Chapter 2

Technological Change and Home Copying

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INTRODUCTION

Copyright law defines the boundaries between *permissible and prohibited* uses of copyrighted works. These boundaries are based on copyright's intellectual property bargain,[1] tempered by the feasibility and efficiency of enforcement. Technology, driven by the social and economic objectives of its users, defines the frontiers of *possible* uses and feasible enforcement. Technological changes that substantially alter the nature and extent of possible uses, or the feasibility of enforcing prohibitions against certain uses, give rise to tensions between users and copyright proprietors.

Technological change as it relates to copyright presents a major challenge to government policymakers, who must continually seek to define and maintain the appropriate relationship among policy, the laws implementing it, and the consequences of technological change. While technology and the law are fundamentally interrelated, new uses of technology should not, in themselves, have the force of law.

New uses *of technology can, however, exploit persistent ambiguities in existing laws, and by making possible — or prohibiting — selected actions, they can have the effect of lawmaking.* This may be happening for copyright. There-

cording industry considers that the growth in and current prevalence of home audiotaping have created a situation in which persistent ambiguities in the law have been exploited to the point that consumers believe that they have a "right" to tape.[2] On the other hand, any industry agreements resulting in technological copy protections implemented in the works themselves and/or in recording devices would redefine "possible" uses and would effectively shift the boundary toward the prohibited. From the public's viewpoint, the result would be equivalent to a change in the copy-right law. Moreover, although home copying would be the intended target for these copy protections, they could potentially limit the doctrine of fair uses

The debate over home audiotaping, which prompted Congress to request this study, is a situation in which technological change has strained ambiguities in the current law to the point where copyright proprietors have petitioned for legislative relief from the projected consequences of new copying technologies. In this instance, new consumer products would enable users to make digital copies of copyrighted recordings in their homes, at a time when digital recordings (i.e., compact discs) were becoming increasingly important to record companies' profits. Multigenerational digital copies (i.e., "clones") could be produced with no loss of quality.[3] In support of

[1]The bargain is a balancing of social objectives: encouraging the production and dissemination of diverse new works (by providing economic incentives for creators via a limited monopoly) and encouraging widespread access to and utilization of works. See *Intellectual Property Rights in an Age of Electronics and Information,* OTA-CIT-302 (Melbourne, FL: Kreiger Publishing Co., April 1986), especially ch. 2 and ch. 7, for more on the intellectual property bargain between creators and the public, and how it is changing in an era of electronic information.

[2]This point was raised in RIAA commentson a draft of this report. (H. Rosen, RIAA, letter toJ. Winston, OTA, May 2, 1989. Enclosure with comments on draft ch. 9, p. 1.)

[3]Although copy-protection technologies would not necessarily prevent all copying under the doctrine of fair use, special Provisions and exceptions would have to be worked out to allow fair-use copying. Even so, transactional or "hassle" costs for individuals *would be* higher, perhaps discouraging some fair use.

[4]Another example is the debate over videocassette recorders and home videotaping, which is being reopened by the Motion Picture Association of America (MPAA). The MPAA is calling for technological means to prevent home recording of movies shown on pay cable, or delivered by premium satellite or pay-per-view services. (Jack Valenti (President/MPAA), "Viewpoints," *Television/Radio Age,* Feb. 6, 1989, p. 91.)

proposed legislation to introduce home-taping royalties or restrict home copying,[5] the Recording Industry Association of America, Inc. (RIAA) has argued that the technological change from analog to digital recording will greatly increase home copying, so as to seriously threaten the industry's economic viability. Considering that sound recordings have historically had inadequate copyright protection, compared with other types of works,[6] copyright proprietors (for both the music and the sound recordings) have called for Congress to enforce what they consider to be the existing boundaries of copyright.[7]

The legal status of home audiotaping and other types of private use is ambiguous, however (see ch. 3). Although the status of some specific private uses has been determined judicially, current legislation does not provide explicit guidance as to whether copyright proprietors' rights extend to noncommercial private uses. Many believe that they do not. Others consider that home audiotaping, at least, is noninfringing under the doctrine of fair use. From either of these perspectives, proposals to extend proprietors' rights can be regarded as a call for Congress to strike a new intellectual property bargain, in which unrestricted and/or uncompensated home copying of audio materials is deemed not (or no longer) to be in the public interest.

At the same time, some copyright proprietors are pursuing unilateral and/or cooperative industry measures to implement technological means for copy protection. Such protective measures would shrink the frontier of possible uses of works, which would in effect shift the boundary of permissible uses–including some fair uses as defined in the 1976 Copyright Law.[8]

The 1986 OTA report, *Intellectual Property Rights in an Age of Electronics and Information*,[9] broadly examined the impacts of new technologies on the enforcement of intellectual property rights, including the right to control reproduction of copyrighted works, the right to control publication and performance of works, and the right to control the making of derivative works. That report found that technological changes offer opportunities for social and private gain at the same time that they challenge the current business and legal environments.[10] For example, technologies that lower the cost and time required to copy, transfer, or manipulate information and intellectual property can make works more accessible, make them more valuable to

[5] See, for example, the *Home Audio* Recording Act, S. 1739, 99th Cong.; or H.R. 1384 and S. 506 in the 100th Cong.

[6] This viewpoint was presented by C. Sherman (Arnold and Porter, representing the RIAA) at the study's final advisory panel meeting on Apr. 24, 1989. Sherman also considered the distinctions in OTA's analysis of electronic-delivery -versus-performance (see below) to be "perilous" ones that proprietors of other types of works did not have to deal with.

[7] According to the RIAA, "... the music industry has consistently maintained that home copying is illegal undercurrent copyright law and has simply sought legislation to make copyright protection more than an empty right. " (H. Rosen, RIAA, letter to J. Winston, OTA, May 2, 1989. Enclosure with comments on draft ch. 9, p. 1.)

[8] For example, copying brief excerpts from one or more "technologically copy-protected" recordings, for the purposes of teaching or criticism, would be problematic.

The recording industry does not consider that technological copy protection would eliminate copying permitted under the doctrine of fair use and takes the position that legitimate fair uses should be preserved and that exemptions should and could be worked out. (H. Rosen, RIAA, letter to J. Winston, OTA, May 2, 1989. Enclosure with comments on draft ch. 9, p. 12.)

[9] OTA-CIT-302, op. cit., footnote 1.

[10] At this study's final advisory panel meeting on Apr. 24, 1989, some panel members reemphasized the challenges that new technologies present for the current copyright system, which they considered to be nearing obsolescence, but dauntingly complex to overhaul.

For a more complete discussion of technological changes and the enforcement of intellectual property rights, including impacts on print, music, video, and other media, see OTA-CIT-302, op. cit., footnote 1, pp. 97-123.

consumers, and make using them more convenient. These technologies can also make enforcing intellectual property rights more difficult, and may lower rights holders' expectations of economic returns. If so, this might reduce creators' financial incentives to produce new works. Furthermore, the 1986 report noted that enforcement of intellectual property rights will potentially be more intrusive, as copying, transferring, and manipulating works become private activities in the home.

The *Copyright and Home Copying* study focuses on one type of intellectual property protection – copyright — and one venue — the home. The study's empirical work examines the home use and/or taping of copyrighted audio materials and, to a lesser extent, video materials. The copyright issues raised by home audio- or videotaping are enmeshed with broader questions about the general status of private use, including home copying. Because the current copyright law gives little guidance on private use, especially whether private use is an infringement of copyright, the question remains whether the overall objectives of copyright are best served by granting copyright proprietors exclusive rights over home copying, including the rights to be compensated for and/or to prevent it.

Up to now, the courts have applied the doctrine of fair use, absent other statutory guidance, to make explicit but limited and niche-oriented determinations about home copying and other private uses of specific categories of copy-righted works. Leaving these determinations to the courts, as specific cases arise, has allowed Congress to avoid premature or short-lived copyright legislation, and has helped maintain flexibility in the face of changing technologies.

The confluence of current technological and business trends, however, may make an explicit congressional definition of the legal status of home copying more desirable to reduce legal and market uncertainties and to prevent de facto changes to the copyright law. These trends are:

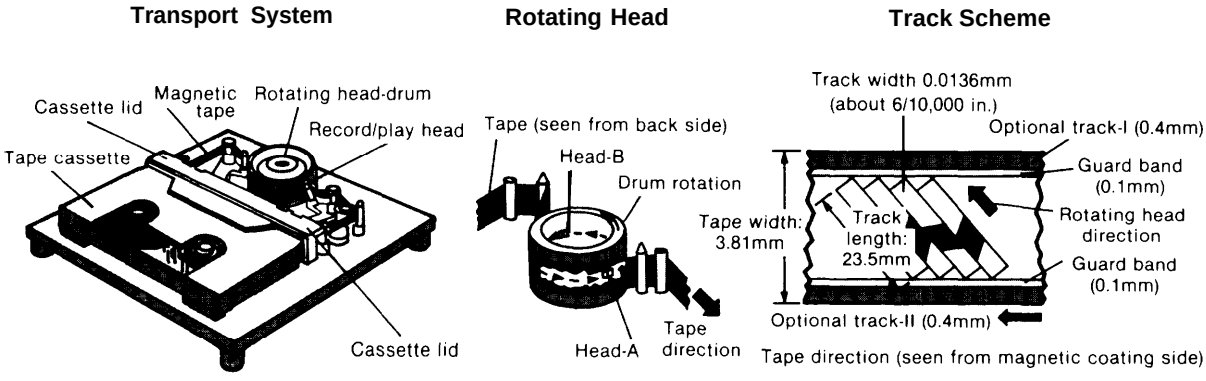
- The movement to *digital representations* of music, video, and other types of entertainment and information available to consumers. With these come new digital recording technologies for home use, and more powerful means for home users to interact with and manipulate digital works, as well as to make derivative works.
- The *erosion of niche boundaries* used to categorize copyrightable works according to their content (e.g., audio, video, computer software) or physical format (e.g., audiotape, videotape, computer disc).
- The emergence of new *delivery infrastructures* to bring music, video, and other forms of information and entertainment into the home (e.g., fiber optic cable, pay-per-view, and interactive cable services).
- The efforts of some copyright proprietors (e.g., in sound recordings and motion pictures) to develop and implement *technical means for copy protection.*

Some industry stakeholders do not consider that the ambiguous legal status of home copying represents a "problem" requiring any additional legislation to deal with home audiotaping. In part, this position reflects the view that the doctrine of fair use is sufficiently adaptable to address home audiotaping, at least, and that Congress intended for the courts to use this "safety valve" in dealing with home copying.[11]

[11] Gary J. Shapiro, Electronic Industries Association, Apr. 28, 1989, letter to OTA with comments on draft ch. 5, pp. 1,5.

Box 2-A–DAT: *How It Works*

Digital audiotape's transport system (left) works just like that of a videocassette recorder. Once inserted in the deck, the cassette's protective lid opens and the tape is extracted and wrapped 90 degrees around the head-bearing drum. As the tape moves past the drum from left to right at 1/3 inch per second, the drum moves counter-clockwise at 2,000 rpm (middle). This combination yields a recording speed of 123 inches per second —65 times faster than today's analog cassette decks. Because the tape is held at an angle to the drum in a helical pattern, the drum's two magnetic heads write and read information in diagonal tracks across the width of the tape instead of longitudinally along its length, as in analog recording (right). This space-saving arrangement provides 2 hours of information on a matchbox-size cassette. Because each of the two heads is mounted at a different azimuth, the information-bearing tracks are laid down in an alternating pattern.



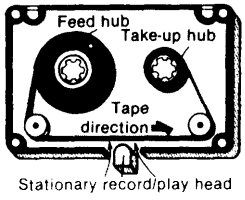
Continued ambiguity about congressional intent and the legal status of home copying may, however, become undesirable, for two main reasons. First, the legal ambiguity gives rise to market uncertainty. As new digital formats and recording technologies develop, hardware and software producers will become even more interdependent: just as for computers and computer software, decisions about technical standards and formats made by one industry will critically affect the other.[12] Because of this mutual dependency, the market uncertainty will impinge on broader groups of stakeholders, including the public.

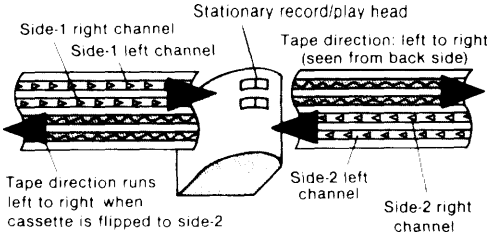
Continued uncertainty blurs market signals and raises business risks for hardware and software producers alike; pricing and output decisions are more difficult. Potential offerings of new products and services may be delayed or withheld; delays and/or limited markets have real costs for consumers and producers:

[12]Industry standards determine the compatibility and features of different hardware and/or software products. For more on industry standards and their role in determining markets, see U.S. Congress, Office of Technology Assessment, *Critical* Connections: *Communications for the Future, OTA-CIT-407* (Washington, DC: U.S. Government Printing Office, forthcoming).

Box 2-B–Analog Cassette: How It Works

In analog cassette recording, a nonrotating freed head enters the housing to press against the tape. The tape passes by the head at 17/8 inches per second, and separate tracks for the left and right stereo channels are recorded simultaneously along the length of the tape. When the first side is recorded, the cassette is flipped to record a second set of stereo tracks on the remaining width of the tape. In DAT recording, just like videotape, there's no need to flip the cassette.





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. In 1987, the RIAA threatened to sue the first manufacturer selling consumer-model digital audiotape (DAT) recorders in the United States. (See box 2-C.) Many consider that this threat is largely responsible for consumer-model DAT recorders being withheld from the U.S. mass market for the past 2 years. In late April 1989, one manufacturer began importing and selling modest quantities of DAT recorders (with professional features) in the consumer market. The firm reportedly expects to sell about 500 of the ($10,000) machines in the first year, while consumer models with more limited features typically sell for about $1,500 in Japan and Europe.[13]

The July 1989 Memo of Understanding (MOU) between the international recording industry and several consumer-electronics manufacturers (see box l-E) may eventually lead to mass introduction of DATs with copy-limiting features. However, early press accounts of reactions to the agreement indicated that hardware industry executives considered it unlikely that DAT recorders manufactured with the special features could appear on the market before spring 1990.14 Some copy-right holders and music publishers also expressed concerns that the legislative objectives did not include royalties.[15]

- Another emerging digital technology (recordable/erasable compact disc) faces similar uncertainties– some copyright proprietors have already branded it as "a worse problem" than DAT.[16] A Japanese firm announced sample-size shipments of write-once, recordable compact disc (CD-R) recorders in late 1988, with the initial market intended to be limited to professional applications as an editing tool for CD-ROMs or for small-lot production of CDs or CD-ROMs. To minimize copy-right-related controversies, another firm selling blank discs announced that it did not plan to supply

[13] Jean Rosenbluth, "Defying RIAA Threats of Lawsuits, Nakamichi Importing DAT players," *Variety,* Apr. 26- May 2,1989, p. 208.

[14] *TV Digest*, vol. 29, No. 31, July 31, 1989.

[15] *TV Digest*, vol. 29, No. 32, Aug. 7, 1989.

[16] Recording CD Worse than DAT--IFPI/RIAA," *TV Digest, vol. 28, No. 45, Nov. 7,* 1988; "Blank and Erasable CDs Prompt Fears of Piracy in Trade Group," *Variety, Nov.* 23, 1988, p. 96.

Box *2-C–Digital Audio Tape*

Rotary-head digital audio tape (R-DAT, usually referred to as DAT in this report) is a format with consumer-entertainment and computer data-storage applications. For consumer entertainment, the DAT format permits high-quality digital recording/playback of CD-quality music. The current DAT standard specifies two basic operating modes: a 44.1 kHz sampling rate (the same as for audio CD) for playback only, and a 48 kHz sampling rate for recording and playback. The 44.1 kHz mode can playback either prerecorded tapes made (in real time) from CD master tapes or prerecorded tapes made using high-speed contact printing. As of mid-1989, most consumer models operated at the 48 kHz rate, with 16-bit resolution; the 48 kHz rate was intended to prevent direct digital-to-digital recording from CDs. However, these tapes can themselves reduplicated directly, or "cloned," without further degradation or noise.[1]

Prerecorded DAT tapes and CDs usually have digital "copy-protect" flags– not part of the music itself –designed to be read by consumer-model digital recorders. These flags are intended to inhibit digital-to-digital copying, but to do so the hardware must be capable of reading and using the flags. Current DAT hardware is not, according to the RIAA.[2]

For computer data storage, DAT provides a high-capacity alternative to CD-ROM. A standard R-DAT cassette can store two encyclopedias' worth of data, the equivalent of 65 12-inch tape reels or 8 of the conventional "streaming tape drive" cartridges used for backup storage. One market niche for DAT storage is thought to be as backup for high-capacity, hard-disk personal computers and work stations, where floppy diskettes are impractical.

DAT tapes are about half the size of a conventional analog audio cassette and come in a sealed "box" similar to a videotape. The DAT recorder differs from an analog recorder in that (like the VCR) the record/play head rotates. Digital recording gives a high dynamic range (96 db) and audio frequency response similar to a CD (2-22 kHz).

Unlike the CD, DAT is a contact medium in which the tape must be wound and rewound repeatedly. Eventually, DAT tapes will degrade, and the use of DAT as an archival medium is in question by some, including the National Academy of Recording Arts and Sciences (NARAS). One of the market questions for DAT is whether consumers would accept a relatively expensive contact-playback medium, if they had no way to make backup copies of the tapes, when less-expensive CD players are already available for less than $200.

Many consider the RIAA's threat to sue the first manufacturer to sell consumer-model DATs in the United States largely responsible for delaying widespread introduction of DAT here. For example, the first consumer DAT recorders models had been expected in the United States in 1987. Car DAT players without recording capability have been available for $1,500 and up since mid-1988; prerecorded software, mainly classical and jazz, sells for $25 and up. With *no* end to the RIAA dispute in sight, alternative channels of distribution for DAT recorders opened up:

- The "gray market" for unofficial imports, selling for $1,600-$3)000. By early 1989, importers began planning for large imports of gray-market DAT recorders, despite the RIAA's threats to sue anyone importing the machines. One New Jersey importer expected to import 5,00010,000 DAT recorders by mid-1989 and sell them through audio stores; an affiliate sold about 600 DAT machines in 1988, primarily to recording studios and Government agencies, including the Department of Defense.
- "Professional" models selling for $2,500-$7,000, which have been legally imported and sold since 1987. The RIAA has not opposed DAT as a professional medium, despite the fact that, unlike consumer models, the pro units can record at 44.1 kHz (the CD rate).

By contrast, mid-1987 forecasts for DAT expected that the recorders would initially sell for about $1,500, but that the price would drop to around $250 in a few years as sales volume increased (earlier projections had expected consumer models to sell for $950-$1,250 in 1987). Conservative estimates of 1987 sales were in the 20,000-50,000 range, with reported forecasts of 220)000 DAT sales in the U.S. for 1988 and a cumulative total of 1.1 million units by 1990. Cassette prices were expected to be $9 for 60 minutes and $12 for 120 minutes.

[1]Under the proposed serial copy management system (SCMS) standard, new consumer-model DAT recorders would operate with a 44.1 kHz sampling rate, the same as the CD standard. However, copies of copies could not be "cloned."

[2]Under the SCMS standard, DAT recorders would recognize the flags.

Continued on next page

During the delay, some controversies have emerged concerning DAT as a professional tool. Tests conducted in 1988 by the Radio Technical Institute in Munich found that some DAT tapes made on professional and consumer-model machines were unsatisfactory in terms of machine-to-machine playback compatibility, recording quality, and sound storage. The Institute concluded that significant changes in the DAT format, such as increasing tape width and the size of the recording tracks, would be necessary to make DAT satisfactory for professional use.

In the meanwhile, a West German firm introduced the first DAT computer drive in March 1988; by the end of 1989 perhaps a dozen U.S. and foreign firms are expected to introduce DAT computer products. The DAT storage drives can hold about 1.2 billion characters of information, and search the data much faster than conventional tape-cartridge drives.

SOURCES: Steve Birchall, "Digital Audio Tape Issues and Answers, "Stereo ReviewMagazine, March 1987, pp. 56-59. Mark Brownstein, "Gigatrend Data DAT Drive Features QIC Interface," ***Infoworld,*** Aug. 14, 1989, p. 25. Patrick Cole, "The Dash for DAT Dominance, " Business ***Week,*** May 15, 1989, pp. 138H-138J. Michael Greene, "Permanence of New Disk Formats Should Cue Formation of a National Music Archive)" ***Variety Daily,*** Oct. 25, 1988. Wayne Greene, "The THOR Thpot, " CD ***Review,*** February 1989, pp. 88-86. John W. Merline, "What's All This about DAT?" ***Consumers' Research,*** June 1987, pp. 35-37. Edward Murray, "DAT's a Snap," Digital ***Audio,*** December 1988, p. 118. Mary Ann O'Connor, "DAT: The Controversy Continues, " ***Optical Information Systems Update,*** Aug. 1, 1987, pp. 4-6. Andrew Pollack, "New Storage Function for Digital Audio Tape," ***The New York Times,*** May 25, 1988, p. D6. Martin Porter, "DAT's NOT Ail, Folks!," GQ, September 1988, pp. 317-326. "Board Turns Digital Audio Tape into Backup Storage," ***Electronics,*** February 1988, p. 26. "The Gray Market Is Open for Digital Audio Tape," Electronics, February 1989, p. 60. ***TV Digest, vol.*** 29, No. 16, Apr. 17, 1989, p. 14.

them to the consumer market.[17] Nevertheless, the International Federation of the Phonographic Industry (IFPI) hasreportedly branded the planned launch as "deplorable," and stated that, "introducing the CD-R without putting copyright safeguards into place will undo any progress made on the anti-piracy and home-taping front during the last 3 years. "[18]

[The signatories to the MOU have agreed to meet to discuss copyright issues related to recordable/erasable CDs.]

Moreover, as niche boundaries erode, these effects can spill over from one industry to another:

. DAT cassettes can store much more computer data than regular computer-tape cartridges. (See box 2-C.) Some industry analysts expect DAT storage devices to account for about one-seventh of the computer tape-drive industry by 1993. Unit manufacturing costs for the DAT cassettes depend on the volume being produced, but because DAT is not yet a mass consumer-audio product, large scale economies are not yet being enjoyed. Because of the delays in introducing DAT as a consumer-audio format, some DAT tape-drive manufacturers are adopting a different DAT format intended primarily for computer data storage, and prices for data-storage DATs may be higher than if there were a common format.[19] Manufacturers have be-

[17]"CD Recorder Shipments Scheduled Next Month," ***TV Digest,*** vol. 28, No. 46, Nov. 14, 1988, p. 10; "CD-R Coming to U.S.?" TV ***Digest, vol. 28, No. 50, Dec. 12, 1988,*** p. 17. The blank discs would cost about $8.50 each.

[18]Pippa Collins, "IFPI Decries Launch of Japanese Recordable CD," ***Billboard, vol.*** 101, No. 1, Jan. 7, 1989.

[19]Patrick Cole, "The Dash for DAT Dominance, " ***Business Week***, May 15, 1989, pp. 138H-183J.

gun to introduce the data-storage DAT drives, which use 4-millimeter tape, compared to the 8-millimeter DAT cassettes for audio recorders.[20]

Continued uncertainty might even hinder the ability of copyright industries to adapt to new technical and market environments, if proprietors continue to seek and/or do obtain remedies based on their current ways of doing business. If legal uncertainties were reduced –by sanctioning, licensing, or prohibiting home copying— then businesses and consumers might better adjust to the new technical and legal environments.

Second, if technological means for restricting private copying of copyrighted works are implemented by the software and/or hardware producers, one result could be the virtual elimination of home copying, as well as some other types of copying now specifically permitted under the doctrine of fair use.[21] If this were to occur, it would be a de facto revision of the 1976 copyright law, but by industry and not Congress.[22] Technological uses would establish law, rather than follow it.[23] For some types of technological copy protection, implemented through voluntary intra- and inter-industry agreements, government approval or consent might be sought, to avoid antitrust problems. Antitrust reviews might not, however, be the best vehicles for setting copyright policy.

DIGITAL REPRESENTATIONS

Although audio compact discs, the first digital format for home-entertainment products, were introduced only a few years ago, digital representations of music, images, and other information have become central to the future of home entertainment/information products and services (see boxes 2-D and 2-E for more information about compact discs). New technologies continue to facilitate copying, manipulating, and transmitting digital information at declining costs. As the costs of these new technologies decrease, they are becoming available for home use, and thus may increase the scope, quantity, and quality of home copying.[24]

Some important differences between digital formats and analog formats for information storage, recording, playback, and transmission are:

- The resolution and signal-to-noise ratio are greater for digital than for analog recordings. For audio recordings, this gives a larger dynamic range, absence of "background hiss," and more brilliant sound quality. Digital filtering and error-correction techniques can be used during playback to "fill in" missing bits (somewhat equivalent to eliminating the effects of scratches and dust when playing

[20] David J. Buerger, "Emerald DAT Backup Device Can Store 2.2 Gigabyte," *Infoworld,* Aug. 21, 1989, p. 13; and Mark Brownstein, "Gigatrend Data DAT Drive Features QIC Interface," *Infoworld,* Aug. 14, 1989, p. 25.

[21] Some technological means might require transaction-based payments for home copying, this would be the technological equivalent of a fee-based compulsory license.

[22] See footnote 8.

[23] OTA is grateful to David Moulton for his comments in this regard. (D. Moulton, Berklee College of Music, letter to OTA, Aug. 5, 1988.)

[24] This strains the traditional concept of copyright as a private right, privately enforced, which was established when home copying techniques were relatively inferior to those used for commercial publication. Now, "publishing" can be a private act. For an extensive examination of the implications of technological change for copyright enforcement, see OTA-CIT-302, op. cit., footnote 1, especially ch. 4.

Box 2-D–How Compact Discs Work

The audio compact disc (CD), introduced in Japan in 1982 and in the U.S. and Europe in 1983, offers improvements over some of the shortcomings of longplay vinyl discs (LP records). While LP records can produce very high quality sound, they are subject to problems such as disc wear and damage, background noise, and "wow and flutter." These problems arise largely because the LP depends on a mechanical scanning system. The player's needle-stylus must be in direct contact with the grooves in the LP, where the analog sound is encoded. Dust, surface damage, warping, and variations in rotational speed will affect the quality of playback sound.

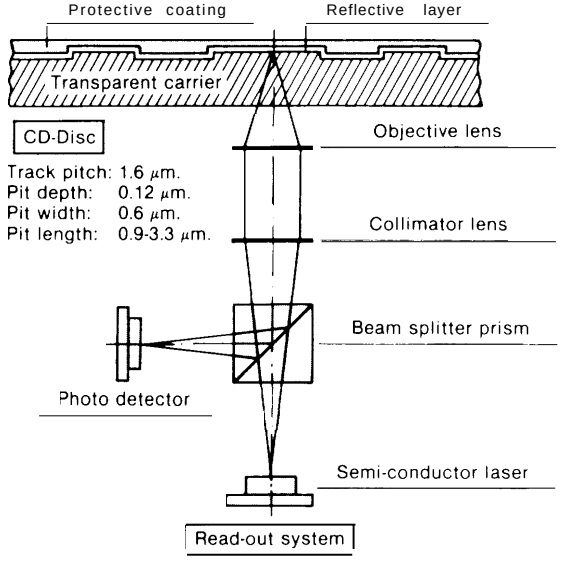
The CD technology uses a different approach. The digital information recorded on the surface of a CD represents sampling of an audio signal at the rate of 44.1 kHz. The CD player reads this digital information with a laser-optical scanning system that requires no physical contact. Further, the player's digital signal processing system is independent of the rotational speed of the disc. The result is very nearly perfect reproduction of sound that will not degrade even after repeated plays.

Information is recorded on a CD as a succession of tiny pits, each one 0.12 micron deep and 0.6 micron wide. Length of the pits varies from 0.9 to 3.3 micron. [Note: one micron = 0.000039 in.) A standard 5-inch CD, on which 60 minutes of music is recorded, would have about 3 billion pits. Each series of pits and "lands" (spaces between pits), represents a series of digital bits. The encoded information includes not only the "channel bits" that represent the audio information, but also the "subcodes" that govern the control and display functions of the player and the tracking signal that allows the player to follow and read the pit pattern.

The playback system for a CD is shown in the illustration below. Light beams from the semi-conductor laser (780 nanometer wavelength – in the infrared range), are made parallel by the collimator lens and then focused by the objective lens into a 1 micron spot that scans the disc. Light reflected from the reflective layer on top of the disc returns through both lenses to the beam splitter prism, which diverts it onto the photo detector. The photo detector can distinguish between light reflected from a land and light reflected from a pit. Light from the latter is slightly dimmer because the pit is approximately 1/4 wavelength closer to the lens, and thus it generates destructive interference.

The signals derived from the photo detector then go into a signal processing system that detects and corrects errors in the bit stream.

The CD-System



SOURCES: N. van Slageren, "Basics on Compact Disc: A Short Introduction," Nederlanse Philips Bedrijeven B. V., Electro Acoustics Division, Optical Disc Mastering, Eindoven, The Netherlands, various pagings, n.d.

For a brief history of the CD see Fred Guterl, "Compact Disc," in "Technology '88," ***IEEE Spectrum,*** January 1988, pp. 102-108.

Box 2-E–How Compact Discs Are Made

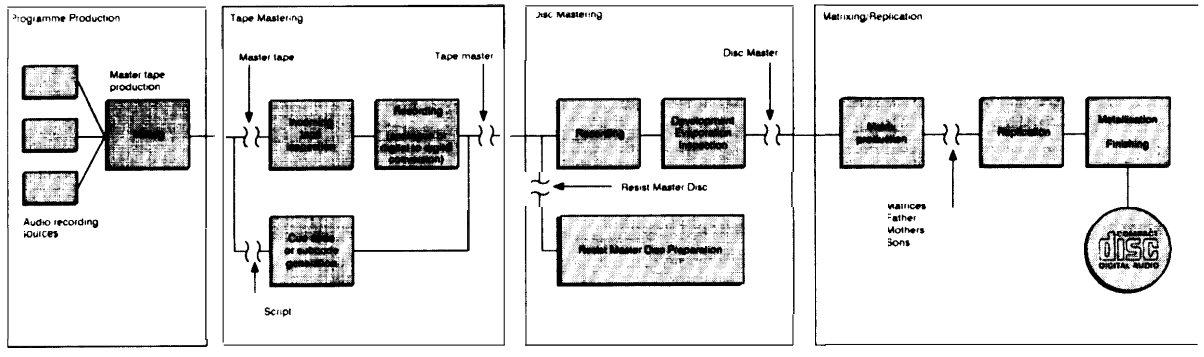
The production of compact discs (CDs) differs in a number of respects from the manufacture of long-play vinyl discs (LP records). There are two sizes of audio CDs in current use: the 5-inch CD, which can contain about 60 minutes of recorded music, and the 3-inch "single," which holds *2* or **3** songs. The steps for making them are outlined in the illustration below.

Program production – recording, mixing and creating a "master tape" of audio material — is essentially the same as for LP records. The master tape, containing two stereo audio channels, maybe in either digital or analog format.

In the tape mastering process, the master tape is converted from analog to digital or from digital to another digital format. Subcodes (indexes and other information needed for control and display functions of the CD player) are also added to the bit stream. The result, a digital "tape master" is used to produce the "disc master. "

Many of the following steps must be performed under "clean-room" conditions, because of the high level of precision required. In the disc mastering process, the information from the tape master is recorded optically (that is, using a laser) onto the surface of a glass disc which has been coated with photoresist. This surface is then developed, much as a photograph would be, producing the "disc master." In matrixing, the surface of the disc master is transferred to a nickel shell ("father"). The father is a negative from which a number of positive "mothers" are made. From the mothers, "sons" or "stampers" are produced. After suitable processing, these stampers are used for replication. The pattern on the surface of the stamper is used to make a pattern of pits on the surface of a transparent polycarbonate plastic disc. The plastic disc is then sprayed with a reflective aluminum coating, and a layer of protective lacquer. Finally, the center hole is punched out and the label is printed onto the protective layer.

The Production of CD-Discs



SOURCES: Material in this section is based on information from: N. van Slageren, "Basics on Compact Disc: A Short Introduction," Nederlanse Philips Bedrijeven B. V., Electro Acoustics Division, Optical Disc Mastering, Eindoven, The Netherlands, various pagings, n.d.

an LP record). Some playback methods for digital recordings do not require physical contact (e.g., record/stylus or tape/head), so those recordings will not suffer '(normal wear and tear" from repeated play.

- Multigenerational digital copies (of digital recordings) can be made with no loss of quality or clarity – copies are "clonable." With analog audiotaping, for example, the quality of successive genera-

tions degrades fairly rapidly. With digital-to-digital copying, however, the quality of successive generations can be indistinguishable from "originals."

- Computer- and/or microprocessor-based recording and playback equipment can capture, store, copy, and manipulate digital information (including music or images) more rapidly and cheaply than in the analog realm.
- Digital representations of music, images, and information "code" the content as a bit stream of ones and zeros, which can exist in electronic form, independent of any tangible, physical object. The bit stream representing an artistic work can be transmitted in electronic form (with no physical embodiment), or it can be stored in a new physical medium, without altering the essential characteristics of the work.[25] A physical embodiment is not essential for a digital work to be a "freed" piece of intellectual property: the work can be fixed in electronic form, and can be distributed electronically, rather than in a physical embodiment (see ch. 3).

In addition to DAT, some of the other digital (playback and/or recording) formats that are available now, or are expected to be available over the next several years, are highlighted in box 2-F.[26]

EROSION OF NICHE BOUNDARIES

Over the next decade, digital representations of creative works and other home entertainment will come to predominate. Consumers will grow increasingly accustomed to high-quality digital formats, and the ability to efficiently store, copy, transmit, and manipulate their contents (e.g., with digital video interactive, erasable/recordable digital media, or audio and video computer peripherals). As this happens, *niche boundaries* predicated on content or format (e.g., "audio" v. "video," or "audiotape" v. "computer media") will break down. These niche boundaries have already begun to erode significantly: the optical-disc formats of the 1980s–audio compact disc, compact disc video, compact disc interactive, and digital video interactive — have evolved from read-only, content-specific carriers to manipulable, audio/video/software operating systems. Moreover, new digital media like digital audiotape (DAT) and erasable/recordable compact disc (CD-E) will have multiple applications in business and the home, for example, computer data storage, as well as prerecorded images and music. Multipurpose hardware (i.e., computer-based player/receivers) will come into use.[27]

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25 For example, the digital representation of a sound recording could be stripped from a compact disc, transmitted via modem to a personal computer with a peripheral DAT, and then played. The information content in electronic form duringtransrnission would be the same as in the disc and tape embodiments. Similarly, computer software or data can be transmitted from one computer to another; it is the same program irrespective of whether it is stored on a diskette.

26A longer-term example might be miniature "silicon recorders on a chip, " available in perhaps 10 years or so. All the digital circuits equivalent to those in a conventional CD player could be contained in a single chip, which would become a "player" without moving parts. Another chip with several gigabits of memory would carry digital music (approximately 4 gigabits of ROM could carry the contents of a conventional CD). (Heitaro Nakajima (Sony Corp.), quoted in *TV Digest*, vol. 29, No. 8, Feb. 20) 1989, p. 12.)

27 For example, Andrew Lippman (Associate Director/MIT Media Lab) has been quoted as saying in the context of high–density television, "forget TV sets. In 3 years there won't be any. Instead, there will be computers with high-quality display screens. Inside these computers there will be digital instructions allowing them to receive ABC, NBC, HBO, and anything we can dream up. " (*TV Digest, vol. 29, No. 6,* Feb. 6, 1989, p. 13.)

Box 2-F–Other Digital Formats Using CD Technology

In addition to the compact disc audio format, various other formats can be used to record music, images, data, and other information on a compact disc. The following section describes some of these now in use to encode audio, video, and computer material on optical discs. Until now, discs for home use have been for play only: information was recorded at the factory by a complex mastering procedure that could not be changed by the consumer. However, recordable and erasable/recordable CDs for home use are under development.

Compact Disc Video: Compact disc video (CD-V) is a laser disc format carrying digital video, as well as digital audio, tracks. A precursor, the analog laser disc, was first introduced in 1979, but its popularity was limited (in part, by the introduction of videocassette recorders).

CD-V discs come in 5-inch, 8-inch, and 12-inch sizes. The 5-inch CD-V "single" (the same size as a conventional audio CD) holds 5 minutes of analog video (e.g., a music video) with a digital soundtrack on the outer portion, plus about 20 minutes of additional CD-audio material. The current 8-inch version, called the CD-V EP, holds about 40 minutes of analog video and analog and digital sound (e.g., short films, cartoons, educational shorts), and the 12-inch, or CD-V LP, version holds up to 120 minutes of analog video with digital and analog sound (e.g., movies). Existing video disc players will play the larger versions; older ones play analog sound only and newer ones play digital sound. A different player is required for the single because the scanning sped is different. Combination, or "combi" players will play all three sizes, plus audio CDs; there also are dedicated players for the 5-inch CD-V singles and 5-inch audio CDs.

Compact Disc Interactive: The compact disc-interactive forrnat, or CD-I, was first announced in 1986. It is a specification for video, audio, software interfaces, and data on one 5-inch disc. The CD-I player (in reality, a personal computer with a special interface and TV monitor) will display still pictures, animation, or full motion video. CD-I also offers varying levels of audio quality for music and speech; the highest-quality music is comparable to that on an audio CD. Playing time depends on the combination of audio, video, and data on thedisc, as well as sound quality. One disc will hold about 74 minutes of digital audio sound, or 288 minutes of analog "mid-fi" stereo, or 19 hours of speech-grade monaural sound. Video and data storage greatly shortens playing time.

Digital Video Interactive: Digital video interactive (DVI) offers about an hour of digital full-screen, full-motion video, or else various combinations of full-motion video, still images, graphics, programming, digital sound and text. A frame of video television takes up 600,000 bytes, so conventional full-motion video at 30 frames/second corresponds to a data rate of 18 megabytes/second. A CD holding 648 megabytes of data could contain only about half a minute's worth of full-motion video. DVI uses computer data-compaction technology to compress digital video data, thus increasing the amount of information that can be recorded.

For recording, DVI uses a computer and proprietary data compression technique to analyze the video frame-by-frame. Only the relatively small portion of a frame that differs from the preceding one–the part actually conveying motion — is stored. For playback, the DVI microprocessor takes data off the CD-ROM in real time and "decompresses" it to recreate a high quality, moving image. This microprocessor can allowtheviewer to manipulate or modify the picture on the screen (e.g., rotate it, freeze a frame, zoom in, invert it).

At the end of 1988, beta tests of various DVI applications were being conducted; these include commercial adult and children's educational/training systems, government training systems, home information and shopping services, travel agency information, furniture point-of-sale and interior design tools, imaging and 3-D modeling systems, marketing research systems, and museum exhibits. In March 1989, a major computer manufacturer announced that it would endorse the DVI standard. Add-on modules are expected to be available by early 1990 that will allow DVI to be played on some personal computers.

Recordable/Erasable Compact Disc: As the controversy concerning large-scale introduction of consumer DATs continues, a new set of home recording technologies is emerging recordable and recordable/erasable compact discs.

The newest of these-the thermo-optical recordable/erasable compact disc, called THOR (Tandy High-Intensity Optical Recording) –was announced by the Tandy Corp. in April 1988. Different versions of play-erase-record CD systems had previously been announced (e.g., by Sanyo and Thomson SA), and others are reportedly under development in the United States and Japan. THOR technology is said to be compatible with current CD audio technology, so that the discs could be played in a conventional CD player (and vice versa).

Continued on next page

The read/write/erase technology is called CD-E. Blank CD-E discs will be blue, unlike conventional silver CDs. According to the developer, a "blank" THOR CD can be recorded over and over again, using a low-level recording laser to heat a thermally sensitive dye polymer material in the disc. Heating the dye changes its optical properties and creates the equivalent of the "pits" in a conventional audio CD. These pits are environmentally stable, enclosed in a protective layer to minimize the possibility of damage. To erase the disc, the same laser reverses the thermo-optical process, smoothing one or all of the pits. Tandy plans to make consumer-audio THOR recorders available in 1990, and also plans to introduce THOR computer data storage devices in 1991.

In 1987, Philips and Sony had announced plans for a CD mite-once player (producing discs that could not be erased and reused), aimed at professional markets for computer data storage or sound recording. The write-once technology is called CD-R; according to Philips, blank CD-R discs will be gold.

SOURCES: Robert P. Freese, "Optical Disks Become Erasable," ***IEEE Spectrum,*** February 1988, pp. 41-45. John Gosch, "From Thomson, a CD Player that Erases and Records, "Electronics, Mar. 17, 1988, pp. 42-46. Ronald K Jurgen, "Consumer Electronics, " in "Technology '88," ***IEEE Spectrum,*** January 1988, pp. 56-57. Peter H. Lewis, "Bringing Realism to the Screen, " ***The New York Times, Nov.*** 27, 1988, p. F9). John W. Lyons, National Engineering Laboratory, National Institute of Standards and Technology, letter to J. Winston, OTA Apr. 17, 1989. Ken Pohlmann, "DAT Hears Footsteps," ***Digital Audio,*** August 1988, pp. 16-17. Harry Somerfield, "CD Recorder Could Make Tape Obsolete," ***St. Petersburg Times,*** May 29, 1988, p. 3F. "Are Multimedia PCs around the Corner?", ***Electronics,*** May 1989, pp. 42-43. "Philips and Sony Design CDs That Can Record, " ***Telecom Highlights International, Nov.*** 11, 1987, p. 18.***TV Digest,*** vol. 28, No. 51, Dec. 19, 1988, p. 16. "Digital Video Interactive Technology, " (promotional materials) Intel Corp., 1988. Intel acquired the DVI Technology Venture from GE in 1988. DVI was originally developed at the David Sarnoff Research Laboratory (formerly RCA Laboratories). Tandy Corp. product literature, 1988. Tandy has not yet released the details of how THOR works.

Since enactment of the 1976 copyright law, questions about home uses and home copying — specifically, the congressional and judicial debates over home videocassette recorders (VCRs)[28] and the recent congressional debates over home audiotaping– have continued to be addressed on a niche-by-niche basis. The current law (Title 17, U. S. C.) contains special provisions pertaining to "sound recordings," "computer programs," and "motion pictures." The home audio- and videotaping debates of recent Congresses have included arguments for and against a tax or royalty on the media used to make copies — i.e., on "audio-" or "videotapes." Distinctions among these niches are blurring, however, and may well disappear.

So far, it has not been extremely difficult to classify blank media by prospective content/use: audio recorders, video recorders, and computers have used different, physically recognizable blank media. In addition, recording/playback equipment is generally recognizable by intended use: different equipment is generally used to record audio, video, etc.[29]

In the not-so-distant future, however, the same recorder and/or blank medium might be used for sound, images, or computer data. Therefore, durable "compulsory-license-with-fee" provisions (like a "tape tax" or "home-copying royalty") might be complicated by the inability to classify all the prospective uses of omni-purpose media and/or recorders. For example, a provision pertaining to "devices

[28]Videotaping issues were not putt. rest by the 1984 Supreme Court decision in ***Sony Corp. v. Universal City Studios, Inc.*** See ch. 3.

[29]There are exceptions: for example, pulse code modulation (PCM) adapters can be connected to a stereo system, digital radio receiver, or other audio source, to record audio on videotapes with a VCR. See: Bob Hodas, "Digital Recording Comes Home, " ***Digital Audio,*** July 1988, pp. 22-23, and Jeffrey A. Tannenbaum, "Adapters Allow Digital Taping Using VCRs," ***The Wall Street Journal,*** May 20, 1987.

and/or media used to copy sound recordings" could well apply to computers and erasable optical discs, or to a computer and its hard disk; a blank digital audiotape could be used to record music or to store computer data.

DIRECT ELECTRONIC DELIVERY

New infrastructures and business arrangements facilitating new methods of distribution for audio, video, and other entertainment and information products are being developed. The new infrastructures include transaction-based systems to deliver audio and video materials on demand (via optical fiber cable or satellite) and the prospect of higher-capacity communications channels to the home. Also, software producers, publishers, and providers are consolidating into totally integrated entities that manage functions from the creation of new artistic works to their final distribution. These developments could eventually make *direct electronic delivery* of audio, video, and other entertainment products to consumers feasible. As Canadian record producers noted in their 1987 study of home taping: "The development of centralized storage computers, satellite and/or interactive cables presages new methods of distribution of intellectual property."[30]

These new modes of delivery challenge or call into question some of the conventional concepts of copyright. In part for this reason, they may be slow to develop. In the meanwhile, representatives of the recording industry maintain that it would not be justifiable to delay or forego addressing copyright and home audiotaping, just because the music industry might eventually benefit economically from direct electronic delivery technologies: "It is not justifiable to allow advances in technology to undercut the financial health of the music industry based on assumptions and predictions that may never bear out."[31]

Regarding the development of electronic delivery, some copyright proprietors consider that technology is less important than the current copyright law. In particular, the recording industry considers that direct electronic delivery of sound recordings would require a (new) performance right for record companies. If the performance right were not granted, RIAA maintains, electronic delivery to consumers would not be economically viable, because other entities, such as cable companies, could offer the same services without the permission of, or compensation to, record companies.[32]

These are arguable conclusions. There is some ambiguity in the current copyright law, and it maybe that clarification might be sufficient to encompass copyright protection for direct electronic delivery to consumers. For example, it is not clear that a one-to-one, preordered and/or prepaid retail transfer of a copyrighted sound recording in electronic form constitutes a "performance," as opposed to a "delivery." Sections 106 and 114 of the current law affirm the control of copyright owners in sound recordings over "delivery" of copies in the form of "phonorecords"; it is the Section 101 definition of phonorecords as '(material objects" that is troublesome. It might be possible to extend the scope of Section 106 to include electronic delivery, without extending record companies' rights over (electronic) performances of the works.

30"A Study of Home Taping," Canadian Independent Record Producers Association (CIRPA), 1987, p. 51.

31H. Rosen, RIAA, letter to J. Winston, OTA, May 2, 1989. Enclosure with comments on draft ch. 9, p. 3.

32OTA staff interview with RIAA executive, Mar. 8, 1989.

Then, direct electronic delivery of copyrighted material by the copyright owner to a bona fide purchaser might (in principle, at least) be considered no more of a "public performance" than would be a delivery of physical material by mail. Rather, an electronic delivery could be considered an instance of distributing copies of the copyrighted work to the public for sale, under section 106(3), albeit in an unconventional manner.

Representatives of the recording industry, however, consider that, in practice, the distinctions between "performance" and "delivery" are seriously undermined by consumers' ability to make home copies of music distributed by cable or satellite services. They argue that the preceding discussion fails to capture the basic copyright problem in this area, because it ignores the widespread practice of home copying. Although customers who subscribe to cable and other music services are not licensed[33] to copy the music being performed, RIAA argues that they will make copies. Thus, the end result, especially for digital formats, will be indistinguishable from an electronically delivered "original" — except that the recording company would receive no compensation. According to RIAA, cable companies and other entities perform the recording industry's product without compensation to the industry and, in fact, "sell" that product in competition with the recording industry by offering a substitute for record purchases. To the extent that the performances are copied, RIAA considers that record sales are further displaced. Therefore, RIAA considers that the lack of a performance right makes existing rights over distribution unenforceable.[34]

Thus, it appears that the otherwise separate issues of home copying and performance rights can be linked by home copying practices. But creating a new performance right (and royalty) would be a more indirect means for addressing home-copying issues than other possible actions like a home-copying royalty or technological copy-protection.

Recent business decisions by some copyright proprietors may have placed them in a better position to move towards direct delivery. Motion picture studios are entering the home video rental and cable markets. Recording companies, most of which have music-publishing subsidiaries, are acquiring independent music publishers; their music-publishing activities earn revenues from licensing and synchronization royalties for soundtracks, commercials, etc., as well as from performance royalties for broadcasts and public performances.[35] The net effect is a trend towards very large, consolidated firms that can produce new works and distribute them through a number of channels. For example, the Time-Warner merger could unite

[33]While a cable company or other carrier may "distribute" performances electronically (by playing sound recordings for a mass audience), it does not have the right to sell buyers a license to make copies. For direct electronic delivery, the seller would need the right to license the buyer to make at least one copy of the material. The right to sell copies (or to contract with someone else, e.g., a manufacturer, to make copies for sale) is a right that section 106(3) grants exclusively to the copyright owner.

[34]H. Rosen, RIAA, letter to J. Winston, OTA, May 2, 1989. Enclosure with comments on draft ch. 9, pp. 2–3.

[35]For example, in early 1989 Thorn-EMI (which owns Capitol and EMI Records) announced plans to buy SBK Entertainment World, with its catalog of 250,000 songs, including copyrights formerly held by CBS Songs and MGM-United Artists. In 1987, Warner Communications Inc. (which owns Warner Records) bought the then-largest music publisher, Chappell-Intersong Music, Inc., with its catalog of 400,000 songs; Warner/Chappell now has a catalog of some 750,000 songs. (Jon Pareles, "Thorn-EMI Gets SBK for $337 Million," *The New York Times,* Jan. 6, 1989, p. D14.)

The acquisition of Chappell-Intersong Music, Inc. by Warner Communications produced the world's largest music publisher, Warner/Chappell; SBK-EMI is its closest rival. Warner/Chappell reportedly plans to grow by acquiring foreign music publishers, as well as smaller domestic catalogs. (Jean Rosenbluth, "Warner/Chappell Head Looks to Overseas Expansion," Variety, n.d., 1989, p. 123.)

the media fins' publishing, motion picture, record, cable programming, and cable system operation activities.[36]

Boxes 2-G and 2-H spotlight some of the new services and systems being developed to bring entertainment and information to the home.[37]

TECHNOLOGICAL COPY PROTECTION

Proponents of technological means for copy protection note that much of the legal tradition of copy-right was developed under the assumption that there was no technical "solution" to prevent private copying, and that enforcement of laws against private copying would be virtually impossible.[38] Therefore, the "solutions" historically sought by rights holders were private-copying royalties,[39] as opposed to unenforceable bans on private copying. New techniques that would prevent, or raise substantial barriers to, private copying are being developed. While these may be technically feasible, important – and possibly overriding– issues remain as to their political feasibility and social desirability. In considering proposals for technological means for copy protection, technical advances should be regarded as necessary servants of policy, rather than as sufficient reasons for setting policy.

Some issues raised by the prospect of technological means for copy protection have been noted earlier by OTA, in testimony concerning the copyright issues posed by DAT:

- *Technological approaches to preventing copying vary in effectiveness, and can be undermined or defeated by new techniques.* The extent to which consumers do seek to circumvent a particular technique will depend in part on the time and cost required to do so, as well as the perceived acceptability of the copy protection.
- *Technological approaches may require a greater role for government than more traditional ones like royalties.* For example, insofar as the technologies are susceptible to bypass or deactivation, the Government might wish to make such modifications illegal. Then, to enforce this prohibition, either government or private parties would have to conduct some form of search, inspection, or surveillance. In addition, if such laws controlled imports, this enforcement would also need to be taken into account.
- *Technological approaches may amplify the intermingling of international intellectual property and trade issues. As* the **1986 OTA report on intellectual property noted, attempts to resolve intellectual property problems are likely to be more effective when undertaken as** part

[36]Floyd Norris, "Time Inc. and Winner to Merge, Creating Largest Media Company," *The New York Times*, Mar. 5, 1989, p. A1. In addition to magazine and book publishing, Time Inc. 's lines of business include cable television and cable programming (Home Box Office). Warner Communications, Inc.)s lines of business include film, recorded music, cable television, and music publishing.

[37]For a more thorough treatment of new telecommunication infrastructures and opportunities, see OTA-CIT-407, op. cit., footnote 12.

[38]Computer software is an area where unilateral technical means for copy protection have longbeenavailable. Interestingly, most of the major computer software producers have abandoned copy protection for applications software packages, largely for marketing reasons: protected programs caused technical problems for legitimate users and were targets for hackers who bypassed the protection with a "code breaker" or "copy buster".

[39]See, for example, "A Technical Solution to Private Copying: the Case of Digital Audio Tape," Gillian Davies, *European Intellectual Property Review* (Opinion), vol. 6, 1987, pp. 155-158.

Box 2-G–New Infrastructures and Services

Technology is opening up new ways to deliver information and entertainment into the home. These new delivery systems may eventually replace, or at least supplement, sales of audio recordings, videocassettes, and preprogrammed computer discs. If information is delivered to the home in electronic form, people can use currently available technology to make their own temporary or permanent copies for future use.

Cable Systems: The Cable Communications Policy Act of 1984 (Public Law 98-549) prohibited telephone companies from operating cable television systems in their own regions, but telephone companies currently may own and operate cable systems outside their own regions or abroad. Fiber optic cable systems — whether provided by cable system operators, phone companies, or others — would offer enormous capacity, compared with conventional copperware telephone lines or the coaxial cabling traditionally used for cable systems. They could, for example, carry integrated services digital network (ISDN) voice telephone service simultaneously with high-quality audio and video (including high-definition television), and high-speed data services to private homes. Cost is a major barrier to installing the "last mile" of fiber to individual subscribers, and economic justifications for installing fiber to homes are often based on projected service offerings like cable TV or video on demand. Telephone companies and cable operators are examining fiber-to-the-home systems, and telecommunications and cable-equipment firms are developing fiber-based trunk and distribution system products for cable operators.

Digital Music Services: Even without fiberoptic cable, it impossible to deliver CD-quality sound to homes. A New York-based firm plans to introduce a cable radio service in 1989. The service will provide eight channels of digital music over conventional cable TV lines, plus an optional ninth channel offering "pay-per-play" reception of special concerts or album releases (for an additional fee). The firm is reportedly negotiating blanket licenses with BMI and ASCAP and having discussions with recording company executives, who have traditionally been unreceptive to pay-per-play home delivery systems. The service will offer digital audio in the CD-audio format, using proprietary technology to compress up to nine channels of 16bit, 44.1 kHz full-bandwidth digital audio, plus multiple data channels, to the regular 6 Mhz cable bandwidth. Cable companies would receive the encrypted signal via satellite and distribute it to their subscribers over regular cable trunk and drop lines. A special tuner (leased or purchased by the subscriber) would attach to the subscriber's stereo tuner and to the cable like an additional TV.

In January 1988, a California firm announced a planned music-only *digital radio service* offering 16 stereo channels of CD-quality sound, plus graphics/teletext, to subscribers via coaxial, satellite, and/or UHF-TV transmission. The scrambled signal, carried in the 6 Mhz TV bandwidth, would be received via a special tuner that would take the digital input and convert it to an analog output. The firm reportedly hopes to enter into agreements with recording companies for album distribution via a "pay-per-album" service. With this service, consumers (with addressable receivers) would be able to buy CD-quality music at lower cost. (They would order it by credit card via toll-free numbers and record it at home on DAT or conventional tape recorders.) Recording companies would receive a negotiated, "pure profit" licensing fee without having to bear manufacturing or distribution costs. Other than this special service, the firm plans to operate as a conventional radio station: playing singles and "announcing" the album and artist via a text generator display on the TV screen. As of early 1989, the firm was testing the service with a small subscriber base, and hoped to be "on the air" by late 1989. According to the firm's president, some of the smaller recording companies, without distribution arms of their own, had expressed interest in the pay-per-album concept, but as of February 1989 no agreements had been reached.

SOURCES: Lawrence Curran, "Two Firms Link Arms to Run the Last Mile," ***Electronics,*** February 1989, p. 95.

Fred Dawson, "GI Makes Major Moves into Fiber," Cablevision, Sept. 12, 1988, p. 12.

Steven Dupler, "N.Y. Cable Firm Sets 8-Channel Digital Service," Billboard, Feb. 4, 1989, p. 1.

Gary Slutsker, "Good-Bye Cable TV, Hello Fiber Optics, " Forbes, Sept. 19, 1988, pp. 174-179.

"Telcos Fight Back: Phone Companies Gear up for Battle to Get into Video Delivery," ***Broadcasting,*** Sept. 9, 1988, pp. 47-48.

"Cerritos: A Testing Ground for the Future," ***Telephony,*** Jan. 2, 1989, p. 1314.

TV Digest, Dec. 5, 1988, vol. 28, No. 49, p. 8.

Digital Radio Laboratories, Inc., Lomita, CA (promotional literature, 1988), and Doug Talley (Digital Radio Laboratories), telephone conversation with OTA staff, Feb. 10, 1989.

International Cablecasting Technologies, Inc. product literature and OTA staff discussions with T. Oliver and M. Seagrave (International Cablecasting Technologies), July 14, 1988.

Box 2-H– Transaction-Based Distribution Systems

Many consumers are already obtaining entertainment products for home use without purchasing a disc or tape. Rentals, pay-per-view, and telephone or cable jukeboxes represent additional ways to deliver entertainment to the home.

Video Rentals: Consumer spending on home video rentals has grown rapidly with the use of VCRs, going from just $350 million in 1981 to about $5.5 billion in 1988. According to projections by Paul Kagan Associates, the video rental business will be a $7 billion per year industry by 1990, even though VCR penetration seems to be leveling off. The trend is toward large video "superstores," each carrying 7,000 to 12,000 titles.

Videotape rental stores or chains originally operated by purchasing videotapes directly from the distributor. Because of growing needs for investment in inventory to compete, there is now some movement towards transaction-based rental arrangements where the rental store leases new releases from the distributor with a per-rental fee arrangement. This pay-per-transaction (PPT) arrangement reduces the inventory investment from the rental store and allows the distributor to share in the rental proceeds.

With the move towards PPT operations comes the development of computer-based support systems. In principle, these systems could be adapted to track electronic, rather than physical, transactions; computers and data storage facilities would replace the physical inventories of prerecorded videotapes.

Cable and Satellite PPV: In part to counter increased competition from video rentals, pay cable and satellite dish program providers are initiating transaction-based, pay-per-view (PPV) offerings. Although by early 1989 perhaps only 25 percent of cable households had the addressable cable converters required for PPV transactions, some industry experts expect that the remainder will have them by 1991, making the PPV business worth a projected $2 billion per year by 1996, compared with $60 million in 1987. PPV typically works by offering subscribers special events or movies not yet available on regular pay cable services. Proponents note that PPV offers more convenience than video rental, but others think that its real appeal is to movie buffs who want to see films at home before they are released on cassettes or pay cable.

While PPV accounted for less than 2 percent of the $13-billion per year cable industry, PPV offerings can be extremely profitable for individual program rights holders. For example, although only 600,000 households ordered the Tyson-Spinks boxing match (at $35 apiece), the fight produced greater revenues for promoters and rights holders than the 1988 Super Bowl. Movie studios earn an average of $250,000 for each film shown on PPV; their PPV earnings were $36 million in 1988 and are expected to reach $1 billion by 1997. Because of PPV's potential profitability, services that collectively transmit movies to cable operators for PPV have been established by a group of movie studios, a group of multiple-system cable operators, and a large cable programmer. The collective PPV services are transmitted by satellite to cable operators, who deliver them to homes equipped with addressable converters. Most of these require a phone call; to make PPV more user-friendly, some converters (in 8 percent of PPV homes) have "impulse technology," which allows the customer to order via pushbuttons on the converter unit.

Until recently, a major barrier to PPV was the lack of reliable technology for wiring homes and handling transactions and billing on a broad enough scale. In 1986, for example, only 2.1 million homes were wired to receive PPV. Now, the number of homes equipped to receive PPV services is approaching 10 million, and is projected to top 40 million by 1996, according to Paul Kagan Associates.

In the long run, PPV is thought to be video rental's closest competitor, especially in 5 to 10 years when addressable converters will be available to all households. One advantage of PPV is thought to be program diversity via "niche-casting": programs with narrow appeal can be profitably offered by PPV. For example, if only one percent of 20 million customers pay $20 to receive an opera, it will bring in $4 million – presumably, enough to produce and distribute it at a profit.

A service to offer satellite dish owners a variation of PPV is scheduled to begin in 1989, using a satellite to deliver the top 10 videos and other made-for-PPV programming 24 hours a day. Customers would order the programs by dialing a toll-free number to "electronically rent" a video. Also, interactive PPV offerings are under development; these w-ill allow viewers to select story options or play games, using a keypad.

Continued on next page

Telephone and Cable Jukeboxes: In GreatBritain a "telephone jukebox" service began in October 1987. The service allows consumers to call a special telephone number and listen to records or albums and order records directly. The system uses a combination of voice recognition, compact disc players, and personal computers on a local area network. The provider (a recording company) refers to the system as "the radio station at the end of the phone." Calls are billed by British Telecom; the minimum is $0.50 for 3 minutes. In late 1987, the service was averaging 1,000 calls a day.

In 1989, a Miami-bad cable network was deriving the bulk of its revenue from charging viewers to see a music video on demand – more or less. In this service, a selection of up to 1,000 music Video titles scrolls along the bottom of the TV screen; by dialing a local 976-number and punching in selected song codes, the viewer can order a particular title. However, like a conventional jukebox, the Video jukebox selections play in the order received, so there may be a 20-minute to several-hour wait. The charge is $2 for one video, $5 for three. The telephone company keeps a small portion and the service shares the balance with the cable operators. In early 1989, the video jukebox service was on nine cable systems, as well as a few low-power VHF affiliates. While the scheme maybe well suited for exploiting popular local niches (reggae in Miami, for example), and proponents hope that the technology will expand to local job and real estate classified, it faces problems finding enough cable systems with spare channels.

SOURCES: Mark Albright, "On Fast Forward: Video Superstores Bust into Tampa Bay Market," St. *Petersburg Times,* Mar. 20, 1988, p. I-l. (Article reports data from Paul Kagan Associates, Inc.)

Greg Clarkin, "Burnett and Virgin Vision Dare to be Different," *Video Business* (New York, NY), Sept. 30, 1988, pp. 38-40.

Rich Katz, "Pay-per-ViewMusic Videos: Will Viewers Ante up to Play Them?" Channels, January 1989, p. 16.

Francesca Lunzer, "New Developments (Movies by the Hour)," *High Technology Business,* November 1988, p. 8

Edmond M. Rosenthal, "Cable Operators Stage a Comeback for Pay-TV Services," *Television/Rudio Age,* Sept. 19, 1988, pp. 46-48.

Andrew L. Yarrow, "Pay-per-View Television Is Ready for Takeoff," *The New York Times, Nov. 14, 1988,* p. D9. (Article reports data from Paul Kagan Associates, Inc.)

"Computer Group Starts," *Video Business,* Sept. 30, 1988, p. 10.

"PPT: Money Hasn't Changed Everything after an Emotional VSDA," Staff Report, *Video Business,* Sept. 16. 1988, pp. 18-19.

Telephone News, vol. 9, No. 15, Washington, DC, Apr. 11, 1988, pp. 2-3.

> of a multilateral effort; unilateral imposition of trade restrictions might lead to retaliatory restraints on trade or to deteriorating international relationships. Also, there is a danger that if intellectual property policy is established in the context of trade issues, it may be skewed from its original goals.[40]

In comments on a draft of this report, the RIAA took exception to the latter two points, noting that "...it is incorrect to assume that a technological approach would require a 'greater role for government' than a traditional approach such as royalties," and that "...the integrity of intellectual property protection is essential to U.S. competitiveness in international commerce and we do not see why technological approaches to defending the integrity of copyright should be disparaged or rejected because they have some impacts on trade."[41]

As another issue, to the extent that technological approaches may make it more difficult to make noninfringing or fair-use copies,

"" Copyright Issues Presented by Digital Audio Tape," Testimony of Fred W. Weingarten and Linda Garcia, Office of Technology Assessment, U.S. Congress, before a hearing of the Communications Subcommittee of the Senate Committee on *Commerce, Science,* and Transportation, May 15, 1987.

•l H. Rosen, RIAA, letter to J. Winston, OTA, May 2, 1989. Enclosure with comments on draft ch. 9, PP. 4–5.

means would have to be developed to allow such copying. The recording industry takes the position that legitimate fair uses should be preserved and that exemptions (from technological copy protections) "should and could be worked out."[42] In practice, however, specific exemption procedures and/or techniques to circumvent technological copy protections, or to administer exemptions from or reimbursements of copying royalties, might be so complicated or cumbersome that some fair use would be discouraged.

Audio Recordings

New technologies have made copy protection possible for digital and, perhaps, for analog sound recordings. Machine-readable identification of copyrighted works (i.e., an electronic [circle-C] /[circle-P] marking) and specific identification of works (e.g., title and publisher) are now feasible.[43] Several technological copy-protection techniques have been developed or proposed to prevent or limit copying of digital recordings. The best known of these is the CBS Copycode system, designed to prevent digital-to-analog-to-digital or analog-to-digital copying on DAT machines.[44] Other techniques that have received some attention in the trade press are the "Unicopy" system proposed by the RIAA (that reportedly would allow one analog or digital copy of a CD to be made),[45] the "Solo-Copy" proposal by Philips (that reportedly would allow consumers to make DAT copies of a CD, but not to make DAT copies of those copies), and the "Stop-Cop" proposal by Kahn Communications (that reportedly would prevent DAT copying of copyrighted material on tapes or CDS).[46] None of these techniques can be implemented unilaterally by the recording companies; hardware modifications would also be required. For now, recording companies would need joint agreements with (mostly, overseas) consumer-electronics firms to effect technological copy protections.

Serial Copy Management System

A working group comprising representatives of Japanese and European hardware manufacturers and United States and European software associations (e.g., RIAA and IFPI) met in April, June, and July 1989 to discuss DAT and copyright issues. The working group agenda focused on technological means for preventing or limiting DAT copying of CDs and other digital sources.[47] In July 1989, RIAA, IFPI, and hardware manufacturers signed a MOU agreeing to seek legislation mandating a new DAT format called Serial Copy Management System (SCMS). SCMS would permit direct, digital-to-digital copying of digital recordings and broadcasts, but not digital-to-digital copies of these copies.[48] (For details about the agreement and SCMS, see box l-E.)

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[42] H. Rosen, RIAA, letter to J. Winston, OTA, May 2, 1989. Enclosure with comments on draft ch. 9, p. 2. The RIAA comments did not detail specific exemption procedures.

[43] OTA staff interviews with RIAA Engineering Committee, Dec. 6, 1988.

44 The Copycode system is designed to prevent copying of an audio signal that enters the DAT as an analog signal. The method is not intended to stop, and does not prevent, direct digital-to-digital copying. (John W. Lyons, National Engineering Laboratory, National Institute of Standards and Technology, memorandum to OTA, Apr. 10, 1989, comments on draft ch. 9.)

[45] As described in *TV Digest,* Feb. 22, 1988, vol. 29, No. 8, p. 14.

[46] *TV Digest*, vol. 28, No. 6, Feb. 8, 1988; *TV Digest, vol. 29, No. 29,* July 17, 1989, p. 15.

[47] *TV Digest*, Mar. 20, 1989, vol. 29, No. 12, p. 16; Shig Fujita, "Hardware Firms, Labels Closer to Accord on DAT," *Billboard*, Apr. 1, 1989, pp. 1,83.

[48] The main barrier to direct digital-to-digital DAT Copying of CDs-different sampling rates — would be eliminated. DAT recorders with SCMS would make only one additional generation of copies made from analog sources.

The MOU agreement to implement SCMS is not binding on the parties unless legislation is passed. The RIAA has maintained the position that Federal legislation is essential to implementing any agreed-on technological solutions, because such agreements, absent legislation, would raise serious antitrust concerns.[49] Also, the Electronic Industries Association (EIA) and RIAA note that legislation would be needed to make the agreement binding on manufacturers not participating in the working group.[50]

CBS Copycode System

In an earlier attempt to resolve the home audiotaping controversy generated by the prospect of DAT recorders coming into widespread home use, legislation was proposed in 1987[51] requiring that DAT recorders sold in the United States befitted with a copy prevention decoder so that suitably "coded" material could not be copied. The Copycode system, developed by CBS Records, was the basis for the proposals:

> The Copycode system "codes" audio recordings by removing a narrow band of frequencies from the audio signal; this is referred to as "putting a notch" in the signal. The DAT recorder would contain a decoder to sense the presence of the notch; when it was detected, the recorder would be disabled, preventing copying. The intent was to prevent copying, without noticeably degrading the sound quality of the recorded audio signal. The analog Copycode encoder had logic circuitry used to determine whether to encode the audio signal, based on its signal levels near 3840 and 2175 Hz. This logic circuitry would switch the encoding notch filter on and off, presumably to prevent notching of the audio signal when it might be more noticeable. The notch was a narrow band of frequencies in the vicinity of 3840 Hz, which lies between the highest B-flat and B on the standard piano keyboard. This frequency range is well within the range of normal hearing for young adults; musical instruments like pianos, synthesizers, piccolos, and bells produce fundamental notes in the encoding notch.[52]

Those opposing this legislation argued, among other things, that the notching could seriously degrade the recorded sound (compared with the unnotched version), that it might produce false positives (i.e., refuse to record unnotched materials), and that it would be relatively easy to circumvent. Copycode's proponents strongly disagreed with these arguments. To resolve this technical dispute, Congress requested that the National Bureau of Standards (NBS, now the National Institute of Standards and Technology) study a specific implementation of the Copycode system. NBS received two recorders and encoders from CBS, along with proprietary descriptive material that was kept confidential. Part of the testing was done by a subcontractor specializing in psychoacoustic measurements. Two stakeholder groups — the RIAA and the Home Recording Rights Coalition (HRRC) – agreed to fund the NBS test.

NBS was asked to answer three questions:

1. *Does the copy prevention system achieve its purpose to prevent DAT machines from recording?*

   NBS found that it did not achieve its stated purpose. Although it prevented copying notched material much of the

@H. Rosen, RIAA, letter to OTA, May 2, 1989. Enclosure with comments on draft ch. 9, p. 5.

[50] *TV Digest*, VO]. 29, NO. 31, pp. 10-12.

[51] H.R. 1384 and S. 506

[52] See U.S. Department of Commerce, National Bureau of Standards, National Engineering Laboratory, "Evaluation of a Copy Prevention Method for Digital Audio Tape Systems," NBSIR88-3725 (February 1988), ch. 2. The material in this section is based on the NBS report.

time, it also exhibited false positives (refused to record unnotched material) and false negatives (recorded notched material). NBS studied 502 tracks on 54 CDs, and found false positives for 16 tracks on 10 discs.[53]

2. *Does the system diminish the quality of the prerecorded material?*

   NBS concluded that, for some listeners and some selections, the encoder notching produced discernible differences between notched and unnotched recordings. Although the effects were fairly subtle for some selections, for others subjects could hear differences.[54]

3. *Can the system be bypassed, and, if so, how easily?*

   NBS found that the copy prevention system could be bypassed easily; NBS engineers designed and implemented five different circuits to bypass the copy prevention system. According to NBS, these circuits were simple and would be easy to construct for about $100 each.[55]

After the NBS test results were reported and published, the Copycode legislation was withdrawn.

Generic Approaches to Preventing Audio Copying[56]

After discussions with the RIAA Engineering Committee, the OTA staff requested more information on technical approaches to copy protection, and on ways to implement them.[57] To identify the range of technically feasible alternatives to prevent or limit copying, the information summarized below was provided in April 1989 by the RIAA Engineering Committee. Neither the Engineering Committee nor the RIAA intended the information outlined below as an endorsement of any particular system or approach.[58]

According to the RIAA Engineering Committee, copy-protection systems could be designed to prevent copying of prerecorded and/or broadcast material, to limit copying, or to allow copying with remuneration (see box 2-I). Copy-protection systems of these types might be implemented in the analog domain, the digital domain, or both.

For example, copyrighted materials might be identified via an *analog baseband signalling system*. By identifying materials in the analog domain, the copyright-identification information in a digital recording could not be suppressed by using analog channels in a recorder (see discussion of analog circumvention below). The copy-protection signal would be contained within the spectrum of the recorded music (or background noise) and would be inaudible. According to information provided by the RIAA Engineering Committee, efforts are ongoing to develop a system of this type.

Copyrighted materials could also be identified in the *digital subcodes* currently in (digital) recordings. If these markings were recognized by recorders, they could be used to provide protection from direct digital-to-digital copying. But this type of copy protection

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[53]NBS, Op. cit., footnote 52, P. 44-48.

[54]NBS, op. cit., footnote [5]2! 49-64.

[55]NBS, Op. cit., footnote 52, P. 65-71.

[56]Material in this section summarizes information provided by the RIAA Engineering Committee. (H. Rosen, RIAA, letter to J. Winston, OTA, Apr. 17, 1989 (enclosure); H. Rosen, RIAA, letter to J. Winston, OTA, Jun. 2, 1989 (enclosure).)

57J. Winston, OTA, letter to H. Rosen, RIAA, Dec. 12, 1988.

[58]H. Rosen, RIAA, letter to J. Winston, OTA, Apr. 17, 1989 (enclosure).

Box ***2-I–Systems to Copy Protect Sound Recodings***

Option 1: Prevent copying of original prerecorded and broadcast material ("original copying"). To do this, the original copyrighted recording would be encoded with a digital flag or an analog baseband signal. A detector in the recorder would sense the code indicating that the material was copyrighted and would then disable the recording function.

Option 2: Limit Copying.

a. Limit **the amount of original** copying-This type of system would limit the number of copies of prerecorded and broadcast material that could be made on anyone recorder. It could operate in the digital or analog domain. Each prerecorded source would have the catalog number and time code or track number encoded in a digital subcode or baseband signal. When the prerecorded or broadcast source material is copied, the code would be entered into a nonvolatile, cyclical memory in the recorder. The recorder would only be able to record a particular selection once (until the recorder's memory was filled and reset, several thousands of copies later).

b. Prevent serial copying-This type of system would allow an unlimited number of copies to be made from the original prerecorded material, but would not allow copies to be made from copies. In the digital domain, copies of copyrighted materials would be marked with a digital flag. The recorder would recognize the flag (indicating that the material to be copied was itself a copy) and no additional copies of the copy could be made. In the analog domain, this system could operate with a baseband signal indicating that the work was copyrighted.
IOTA Note: The SCMS format corresponds to this option in the digital domain.]

Option 3: Allow unlimited copying with remuneration.

a. Debit card system– This type of system would allow unlimited copying but would use prepaid debit cards to provide remuneration to copy-right holders for each copy made. It could operate in both the digital and the analog domains. Recorders would be equipped with a debit card reader, and the original copyrighted recordings would be encoded with a digital identification code and analog baseband signal. To copy a copyrighted work, the debit card would have to be inserted and left in the machine for the duration of the recording; otherwise, the machine would fail to record. Noncopyrighted works could be copied without a card. The recorder's card reader would deduct a fee from the debit card each time a track was recorded. When the card's value was used up, the consumer would need to purchase a new card to make more copies. Cards might be sold at record stores or other consumer outlets; revenues would be distributed to copyright holders, less a commission for the dealers. Cards could be disposable, but if the reader could record information on the card itself (as on a D.C. Metro fare card) and if consumers were given incentives to return the cards, they could be used to provide information about the material copied or the hardware used.

b. Two-tiered blank tape levy– For this sort of system, blank digital audiotape would be classified into two categories – one that could be used to copy copyrighted material (and would carry the levy) and one that would not. For example, tape carrying the levy might be printed with white stripes on the nonmagnetic back. The recorder would have a simple diode light detector that would look at the tape back as it passed around the DAT recorder's helical scan drum. Prerecorded material would be encoded with a digital flag or baseband signal. Attempts to copy material with the copyright code would fail unless the recorder's light detector indicated the proper output from the striped tape.

SOURCE: RIAA Engineering Committee, April 1989. Material provided for information only, to identify the range of technical alternatives to prevent or limit copying, and not as an endorsement of any particular system or approach.

could be circumvented by passing the material through a digital-to-analog (D/A) converter. Digital or analog copies of the converted signal (without the digital subcodes) could then be made. Such *analog circumvention* presents a technical problem in designing copy protections for prerecorded and broadcast digital sources. According to the RIAA Engineering Committee, to limit this circumvention, one (legislative) alternative would be

to eliminate analog inputs on digital recorders. This would force (copy-protected) direct digital-to-digital copying, or the use of a separate analog-to-digital (A/D) converter to COPY. To prevent the latter, the purchase of such A/D converters might be prohibited, except for professional use. Alternatively, specialized A/D converters that would generate a copyright flag could be mandated. Another option would be require A/D converters or analog inputs on digital recorders to be designed so as to reduce the quality (signal-to-noise ratio) of the analog signal. This would penalize circumvention with copies of lesser quality.[59] Another option, not yet technically feasible, would be to identify copyrighted materials via an analog baseband signal, as described above.

Video Recordings

The *home video* industry, with sales and rentals of prerecorded videotapes of movies, cartoons, sporting events, and the like, developed around the use of home videocassette recorders (VCRs). Ten years ago, the studios did not foresee the benefits of home video for the motion picture industry. Indeed, in their attempts to prevent the introduction of VCRs during the Sony case, studio representatives argued that the VCR would necessarily cause the demise of the entire motion picture industry. As VCR use burgeoned, however, the studios set up home-video arms to produce and distribute prerecorded videocassettes. By the mid-1980s, movie industry revenues from videocassette sales (often, sales to rental stores) equaled their revenues from box office receipts.[60] By 1988, the studios saw the profitability of rentals and observed that they did not appear to cause a decline in box office receipts.[61] Subsequently, they began to diversify into pay-per-transaction (PPT) video rentals (see box 2-H).

At about the same time, the motion picture industry began to consider establishing new barriers to VCR recording of pay cable and pay-per-view (PPV) programming, video rental's major competitors.[62] In a speech before the **1989 Winter Consumer Electronics Show, Jack Valenti, President of the Motion Picture Association of America (MPAA), urged the electronics and motion picture industries to agree on technological means of copy protection for videotapes and movies delivered by pay cable,** PPV, and premium satellite services.[63]

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[59] H. Rosen, RIAA, letter to J. Winston, OTA, Apr. 17, 1989 (enclosure); H. Rosen, RIAA, letter to J. Winston, OTA, Jun. 2, 1989 (enclosure).

[60] LINK Resources data cited in *Technology and the American Economic Transition: Choices for the Future,* OTA-TET-283 (Washington, DC: U.S. Government Printing Office, May 1988), p. 268.

[61] According to Jack Valenti (MPAA), "the more a person watches movies on a VCR, the more that person is drawn to viewing a movie in a theater." Valenti reportedly attributes the rise in movie attendance by the over-40 age group to home VCR viewing. (*Billboard*, Jan. 21, 1989, pp. 7, 94.)

[62] According to Nielsen Media Research, although VCR usage is rising, pay and basic cable taping is declining as a proportion of VCR use. For the first quarter of 1987, Nielsen's data show that recordings from pay and basic cable constitute 9 and 5 percent, respectively, of all VCR tapings; for the first part of 1988 the figures were 7 and 4 percent, respectively. However, the total number of tapings during these periods increased, from an average of 13 per month to 14 per month. (Catherine Stratton, "Cable Taping Down, VCR Usage Rising," *Multichannel News,* Sept. 12, 1988, p. 24.)

[63] According to Valenti, "... In the long term best interests of both industries and the paying public, prerecorded videocassettes as well as movies delivered via pay cable, pay-per-view, and satellite premium services must be made copyproof." (*Television/Radio Age*, Feb. 6, 1989, p. 91.)

Earlier MPAA concerns over unauthorized duplication of prerecorded videotapes have made some VCR product innovations problematic. For example, when one U.S. company announced plans to market dual-deck VCRs in 1984, the motion picture industry's representatives raised such furor that their introduction was halted. Foreign manufacturers declined to produce them after being approached by representatives of the motion picture industry.[64]

The company filed suit against MPAA and eight VCR manufacturers; the case was reportedly settled in early 1989.[65] Another example is a new home video product that combines a VCR with a personal computer and an artificial intelligence system. The enhanced VCR can automatically tape shows matching a profile of the household's viewing interests, then play them back via remote control. The system works by linking individual units to a central computer via telephone lines; each unit scans TV listings and selects shows to be taped. Because the system uses "at least two" VCRs, however, it potentially raises concerns about its use for unauthorized duplication of prerecorded tapes.[66]

Some commercial videotapes are manufactured using a copy-protection system that adjusts the gain signals being recorded. If this tape is copied on a home VCR, the gain signals on the copy are further attenuated, to the point where it produces unstable images when played. But some "booster cables" or "video stabilizers" sold, ostensibly to improve picture quality when viewing tapes, could be used to circumvent copy-protection techniques like this.[67] A new copy-protection technique intended to "code" movies, sporting events, and other copyrighted material shown on pay cable and/or PPV services is undergoing laboratory and market tests. The technique reportedly works by fluctuating the per-frame transmission rate of the film to distort copies made with a home VCR. The developer hopes to introduce processed, or "coded" films on a nationwide basis later in 1989.[68]

Summary

Technological advances spurring the growing use of home recording devices have substantially changed the nature and extent of possible home uses of copyrighted material. Policymakers are now faced with a need to define the appropriate balance between the consequences of technological change and copyright law. The next chapter will analyze the legal aspects of home copying.

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[64] *TV Digest*, vol. 27, No. 26, June 29, 1987, p. 13.

[65] *TV Digest*, vol. 29, No. 10, Mar. 6, 1989, p. 10. The firm, Go-Video, has reportedly received $1,8 million in settlements from manufacturers and plans to market the double-deck VCR in 1989. (TV *Digest*, vol. 29, No. 8, Feb. 20, 1989.)
According to MPAA, Go-Video agreed to insert anti-copying devices in all its dual-deck machines. (Jack Valenti, "Peace Treaty Offered between Electronics, Entertainment Interests," *Television/Radio Age,* Feb. 6, 1989, p. 91.)

66 The SmarTV system, introduced by Metaview Corp., is initially being offered at $6,000, and is projected to sell for less than $1,000 in 2t03years. (Tom Bierbaum, "RecordingTVFare Without TouchingEithera Video Machine or a Tape," Variety, Feb. 1-7, 1989, p. 52.)

67 For example an advertisement in The *New Yorker* (Jan. 23, 1989, p. 101) offers a "digital video stabilizer" to eliminate "video copyguards, color shifts and distortion s." According to the ad, the device, available for about $50, "is not intended to copy rental movies or copyrighted tapes that may constitute copyright infringement. "

[68] Eidak Corp. product literature (Cambridge, MA:1989).