim of the Format Wars.

Recording Discs

While the graphophone and the phonograph competed to dominate the emerging record industry of the 1890s, Emile Berliner was attempting to invent a better recording format. Berliner was already a pioneer in voice technologies, having invented the microphone in 1876, which he sold to the Bell Telephone Company for $50,000. He used that capital to fund his efforts to create audio reproductions that could be commercially marketed.

Berliner resorted to using an "indestructible" flat disc with lateral-cut groves for recording, instead of the fragile, vertically grooved cylinders Edison and Tainter were using. The lateral recording format had been tried in 1857 for linguistic analysis, but it was never patented for recording. Berliner patented his design in May 1887 and set out to launch The Gramophone Company.

Berliner's talking machine design was superior in that the hard vulcanized rubber discs were more durable than wax cylinders, and gravity held the stylus needle securely in the recording track. The platter format was also easier to ship and store, and it provided space for attaching a label. Most important, Berliner's sound discs, as he called them, could be reproduced from a master—something the wax cylinder could not do—opening the door to mass produced records.

Berliner later abandoned using rubber for pressing sound discs in favor of Durinoid, a shellac compound used for making buttons and electrical parts. By 1895 shellac records had become the new recording standard.

Edison scoffed at the scratchy sounding gramophones, and he persisted in believing that the public would reject a talking machine that could not also record voices. Edison was wrong. The gramophone was immediately popular. Within a decade of the introduction of sound discs—or gramophone records, as they grew to be called—the new recording format had nearly replaced wax cylinders. Even Edison had to concede that times had

changed, and in 1912 his company started producing gramophone records, as well.

The first major Format War had ended.

New Technologies Usher in New Recording Formats

Music was recorded on shellac records for half a century. But an experimental product developed by an Ohio tire company was destined to usher in the next generation of record technology—vinyl.

Vinyl Records

In 1926, Dr. Waldo Semon, a chemist at the BFGoodrich Company, in Akron, Ohio, developed a kind of plasticized rubber. The tire manufacturer could not immediately find a commercial use for the curious substance, but polyvinyl chloride (PVC) soon proved to have advantages for pressing records.

RCA Victor released the first vinyl record in 1930. Introduced as Program Transcription discs, the new discs were designed to play back at 33 1/3 rpm—half the speed of popular 78 rpm records. Despite the longer playing time and superior sound quality compared to shellac records, the new recording format was a commercial failure. Most potential customers could not afford the expensive playback equipment just when the Great Depression was getting underway. Those who could were disappointed by how the heavy pick-ups that were available at that time quickly wore through the soft vinyl discs.

Radio had also come of age by the 1930s, making records virtually obsolete. Vinyl was used at that time primarily for the recordings that were sent to disc jockeys for radio commercials and prerecorded programs, largely because the vinyl material was less likely to break on the way to the radio station. DJ copies of recorded music soon followed, for the same reason. Transcription services, which typically recorded at 33 1/3 rpm on 16-inch and 12-inch discs, also used vinyl, because their records were typically played only once.

World War II was ultimately responsible for the transition to vinyl records. Shellac had become scarce during and after the war, so record companies turned to vinyl to press some of their 78 rpm records. Vinyl records were lasting longer by then, because lighter tone arms prevented the needle from eating into them as quickly.

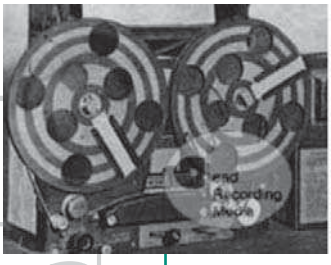
Columbia Records saw a brighter future for vinyl, however. The company had spent 10 years developing its microgroove technology and the equipment to record and play back music at the slower 33 1/3 rpm speed. During that time, Columbia made sure that every 78 rpm recording they made was also recorded at 33 1/3 rpm on 16-inch discs or on tape, another new recording medium. Columbia's library was already stocked with high-fidelity recordings when the new, long-playing format was introduced, giving the company a major competitive edge.

Columbia released the first Long Play (LP) record in 1948, packing 22 minutes of music on each side of a 12-inch disc. The company's focus at that time was on classical music, which required the longer playing time. Columbia had decided to continue recording its shorter pop tunes at 78 rpm. Less than one year later, RCA moved in on the single-recording market and started producing seven-inch singles at 45 rpm. The new "LPs" and "45s" were immediately successful. These popular recording formats helped define the 1950s and revive the flagging record industry.

Audiotape

While Columbia was developing the LP, the company was also experimenting with another recording medium—magnetic tape. Audio recordings on a magnetic medium had been around for almost as long as the gramophone. Valdemar Poulsen, a Danish engineer, demonstrated the first magnetic audio recording in 1898. For Poulsen's Telegraphone, a length of wire

1930
Vinyl record: RCA Victor launched "Program Transcription" discs, made from vinyl instead of shellac. The12-inch records could be recorded at 33 1/3 rpm, and they were not a fragile as 78 rpm gramophone discs.



1935
Audiotape: The Magnetophone was introduced at the 1935 Berlin Radio Fair. The accidental discovery in 1939 of high-frequency bias greatly improved recording sound fidelity.

1951
Video Tape Recorder (VTR): Bing Crosby Enterprises demonstrated the first black and white magnetic tape recording, spurring international efforts to develop a practical video recorder.

1963
Compact Cassette: Philips introduced the audio cassette medium that would make home recording popular for the first time since the phonograph was introduced.

was magnetized by running it across a recording head while sounds were being introduced. By running the same wire across a playback head, the magnetic pattern would reproduce the original sounds.

In 1928, German engineer Fritz Pfleumer adapted Poulsen's invention by substituting the recording wire with a long strip of paper coated with iron oxide powder. Pfleumer's audiotape was soon to be manufactured by German chemical giant BASF, and the Magnetophone it played on was in full production by 1935.

Although Columbia Records had been recording masters on audiotape since the 1940s, company executives did not foresee audiotape as a threat to their newly released vinyl LPs. The conditions were right for the next round of the Format Wars.

While the 1950s belonged to LPs and 45s, records gave way to tape recordings in the 1960s. Reel-to-reel tape recorders had been used on sound stages and in recording studios ever since 1948, when Bing Crosby premiered an Ampex Model 200 tape recorder to record his radio show. A loyal following of music enthusiasts brought Ampex and Wollensak tape recorders into their homes, but the format was too bulky and cumbersome for most casual listeners.

Ten years later, RCA developed a compact recorder that used ¼-inch magnetic tape that was conveniently preloaded in a plastic cartridge. The reversible, four-track tape provided a typical playtime of 30 minutes per side of stereo sound. Even at this smaller size, compared with the recently introduced pocket transistor radio, the tape recorder was still too large for general use.

In wasn't until Philips launched the Compact Cassette, in 1964, that audiotape became a serious challenger to records. The low cost and high fidelity of portable cassette tapes and the convenient recording option helped to convince music lovers to turn in their turntables for cassette recorders. The 1979 introduction of the Sony Walkman all but sealed the fate of the record player. After reigning over the recording industry for three-quarters of a century, the gramophone-style record became just another victim of the Format Wars.

Videotape

Magnetic tape was not limited to making audio recordings. Soon after Ampex introduced the Model 200 tape recorder, the company modified the machine to record video as well. Once again, Bing Crosby Enterprises (BCE) gave the world's first demonstration of a revolutionary recording technology. On 11 November 1951, the first practical video tape recorder (VTR) played back blurry black-and-white images of what it had recorded.

RCA followed two years later with a color VTR. Although the picture quality was somewhat better, the machine still was not practical. With the tape traveling at 360 inches per second, a 15-minute recording would require a tape reel over 10 feet in diameter.

It wasn't until 1956 that a commercial VTR with high enough quality for broadcast television was marketed. The desk-size Ampex Quadruplex machines used a four-head system that recorded on two-inch tape. The introduction of videotape spelled the end for the film-based kinescopes, which had been used in studios since the inception of television.

Videotape found its way into households in the 1970s. Sony introduced its half-inch Betamax video cassette recorder (VCR) in 1975, setting the stage for what was perhaps the most notorious format war of all time. The next year, rival Japanese companies, led by JVC, launched the Video Home System (VHS), effectively declaring war on Sony. After a decade-long battle, VHS triumphed to control the home entertainment industry. Sony did not

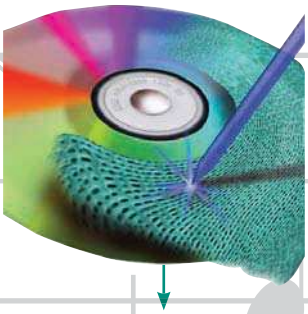
1971
Video Cassette Recorder (VCR): The Sony U-matic VCR, introduced in Tokyo in September 1971, was the world's first commercial videocassette format.

1978
LaserDisc (LD): *Jaws* was released in 1978 as the first movie available on LD. Although Philip's LD format experienced limited success, the technology paved the way for future generations of recording formats.

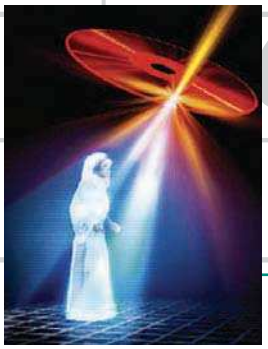
1982
Compact Disc (CD): Philips and Sony rolled out the first CD players in 1982. The first CD recording was ABBA's *The Visitors*

1976
Video Home System (VHS): JVC introduced the VHS in 1976—one year after Sony launched Betamax. The two companies battled for over a decade to decide which format would dominate the home recording market.

1991
DVD: The DVD Consortium avoided the type of conflict that slowed the adoption video cassettes in the 1980s, reaching a compromise between the Philips/Sony partnership and the Toshiba alliance to set the DVD standard.



2006
Blu-ray: Sony's Blu-ray format relied heavily on Hollywood backing to eventually convince Toshiba to drop support for its HD-DVD format.



2010 and beyond
The next generation recording format could be based on florescence, holographs, or 3D optical storage solutions.

surrender until 2002, when the company officially retired Betamax.

Laser Optical Discs

The recording industry endured numerous format changes during the twentieth century—most of them minor, a few revolutionary. But the greatest transition came at the close of the century, when digital technology overtook its analog predecessors. Digital technology had its roots in computer science. The proliferation of personal computers by the 1990s drove demand for a multipurpose storage format that could record audio, video, and data. A new recording medium was needed, and it needed to be digital.

Digital recording technology was not all that new, however. In 1958, David Paul Gregg invented the first laser disc. The new optical storage format was a major departure from the magnetic tape media used at that time for recording audio, video, and computer data.

Nearly twenty years passed before the laser disc made its first commercial appearance. MCA Discovision released the Videodisc player to consumers in 1976. *Jaws* debuted in 1978 as the first movie released in Laserdisc (LD) format.

A decade later, Philips teamed up with Sony to develop a compact disc (CD) format more convenient than the cumbersome 12-inch Laserdisc platter. The partnership ushered in the era of the ubiquitous CD, one of the most successful recording formats of all time.

Sony and Philips set out in the early 1990s to improve the CD by developing a high density version. Their efforts resulted in the release of the MultiMedia Compact Disc (MMCD) format. Meanwhile Toshiba and its allies were developing a Super Density (SD) compact disc. A deal was brokered in 1995 between the competing factions, yielding a new optical disc format—the DVD. That agreement bestowed the lion's share of the standard—and the royalties—on the Toshiba alliance, setting the stage for the coming battle over the high definition optical disc market.

Sony had been stung before, with the release of the Betamax videocassette. So as not to be shut out again, Sony teamed up with Philips to develop the technology for the next generation of media players. Instead of recording and reading data with red wavelength lasers, Sony's researchers turned to shorter, violet wavelengths to create the Professional Disc for DATA system, also known as PDD or ProDATA. The new optical disc system evolved into Blu-ray. Toshiba countered by developing its own "blue"-wavelength technology, the Advanced Optical Disc, which eventually became HD DVD. This time around the two competing standards were not to be compromised.

A surprise challenger climbed into the HD format ring with the Versatile Multilayer Disc (VMD). American startup company New Medium Enterprises (NME) arrived late to the market, but their VMD system offered a low-cost alternative HD format.

Two small European companies, MultiDisc Ltd. in London and TriGM International in Belgium, were working on a different wavelength—literally. Their solution for extending disc storage capacity was to stack more layers of data—possibly as many as 20 of them—instead of shortening the optical wavelength. The innovation led to the development of VMD. In 2004, NME acquired all of the intellectual property assets for VMD. NME launched its line of VMD systems and discs in US markets in September 2007.

NME has carved out its own niche market for HD video, with a targeted audience numbering in the billions. The New York based company secured agreements with major Indian film producers to distribute box office hits from that country's movie capital, commonly referred to as Bollywood. Indian films are particularly popular in much of Asia and the Middle East, accounting for billions of dollars in ticket sales each year. NME entered the HD home entertainment market with a library of VMD movies less than half the size of its competitors, but the company hoped to draw from an extensive archive of Bollywood films and expand on its small but growing number of Hollywood titles.

Although Toshiba withdrew HD DVD from competition in 2008, VMD is not the only alternative optical storage medium to Blu-ray. China announced in 2003 that Beijing E-world Technology, a multicompany partnership, had developed its own optical medium-based digital audio/video format, Enhanced Versatile Disc (EVD). The CD-size medium is physically a DVD disc that can store data in up to three layers. This approach makes it possible for an EVD to hold up to 15 GB on a single

disc, about three times the storage capacity of a DVD.

In December 2006, twenty Chinese firms unveiled 54 prototype EVD players, announcing that they intended to switch to the home-grown format by 2008. Support for the Chinese format fell off sharply when sales failed to materialize. Only a few movies were made available for EVD, and the low-cost players have not been enabled for high definition decoding.

E-World uses a similar approach to optical storage as NME, so EVD movies are compatible with both players. The two companies have been working together since mid-2007 to breathe life into the EVD format. A proposed partnership between E-World and NME could open China's doors to a red-laser HD format, if the deal can be consummated.

The Transition to HD

The world's transition to HD is rapidly gaining momentum. Come 17 February 2009, the Federal Communications Commission (FCC) will bring an end to all analog television transmissions in the United States (more on this topic can be found in "February 17, 2009: A Second Date that Will Live in Infamy?" also in this issue). After that day, over-the-air analog signals will no longer be transmitted.

Over the past decade, broadcast networks have been steadily adding to their fare of digital television (DTV) broadcasts, enticing some discriminating viewers early to the new standard. More HDTV programming, coupled with falling set prices and increased screen sizes, has accelerated HD conversion. By the end of 2007, approximately 43 percent of US households had at least one digital television set, and nearly 75 percent of all digital televisions currently sold are capable of displaying in high definition.

Comparing Optical Disc Technologies

Optical discs are at the heart of the devices that drive two thriving consumer markets: home entertainment and personal computing. As the resolution of the movies we watch and the video games we play increases, so does the demand for higher capacity media discs. Computing power also continues to grow exponentially, prompting the need for more room to store data. The manufacturers of these devices will reign over the next generation of digital entertainment.

The first generation of HD players saw Blu-ray using two layers per side on their discs and VMD four. Blu-ray had the early lead, storing 50 GB per side, compared to 20 GB for VMD. VMD has since doubled its storage capacity—the HD VMD50 stores 48 GB per side. NME is promoting a 10-layer standard, which is planned for release sometime in 2008. With Sony already working on a three-layer specification and NME claiming that a 20-layer disc is possible, 100 GB storage might not be far off. VMD is not limited to a red laser format, however. Applying VMD's multi-layer technology to blue laser technology could yield a 200 GB disc.

Perhaps the biggest advantage for NME to competitively challenge Sony is the low cost of production. VMDs and VMD players can be manufactured using the same equipment and processes that produce inexpensive DVDs. In an attempt to capture market share, Blu-ray started selling at below-cost prices that are dipping under $400. When NME launched VMD in the US, the basic player sold for less than $200. Red-laser discs are also cheaper to manufacture, costing less than half the price of a Blu-ray disc. Additionally, VMD production can take advantage of using existing manufacturing infrastructure. VMD's biggest disadvantage may be that the system is not interactive, while Blu-ray is capable of supporting videogame play and Internet access.

The Future of HD Formats

The question remains whether NME will be able to mount a serious challenge to Sony's Blu-ray. NME may lack the clout to overcome being shutout by the Hollywood movie industry. The company's strategy of targeting markets in India and much of Asia could pay off, however, with the cost advantages of VMD potentially overwhelming Blu-ray, especially in Asian markets. Another possible outcome is for Sony to acquire the advantages of VMD's multi-layer disc technology. This could be done through a partnership with NME, a direct buyout of the company, or Sony independently developing a competing technology.

Another possible scenario is that viewers will prefer to download HD content directly to their media devices, bypassing the home theater player altogether. The role of high-capacity optical discs would then shift to that of a data transfer and storage medium.

There will always be a need for recording information, and the format that provides the most storage is likely to attract the largest market. The HD generation of optical disc formats has multiplied the storage capacity of DVDs, accommodating 50 gigabytes of information and more. But work has already begun on the generation of data storage that will follow. Florescence, holographs, and various 3D optical storage solutions are under development, promising as much as a terabyte of storage on a thumbnail-size chip. The first fruits of these efforts are expected by the end of this decade.

The next round of Format Wars will likely introduce consumers to radical shifts in technology, prefaced by "nano" and "quantum" and "tera". The change may be imperceptible, however—songs and movies and games are already being downloaded from the ether, a trend that is sure to escalate. Recordings stored on the racks of personal libraries will become nostalgic vestiges of a pre-ambient age. But no matter what technological advantages for recording data, the winner of the next round of Format Wars might offer, its success ultimately will depend on its ability to capture our memories, our thoughts, and our dreams.