ONE TO ONE

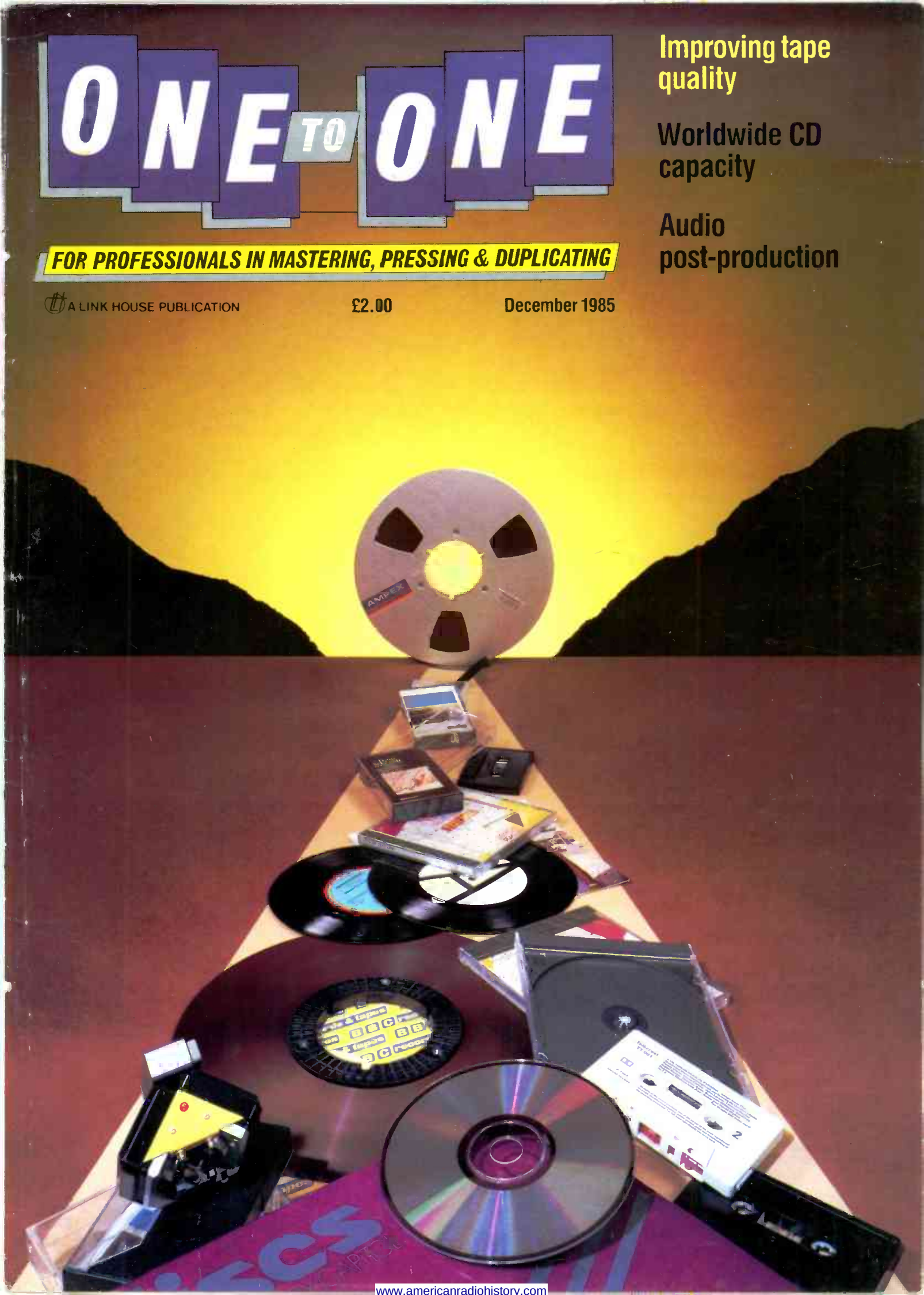
FOR PROFESSIONALS IN MASTERING, PRESSING & DUPLICATING

A LINK HOUSE PUBLICATION £2.00 December 1985

Improving tape quality

Worldwide CD capacity

Audio post-production



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ONE TO ONE

FOR PROFESSIONALS IN MASTERING, PRESSING & DUPLICATING

EDITORIAL

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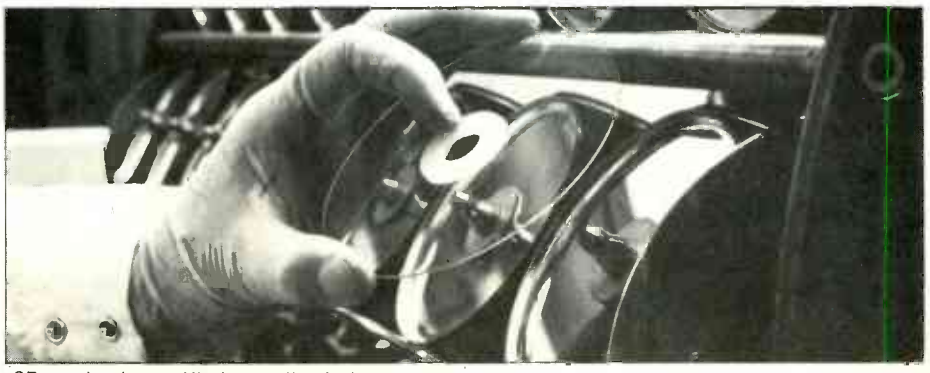

CD production at Nimbus—disc before metallising

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EDITORIAL

Voices in the wilderness?

Welcome to the very first issue of *One to One*. Despite the importance of the record/cassette/CD manufacturing industry and the important role it plays within the overall framework of the entertainment business very little exposure is given to the industry viewpoint.

Over the past year or so the *Studio Sound* team has recognised by talking to industry users, manufacturers and readers, that there is a real need to provide the industry viewpoint. At the moment no such platform exists. *One to One* has been created to redress that balance.

In 1985 it has been estimated that around 2,500 million records, tapes and CDs will have been manufactured worldwide, worth in round figures a staggering US$13,000 million. None of this happened by accident. Almost everyone who has received this first edition of *One to One* will have contributed to those figures in some way or another.

Today virtually every segment of the manufacturing industry is under scrutiny. Technological development continues to accelerate at an ever increasing pace and if you don't keep up with the changing trends there's a very real danger you will get left behind. There can be no denying the fact that with the advent of compact disc fundamental changes are already taking place and many more are undoubtedly on the way.

In addition to discussing day to day problems and providing a broad industry overview *One to One* will aim to provide a much needed forum for frank discussion, highlight the major industry issues, and keep an interested eye on new developments. We will also be providing a platform for individual comment. Stuck for something to write about? Well what about the quality of master tapes—are they getting better or worse? Faulty returns—who is really to blame? Vinyl quality? Or what about pricing, is it realistic and do the public and/or the record companies expect too much for the prices they are paying?

At the end of the day despite the best will in the world *One to One* cannot exist in a vacuum. To be truly effective it needs your support, your comments and your points of view. It is after all *your* magazine. Whether you choose to remain silent or grasp the opportunity with enthusiasm is down to you, not the chap in the next office, or the competitor down the road. The industry has never really had a international publication specifically for its needs—now's your chance to take advantage of the situation.

Carl Snape

PRE-EMPHASIS

USA sales manager appointment at ICM

Rolf Seger, international sales director for ICM Switzerland has recently announced the appointment of Rod Stepan as sales manager for the USA: Rod Stepan, 4617 Dunwoody Club Drive, Dunwoody, GA 30338.

New CD plant goes into production

ICM has announced that its new compact disc plant has started production in Diessenhofen, Switzerland, on schedule, with a capacity in excess of 3 million units per year.

Better known for manufacture of cassette shells and library cases, ICM also specialises in supplying 'own label' cassettes in addition it has its own high speed duplicating plant.

ICM sees its new venture as a natural development from its involvement in the recording industry to which it is totally committed.

This is the fifth plant in Europe to start CD production and ICM are planning to increase production in 1986 by 100% bringing total capacity to 6 million units.

Tapetek speed up service

London based, service engineers to the duplicating industry Tapetek, can now offer technical support round the clock thanks to cellular radio.

As Dave Hill, the proprietor of Tapetek, explains, "Because of cellular radio we can achieve a lot more in the time available to us. But more importantly our customers can keep down time to a minimum, because they do not have to wait for an engineer to return to the office before they can obtain the technical information that they need."

Dave Hill is already established as one of the UK's leading, independent, service engineers for a wide range of duplicating equipment including King, Tape Automation and Tapematic. In addition to this and following Tapetek's recent appointment as agents for Saki magnetic heads, the company has extended the scope of its specialised laping and refurbishing service to include all types and makes of magnetic heads.

Dave Hill, Tapetek, 44A Brighton Road, Stoke Newington, London N16 8EG, UK. Tel: 01-254 5203. Cellular: 0860 317260.

USA tests to improve pre-recorded audio cassette quality

The International Tape/Disc Association is conducting a series of tests aimed at improving the quality of C-Os used in pre-recorded audio cassettes and thus the quality of the recorded cassettes.

These tests involve 10 suppliers of C-Os and six tape duplicators. The suppliers are Athenia Industries Inc, Data Packaging Corp, Filam National Plastics Inc, ICM, Inc, IPS Inc, Lenco Co, Magnetic Media, Rainbow USA, Shape Inc and Trans Am Industries. The tape duplicators are Capitol Records, Cassettes Productions, CBD Records, MCA Manufacturing, RCA Records and WEA Manufacturing.

The objective of the tests is to reduce angle error in the cassette shells which causes loss of signal, thereby reducing their play level of high frequencies. The reason for record company concern in this area is that sales of pre-recorded cassettes have overtaken those of LPs, becoming the dominant format in the recording industry. This has brought about more concern with cassette quality than was shown in the past. C-O suppliers, however, had been finding that whilst one record company might approve a shipment, another would reject identical goods if they didn't pass their azimuth test.

Initial steps were taken to discover whether the six tape duplicators would arrive at similar test results in measuring the angle error of the various brands of C-Os. When correlation was found, a new series of tests was initiated with all duplicators using the same equipment and methods, down to the same brand of tape identically recorded.

If the new round of tests, currently in progress, establishes a correlation in the findings of all six user companies, the test specifications will be added to the International Tape/Disc Association A-101-A (Revised) Standard for Audio Cassettes.

ITA, 10 Columbus Circle, Suite 2270, New York, NY, USA. Tel: (212) 956-7110.

New Vice-president at Electro Sound

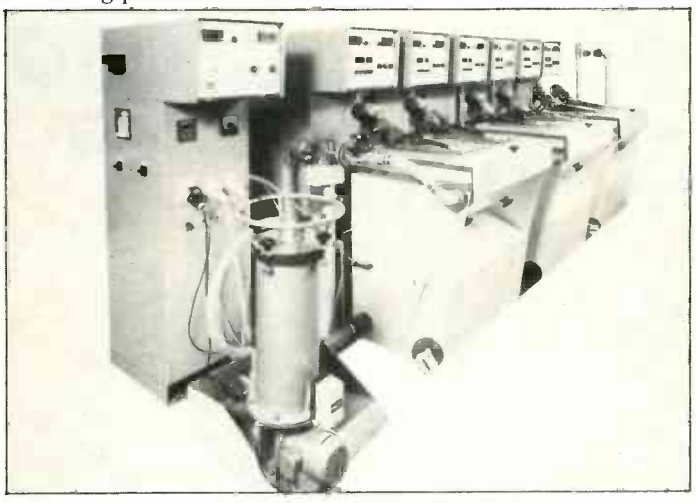
Electro Sound has announced the appointment of Mark Nevejans as vice-president (sales) following the departure of David Bowman. Prior to this Mark Nevejans was assistant to the president of the Electro Sound group.

Musitech turnkey packages for CD manufacturers

Buckinghamshire based CD and record manufacturing specialists Musitech can now offer complete turnkey packages for those people who wish to build compact disc manufacturing plants. Included in the package are mastering facilities, electro-forming, moulding, silvering, printing, packaging and all services. Also included is staff training, technical support and after sales service.

The turnkey packages are designed and produced in conjunction with several other leading specialist consultants and companies. Following many years of experience within the record manufacturing industry, including production of laser vision discs, Musitech have recently developed a new range of plating equipment designed specifically for CD production. The new units are made from non-corrosive materials with all non-essential processes being kept outside the clean room in which the plating units should be located in order to obtain maximum, error free, yield. The unique flow path of fluid within the plating cell ensures that the critical anode/cathode area is always presented with fresh electrolytic.

Roy Mathews, Musitech Ltd, 11-13 Temple End, High Wycombe, Bucks HP13 5DM, UK. Tel: 0494 37526.



Graff and the Koran in Tunisia

High speed cassette duplicators supplied by Graff Electronics, having been used to help spread the word of Buddhism in Thailand, are now helping spread the word of Mohammed in North Africa. C-60 cassettes will be copied at the rate of 285 per hour.

The stereo duplicator, which is being installed on the outskirts of Tunis, consists of one master unit and 13 slaves and will eventually be expanded into a 1:20 system, allowing an output of over 3,000 cassettes a day. Slight modifications were carried out on this system for high humidity and 220 V operation.

CBS mastering business up

CBS Studios W1 are increasing their mastering staff to accommodate increased demand as well as shorten their turnround time. Cutting engineer Andy da Costa who for the past seven years has been responsible for the bulk of CBS records mastering, will in future be working alongside Tim Young who continues to concentrate on third party client work.

A third engineer is also being appointed to share the increased workload by night-time cutting, which is being introduced at the central London facility.

Equipment updates have included a second Neumann *VMS80*, a third Sony *PCM 1610* and a Sony *PQ Addressor*.

CBS Studios W1, 31 Whitfield Street, London W1P 5RE, UK. Tel: 01-636 3434.

CBS/Fox Video

The audio quality of pre-recorded video cassettes has improved, says CBS/Fox Video, following installation of over 500 National Panasonic *AG 6810 S* VHS hi-fi video recorders and 150 Sony 8 mm recorders with PCM sound. The company has also replaced their Beta and *V2000* recorders making it one of the most advanced duplicating facilities in the UK with a capacity of up to 2 million units a year.

In addition to the duplication facility the company has its own editing suite complete with sub titling. A wide range of packaging options are available and their own distribution services, operated by Securicor, can deliver units singly or in bulk within 24 hr.

Philips/Du Pont optical storage

Philips in the Netherlands and the Du Pont Company, USA, are discussing the formation of a worldwide venture on optical storage media (optical discs) for data, audio and video markets.

Philips are well established in the optical disc field and Du Pont has been actively involved in the development of high density optical information storage media.

Details of the proposed new venture will be published when available.

New sources of chrome duplicating tape

Ampex have joined BASF and Dupont in supplying chrome tape for loading into blank cassettes and for duplication.

The Ampex chrome tape has been designated type *619* (C-60) and type *620* (C-90) and offers 8 dB extra dynamic range at 10 kHz and just over 1.0 dB at 1 kHz when compared to standard Ampex ferric tape.

Ampex Corp, Magnetic tape Division, 401 Broadway, Redwood City, CA 94063-3199, USA. Tel: (415) 367-3809. Telex: 348464.
UK: Ampex Great Britain Ltd, Acre Road, Reading RG2 0QR. Tel: 0734 875200, Telex: 848346.

US Lyrec distributor

Danish manufacturer of duplicating and magnetic recording equipment Lyrec, has appointed AEG Telefunken Corporation to distribute and service its range of high speed loop bin duplication systems throughout the United States.

The systems run at 32:1 and 64:1 and Dolby *HX Pro* is available on the 64:1 slaves as an optional extra. Features include quiet operation, high output for minimum floor space, each unit is self contained, has switchable equalisation and automatic tape cleaner, and competitively priced.

TracSystems buyout

TracSystems Ltd is a new British company entering the field of high-speed cassette duplication. The company was formed in August 1985 as a result of a management buyout of the Cassette Systems Division at Soundcraft Electronics. Muna Dawoodi, a former director of Soundcraft Cassette Systems, becomes TracSystems' managing director and financial experts Morris and Henry Laniado become co-directors.

Trading began from premises in central London but new investment to the tune of £½ million will soon result in production at a purpose-built factory in Abergavenny, South Wales. About 70 new jobs will be created.

Muna Dawoodi has extensive experience in the field of cassette duplication and was responsible for the production design of Soundcraft's *CD201* for which TracSystems now owns design and sole production rights. TracSystems will continue to supply Soundcraft on an OEM basis.

Calibration system for high speed duplication equipment

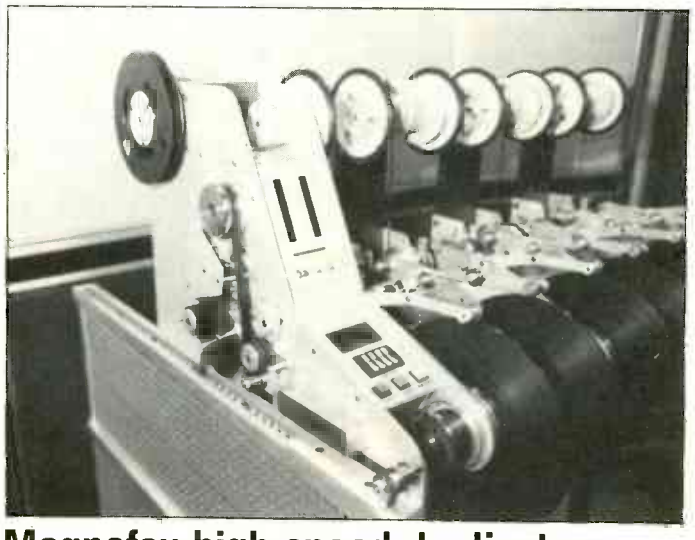
AEG Telefunken launched their Precision Master/Slave Duplicator Calibration system at the recent AES meeting in New York.

The system consists of a small precision playback head assembly fitted with a micrometer to adjust the head to the required track position, a proprietary ¼ in reference tape and a separate calibration instrument.

The calibration instrument has 12 bandpass filters which can be manually selected with front panel push button switches or automatically swept through the entire frequency range to provide a graphic display of the frequency response on an oscilloscope.

The unit is available for 16:1, 32:1 and 64:1 duplicating ratios.

AEG Telefunken, Route 22 Orr Drive, Somerville, NJ 08876, USA. Tel: (201) 722-9800.



Magnefax high speed duplicators

The *7000* series is the latest addition to the Magnefax line of high speed tape duplicators. It features the common mandrel capstan design in use on all Magnefax duplicators since 1959. Digital peak-meters with memory hold provide level information throughout the entire bandwidth even during short musical passages. The total low level audio path from the playback heads has been shortened to the minimum while selected components and plug-in amplifiers reduce noise and high-end dropouts.

The tone injection module offers a wide range of level and frequency adjustments for flexibility when dealing with the loader requirements. A digital counter on the control module indicates the number of tapes recorded per slave which can be automatically controlled. The STOP function is performed in two steps to leave enough tape at the end of the pancake for easy threading of a loader without losing the first cassette. All the commutation circuits make use of optocoupling technology for minimum noise and increased reliability.

The loop bin will accommodate up to 1800 ft of master tape recorded at 7½ in/s, the *7574* uses a ¼ in format while the *7575* uses ½ in tape. The conductive nature of the material used for the bin contributes to the absence of static electricity; the open design also eliminates problems associated with air compression which often result in poor tape handling.

Either duplicator will produce in excess of 6900 C-45s in a 24-hr day using a 16:1 duplicating ratio for optimum quality and low maintenance. Frequency response is 30 Hz to 15 kHz ±2 dB, crosstalk from A to B is more than 55 dB and signal to noise ratio is within 2 dB of bulk erased tape.

Magnefax International Inc, Route 1, Box 764, Rogers, AR 72756 SA. Tel: (501) 925-1818.

Polyform precision electroforming equipment

Polyform manufactures precision disc electroforming systems which are used by major optical disk and compact audio disc manufacturers in Japan, Europe and the USA to make computer optical memory disks, CDs, laser video discs, holographic embossing plates and records.

Polyform has developed proprietary chemical metallising technology for optical computer ROM disks. All optical computer ROM disks, CDs and laser video discs must be coated with a reflective metal film. This coating reflects the laser beam which reads the encoded information on the disc.

The metallisation equipment includes process conveyors which move moulded plastic optical ROM disks through a series of chemical sprays. These clean and condition the disks and deposit the thin reflective mirror of metal. This method takes the place of the more traditional vacuum sputtering.

The Polyform precision disc electroforming systems are equipped with the latest features required for CD electroforms. They are available in one to six station models and standard equipment includes: fully automated low ripple 'soft start' power supply; fully automated microprocessor control of each individual electroforming station; one button operation; serial computer interface; clean room-ready design of electroforming console; submicronic, absolute filtration system; pressurised heat exchanger system; electrolytic purification cell; solution sump system; self-cleaning electroforming cell; flat stamper electroforming capability; heavy duty cathode rotary heads; cathode backplates simplify resist master, father and mother handling.

Options available are: class 100 laminar flow enclosure; special software for microprocessor for serial computer interface; pH meter; pH controller (for automatic control); ampere/hour controller (automatically adds wetting agent or other additive at your preset ampere/hour interval); chart recorder; automatic electronic surface tension monitor; flow meter (direct read out of flow in gallons/minute).

Polyform Inc, 516 S Fifth Avenue, Mt Vernon, NY 10550, USA. Tel: (914) 668-4700.

Telex 6120 high speed duplication system

A modular high speed tape duplication system from Telex, the *6120* operates at 16:1 speed ratio and can be expanded to an 11-cassette slave system with a reel master and two reel slaves. Modules mount easily on to consoles and are connected with a single ribbon cable and power cord.

Modules available are for cassette to cassette, reel-to-cassette, reel-to-reel or cassette-to-reel and all are compatible, with one control module needed to operate the entire system.

The control module contains all system functions and audio level and bias controls. Reel modules use standard 7 in or 10½ in NAB reels. Four screws secure the entire headblock assembly to the module. The reel master and slave modules have four pushbuttons that control tape movement, which can be used to override the control module. Possible tape damage is eliminated when changing modes because brakes, spring dampened arms and idler wheels maintain constant tape tension.

The cassette master-slave module contains one master cassette position and three copy cassette positions and features end of tape sensing, short tape/jammed tape indicators and track select switches.

Telex Communications Inc, 9600 Aldrich Avenue So, Minneapolis, MN 55420, USA. Tel: (800) 828-6107.

Concept Design 1 in loop bin

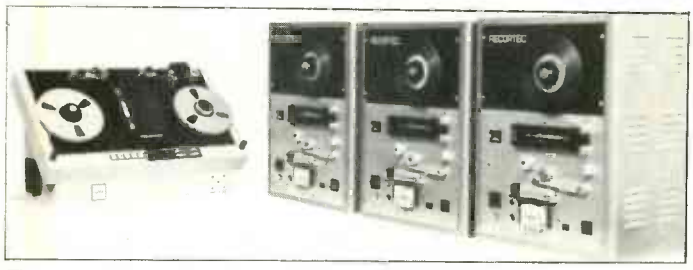
Concept Design, the engineering division of American Multimedia, from Burlington, North Carolina launched their new 480 in/s bin which uses 1 in tape mastered at 7½ in/s.

The 1 in bin follows successful production trials of a ½ in bin which has been in constant production for the last six months at AMI. Both bins feature a new concept in transport technology and because of this they do not run into the air film problems normally associated with running tape across stationary heads at high speed.

Audio quality is claimed to be better than that obtained from a master recorded at 3¾ in/s, especially at the high end of the spectrum.

Concept Design also market a range of accessories, including a high precision splicer, for the King range of automatic cassette loaders and a production monitoring system which avoids much of the paperwork associated with production control.

Concept Design, American Multimedia Inc, Route 8, PO Box 215A, Burlington, NC 27215, USA. Tel: (919) 229-5554.
Europe: Mike Jones Associates, 500 Chesham House, 150 Regent St, London W1R 5FA, UK. Tel: 01-439 6288



Recortec super high speed cassette duplicator

Recortec has introduced the Asynchronous Cassette Duplicator (ACD) which operates at 64:1 speed using 7.5 in/s master. Performance specification is claimed to be equal to any other brand of open reel, bin-loop duplicating equipment.

The system comprises a bi-directional master transport and from one to 12 cassette slave/loaders. Using a single bi-directional master it is possible to duplicate one cassette per slave/loader in both the forward and reverse pass. The use of an optional dual master unit will allow duplication of all cassettes in the forward mode since one master rewinds while the other is duplicating.

The slave/loaders duplicate the signal from the master on to the cassette tape external to the cassette shell and simultaneously load it into the shell. Beginning and ending splice operations which connect the leader to the tape are performed by the slave/loader.

The master transport uses reel-to-reel tape handling as opposed to bin loop in order to gain long master tape life.

Available in ¼ in or ½ in tape widths, the system also allows electrically switchable selection of 4-track or 2-track formats—stereo or mono. Recortec holds a basic patent on this transport design. Tape can be shuttled in excess of 25,000 passes without measureable degradation of signal quality at playback.

The design of the slave/loaders ensures constant tension of the tape across the record heads. They will accommodate all cassette tape formulations (oxide or metal) with simple, calibrated master bias control within each slave/loader. A recording bias frequency of 10 MHz and each unit has individual record and bias electronics that does not require the master for alignment or testing.

The slave/loaders also accept C-60 or C-90 base film without adjustment.

Sample cassettes demonstrating the product quality are available FOC to duplication facilities.

Recortec Inc, 275 Santa Ana Court, Sunnyvale, CA 94086, USA. Tel: (408) 737-8441.

TracSystems high-speed duplication

The *CD201* cassette duplication system provides high quality copies of cassette recordings at a low cost.

The *CD201* records directly on to blank cassettes from a single master cassette and is particularly appropriate for relatively short runs which require a fast turn round.

The modular character of the *CD201* provides a very flexible system. A basic set up consists of the power module, a 'master' module and a 'slave' module. The system is expanded by plugging additional slave modules into the row by means of direct connectors. As long as there is a power module per four extra slave units, there is really no limit to the number of slaves possible in each system.

This 'daisy-chain' design is complemented by advanced electronic engineering which is claimed to maintain excellent frequency response and signal to noise ratios at very high speeds. According to the manufacturer there is no discernible audio degradation even at 17 times normal tape speed.

Using one slave unit, 35 C-45 cassettes can be made within 1 hr. With 50 slaves 10,000 C-60s can be produced in a day.

The *CD201* is easy to use and maintain. The only moving mechanical component is the single floating head mechanism—there are no belts, clutches, gears or pulleys so mechanical wear is negligible.

Available in its basic configuration comprising a power module, 'master' module and 'slave' module, further power and 'slave' modules can be added.

TracSystems Ltd, 27 Little Russell Street, London WC1A 2HN, UK. Tel: 01-405 4075/7030.

KABA real-time cassette duplication

KABA R&D presented their 50-deck 4-track real-time cassette duplication system at the recent New York AES Convention. Designed specifically to produce high audio quality cassettes under continuous production conditions the system has the following features:

The master/control unit is a play only reference deck that includes all system controls. The slave units are dual transport record only decks. By eliminating nearly half the electronics required in the conventional consumer decks being used for professional real-time duplication, costs have been reduced and reliability improved.

The 4-track capability enables simultaneous duplication of both sides of the cassette thus doubling system output and head life.

Dual speed (1⅞ and 3¾ in/s) can also double system output when used with a compatible source master.

A claimed 10,000 hour transport life is provided by the large capstan, ball-bearing transport, in use for several years in commercial music distribution.

Modular, plug in circuits and transport mechanisms allow fast, easy maintenance by card substitution.

The system is currently only available in the USA.

Kenneth A. Bacon Associates, 24 Commercial Blvd, Suite E, Novato, CA 94947, USA. Tel: (415) 883-5041.

Improving Cassette Quality

In the last decade there have been great improvements in the quality of sound reproduction in the home. While the compact disc has undoubtedly been the most spectacular, writes John Fisher of Dolby Labs, the potential has emerged for a similar improvement from the more widespread Compact Cassette.

The compact cassette has become increasingly popular, partly due to its flexibility and partly to the improvements achieved in duplicating. The boom in sales of car and personal portable players has been a significant factor: pre-recorded cassettes now account for over half the total sales of all recordings.

One of the most significant steps in improving cassette quality was the introduction of the Dolby *B*-type noise reduction system in 1968. It has been used to produce hundreds of millions of pre-recorded cassettes, as well as being incorporated in tens of millions of cassette recorders and players. Dolby *B*-type noise reduction has become a world standard. Because the compression and expansion is limited to 10 dB, there is good compatibility with non-Dolby reproducing systems.

While cassette hardware and software have both improved over the decade, public expectations have continued to rise, and artists and engineers are anxious for their productions to reach the public with the highest sound quality.

A number of smaller companies have carved themselves a specialist niche by duplicating cassettes for a premium market, often using real-time copying. Today, even bulk-duplicated pre-recorded cassettes can rival the quality of any other consumer medium.

Correct biasing—the introduction of HX Pro

Early pre-recorded cassettes suffered from lack of high frequencies, from drop-outs and high distortion levels (particularly at middle and upper frequencies). Over the years they have been improved by better recording heads, which saturate less easily; better tape formulations; and better duplicator mechanisms, giving improved head-to-tape contact.

The fundamental problem of correct biasing persisted. Dolby Laboratories, in conjunction with Bang & Olufsen, investigated the phenomenon of 'self-biasing'. They found that the high frequency component of an audio signal itself acts as bias for the lower frequencies; in the presence of high-frequency signals at a significant level, less bias signal is required for the correct recording of a low frequency signal than without.

The outcome of this research was Dolby *HX Pro* headroom extension. During recording, *HX Pro* monitors the level and spectrum of the signal and adjusts the applied high-frequency bias, so that the total effective bias is kept constant. In this way *HX Pro* minimises the compromises otherwise inherent in biasing: the tape is always correctly biased at all levels, irrespective of the programme material. The frequency response then remains constant up to substantially higher recording levels than with conventional biasing, and the bias can be optimised for low distortion and less drop-outs without impairing high frequency response.

The result is improved clarity and stereo image stability, since the high frequency response becomes more independent of signal level; because recording at higher average levels is made possible, there is also a potential improvement in signal-to-noise ratio.

Dolby *HX Pro* is a record-only feature that makes the recording intrinsically more accurate. It requires no change in playback circuitry, nor special decoding. (Where the recording is encoded for Dolby *B* or *C*-type noise reduction, appropriate decoding is, of course, still required.) While *HX Pro* offers an improvement on any cassette recorder, its most widespread application is in high-speed duplication (**Fig 1**). *HX Pro* is available as an option or simple plug-in conversion on duplicators by Electro Sound, Cetec Gauss, Lyrec and Otari.

A number of duplicating facilities—in particular those for the Capitol, Liberty, EMI/America, Warner Brothers, Electra/Asylum, Sire, Windham Hill and Atlantic labels—have already adopted Dolby *HX Pro* for duplicating cassettes. They are also marking cassettes with the special logo to indicate to the quality conscious consumer that the cassette has been duplicated on equipment using Dolby *HX Pro* circuitry.

Improving the master

When the duplicated cassette has been improved, the next weakest link in the chain may be the duplicating loop-bin master, which can have high-frequency saturation levels lower than those of ferric cassettes. If chrome tape is used in the cassettes to improve the quality still further, this limitation on the quality of the master becomes particularly acute. By using *HX Pro* in making the duplicating master, the Maximum Output Level (MOL) for a master recorded at $3\frac{3}{4}$ in/s can be improved as shown in **Fig 2**. A similar improvement is achieved in the stereo image produced by the loop bin master to the improvement that can be achieved from the cassette itself.

Companies such as Studer and Otari have now developed new heads and electronics for mastering, to improve the low-speed performance including phase response; BASF has also introduced chrome mastering tapes. Taken together these three elements—better recorders, better tape and Dolby *HX Pro*—can effect a startling improvement in the duplicating master, and enable excellent results to be obtained at the preferred 64:1 ratio.

Care in duplicating

To achieve the highest possible quality, duplicators should have access to an early generation of source material, not a copy compressed and equalised for disc cutting.

Equally, it is important that overall quality should not be spoiled by misdirected attempts to extend the frequency range too far. If the noise reduction is to track properly, the frequency response of the signal reproduced from the tape must be the same as that applied to it. If a wider bandwidth signal is applied during recording than the combination of the record and replay processes can reproduce, some high frequency energy will be missing when the tape is replayed; consequently the replay noise reduction processor will 'interpret' this as though a different spectrum signal had been applied during recording.

Another factor frequently overlooked is that the replay high-frequency response of a typical domestic cassette machine is limited to about 14 kHz by the gap width; this may be the main constraining factor on extending the frequency response. If higher frequencies are recorded but cannot be reproduced by the combination of replay head and preamplifier, there will be a

missing high-frequency component in the control signal of the noise reduction decoder, which may consequently mistrack and cause a frequency response error lower in the audio spectrum.

Consequently, attempts to extend the frequency range of the recorded cassette to beyond 18 kHz may often result in the finished product actually sounding worse, when reproduced on a typical domestic cassette machine, even though it reproduces well on a professional three-head deck. It is therefore important that only frequencies easily reproduced via cassette should be recorded on the duplicating master.

More noise reduction

Dolby *B*-type noise reduction offers a 10 dB improvement in signal-to-noise ratio above about 4 kHz. It uses a single, sliding band of frequencies in the noise reduction side-chain, and operates at signal levels well below peak recording levels but well above the tape noise threshold. Consequently its operation is independent of system noise or transient overshoots; it tolerates minor record/playback errors in frequency and level; and it does not suffer from modulation of the background noise. Encoded cassettes can also be replayed on equipment that does not incorporate Dolby-*B*.

Pressure from consumers and manufacturers for a new domestic noise reduction system that retained all the advantages of *B*-type, while offering more noise reduction resulted in the introduction of the Dolby *C*-type noise reduction system in 1980. Since then, many new models of cassette recorders have included *C*-type noise reduction.

Dolby *C*-type provides 20 dB of noise reduction above 1 kHz, with a lesser amount down to about 100 Hz; below this it has no effect (the system deliberately avoids the region in which mistracking might be caused by replay bass bumps, due to poor head design, and by hum).

A number of devices exist which offer more noise reduction than Dolby *B*-type under certain conditions, mainly the absence of programme signals altogether. However, under practical programme conditions, all such circuits introduce side-effects such as noise modulation, programme modulation and overshoot distortion. Dolby *C* was designed to minimise such side-effects and to be as tolerant as Dolby *B* to the normal performance variations of the compact cassette. To provide economical encoding and decoding of *B*-type recordings as well, the *C*-type processor was designed to be switchable between the two characteristics.

Dolby *C* uses two sliding-band compander circuits in tandem, operating at different signal levels. One processor operates at a similar signal level to Dolby *B*, while the other operates at a lower level: each processor provides 10 dB of companding.

As in the Dolby *B* processor, the system has a fixed gain at high and low

Fig 1
OdB (Dolby Level)

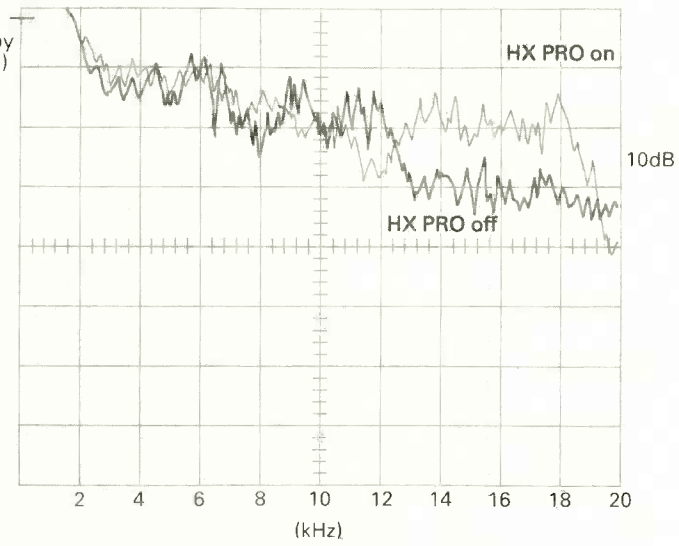
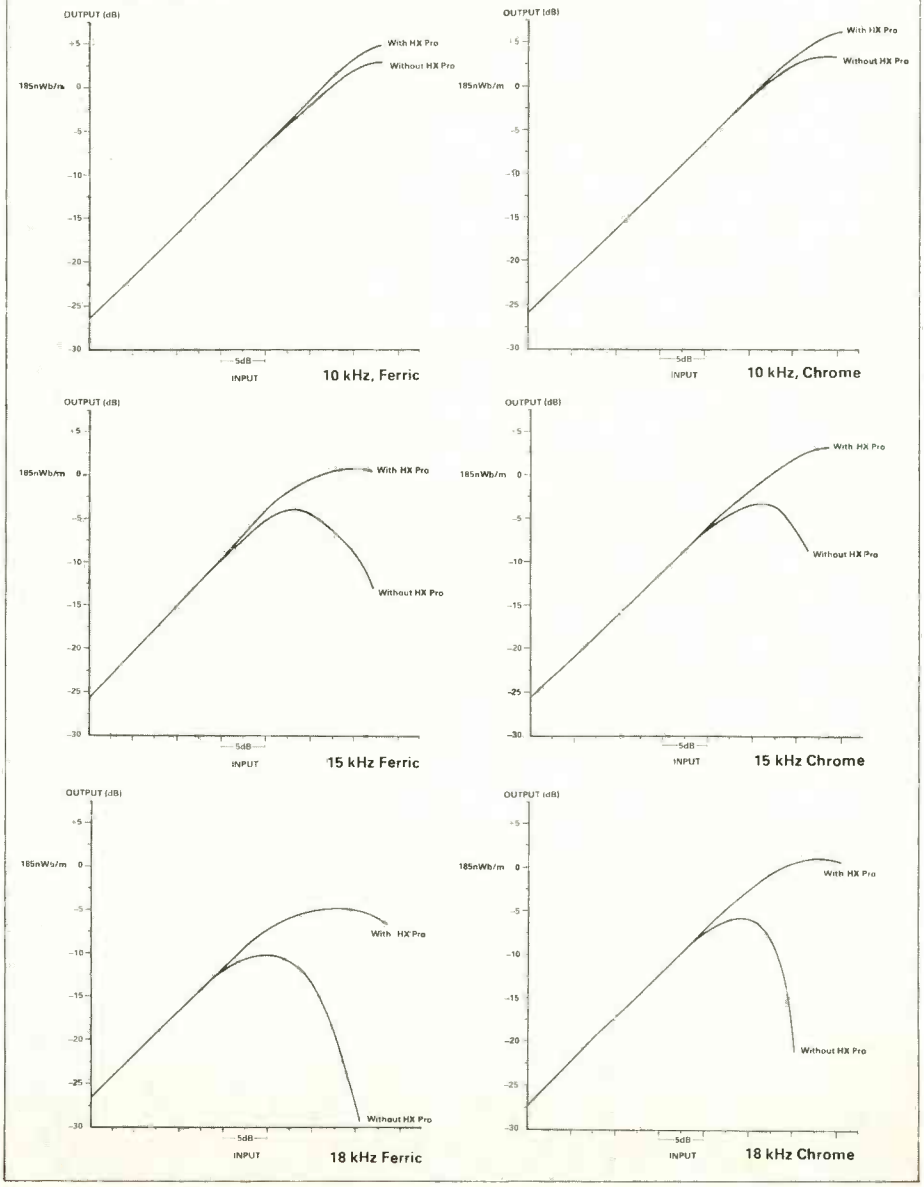


Fig 2
Input/output level comparison
Ferric and Chrome tape with and without
Dolby HX Pro at 3¾ in/s



levels: the variable gain region lies in the middle of the dynamic range. These factors together avoid overshoot distortion as well as modulation problems caused by uncertain noise thresholds.

In order to maintain a balanced residual-noise spectrum, it is necessary to remove more mid-frequency noise with *C*-type noise reduction. Processing begins approximately two octaves lower than in *B*-type, providing about 15 dB of noise reduction at 400 Hz and 20 dB in the critical 2 kHz to 10 kHz region.

For correct reproduction, the expander circuits must track the compressors precisely. Since the expander derives its signal after it has been recorded and reproduced via the cassette medium, any level and frequency response errors could alter the tracking, with audible results.

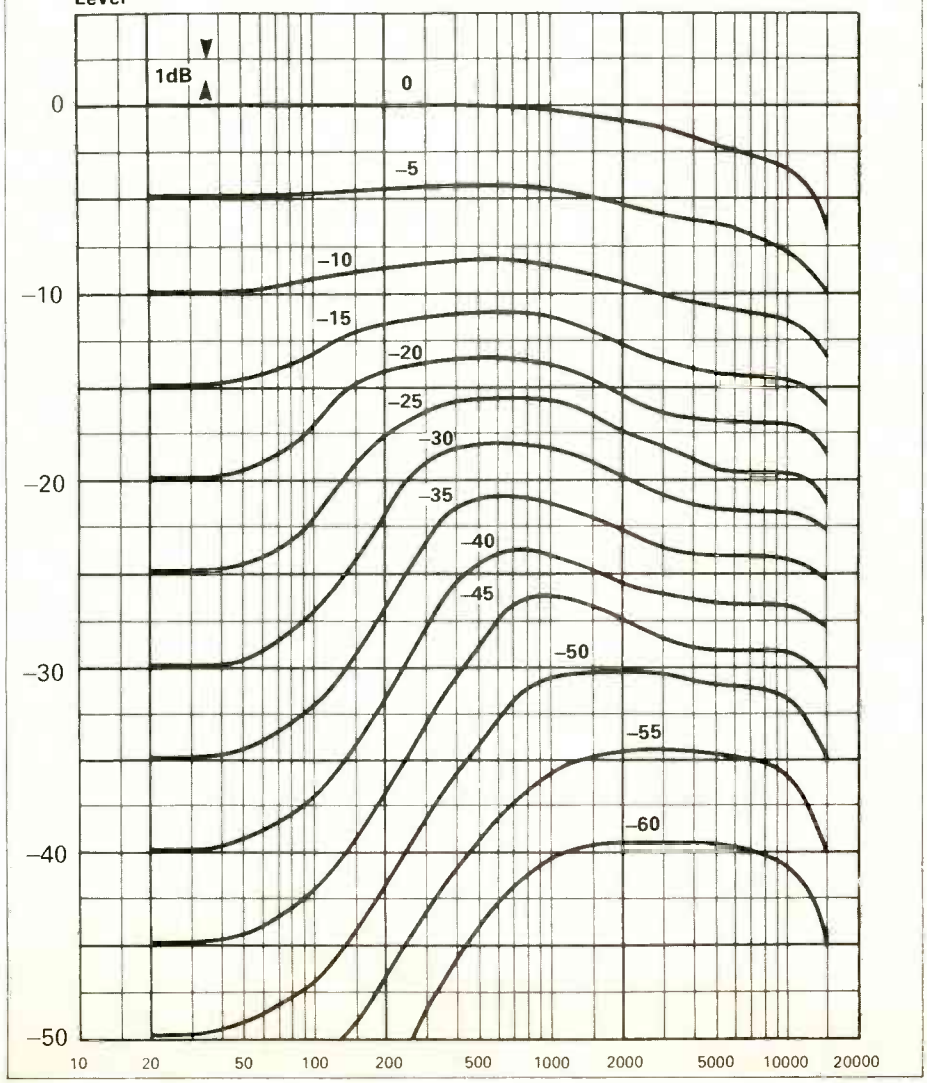
For instance, while a flat, extended response can be achieved well above 10 kHz, actual response may vary slightly with the sample of tape, head wear, dirt on the heads, recording level errors and high-frequency compression effects, which vary from one tape to another. Because the noise reduction side-chain boosts high frequencies, those above 10 kHz would form a significant part of the noise reduction control signal. Any frequency response error would therefore affect the control signal, which might cause further errors in reproducing other, lower frequencies. Ideally, a noise reduction system should only be controlled by frequencies that are predictable.

The *C*-type system was therefore designed to be tolerant of shortcomings of this kind. A high-frequency roll-off is introduced ahead of the *C*-type encode compressor and reciprocal compensation is applied after the replay expander, to maintain an overall flat frequency response. This technique is known as 'spectral skewing'. It reduces the uncertain frequencies to a non-critical level before deriving the control signal, thereby minimising their influence on the noise reduction tracking. While this also reduces the noise reduction available above 10 kHz, the ear's insensitivity at these frequencies makes any degradation insignificant.

Similarly, to reduce the severity of mid- to high-frequency saturation, which can occur if, for instance, a 70 µs characteristic is used on cassettes, a network to reduce the level of these frequencies is placed in the direct signal path of the compressor. At low signal levels the dominant signal comes from the compressor side-chain, so the effect of the network is negligible; at high signal levels the side-chain's contribution is negligible and therefore the shelving network comes into effect, reducing the amount of upper-mid and high frequencies recorded. To compensate, a boosting network is applied on replay to restore the output in the direct signal path at high levels; the effect on low level signals and thus on the circuit's noise reduction effect is again negligible.

The overall characteristic of the *C*-type noise reduction system, including the 'spectral skewing' and anti-saturation circuitry, is shown in **Fig 3**.

Fig 3
Typical C-Type Encoder Characteristics



Conclusion

Dolby *C* provides 20 dB of noise reduction as compared with 10 dB for *B*. It offers a high tolerance of frequency response errors as well as improved high-frequency saturation performance.

The public has become increasingly conscious of technical standards and has demonstrated that it wants good recordings in cassette format. As a result, a number of manufacturers are now introducing *C*-type encoded cassettes, marked with the logo, for this considerable market.

When Dolby *C* and *HX Pro* are used together on a compact cassette, with due care in choice of material and in duplicating, the resulting audio quality can rival that of any practical pre-recorded medium. Moreover, unless the user has an expensive three-head machine, the potential quality of mass-duplicated cassettes is also better than he can achieve by home taping. This is the quality with which recording artists deserve to be heard on cassette.

Many people already have the equipment necessary to play *C* encoded cassettes: over 14 million products with Dolby *C* have been sold world-wide, over half a million *C*-type products are sold each month. This represents a very significant potential market—much greater than for CD products, for example—and one which can be entered quickly with minimal outlay.

The record company wishing to sell premium quality cassettes does not have to stand in line at another factory to produce the product. Only a modest investment is required to install *HX Pro* for tape duplication. Dolby *C*-type noise reduction for the loop-bin master costs even less. This basic equipment, some wide-range dynamic range material, and due care in setting up the master recorder and slaves is all that is needed to start producing premium quality cassettes that can compete effectively with any other medium in both quality and cost.

Gauss stands alone.

Among all the available high speed tape duplicating systems, one towers above the rest: the Gauss 2400. No other system in the world integrates the technological advancements, reliability and craftsmanship epitomized by the name Gauss.

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Are the Record Companies Trying to Kill Off CD?

Of the major record companies only EMI has committed money to the production of CDs in Britain. EMI's move, although commendable, was inevitable. The company invested heavily in the construction of a factory in Swindon to press VHD videodiscs. When the decision was taken not to launch VHD on the domestic market in Britain, Europe and America, Thorn-EMI was left with a high tech factory capable of producing millions of VHD discs a year, and no market for the discs. Although VHD is sold on the industrial market, and as a music carrier for video juke-boxes, the Swindon plant has been heavily under used. With mastering and clean room facilities already constructed, it would have been insane for EMI not to switch some of the capacity from VHD to CD. The only surprise is that it took the company so long to make the decision. Swindon should be on stream by next year (unless Thorn sells EMI and scuppers the music division's plans).

Some of the other major record companies seem to be just hoping that CD will go away. To help it disappear, they are putting up the price of software. Even Polygram is in on the act. The company has raised the trade price of classical compact discs from £5.75 to £6.25. At the same time pop discs went up from £5.25 to £5.75. By the time these words appear in print, the trade price may well have risen to a uniform £6.79 for all types of title. At the same time WEA is looking for a 23% hike, from £6.50 to £7.99. Other labels look likely to put up trade prices by the best part of 25%.

Of course, if you are a record company with no investment in compact disc production, this ploy makes sense. The last thing a company without a factory to produce CD wants is to encourage people to buy CDs. But if WEA, RCA, Chrysalis and Virgin think they will kill CD, then they have another think coming. More likely CD will kill them. No-one who visited the recent Tokyo hi-fi show, or before that the Berlin Funkausstellung, or has been shopping in Tokyo or Tottenham Court Road can be in any doubt that CD is the medium of the future.

This Christmas Barry Fox will wear a marzipan hat. He predicted a year ago that by the end of 1985, the price of CDs would have fallen across the board—they haven't. But because demand for discs still outstrips supply and the record companies exploit the situation by putting up prices, the British record industry is making a suicidal mistake. It is gambling on the *failure* of compact discs.

Hardware prices are now half what they were when the system was first launched in March 1983. The disc pressing plants cannot keep up with the demand this creates. In the short term this gives the record industry a wonderful opportunity not only to try to kill CD but make some easy money in the process. The big question now is how soon will it be before supply outstrips demand? A lot will of course depend on how many CD players are sold. And this of course depends on the price at which they are offered. In Japan both Sony and Technics sell portables at around £150. The price in Britain is inflated, by almost 100% but they are still relatively cheap. Enough are being sold to create a situation—cited by Sony—in which demand exceeds supply by 80%.

'No-one who visited the recent Tokyo hi-fi show, or before that the Berlin Funkausstellung, or has been shopping in Tokyo or Tottenham Court Road can be in any doubt that CD is the medium of the future'

In practice what this means is that although there are in theory around 3,500 CD titles available in British shops, at any one time only a small fraction of these are actually available. The record companies have had to start thinking ahead far further than they ever imagined would be necessary. When EMI released Tosca, they ordered 10,000 discs. These were sold in a couple of weeks. There was no way that EMI could get a further batch pressed within months. The same thing has happened, all round the world, with the Beatles recordings. You just can't buy them.

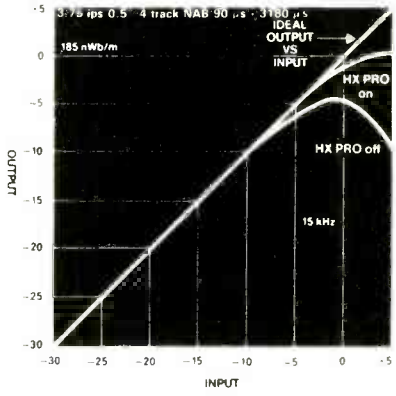
Pickwick is selling cut price CDs and some shops still gallantly sheer off a £1 or more from the list price of a CD. But they are fighting an uphill battle.

Capacities

So what is world pressing capacity? The simple answer is that no-one really knows for sure. Every day brings some new promise of a new compact disc pressing plant somewhere in the Western world. Recently I was telephoned by someone in the record business who wanted to know where he could buy compact disc pressing equipment. He thought his company might have a go at making CDs. That level of naivety would be funny if it weren't so sad.

The popular music press frequently publishes reports of new plants planned for the UK. As often as not the site is secret and so is the financial backer. In plain English what this means is that someone is trying to raise money for a scheme to build a CD factory. They haven't yet found anyone to put up the ante and they don't know where they will build it if they do get the money.

STOP SLAVING OVER YOUR MASTERS



Dolby HX Pro™ headroom extension, developed by DOLBY LABORATORIES and BANG AND OLUFSEN, represents a breakthrough in cassette duplication quality, resulting in a startling improvement in high frequency response.

High speed duplicating slaves from the major manufacturers are now available with HX Pro circuitry. This new generation of duplication slaves provides such an improved response that the limitations of the duplicating master become the major quality constraint.

The incorporation of Dolby HX Pro circuitry in the mastering machine can remove this constraint, resulting in clearer, cleaner cassette copies. Retrofit HX Pro modules are already available for several of the well known mastering machines.

DOLBY HX PRO

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Telephone: 01-720 1111. Telex: 919109.
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ASONA offers a complete program of tape duplication and winding systems.

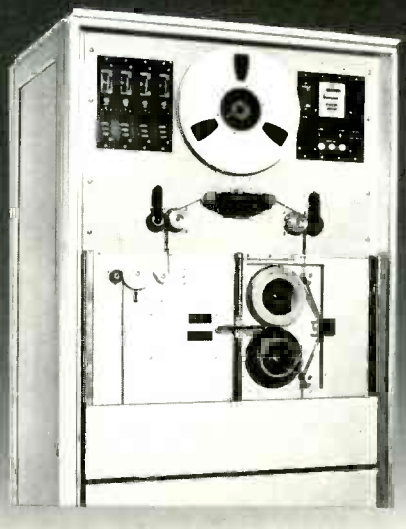
The ASONA loop-bin, a high-speed master tape reproducer, feeds and controls up to 40 slave recorders. Long-life ferrite heads provide flat frequency response and high dynamic range.

Available for 16 : 1 and 32 : 1 duplication ratios for a variety of tape formats.

Robust construction, with a minimum of moving parts.

Low maintenance requirements, low personnel costs.

Economically priced



ASONA High-Speed Loop-Bin

The loop-bin/slave system employs neither compressed air nor vacuum. Completely self-contained; requires only one mains point

We can tailor a cassette production system to your needs. Write or call for a proposal.

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The only way to form a reasonable picture of world pressing capacity, is to take information from all round, drop it in the pot and see what comes out. At the Berlin Radio Show in early Autumn, Philips estimated that around 2.5 million CD players had been sold on the world market. Philips should know about this because the company gets a royalty from each one. By now the figure should be around 3 million. This year (1985) Japanese companies alone will have produced 2.5 million CD players. Next year the Japanese total will be 4 million.

Polygram's plant in Hannover started pressing in August 1982 and hit 10 million discs (net after rejects) by June 1984. Production target for 1984 was 14 million. Production by the end of 1985 was 28 million a year and Polygram hopes for 36 million next year (1986), rising eventually to a maximum of 55 million a year in the late '80s.

Polygram is not popular in the record trade. Custom pressing prices fell by around 10% in the middle of 1985, to encourage the new medium. Then towards the end of the year, when the Christmas pressing demand increased, Polygram put the prices up again. The enormous capacity of Polygram at Hannover, currently around 28 million a year, needs putting into perspective. Around 20 million of these discs are for Polygram-associated companies. That leaves only around 8 million for all the others. As most of them could easily use 8 million each, it is nowhere near enough.

Nimbus

Nimbus in Wales was due on stream in July 1984. The date slipped several times to September. When the factory opened there was one press and one vacuum chamber, capable of turning out 50,000 discs a month. Nimbus now has six presses, and three metallisation chambers, producing around 20,000 discs a day or nearly 0.5 million discs a month. Unlike the majors, Nimbus has not put up its prices. The company still charges the same as it did a year ago, around £2 a disc, complete with artwork and jewel box.

Nimbus sells off chunks of its manufacturing capacity to majors but still sets some aside for independents. "Everyone is clamouring for more," says Adrian Farmer. "It gets worse because as the catalogue of new titles gets bigger, so it gets more difficult to get old titles re-pressed. Even with our relatively small catalogue, we still have to choose between new titles and back catalogue re-pressing. It will be a great relief to us when someone else starts pressing in Britain. It's very lonely being the only one."

Nimbus is now so over-subscribed, that a new customer (ie without a guaranteed chunk of Nimbus capacity) placing an order in late 1985 might well not see any product until 1987. Nimbus is already planning a second factory in the grounds of the Welsh estate, to go on stream around mid 1986. Phase three will be a third factory, built "somewhere else".

'The only way to form a reasonable picture of world pressing capacity is to take information from all round, drop it in the pot and see what comes out'

Phase two could put Nimbus's production up to 25 million discs a year. The company is not talking about the capacity of phase three, it's too far in the future.

"Quality and quantity is what we are aiming at" says Numa Libin of Nimbus.

Planned plants

EMI says it will start producing early in 1986, and will then gradually build up to an annual capacity of between 8 and 10 million discs. In France MPO Disques, near Le Mans, has a joint venture with British record company Mayking. Earlier in 1985 Mayking started with two presses. Mayking/MPO now have three presses, producing around 300,000 discs a month. "We got it cracked around August 1985," says Brian Bonnar of Mayking, "before that we had the usual run up problems."

Mayking, like Nimbus, has not put up its prices. They stay at around £2 a disc. Mayking presses for Pickwick, whose discs, at £6.99 are the cheapest on the market. Mayking serves mainly the small independents and plans heavy expansion in France to meet demand.

Treat other reports about British plants with suspicion—until the people involved have a factory to show, with working presses inside and playable discs coming off the production line. The same can be said for recently reported plants promised around the world, in France, Italy and Korea. The word on the grapevine is that of all the promised British plants, Disctec, put together by Phil Race, is most likely to be a goer. Advance publicity talked of a 5.5 million plant with a start up capacity of 4 million discs a year and design capacity capable of reaching 12 million. But only time will tell.

In Europe, Philips is joining forces with Dupont of the US, on all aspects of optical storage technology, audio, video and data. The joint venture is believed to be planning a CD pressing plant in Europe, probably West Germany and perhaps another in the US.

In America, the only compact disc pressing plant is a joint venture between Sony and CBS in Terre Haute, Indiana. The joint venture, Digital Audio Disc Corp was struck in 1983 and the $20 million plant went on stream in the Autumn of 1984. Initially there were technical problems, with as many as three out of four pressed discs faulty. Current production rate is around 0.5 million a month, with 1 million a month predicted for the end of 1985.

CBS is now negotiating to sell out its share to Sony. The plan is for Sony to run the US plant on its own and press discs for CBS on a custom basis. The word in the trade is that this may be a dangerous move. The deal between CBS and Sony may prohibit CBS from any competitive manufacture before 1990. CBS has also invested heavily in a conventional vinyl LP pressing plant in Holland. If relations between CBS and Sony turn sour, CBS could be in a most unenviable position.

Japan

In Japan everything, predictably, is full steam ahead. All companies, except one, are increasing production. The only exception to the rule is Matsushita-Technics, who appear to have shut down their CD line. This had a capacity of around 0.2 million discs a month. The shut down has left independents like Telarc, looking for another supplier. The Technics rationale, is that the disc pressing plant was only built to help the company design better CD players. Matsushita is essentially a hardware company, with no real interest in software. Once the line was on stream, the company used it for custom pressing. Now the production line is being used for research, mainly into CD ROM, the computer data version of CD.

JVC is producing around 1 million discs a month. Denon has 14 presses working in three shifts 24 hours a day, seven days a week, producing 0.9 million discs a month. In January 1986 Denon will add four more presses which will give the factory more down time and raise production to around 1.2 million a month. CBS-Sony in Japan has 16 presses running with similar capacity. Sanyo has also raised production to a similar level.

Conclusion

The situation is so fluid, and some of the Japanese manufacturers so reluctant to say what they are actually doing—rather than predicting what they will do—that it is almost impossible to put a firm figure on total world production of CDs. But at a rough tot up, it comes out at around 100 million a year, as from the end of 1985. The total is well in excess of what should be adequate for the players sold. Either people are buying far, far more discs than anyone expected (despite the price and shortage of titles) or the factories are not being truthful about their actual production. Sony UK estimates world production at around 50 or 55 million, which is half the tot-up figure.

Without doubt the number of discs produced will continue to rise through 1986 but so will the number of players sold as their prices decreases. While demand outstrips supply, the record companies will be in the happy position of being able to screw the public. Recent events show this is exactly what some of them will do.

PR Records: Vinyl Pressing and CD Expansion

That the management of a vinyl disc pressing company should wish to expand into CD pressing is no great surprise. But when he visited the company in South London Tim Leigh Smith found that the original vinyl pressing plant is also being relocated and enlarged.

Philip Race spent some eight years with Island Records, ending up as a director running the manufacturing and distribution division, and then a couple of years with CBS before he set up his own disc pressing plant, PR Records, in Merton Abbey Station Road in 1979. The abbey was long gone and the station had closed in 1929 leaving the area to develop as an industrial estate about eight miles (13 km) south west of central London and close to Wimbledon, home of the Lawn Tennis Championships.

PR Records' factory came on stream in October 1979 and set out to establish itself in the industry. "We came into the market place at a time when the world did not need another pressing plant," says Philip Race, "so the only way we were going to do it was to keep it fairly small, run it efficiently and produce good records—really tackle it on the quality side. We succeeded and we have run the plant on three shifts five days a week since May 1980, virtually without a break, with occasional weekend overtime and subcontracting work out for the high season."

Philip Race is justly proud of reviews in hi-fi magazines like *The Gramophone* —where the reviewers do not know which company pressed the discs—referring to the 'unusually high standard', 'impeccable quality' and surfaces which are 'pretty exemplary'.

"We charge a little more than most of the contract pressers but we need to do that to make records of that quality—one gets what one pays for. And I'm certainly a commercial man—I'm not operating this company unless the margins are right because there's no point; you can't trade properly and then the cash flow problems come. There's only one way to run a business: that's to do it right, charge the correct price and remain as competitive as possible."

This deceptively simple philosophy seems to have paid off. Philip Race says that most customers who have gone off in search of a lower price have later returned for the reliable quality. He attributes this success to a disciplined approach to the work. It is a matter of taking care at every stage of the process: being very selective about the quality of vinyl, using special procedures with reclaim (scrap vinyl) and in the post-pressing handling of the disc when it is most vulnerable, etc.

The company handles the entire process in-house: growing the metal plates for the stamper from the lacquer, right though to visual inspection and manual packing of every disc. With the careful quality control only about 0.1% of the output is returned by customers as faulty.

"Should we make a mistake—and we do make mistakes—then we have a non-quibble replacement policy. If they come back to us and we pressed them—they're encoded so we know if they're ours—if they are faulty we will replace or credit without a haggle. I think we've built ourselves a reputation for first class quality and first class service."

Into CD

The cosmetic quality of the vinyl discs is important to Philip Race as well as the technical quality. So he naturally found compact discs very attractive—"a marketing man's dream". When CD was launched in Britain in March 1983 he immediately set out to get a patent licence from Philips to manufacture compact discs. It then took some time to put the package together and raise finance for his new CD pressing company, Disctec Ltd.

"It's not been an easy thing because it's an immensely complicated process and there are many pitfalls. One of the major problems was finding suitable premises. I always consider that it's important to be near the hub of the industry. PR Records is near to London and that has repaid us a thousandfold. I was determined that the compact disc plant should be near London and to put in a plant of the size we were planning, with an ultimate capability of 12 million units per annum, you need fairly large premises."

The special requirements for CD manufacture, such as very clean air and freedom from vibration, meant that general-purpose factories put up by speculative builders were found not to be suitable. It was decided that the best solution would be a 55,000 ft² (5,110 m²) purpose-built factory with an initial production capacity of 4 million CDs per year and room for expansion to three

Plating: the metal work is separated

Centring: the centre hole is cut

The record is stamped

times this output. The construction was undertaken by IDC Property Developments at Southwater Business Park, near Horsham in West Sussex, 35 miles (56 km) south of London.

"It's a particularly good location. It's a rural location where we can be absolutely assured that we will not get undesirable neighbours—that is someone pumping stuff into the air which we've got to filter out for our clean rooms, or someone who's going to vibrate everything all over the place because you can't master a CD in a building which vibrates in the wrong way. So it's a super location overlooking a wooded slope and a lake, in fact it's attached to Southwater Country Park which has just won a major conservation award."

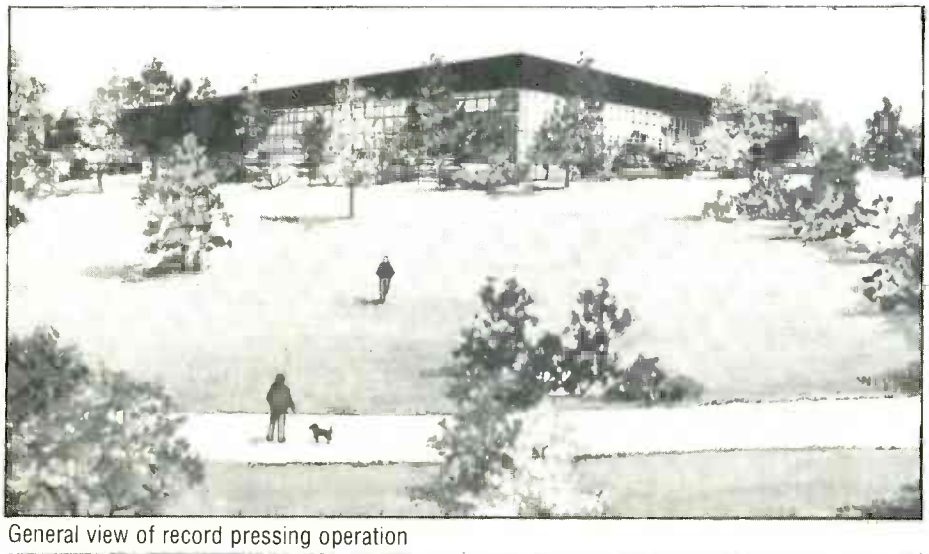
Finance

The fund-raising had started with a fairly modest figure but as the various special requirements were taken into account the investment gradually rose to a total of £8.7 million. There are four equity investors: 3i Ventures (Investors in Industry) is the lead investor with CIN Industrial Investments (the National Coal Board Pension fund), Fleming Ventures (Robert Fleming, bankers), and Pru Venture (Prudential Assurance Company). Additional facilities are provided by Bank of Scotland, Scandinavian Bank and Philips Finance Services.

Philip Race believes that this sort of investment is essential for anyone wanting to get into compact disc manufacture.

"You cannot nudge into CD. In record pressing one could, in theory, sling a couple of presses in a garage and make do. You'll never, never do that with CD. There's a definite minimum scale that you can start at. For example, the first stage of making a CD is to produce a glass master from the tape. This process is very critical and without it one can never claim to offer a full service. It's £1 million for that one process. We're buying a CD mastering suite as a turnkey operation from Philips so we will have facilities equal to the finest in the world."

Artist's impression of the new CD plant



General view of record pressing operation

Production process

With the mastering facility Disctec will be able to accept customers' master tapes and carry out pre-mastering, PQ encoding, etc. The Philips mastering suite produces a glass master disc using a laser modulated by the digital audio signal. Then an electroforming process creates a nickel mother. This in turn is used to grow nickel stampers which will mould the pits on the plastic CD—that is the pattern of infinitesimal dots which modulate the laser in the player.

The pits on a CD are so fine that a single speck of dust could obliterate a great chunk of recorded information. This is why the process is carried out in a *very* clean room with filtered air, temperature and humidity controlled. Country air may be comparatively free from mankind's pollution but nature throws up its own problems, such as pollen.

Optical grade polycarbonate will be used in an injection moulding process to form the actual compact disc. This material helps to reduce the problem of bi-refringence, that is double refraction of the player laser, which can be caused by residual stress in the plastic.

"One of the major process problems was moulding a disc flat enough and without residual stress. The laser actually passes through the plastic and if you've got distortions there it will be refracted. The bi-refringence specification is difficult to achieve. There was a lot of fundamental development that needed to be done; like the development of suitable optical grade polymers and the general availability of those for people coming in as independents.

"Polycarbonate is a very strong, dimensionally stable, engineering polymer. It's widely used for machine guarding and other areas where you need clear plastic that will withstand pretty rough usage. It was chosen as a natural choice for this application because of its dimensional stability. But it was never originally developed for optical use, so there's been a considerable amount of activity amongst the major polymer suppliers. Beyer in Germany, and Mitsubishi in Japan are the main contenders who have seized this application and developed an optical grade polycarbonate which aids the process."

The final stages of the process are the application of a metal coating to reflect the laser—vacuum thin-film coating technology is used to apply aluminium to one surface of the CD—this is then sealed with a protective lacquer and the label is printed on the finished disc.

The various companies pressing CDs have often developed their own techniques for certain stages of the process. Everyone tends to be very

secretive about their own developments but as far as possible Disctec is aiming to put together the best of the available technology on a worldwide basis, along with a number of its own, equally secret, innovations. Jim Johnston, who joined the company in January 1985 as manufacturing director, has had experience of the demanding clean room disc manufacturing process with VHD video discs. Philip Race regards this as a very valuable contribution.

Development considerations

"We've tried to select the best technology for each major process step and to bring to that Jim Johnston's additional experience. We're using a considerable amount of automation, because people and clean rooms really don't go together.

"I believe that there will be increasing pressure on manufacturers to produce very fine discs because cheaper players may be—and we must say *may* be—less disc friendly. There is a very sophisticated error correction system on the disc which needs sophisticated circuitry to make use of it. I feel that we can't rely on cheaper, portable and in-car players being overly disc friendly.

"But the main point is that there are computer applications coming down the line. One which already exists, and is specified, is CD ROM (Read Only Memory). The disc will hold 500 Mbytes which is about 1,000 floppy disks. It's a vast amount of storage, it's very robust and it's virtually incorruptible. We see a lot of applications for this, and our investors are immensely keen that we are able to approach the CD ROM industry very early on and keep pace with all optical disc developments in that field.

"At the moment it seems that the capacity of the plant we're putting in will be rapidly used up to satisfy our audio customers' requirements, and that we're going to need another plant if we're going to do CD ROM. So although we're building up to it I don't think we need it commercially at this stage of development. Our task now is actually to bring the thing to fruition—producing good discs at a sensible commercial yield rate—no mean feat in itself. The problem then, I think, is growing rapidly enough to sustain the demand that I'm being told about now.

"It can't last forever. There are some horrendous stories of shortfall of supply, both here and the other side of the Atlantic, but I don't really think there is a CD bandwagon—although it might appear to be one at the moment. I think this demand curve will flatten off, the panic will go and it will shake down to a number of first class plants. It will be difficult to enter at a later stage because the investment will always be massive and it'll always be difficult to do. I don't think it's a licence to print money by any manner of means."

The new factory is due on stream around the middle of 1986 and is ahead of schedule at the moment. EMI is expected to open a CD plant about the same time, so the two will be the second and third CD plants in Britain, following Nimbus Records' first at a respectful distance. Staff for Disctec's factory will be recruited locally and trained to run the routine elements of the process.

"A lot of the success of high quality, especially high-tech plants, is a disciplined approach to the work. It's important that things are done the right way. Even now with the record pressing factory, when it comes to setting the plate in the press there are some people who always do it better than others and they're the people who work carefully, to a routine, and never let anything slide. Now, whereas one can get away with an awful lot of loose practice in a record factory, for a number of reasons, one certainly can't with the CD manufacturing process. The procedures are very important.

"There's evidence that merely spending a lot of money on the process itself is not sufficient. The Japanese plants are amazingly successful at making CDs. I'm not sure that is true worldwide. As with all manufacturing processes there are a few 'black arts'. There certainly are with pressing records, and making CDs is many, many times more difficult than making black records."

Vinyl records

Making vinyl records can be quite hard under certain circumstances. Recently there have been some changes in Merton Abbey Station Road. A large factory closed and the area began to develop into something of an industrial wasteland. Having lost its abbey and its station, the road lost its surface as heavy lorries came to dump tons of rubbish all too close to the PR Records factory. This provided Philip Race with the incentive to move it to new premises about a mile away.

"I've really got enough to worry about, building a CD plant, without choosing to move PR Records. But I believe in trying to make a virtue of a problem and we've taken the opportunity to improve the plant. There'll be a much cleaner working environment, particularly as regards the pre-pressing stages, and we're also putting in two further machines."

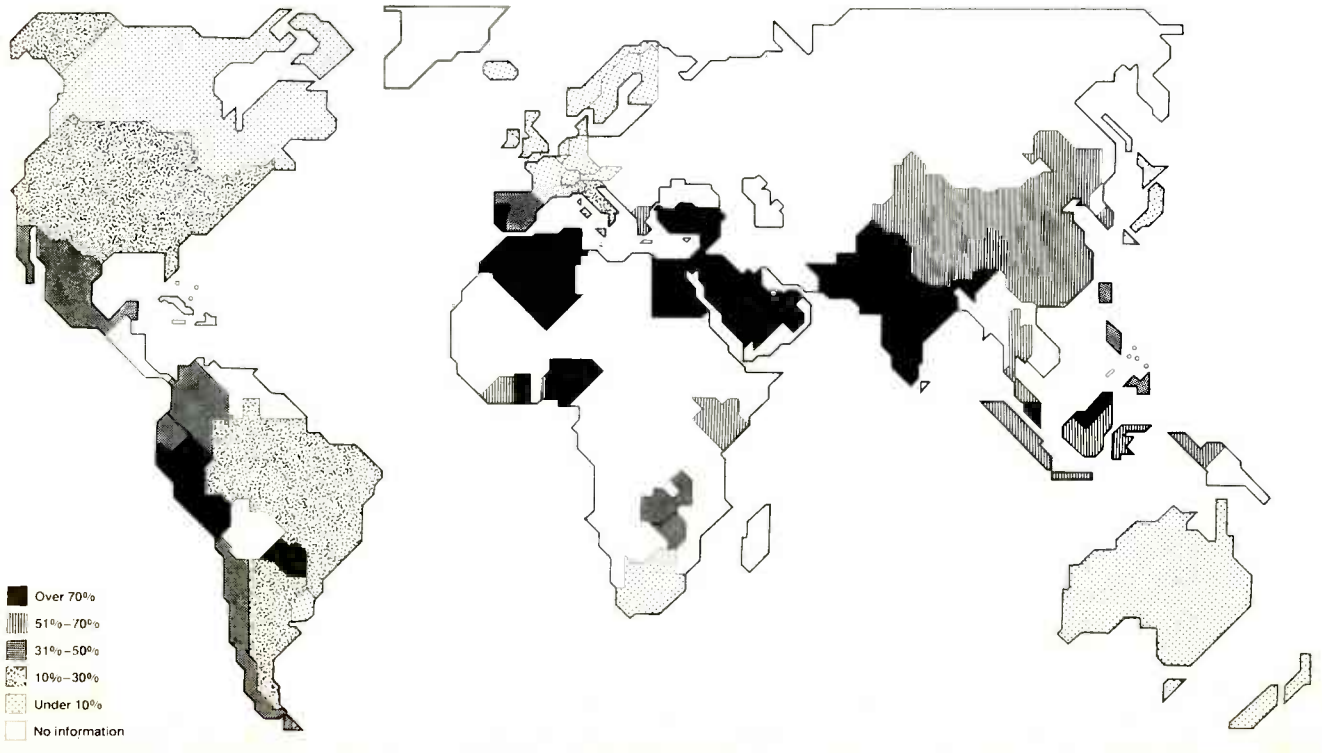
The original factory had four Toolex Alpha presses, with slight modifications by PR Records, which pressed about 3 million discs per year. The company shipped about 2.8 million discs per year on average. Two new machines, similarly modified, will increase the capacity by 50% to cover the high season and avoid having to subcontract work out.

"It's still a fairly small plant, and I'm confident that there's sufficient life in black vinyl for us to run PR Records for some years, and run these additional presses most of the time as well." ■

TAPE PIRACY

Tape piracy in 1984

The map shows the size of the market for pirate, counterfeit and bootleg tapes in 1984 calculated as a percentage of the total market for pre-recorded tapes in each country



EQ Copies and the Master Tape

Equalised tape copies have been much mentioned particularly within the cassette industry, so it's about time that someone put the record straight. Bill Foster of London's Tape One facility explains the principal purpose of these copies and looks at the history of what has become known as Audio Post-Production (the area covered by the disc cutting and tape mastering houses or APPs) who generate these 'offending' equalised copies.

After the introduction of magnetic tape in the early '50s, disc cutting became a much more straightforward operation. The original master mix was equalised and level-corrected as required, a lacquer cut and all settings noted in the cutting engineer's log, which usually stayed in the cutting room. When a recording was sold overseas the original master tape was duplicated 1:1 and a copy of the pressing sent to the overseas licensee along with the tape for them to match the level and EQ (although in my experience the disc usually ended up in the promotions dept leaving the mastering engineer to sort out the whole thing all over again).

The arrival of the Compact Cassette in the '60s caught many record companies off-guard. Some chose to ignore this fledgling medium in the hope that it might go away, while others pushed ahead with cassette releases, although not always simultaneously. After all, the majors were only just ceasing the dual manufacture of mono and stereo LPs so the additional expense was probably very unwelcome.

In the early days of cassette production very little trouble was generally taken over the intermaster. Usual practice was to run off a straight (or 'flat') copy from the original tape and send it to the cassette plant with no information other than the running order. (In fact, most export copies to other territories were prepared in the same way.) This was a very unsatisfactory state of affairs so, in the early '70s, 'equalised copies' began to appear. These were basically dupes made at the time of disc mastering which reflected any equalisation used during the cut—hopefully under the direction of the record's producer—which were then re-copied for both export mastering and cassette production use. Although a further generation away from the master it did avoid the risk of each territory's discs sounding completely different.

Of course, there was also a snag. As the quality of pre-recorded cassettes improved, the more advanced duplicators began to question the sensibility of producing cassettes from a tape that had been equalised for optimum disc performance. Before the introduction of 'new generation' disc cutting amplifiers in the mid '70s it had been necessary sometimes to compromise the frequency and/or dynamic range of a disc master in order to avoid HF distortion on the finished record. However, the critical frequencies were not always the same for vinyl and cassette, with the result that the latter often suffered from a double compromise which resulted in a swing away from equalised tapes for cassette manufacture. This in turn led to new problems because, despite the popular misconception in some circles, not all adjustments made during disc mastering are to the detriment of the recording. At the producer's direction, a cutting engineer may lift the level of a guitar solo or add some mid-range to a drum break and unless this is carefully noted, the cassette transfer engineer will be unaware of these subtle changes. A producer is unlikely to want to make the trip to some out of the way place in order to visit the factory and therefore the cassette will not fully reflect the wishes of producer or artist.

Until quite recently, EQ'd copies were produced on a ¼ in analogue machine located in the disc cutting room. Although usually encoded Dolby *A*, these copies were, of course, a generation away from the original and even with the best analogue equipment it was possible to distinguish the difference. It was as a result of this that a certain manufacturer of high quality cassette tape, realising that with the finest quality cassette masters there would be no advantage in using his product, began a programme of 'educating' the cassette manufacturers about the 'dangers' of using second generation EQ'd tapes for production. The result was mild panic at the manufacturing end and a stream of requests from cassette plants to supply them with the original tapes to produce the bin masters (one even wanted the original multitrack). A moment's reflection will immediately show the pitfalls of this idea. Ignoring for a moment the fact that the cassette mastering engineer will have no idea how the producer wished his product to sound, what happens when the record company order an urgent recut of a record lacquer only to find that the original master tape is 200 miles away at the cassette plant?

'. . . not all adjustments made during disc mastering are to the detriment of the recording'

Quality and originality

So, hopefully having established that the EQ'd copy is not some wart on the face of the record industry, to be purged at all cost, how can the APP's and cassette manufacturers work together to improve the quality of pre-recorded cassettes while ensuring the producer's wishes are reflected in the finished product?

Luckily a technological breakthrough has occurred during the past couple of years—digital recording. Coupled with the new generation of disc cutting amplifiers which now make it necessary only to restrict the frequency response of the most severe recordings (usually at all cost, how can the APP's and cassette manufacturers work together without 'spitting' or 'splashing') the equalised copy can safely be used for disc and cassette manufacture as well as, in some cases, the compact disc.

All the serious cassette manufacturers now have a digital system of one kind or another, with the low-cost Sony *F1/701* being by far the most widely adopted. Exchanging tapes on this system between different territories can be difficult, however, due to varying TV standards and it is for this reason that most (but not all) of the major record companies have settled for the more expensive but unilaterally compatible *1610* system. However, the lack of any 'standard' digital format is beginning to create some problems. One of my clients recently switched their cassette production from a factory using *1610* to another where *F1* is used, with the result that we had to recopy over 150 cassette masters. While I contemplate my retirement in the Bahamas the client's production manager is, understandably, tearing his

Disc cutting at Tape One

hair out! Strangely enough, the new duplicator is one of the world's largest record companies but they appear to have neither the inclination, nor possibly the resources available, to offer transfer from *1610*. The question of compatibility between manufacturers, both record and cassette, is something that record company MDs would be well advised to look at more closely before negotiating new P&D deals in order to save a few pence.

Rationalisation

The manufacturing and production sector of the industry should attempt to rationalise the audio formats used for the interchange of tapes. (For this purpose we will ignore the CD plants as their needs are a little different.) All professional studios and cassette plants are able to handle 15 in/s ¼ in and, I think, almost all have a couple of Dolbies kicking around, although when it comes to 30 in/s, and those monster 14 in reels many fall by the wayside. A few operations are still relying on a trusty (or could that be rusty) old Revox but there is now no need for any cassette duplicator, even with modest resources, to compromise his quality thanks to the little *F1* or its companion *701*. These amazing devices, costing under £2,000 complete, offer high quality, hiss free, copies with an incredibly high level of reliability. So,

'The manufacturing and production sector of the industry should attempt to rationalise the audio formats used for the interchange of tapes'

the problem is solved, or rather it is for the moment. With the arrival of 8 mm video how long will it be before Sony phase out Beta and we're all left with a lot of redundant hardware, not to mention a cupboard full of useless intermasters?

Maybe now is a good moment to forget the whole 'amateur' digital format with its editing limitations, etc, and go all out for the new *1630* system. It's totally compatible with *1610* and a processor with one recorder can be obtained for a 'modest' £20,000. The great advantage of this professional format is that its future is assured—at least, its immediate future.

Once again, however, there is a problem. Digital audio is not the answer to a maiden's prayer that many believe. Just pumping signal in one end will not necessarily result in perfect quality at the other. Drop-outs aside, that flickering little light labelled CTC on the front of a *1610* can be telling all sorts of horrible tales, such as 'average and hold' which can manifest itself as anything from minute clicks to tonal changes in the audio. The *F1* is potentially even more dangerous because, unless attached to one of the available custom interfaces, it has no indications at all to tell you what's going on. Some cassette plants have highly qualified technical staff to take care of these matters but a large number may not have anyone with the skills required to carry out even routine maintenance on this highly sophisticated equipment. The result is beginning to make itself apparent by an increasing number of rejected digital copies, many of which are in fact perfectly alright when replayed on a correctly lined up machine. The level of ignorance about digital in some areas can be epitomised by the comment made recently by a mastering engineer at a leading independent cassette plant, not long after they had installed an *F1* system. Looking at the Betamax tape he commented, "It's amazing how they get that quality when the tape runs so slowly."

This article does not attempt to answer any questions, just pose a few to promote some active, and I hope fruitful, discussion between the various parties involved in our industry. In this way we may all move forward in a unified direction and, by avoiding any expensive mistakes in equipment purchasing, reach the end of the decade with a few more pounds in our pockets than we have at present.

New Developments in Duplicating

Since Mike Jones wrote a similar article for our sister magazine *Studio Sound* there have been exciting developments in the duplicating industry, the most important being the general commercial success. Here he discusses some of the many developments which have helped the worldwide sales of pre-recorded cassettes to currently exceed those for vinyl records.

On a local level, the UK has seen the demise of data cassettes due to the collapse of the home computer market. While several specialist duplicators found themselves unable to switch production to high quality, audio cassettes; others have prospered by developing alternative markets. Many duplicators serve their local community and the most successful market seems to be talking books for children.

Two companies very successful in this field are Miller International of Hamburg, West Germany, and American Multimedia (AMI) of Burlington, North Carolina, USA.

Miller produce over 12 million cassettes a year of which more than 70% contain fairy tales or stories for children and many of those have been produced and recorded in their own studios. Each year AMI produce millions of story cassettes and such is the demand for this type of product that they have had their own printing presses installed, on which all the books, labels, insert cards and packaging material are printed.

These two examples amply demonstrate that new markets can always be found, providing duplicators are prepared to go out and look for them.

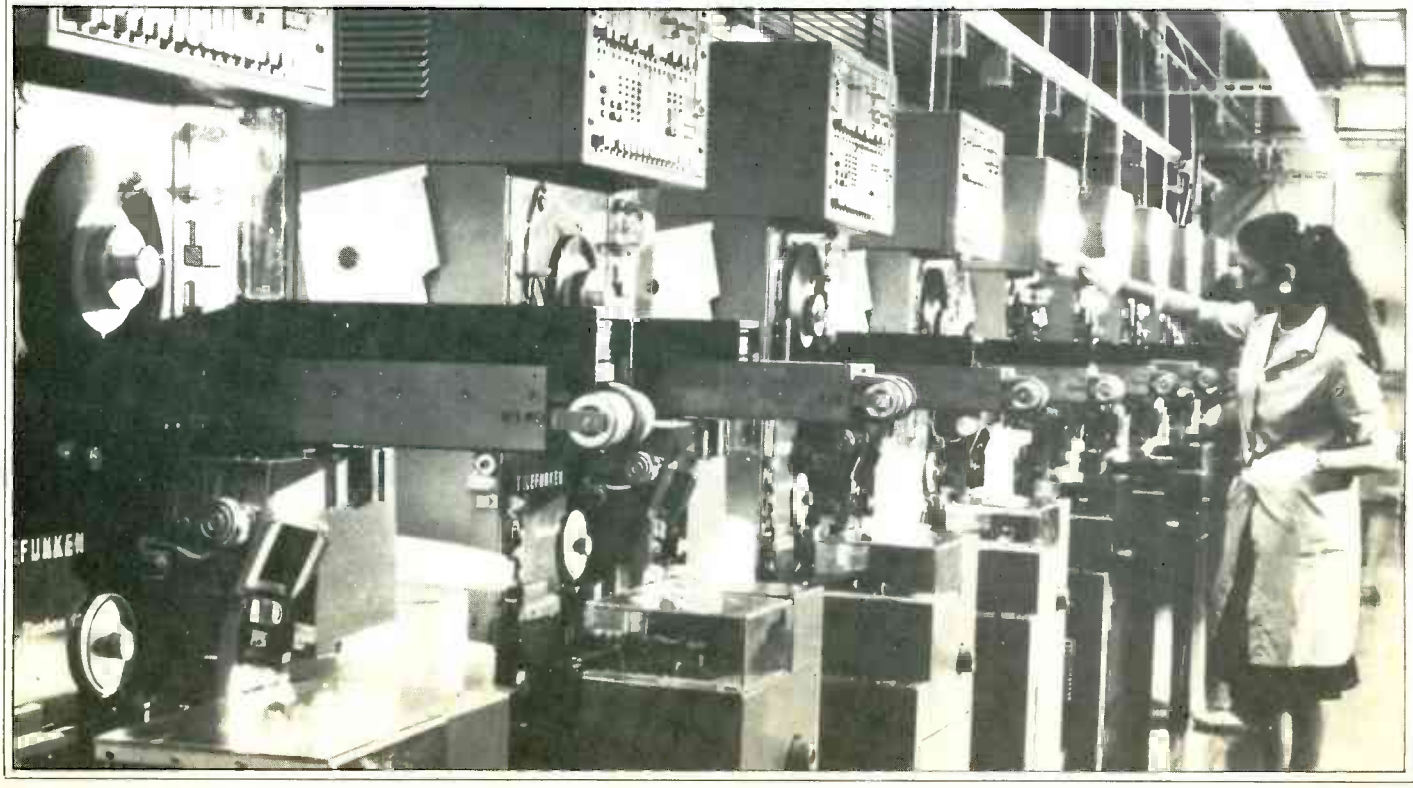
Communication within the industry has been improved by a series of seminars in Europe and the USA. The first of these was held in London during March 1984. Although the second European seminar was poorly attended, the two seminars by Electro Sound were a great success with 125 delegates attending the first held in Sunnyvale during August 1984, and over 325 delegates attending this year's seminar in San Francisco.

In March of this year the International Tape/Disc Association held an extremely interesting session on cassette technology and members of the association are now working to establish an international standard for tracking accuracy, or azimuth, so that cassette housings can be tested to a common specification.

Despite the diversity of subjects discussed at these seminars, the majority concentrate on a similar theme—improvement of quality. However while the first two seminars concentrated on technology the two this year concentrated on applications and during the seminar in San Francisco a new sense of realism became apparent.

Speaker after speaker, including Gill Friesen of A&M records and Bob Barone from Electro Sound, spoke of the need for the industry not to become complacent about its current

Cassettes being loaded automatically with magnetic tape



commercial success and to put its house in order before the compact disc became commercially viable. They feel that this will happen when CD production plants have sufficient capacity to react to market demand and over the next two years or so the production capacity of compact disc will rapidly increase.

The consumer is becoming aware of the superb quality that this exciting new medium has to offer. A level of quality by which all other media, including the pre-recorded cassette, will be judged. While current quality levels may be acceptable now they may not be good enough in years to come.

Another danger to the future of the analogue audio cassette is the impending launch of the digital cassette, so improvement of sound quality is in the industry's best interest.

Fortunately, technology has been developing at the same rate as sales and there are several ways in which quality can be improved. For example, Dolby *HX Pro* has become established and both Otari and Studer incorporate it in their latest master recorders.

Agfa and Capitol have introduced two high performance cassette tapes—*Magnetite* and *CS-1*—while BASF has designed a special, chrome tape, for the loop bin, called Type *620*.

Those sceptics who said that running masters would never run reliably at 480 in/s have been proved wrong: Otari and Tapematic have designed loop bins that can run successfully at this speed, using ½ in tape; Concept Design has succeeded with both ½ in and 1 in tape by developing an entirely new type of transport control system. These machines mean that the industry can return to using masters which have been recorded at 7½ in/s.

For many, the most exciting development has yet to come, for just around the corner is a digital mastering system which will store all the program information on high capacity computer discs instead of the analogue masters we use today. Although several digital processing methods are being considered Delta Modulation would seem to be the most likely which would

'Those sceptics who said that running masters would never run reliably at 480 in/s have been proved wrong'

be combined with *HX Pro* on the slaves using one of the new high performance tapes.

The art of loading tape into cassettes went through a revolution, when Tapematic introduced the series *2000* cassette loader a couple of years ago. Since then the machine has earned an enviable reputation for reliability and productivity and is proving extremely popular in Europe.

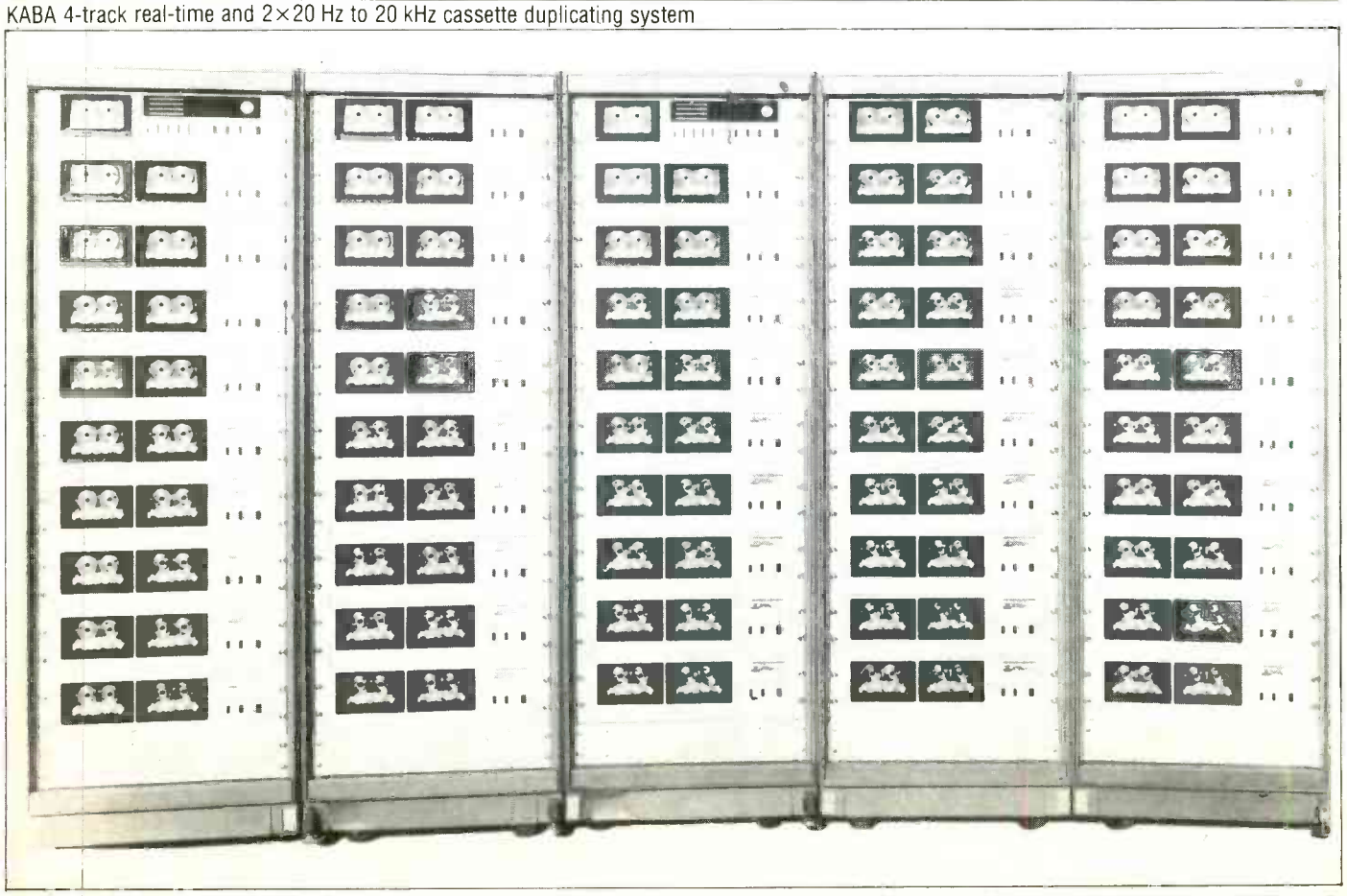
In the US, King Instruments have developed a similar machine, the *793*, which like the Tapematic features automatic changeover of pancakes. For those duplicators with other types of King loader, especially *760*, *770*, *780* and *790*, Concept Design offer a range of accessories and conversions which improve the efficiency of the loaders by up to 30%.

Several record companies have also been developing new techniques and control methods to improve quality. The most well known of these is probably EMI's XDR program—a success story in itself which we hope to cover in more depth in a future issue.

The XDR programme is designed to improve the overall quality of the music cassette, from the master right the way through to the finished cassette. The XDR logo is the consumers' guarantee that they are buying a high quality product. If any part of the recording process fails to reach the high standards laid down by the XDR programme the logo is not applied to the insert card. EMI are to be congratulated on this and we look forward to the day when other record companies and duplicators make a similar commitment towards improving quality.

There is no doubt that those duplicators who invest in new technology—and by doing so are able to offer a higher quality product—will have a distinct commercial advantage over those who do not but as EMI has already proved, improving quality requires a planned and systematic approach which embraces all sectors of the recording and duplicating process. The recording chain can only be as good as its weakest link.

KABA 4-track real-time and 2×20 Hz to 20 kHz cassette duplicating system



Jack Field

Swarf McGoo's Greatest Cut

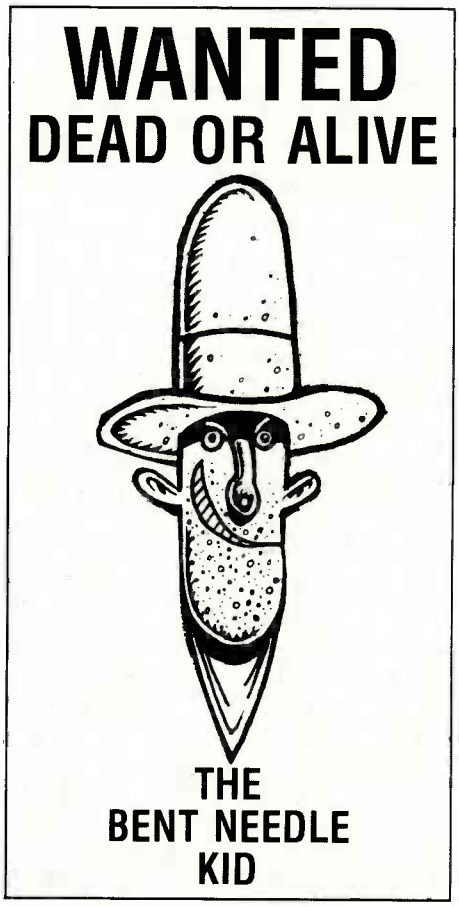
What's that, young man? Oh, that there disc on the wall, oh sure there's a story attached to that. It starts when I was just a lad looking for work, back in the good old days when women were women and men went direct on to disc. I drifted into a small town in the west called Broken Point, damn near had my brains blown out by the first guy I met, he was real hornery on account of learnin' that his 6th recut of a 35 minute slide had been ambushed on its way to the factory. Anyhows he calms down when I tells him I'm just a regular worker, no fancy ideas of becoming a producer or nothing like that, so he shows me the town, startin' up by the cemetery at Jumper's Gulch. The stones was kinda simple but they told the story of the people who opened up that land. people like Josiah Scratchit, first man to get pop level on a cylinder, The Copper Backed Kid, fastest plater in the west until The Nickel Gang got him in his bath. There were tough ones, too like 'Here lies Caleb Smith: he called Joe Ritzick cloth-eared'.

On the way back into town I notices a poster on a tree 'Wanted Dead or Alive the Bent Needle Kid'. I asks Bill, my guide, "Who was this character?"

"He's pure bad news," says Bill. "He's blown more cutterheads than I've had hot dinners and he's been responsible for cutting short the careers of 20 tape-ops. It's on account of being deaf from birth he monitors with 20 kW amps and has his own brand of tape made to take the heat coming off his tape heads."

We'd gotten to the saloon, The Swinging Stamper, and I looked around at some of the local characters. A bunch of tape-ops were playing poker for the week's biggest overtime slip, while a couple of engineers were by the juke-box playing their favourite test tape. Suddenly the swing doors crashed open and a voice, if you could call it that, hollered "Ain't nobody here can cut this goddam tape!"

That voice, well I'm telling you it had boost at 4 k and about 20 dB compression plus about 120% distortion—and it was coming out of the face I'd seen on the poster: The Bent Needle Kid. Well, I tell you, the place went so quiet you could hear a compressor breathe, then up gets this guy, slowly but certain, like he ain't lookin' for trouble, but he wouldn't run from it.



The Bent Needle Kid is pure bad news. He's blown more cutterheads than I've had hot dinners and he's been responsible for cutting short the careers of 20 tape-ops

Bill whispered to me "That's Swarf McGoo, hottest stylus in the west."

McGoo strode slowly to the newcomer: "Why don't you admit it, Bent Needle, you know my range is wider than yours, my background noise is lower, and my lacquer don't saturate like your lousy tape. I can cut anything you or your drunken tape-ops call a recording!"

"We'll see about that," snarled The Kid, "mid day tomorrow." "Right!" was all McGoo said but I tell you the tension was as high as an Ampex on the blink. There was a lot of drinking that night and a lot of bets were laid on the outcome of the session: everyone agreed it was the showdown which had been expected for a long while.

Next morning, as the hangovers slowly cleared from the canyons of our heads people started driftin' to the main street, lining either side but there was nobody in the street itself until just before 12 noon a door at one end opened and Swarf McGoo strode out. He took position in the middle of the dusty street, looking unblinkingly ahead, his hand resting lightly on a bulge by his right hip.

"What's he got there?" I asked Bill.

"That's his battery powered de-magger," explained Bill. "He's takin' no chances 'case the Kid tries any clever stuff."

A murmur from the crowd made us look up and we saw a figure strolling down the street: it was the Bent Needle Kid, nonchalantly twirling the master on a hub. He stopped just beyond magnetic range of McGoo: "Still game, or are ya gonna chicken out at last minute?" he taunted.

"Where's the details?" was all the reply.

"Don't come the clever with me, McGoo, it's 15 NAB non-Dolby like they all are."

McGoo spat acetone in the dust, turned on his heel and strode toward his room, the Kid following, a sly grin on his face.

'Course, everyone wanted to see what would happen but I was lucky as Bill was a friend of McGoo's we was able to squeeze in a corner.

McGoo put the tape on the machine, spooled to the head. "Tones?" He looked in disgust at The Kid.

"It wouldn't make any difference," he snarled in reply but you could tell McGoo had scored a point.

The tape started to roll: well sufferin' Moses we was all unprepared; them monitors leaped clean off their stands while bits of tweeter flew around the room like shrapnel. It was muted trumpets on the right, heavily compressed marraccas and cymbals on the left while the bass was being panned left to right and back again, all plus everything you could imagine thrown in and a layer of real gritty distortion on top.

McGoo's expression was grim but determined, whilst The Kid was smirking all over his stupid face. McGoo spooled back the tape and, saying nothing, he went to a cupboard and brought out some thick copper wire. He opened his amplifier rack and strapped the copper wire across the circuit breakers. Next, he went to a back room and came back with a large cylinder of helium gas, at which we wondered because, you see he already had helium connected to the lathe. Anyhows, he makes up a funny looking bit of pipework, and then we saw what he was about: the two cylinders of helium were both feeding into the same head, to get more pressure, I guess. Leastways, he had to put an extra weight on the head to stop it being lifted off the disc by the helium. He grunted something to Bill, who shouted out to the people outside that everything electrical in the town should be switched off, to keep the volts up. Unneedful, really, since all the town was already outside the cutting room door.

At last McGoo was ready and he started the cut. Nobody dared look at those current meters, while the temperature meters weren't needed on account of the whisp of smoke coming from the head. People was holding their breaths, partly on account of the wagers they'd placed the night before, when about half way through the side the smoke from the head turned a different colour and then one monitor went dead.

The Kid put his head back and was just beginning a loud guffaw but McGoo said, "Quiet, I haven't finished yet." Well, everyone looked real puzzled, especially those looking to collect their winnin's. What nobody'd noticed was that McGoo had had his hand on the cutter lift lever all the time and as soon as the smoke changed colour he'd raised the head. Now, kids what I'm gonna tell you next may seem pretty far fetched but as I'm sittin' here this is what happened. McGoo went to the cupboard and got out another head. He put it on the lathe, then turned to me: "You quick with a button, lad?" He asked.

I was too surprised to answer at first but I managed a "Guess so."

"OK," says McGoo, "when I give you the signal you just start the tape but not one microsecond before or after, understand?"

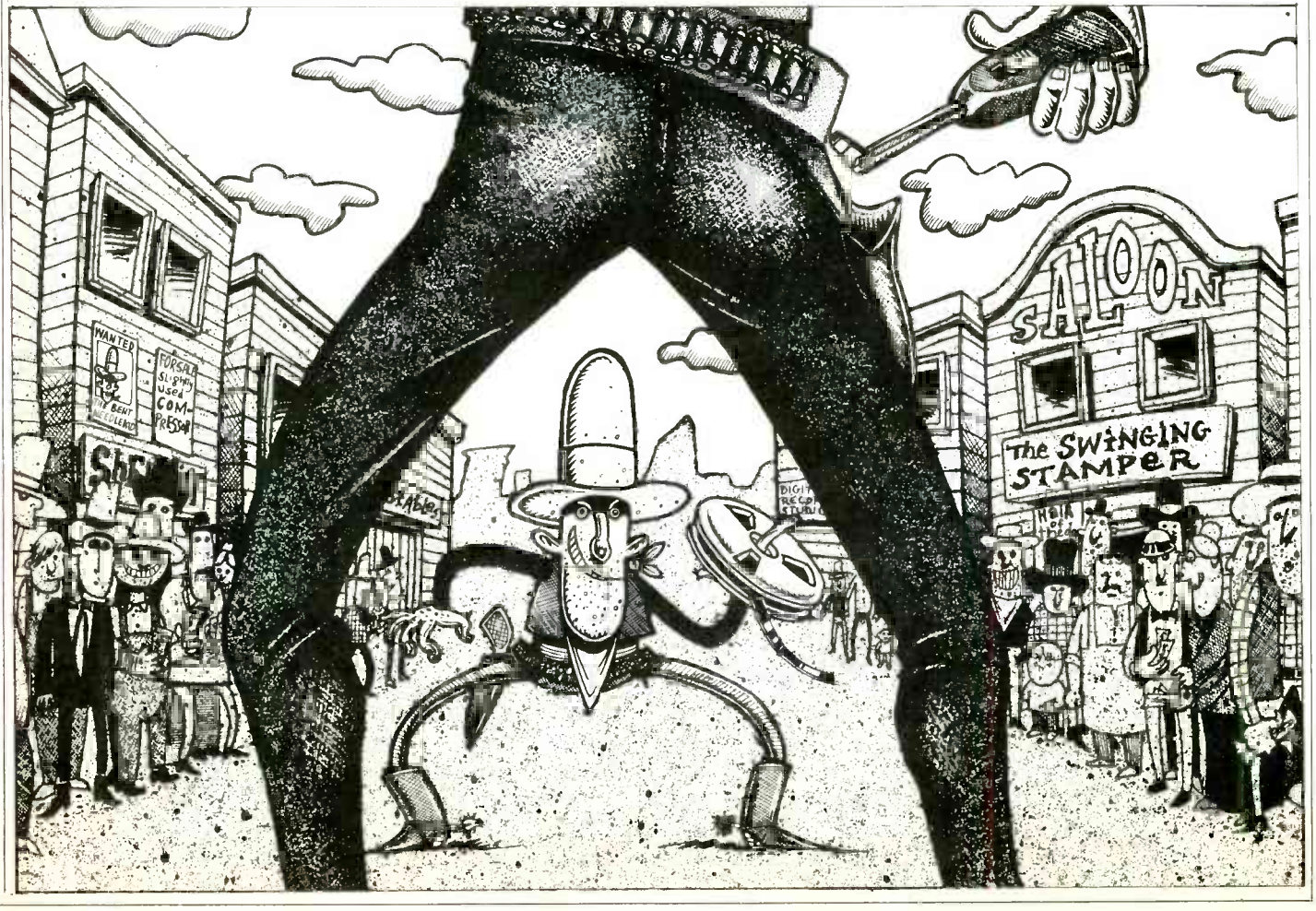
He wound the tape back a few inches, then started the turntable with the stylus over the end of the groove. As it turned he called out, "Ready?" then, "Go," before he dropped the stylus straight on the end of the groove.

Well, the second head smoked a bit but it took it. At the end of the side the crowd went wild, while The Bent Needle Kid slunk outa town for good.

And that's the disc on the wall, Swarf McGoo's greatest cut.

What happened to them? Well McGoo took to distilling and made more money in a month than he used to in a year, and lived a good life till his liver packed in. The Bent Needle Kid went totally deaf plus his brain went, some say on account of too much of McGoo's hooch, after that he became head of some record company.

Next morning people started driftin' to the main street . . . a door at one end opened and Swarf McGoo strode out



Simon Cooper

CD Manufacturing Trials and Tribulations

Lately there has been considerable criticism of the compact disc manufacturing industry and not enough said about the reality. Carl M Rodia of Polyform Inc sets the record straight

Compact disc manufacturing for the mass market is less than three years old. Although some observers lament the sorry state of the industry, a success story is developing—in spite of the inefficiencies of pioneering manufacturing ventures—and millions of CDs are now being supplied and sold.

Knowledge has been accumulated rapidly. Bottlenecks and weak points in the numerous processes involved in making a CD have been identified and many problems have already been corrected. Work is continuing to streamline, correct and improve existing plants and to plan the newer, more cost-effective and less capital-intensive factories which will soon be on line.

The CD boom which 12-18 months ago could only be discussed with crossed fingers now appears inevitable and those of us who suffered the doubts of 1982, 83 and even 84 are now poised to ride the CD crescendo to even greater heights.

From the inside, it seems the major uncertainties about CD are over. We may be in the right place at the right time but are we doing the right thing when it comes to CD manufacturing? The well-documented shortcomings of the first dozen CD factories combined with horrible stories of their high capital and operational costs, still creates anxiety, hesitation and even anger.

We don't like to hear that the right thing is a plant that costs an average $20 million and runs at a 70% yield on a good day. And neither do we want to hear that it may take 12 to 18 months to bring the monster to life and produce those first good 70 out of 100 CDs.

Unfortunately those presently in the business of producing CD software only confirm these circumstances and indicate, somewhat vaguely, that yields are improving and costs are coming down. They don't even offer verifiable statistics, technical details or even a good plant tour to help dispel the concern.

The reasons behind this are not new. Those brave corporations who valiantly, and at great risk of capital and reputation, made huge investments in CD manufacturing are not about to spill the beans on any planned improvements. They must protect their investments, improve from within if possible, prove that there is a large enough market out there worthy of another few million on top of the high-risk millions that started the whole CD thing in the first place and, in the meantime, they must sell CDs. However, the demand for CD hardware, stimulated by lower prices and competition, has kept pace with even the most optimistic projections of two and three years ago and the demand for CD software has grown more rapidly than anticipated by any of us.

This sudden success has attracted a herd of outsiders: money people, armchair technologists, con men, charlatans, incompetents, easy-money seekers but also, thankfully a lot of very talented people as well. Shallowness is usually detected early, but in the wake lies a twisted path of promises and the scepticism of the financial community. People wait for investment dollars, deadlines pass, many investors become confused and intimidated by a distorted view of this industry which to most of them is very close to being 'the music business' with all its mysteries.

So where is the really 'smart money' in CD? It has invested in the dozen or so 'dinosaur' CD plants. A small fleet of first generation factories in Europe and Japan has spawned the success of the compact disc. But what is so smart about spending $20 million or more for a plant that produces CDs at a 50% to 60% yield? The truth is that it was the only choice at the time. The fleet is small, the cost high and the risks great but CDs *are* available. The first generation of CD plants were larger versions of the tiny Philips and Sony pilot laboratories. The money was well spent and when we look at the success, it could not have been better used.

The first generation of CD plants were not built on the edges of cliffs. Every plant in existence was planned, built and is managed by disc manufacturing experts with considerable knowledge of the custom record business. The custom record (and CD) manufacturing business requires special tools. While CD manufacturing processes, taken individually, might resemble processes used in the semi-conductor industry, the philosophy and practice of CD manufacturing must follow the well-tested, established patterns of the marketplace it supplies—the music-buying public.

We make semiconductors the way we do to accommodate the industrial demand for chips. We must continue to make CDs in the classic record industry fashion—with extreme flexibility and with factories capable of rapid adjustments to market demand. Record factories devote, let's say, 10% of capacity to Tchaikovsky, 20% to Kenny Rogers, 5% to Big Bird, and the other 65% to general catalogue all at the same time. When press number one blows a fuse, the others don't blow a fuse in sympathy; when a stamper change is required on press number 6, press number 5 continues working while the adjustment is made.

CD factories should have flexible production capacities. A 100-press plant should be able to produce 100 different catalogue titles simultaneously or one title of a mega-hit that had to be shipped yesterday. Although the reality of day-to-day production lies somewhere between these two extremes custom CD pressing is a commodity business like record pressing and cassette duplicating. Unlike most commodity businesses, however, each day and sometimes each hour, the product mix

0–C60 in 110 seconds.

When it comes to performance, at any price, the new TracSystems CD201 cassette to cassette duplicator leaves the others standing.

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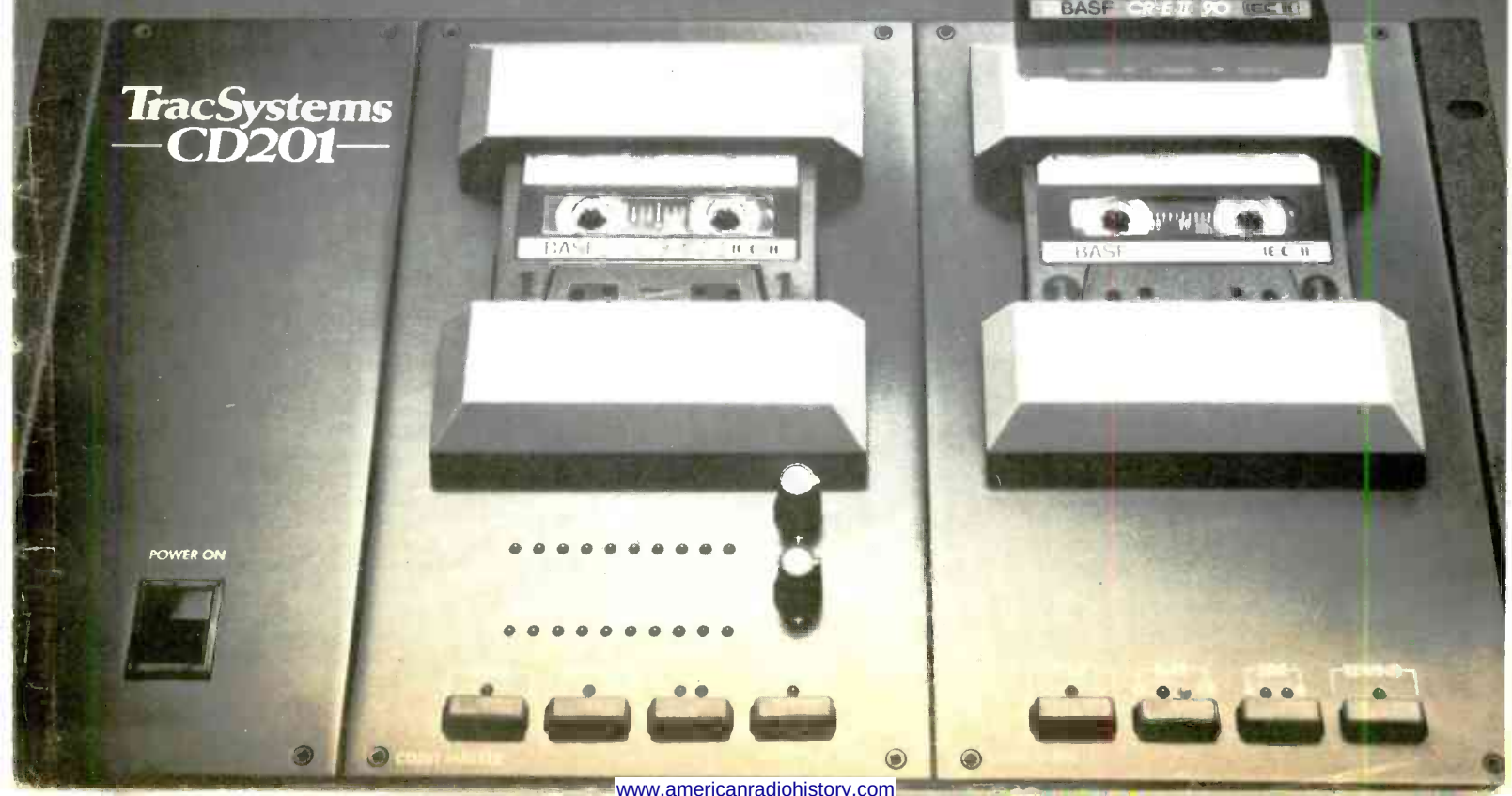

can change as title demand fluctuates with the charts.

A closer look at the alternatives to CD moulding suggest serious questions about unit costs, raw material suitability and availability, and production control. Those who point the finger at the problems of moulding a 4.7 inch CD to optical disc standards and question yields, fail to mention the problems of extruding a sheet of the same material several inches wide and several feet long to those same optical disc standards. They claim low capital costs for machines that don't even exist, yet have wisely modified earlier predictions of producing CDs that could actually cost less than the materials from which they are made! And their earlier dreams of a monopoly in a commodity industry with nationwide service and distribution requirements are ludicrous. Investors should not only explore the promising new technologies but should consider carefully the true nature and needs of the market dynamics of the record industry and determine if they are compatible.

We should all remember that the record business has never been driven by technology—we remain a necessary evil. Music, and the demand for it, is the prime mover—not the technology. Therefore manufacturers should be flexible and accommodating, and keep up to date with improvements in order to provide the necessary service.

We must strive to maintain high quality, increase production speed and keep costs in a downward spiral. CD standardisation demands absolute consistency however. The old solutions of making products lighter, thinner, etc, to reduce costs do not apply.

Critics of first generation CD manufacturing technology would give the impression that all work on process development stopped the day the ribbon was cut but, of course, there are numerous examples of continuing refinement. These refinements are among the first signs of real economic competition among CD manufacturers. Second generation plants are more automated, use shorter moulding cycles, have fewer people involved in handling discs and employ conveyors and robots.

Things are moving very quickly: paint had hardly dried on the PolyGram plant when they invested in doubling its capacity; likewise at DADC. Work has just been completed and improvements include automation and testing of in-line sputtering technology. The examples in Japan such as Toshiba's self-contained systems and Denon's automation project are even more impressive.

Improvement for the future

What lies beyond for the third generation CD plant? The immediate future will make use of existing machinery, technologies and processes to produce CDs quickly, at higher yield levels to meet the record industry's

'. . . the demand for CD software has grown more rapidly than anticipated by any of us.'

escalating production requirements and its rapidly changing demands and distribution patterns.

Eight key areas requiring improvement are:

- disc mastering and quality control;
- capital cost of disc mastering equipment;
- process controls in electroforming;
- capital cost of electroforming equipment;
- clean room conditions when processing moulded discs;
- capital cost of clean rooms;
- contamination of discs before sputtering;
- capital cost of sputtering equipment.

Mastering converts digital tape to digital disc master. At Philips (Eindhoven) new mastering software for CDs makes the process more self-analytical. At Laser Video (Anaheim, USA) a dual mastering system built in-house and costing less than one Philips system, has cut lead times in half. At Optical Disc Corporation (Cerritos, USA) Discovision's advanced ablative optical disc mastering technology cuts huge chunks of time out of the mastering and quality assurance steps of the process.

Electroforming makes negative metal moulds from digital disc masters and Polyform (New York, USA) now sells

'We should all remember that the record business has never been driven by technology . . .'

disc electroforming technology including optical memory discs, that is fully computerised. Computerisation has drastically reduced the cost of the equipment used for electroforming while making hardware reliability the best it has ever been.

A year ago, two moulding machine companies and two polycarbonate suppliers had control of most of the CD moulding technology. Now, spurred by the coming boom, no fewer than 20 moulding machine companies and three additional materials suppliers have serious development programmes in progress for CD or OMD.

Metallisation refers to the application of the reflective metallic coating on plastic discs.

One of the slowest and most dirt-sensitive processes in first generation CD plants is the aluminium sputtering process used to apply the reflective metal coating to the CD. This process, previously only a slow batch operation, has recently been automated by one firm and conveyorised input in direct line with moulding process can now speed up production.

An alternative to sputtering, recently developed, is wet metallisation. This involves the application of a chemical mirror surface to the CD and holds out the promise of tremendous throughput economies and yield improvements over sputtering processes. Wet metallising, already used for two years on Laser Video discs by Philips, chemically washes the surface of the CD before applying the reflective surface. The washing not only removes loose dust that may have settled on the moulded disc but it also reduces the clean room requirements for metallisation due to the self-cleaning nature of the process.

This wet process is not complicated nor particularly expensive and the capital equipment is relatively simple compared to aluminium sputtering equipment. Apart from these benefits, wet metallisation is an automated conveyorised process and, if anything, has too fast a throughput for they often must wait for work. Companies currently perfecting these processes for CD are Polyform Inc, Mt Vernon, New York, and London Labs by licence with Philips, NV, The Netherlands.

Clean room costs

Clean room cost (capital and upkeep) heads the list of things that add to the cost of CD manufacturing. In spite of the enormous investment in clean rooms made by the builders of first generation CD plants, disc contamination is still a major cause of rejects. In first and second generation CD plants, large clean areas are provided to house moulding machines, sputtering machines and the workers who use them. The primary source of contamination is the work force.

In the third generation CD plant, workers seldom touch or even see the discs until they leave the metallisation and lacquering machines. Instead of workers, dedicated robots and intelligent conveyors operating through clean tunnels or tubes moving discs from moulding machines to wet metallisation stations. Clean conveyors connecting moulding machines with continuous wet metallisation processes are the primary earmarks of the third generation CD plant.

There are of course many other areas of improvement—lacquering automation, label printing, other nuances of disc handling, labelling and packaging, warehousing—and all are well past the dream stage. They are tangible realities today. By the end of 1986, there will be more efficient plants in production or near production and they will probably even surpass the improvements suggested here.

One of the more encouraging conclusions we can draw from this evidence is that plants like Poly, DADC in Terre Haute and Shizuoka, the new Laser Video plant in Anaheim, do not teeter on the edge of extinction. On the contrary, they are expanding to meet the growing demand, and they are evolving technologically.

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Cassette Mastering and Chrome Duplication

Terry Yeadon of BASF takes a close look at the tape duplicating industry and questions some of the practices currently being used by the industry

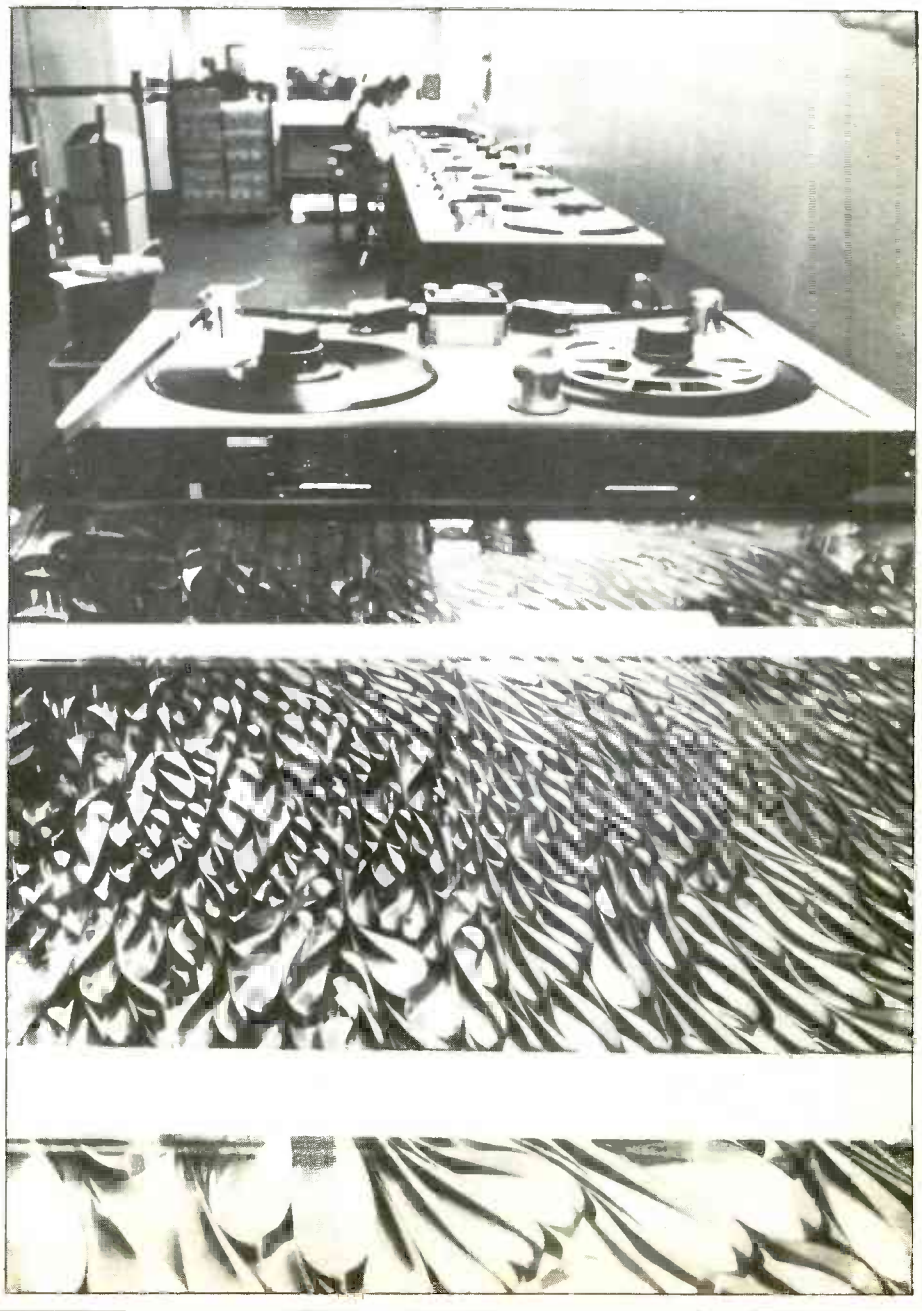
I remember pre-recorded cassettes back in the late '60s and early '70s. Simple, convenient things—pop any one into any player and there it was: instant music anywhere, so convenient. Of course the quality of that music left much to be desired, modified as it was by basic tape noise, modulation noise, distortion, limited frequency response, speed fluctuation, azimuth problems, etc, but it was so convenient. We have come a long way since then—we've *had* to. Dolby noise reduction, chrome tape, improved high speed duplication equipment and techniques all helped to raise the quality of musicassettes to a once undreamt of level and they were still so convenient. I agree there were hiccups—Dolby *B* for instance: The buyers asked, 'What is it? Do I need a new deck with Dolby *B*?' but the public became familiar with it. Chrome tape: 'What is it? Do I need a new deck . . .?' but again they became familiar with it. The procedure then was any pre-recorded cassette, any deck with Dolby *B*—switch to normal EQ (120 µs) and good quality music anywhere and still so convenient.

Recently, however, things have started to get more difficult. Dolby *HX Pro* and the *XDR* system have made the cassette a less straightforward device for the general public to understand and now tests are being carried out with Dolby *C*-type noise reduction on chrome tape but with a playback equalisation of 70 µs. Stop! now that we have standardised the musicassette at 120 µs please leave it, the industry and the buyers do not need yet another standard. Keep the pre-recorded cassette simple and convenient.

BPI figures indicate that 1985 is the year that sales of musi cassettes will overtake vinyl disc sales. Compact disc penetration will continue to increase but I feel that for a great many years to come the analogue cassette will be the number one music carrier. Just as in the past a great deal of care has been taken, over each stage of manufacture involved in the production of vinyl discs, I feel we owe it to the end purchaser of the cassette (the person who, more and more, is paying all our wages) to improve as much as possible the quality of his purchase.

Mastering

All too often, for instance, a producer will attend the cutting session when his stereo master tape—analogue or digital—is transferred to the master lacquer for vinyl disc production and simultaneously a copy is made with any necessary EQ, limiting, compression, etc, required for the limitations of the black disc. This is then submitted for subsequent transfer to cassette. No one would dream of doing this for CD mastering, so why for cassette? Cassettes are not subject to the limitations imposed by the very nature of the vinyl disc and it is imperative that a tape as close to the original master as possible is submitted to the cassette duplicator. All duplicators and



mastering houses have Sony *F1* digital facilities and it is so easy for a studio to run off a copy straight from the first generation stereo master. Please make sure that as much information as possible accompanies this tape, such as full artist and title information, catalogue number, if known, and also the studio where the tape was originated, in case there are problems. It would also help duplicators if the longest running side could be recorded first, even if this happens to be side two, but please indicate this very, very clearly on the cassette label and any accompanying paperwork. Also indicate clearly that the tape is a digital *audio* copy. I have known instances where an inexperienced record company employee has sent out such tapes thinking them to be promotional videos!

So hopefully the cassette mastering engineer receives a first class master, now what does he do with it? It has been normal in the past to make a running master, or loop-bin mother tape at a speed of 19 cm/s if the final cassette is to take advantage of the superior quality available from chrome cassette tape. The tape used in the bin has historically been a standard studio mastering tape of 1 in or ½ in width originally developed for optimum performance at 38 or even 76 cm/s. The performance of such tapes is adequate at 19 cm/s and the operation in the severe conditions encountered at high speed in a loop bin has been acceptable. Recently, however, commercial necessity has forced duplicators to higher speed operation, that means 64:1. Several equipment manufacturers now offer systems that can run at 64:1 with a 19 cm/s master running at 12.16 m/s (480 in/s). All very well if a duplicator wishes to invest in such plant but if not there is only one route: a 9.5 cm/s master.

Dynamic range

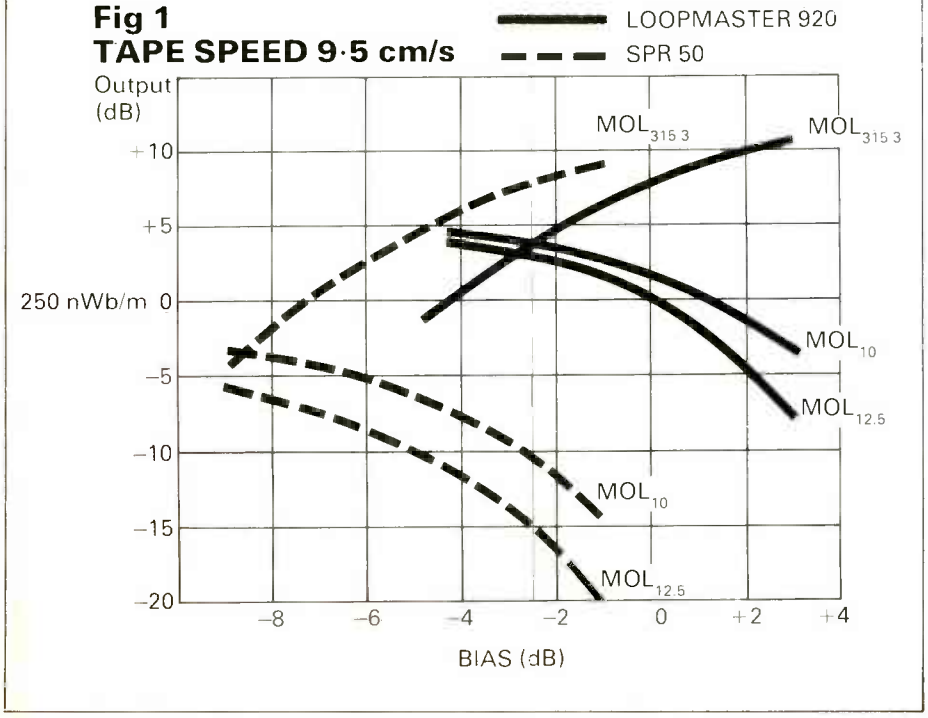
One of the most important criteria for a loop bin tape is that its dynamic range should be at least 10 dB better than the tape on to which you are duplicating, in this case the cassette tape. **Table 1** compares BASF *SPR 50* studio mastering tape with BASF chrome cassette tape and clearly shows the limitations of a studio mastering tape at a speed of 9.5 cm/s.

The performance at low frequencies is satisfactory so only the high frequency figures have been shown. In the case of a 9.5 cm/s speed the performance of the loop bin master tape is inferior to that available from the cassette tape, a situation which would not be tolerated in any other area of recording and clearly one to be avoided in cassette duplication.

Table 1 Dynamic range

Frequency	SPR50 @ 19 cm/s	SPR50 @ 9.5 cm/s	Chrome cassette tape @ 4.76 cm/s 120μs
10 kHz	58.0 dB	48.0 dB	51.0 dB
12.5 kHz	56.5 dB	43.5 dB	48.5 dB
14 kHz	54.0 dB	40.5 dB	47.0 dB

Fig 1
TAPE SPEED 9·5 cm/s



Loopmaster 920

BASF has looked at the basic problems and developed a tape specifically for operation in the loop-bin. *Loopmaster 920* fulfils all the requirements which are:

- wide dynamic range, ideally 10 dB better than cassette tape;
- level stability as a function of head passes;
- several thousand passes readily achieved;
- low print through;
- minimum 'oxide shedding';
- minimum head wear.

Fig 1 Compares maximum output levels of *Loopmaster 920* with BASF *SPR 50* studio mastering tape at a speed of 9.5 cm/s. You will clearly see that a gain of more than 10 dB is achieved at high frequencies. *920* uses a chrome pigment instead of iron oxide which brings other benefits. The ability of chrome to retain its magnetism when subjected to physical abuse is well known. This property, called low magnetostriction makes *Loopmaster 920* particularly suitable for the severe mechanical demands of loop-bin operation. The very low print through figure means that not only will *920* master tapes store well in the tape library but also the annoying 'fizzing' sound apparent before the start of the programme, is eliminated. This is caused by the loops of tape in the bin sliding together during normal running and has been called 'kiss-print'. And, of course, the legendary lack of modulation noise with chrome tape results in a clearer music signal on the running master.

To take advantage of BASF *Loopmaster 920* some modifications may be required to the real-time mastering equipment. For instance Studer are now supplying the *A80 MR* machines with improved reproduce heads, better mechanical guidance components and alignment to improve azimuth stability, a bias amplifier capable of supplying the additional bias required by chrome tape, complete with Dolby *HX Pro*, and finally changes to the record pre-emphasis circuits required because of the increased sensitivity of chrome tape (+15 dB at 12 kHz). Needless to say all these modifications are available as retrofits to existing equipment.

There are gains to be had by using *Loopmaster 920* at 19 cm/s and running that at 480 in/s—very well worth having but not so dramatic as the improvement at 9.5 cm/s.

BASF together with quality-conscious, artists, producers and duplicators foresee a long and healthy future for the analogue cassette. With this in mind we intend to offer to the duplicating industry our full support in this important period in the development of the pre-recorded audio cassette.

The Long and Winding Road

Running masters and loop bin design

We deliberately start with this subject because it is essential that the quality of the master is as high as possible if subsequent stages are not to suffer. Let's start by looking at the dynamic range (measured with a Sound Technology *1510-A* analyser) of two Otari *MTR-10*s, fitted with Dolby *HX Pro* and running at 7½ and 3¾ in/s and compare them with the Nakamichi *1000 ZXL*, which was used without noise reduction or *HX Pro*.

Table 1 shows the accuracy of replay calibration and flux levels using Magnetic Reference Laboratory calibration tapes.

Using an internal program of the analyser, the measured high frequency maximum output level (MOL) of various tapes was measured on the three machines (**Table 2**). Although Sound Technology refer to these tests as MOL a better description might be Compression for this is what they really indicate. The analyser is increasing the input signal in 1 dB steps and measuring the amount of compression.

The results show the 3¾ in/s master has far less output than the 7½ in/s master, or indeed the cassette, at high frequencies.

As a further development of this test we connected the Nakamichi in series following the master recorder and tested the overall dynamic range.

Table 3 shows the dynamic range determined by measuring the CCIR-weighted bias noise and the MOL at 1 kHz (3% D3) and 15 kHz (as detailed in **Table 2**).

The difference in dynamic range between the two master speeds is 7.0 dB when using chrome tape and 3.0 dB with ferric tape.

These figures are significant, showing clearly that the restriction in high frequency performance is caused by the master itself and not the cassette tape. While it is fair to say that a real-time recorder like the Nakamichi *1000 ZXL* can out-perform a high speed slave the Nakamichi did not have the benefit of Dolby *HX Pro*. In view if this we believe the test fair.

From these results it can be concluded that the audio quality of music cassettes could be drastically improved by using a master which had been recorded at 7½ in/s, with *HX Pro* and by running the bin at 480 in/s.

In the coming issues of *One to One* we will be looking at duplication in greater depth but in the meantime here are a few topics which we would like you to consider and comment on.

Track configuration and width

The 8-track cartridge was the most common product being copied in the early days of high speed duplicating and as all eight tracks had to be recorded at once the equipment manufacturers used 1 in tape.

Although the 8-track cartridge is a distant memory, the 1 in format has remained extremely popular especially as the extra track width offers improved noise performance. Against this, it is generally accepted that the wider format leads to larger degrees of phase error at high frequency, especially when using a staggered track format, and the operational costs are higher than those for ½ in.

Now we have the availability of Dolby *HX Pro* and 480 in/s bins, many duplicators will be starting new libraries of masters; should these be on ½ in or 1 in tape? It would seem that ½ in is more than adequate but we would be interested to hear what others felt.

Tape

Over the years, the performance and reliability of cassette and master tape has improved tremendously. If a duplicator is to achieve consistent

Table 1 Replay calibration

Reference level	
Otari MTR-10	185 nWb/m
Nakamichi 1000 ZXL	160 nWb/m
Replay frequency response	
Otari MTR-10 7½ in/s	±0.3 dB 20 Hz to 20 kHz
Otari MTR-10 3¾ in/s	±0.5 dB 20 Hz to 20 kHz
Nakamichi 1000 ZXL	±0.5 dB 50 Hz to 12.5 kHz h+1.7 dB 15 kHz
Track formats	
Otari MTR-10 7½ in/s	Staggered
Otari MTR-10 3¾ in/s	Adjacent
Tape width	½ in

Table 2 High frequency compression. (MOL)

Tape	Chrome Cassette tape and Ampex 456 β 7½ & Agfa 526 β 3¾			
Frequency 20 kHz	Input	Cassette	7½ in/s	3¾ in/s
	+ 5.0	−22.0	+1.8	N/A
	0.0	−16.1	+1.2	N/A
	− 5.0	− 6.1	+1.7	−18.6
	−10.0	− 2.3	−2.1	− 2.3
Frequency 15 kHz	Input	Cassette	7½ in/s	3¾ in/s
	+ 5.0	−11.3	0.0	N/A
	0.0	− 4.2	−0.1	−8.0
	− 5.0	− 1.6	−0.3	−3.2
	−10.0	− 0.9	−0.4	−0.2
Frequency 10 kHz	Input	Cassette	7½ in/s	3¾ in/s
	+ 5.0	− 4.0	−0.3	−4.7
	0.0	− 1.0	−0.1	−0.8
	− 0.5	− 1.2	0.0	−0.9
	−10.0	− 0.7	−0.2	−0.7

results then it is essential that the cassette tape comes from a manufacturer who has effective control over the extremely complex tape making process.

Compared to the price of oil over the last 10 years or so, magnetic tape is extremely good value, so it is worth investing in the best.

Ideally this means using one of the new high performance tapes. This is fine providing the industry can convince its customers that the additional quality obtained from such tapes is worth the additional cost. Many people have already proved their willingness to pay a lot more for CD and super-cut records so it is reasonable to assume they will pay a little extra for a sweeter sounding cassette. This relies on proper marketing but a word of caution is in order here: before asking your customers to pay out more money for the product, make sure that the quality actually is better.

Dolby C

It has been said that Dolby C noise reduction could also be used to improve quality without increasing unit cost. In theory this is true but for this to be practical, system alignment procedures would have to be tightened. This is because the encoding process takes place on the master recorder and the signal is not decoded again until the cassette is played back in the customer's player. Any variations in level or frequency response that occur in between the two stages of the process will affect the tracking accuracy of the decoder and hence the audio quality of the duplicated cassette.

As any engineer will tell you a duplicating system is not the easiest piece of equipment to set up and any variations will be exaggerated by the noise reduction process. And as the compression and expansion ratio of Dolby *C* is greater than that for Dolby *B* below 10 kHz, the tonal balance of any cassettes which have been recorded with Dolby *C* on a non linear slave will be less accurate than if they had been recorded with Dolby *B*. However, providing the duplicating system is aligned correctly both Dolby noise reduction systems, and in particular *C* type, offer a significant improvement in fidelity and dynamic range. In practical terms slaves should be aligned within the limits given in **Table 4**, which are measured without noise reduction.

Table 3 Combined Dynamic Range of Otari MTR-10/Nakamichi 1000 ZXL

Master speed	Tape master	Cassette	Dynamic range 1 kHz	Dynamic range 15 kHz
7½ in/s	Ampex 456	BASF Chrome	53.0	49.0
7½ in/s	Ampex 456	BASF LHD	51.5	42.5
3¾ in/s	Agfa 526	BASF Chrome	50.3	42.8
3¾ in/s	Agfa 526	BASF LHD	50.5	39.0

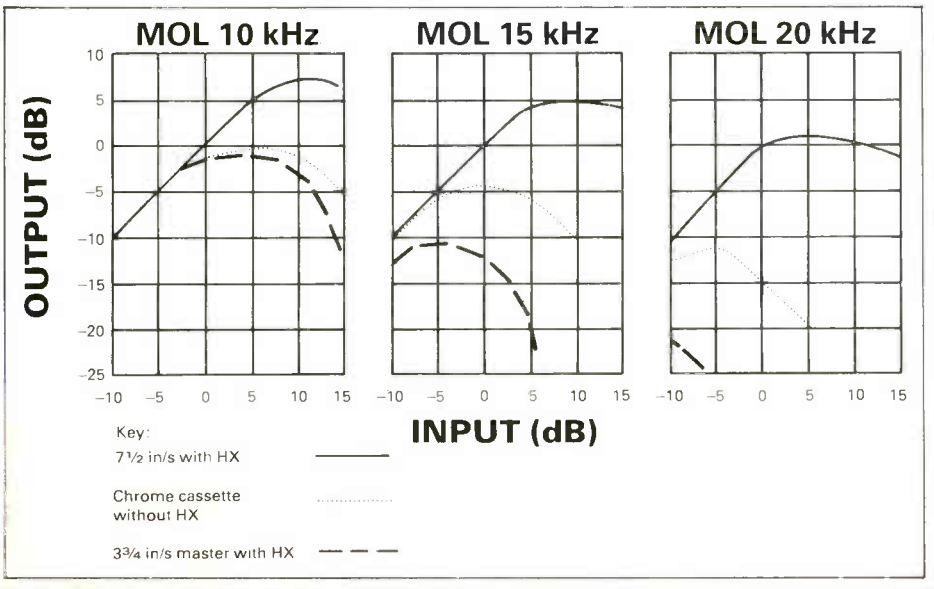
Table 4a Tolerances for level variation at 2 kHz

No noise reduction	Dolby B	Dolby C
within 2.0 dB	within 1.0 dB	within 0.5 dB

Table 4b Tolerances for aligning the frequency response of high speed duplicating slaves

No noise reduction	Dolby B	Dolby C
within 3.0 dB	within 2.0 dB	within 1.5 dB

Fig 1 Effect of Dolby HX Pro on a 15 kHz signal



Dolby HX Pro

While the benefits of Dolby *HX Pro* have long been recognised when in use at real-time, they have not been so obvious at high speed and some duplicators have had difficulty hearing the difference between cassettes recorded with and without *HX*. Could it be that *HX Pro* is only effective when used at real-time or is it poor equipment design and quality of the master: how do these affect the performance of *HX Pro*?

Fig 1 shows the effect *HX Pro* has on a 15 kHz signal and from this we can see that the system is more effective at high level than at low. Given this, it becomes clear than unless there is high level, high frequency information on the master it will not be possible to hear any difference between a cassette recorded with *HX Pro* and one without.

What is important are the detectable differences between the quality of the master and the duplicated cassette and if *HX Pro* has been set up correctly then those differences should be very small indeed.

Dolby's recommended method for setting up an *HX* system is to bias the tape for minimum distortion at 315 Hz, using a spectrum analyser and with the *HX* switched off. Once the correct bias point has been found the record equalisation is adjusted to obtain a flat frequency response at 20 nWb/m. Following this the *HX* is switched on and the gain control adjusted to provide the best MOL at 15 kHz.

Master recorders available with Dolby *HX Pro* are Otari *MTR-10* and Studer *A-80 MR*.

In addition to this it is also possible to fit Dolby *HX Pro* to the following slaves which will further enhance the audio quality of the cassette: Electro Sound *8000*, Gauss *1200*, Gauss *2400*, Lyrec *2500*, Otari *DP85*. The Otari slave can only be used with the *DP83C* master loop bin.

From a commercial viewpoint the advantage of investing capital in new plant of this type, is that costs can be amortised over a period of time. An alternative way of improving quality, providing the duplicating equipment can handle them, is to use chrome masters and high performance cassette tapes. Unfortunately, this would increase the cost of every unit produced. Ideally one should do both but a realistic approach is essential if one wants to stay in business, and margins have to be maintained in order to build up capital for new equipment.

Finally, equipment manufacturers say that the most buoyant market at the present time is in Asia, where they are buying the latest equipment. We would do well to remember that this is an area of the world which is well known for its exports to both Europe and the USA.

Cassette tape lengths— number of cassettes per pancake

C-60

Cassette time	Tape length ft	Tape length m	Yield-cassettes per hub 8200 ft hub	Yield-cassettes per hub 8000 ft hub
C- 1	4.69	1.43	1749	1706
C- 2	9.38	2.86	874	853
C- 3	14.06	4.29	583	568
C- 4	18.75	5.72	437	426
C- 5	23.44	7.14	349	341
C- 6	28.13	8.57	291	284
C- 7	32.81	10.00	249	243
C- 8	37.50	11.43	218	213
C- 9	42.19	12.86	194	189
C-10	46.88	14.29	174	170
C-11	51.56	15.72	159	155
C-12	56.25	17.15	145	142
C-13	60.94	18.57	134	131
C-14	65.63	20.00	124	121
C-15	70.31	21.43	116	113
C-16	75.00	22.86	109	106
C-17	79.69	24.29	102	100
C-18	84.38	25.72	97	94
C-19	89.06	27.15	92	89
C-20	93.75	28.58	87	85
C-21	98.44	30.00	83	81
C-22	103.13	31.43	79	77
C-23	107.81	32.86	76	74
C-24	112.50	34.29	72	71
C-25	117.19	35.72	69	68
C-26	121.88	37.15	67	65
C-27	126.56	38.58	64	63
C-28	131.25	40.01	62	60
C-29	135.94	41.43	60	58
C-30	140.63	42.86	58	56
C-31	145.31	44.29	56	55
C-32	150.00	45.72	54	53
C-33	154.69	47.15	53	51
C-34	159.38	48.58	51	50
C-35	164.06	50.01	49	48
C-36	168.75	51.44	48	47
C-37	173.44	52.86	47	46
C-38	178.13	54.29	46	44
C-39	182.81	55.72	44	43
C-40	187.50	57.15	43	42
C-41	192.19	58.58	42	41
C-42	196.88	60.01	41	40
C-43	201.56	61.44	40	39
C-44	206.25	62.87	39	38
C-45	210.94	64.29	38	37
C-46	215.63	65.72	38	37
C-47	220.31	67.15	37	36
C-48	225.00	68.58	36	35
C-49	229.69	70.01	35	34
C-50	234.38	71.44	34	34
C-51	239.06	72.87	34	33
C-52	243.75	74.30	33	32
C-53	248.44	75.72	33	32
C-54	253.13	77.15	32	31
C-55	257.81	78.58	31	31
C-56	262.50	80.01	31	30
C-57	267.19	81.44	30	29
C-58	271.88	82.87	30	29
C-59	276.56	84.30	29	28
C-60	281.25	85.73	29	28
C-61	285.94	87.15	28	27
C-62	290.63	88.58	28	27
C-63	295.31	90.01	27	27
C-64	300.00	91.44	27	26
C-65	304.69	92.87	26	26
C-66	309.38	94.30	26	25
C-67	314.06	95.73	26	25
C-68	318.75	97.16	25	25

C-90

Cassette time	Tape length ft	Tape length m	Yield—cassettes per hub 11,500ft hub	Yield—cassettes per hub 10,800ft hub
C-69	323.44	98.58	35	33
C-70	328.13	100.01	35	32
C-71	332.81	101.44	34	32
C-72	337.50	102.87	34	32
C-73	342.19	104.30	33	31
C-74	346.88	105.73	33	31
C-75	351.56	107.16	32	30
C-76	356.25	108.59	32	30
C-77	360.94	110.01	31	29
C-78	365.63	111.44	31	29
C-79	370.31	112.87	31	29
C-80	375.00	114.30	30	28
C-81	379.69	115.73	30	28
C-82	384.38	117.16	29	28
C-83	389.06	118.59	29	27
C-84	393.75	120.02	29	27
C-85	398.44	121.44	28	27
C-86	403.13	122.87	28	26
C-87	407.81	124.30	28	26
C-88	412.50	125.73	27	26
C-89	417.19	127.16	27	25
C-90	421.88	128.59	27	25
C-91	426.56	130.02	26	25
C-92	431.25	131.45	26	25
C-93	435.94	132.87	26	24
C-94	440.63	134.30	26	24
C-95	445.31	135.73	25	24
C-96	450.00	137.16	25	24
C-97	454.69	138.59	25	23
C-98	459.38	140.02	25	23
C-99	464.06	141.45	24	23
C-100	468.75	142.88	24	23

C-120

Cassette time	Tape length ft	Tape length m	Yield—cassettes per hub 10,800ft hub	Yield—cassettes per hub 7,200ft hub
C-101	473.44	144.30	22	15
C-102	478.13	145.73	22	15
C-103	482.81	147.16	22	14
C-104	487.50	148.59	22	14
C-105	492.19	150.02	21	14
C-106	496.88	151.45	21	14
C-107	501.56	152.88	21	14
C-108	506.25	154.31	21	14
C-109	510.94	155.73	21	14
C-110	515.63	157.16	20	13
C-111	520.31	158.59	20	13
C-112	525.00	160.02	20	13
C-113	529.69	161.45	20	13
C-114	534.38	162.88	20	13
C-115	539.06	164.31	20	13
C-116	543.75	165.74	19	13
C-117	548.44	167.16	19	13
C-118	553.13	168.59	19	13
C-119	557.81	170.02	19	12
C-120	562.50	171.45	19	12
C-121	567.19	172.88	19	12
C-122	571.88	174.31	18	12
C-123	576.56	175.74	18	12
C-124	581.25	177.17	18	12
C-125	585.94	178.59	18	12
C-126	590.63	180.02	18	12
C-127	595.31	181.45	18	12
C-128	600.00	182.88	18	12

Computerised Quality Control

Computerised quality control has come to duplication, with the recent installation of a 60 unit four bank system for U-matic, VHS and Beta at the SNV Group's UK distribution centre in Bournemouth. This duplicator services the National Westminster Bank's video network and is thought to be the most advanced remote control and monitoring system of its kind in the world.

SNV, working through the design resources of its electronics manufacturing subsidiary Video Data Systems, first began to explore the possible uses of computers in duplication at the Barclays Bank Video Communications Centre in Teddington. Having built a number of manually operated duplication systems for installing and maintaining the bank's nationwide commitment to video, SNV was already investigating a number of options for interfacing computer and video technologies. The error prone duplication area presented an ideal opportunity for development.

To understand fully the advantages offered through computer control, it is necessary to consider the more traditional alternative. The first consideration in a multi-system and multiple bank environment is the ability to route signals from a given source (1 in, high band or low band usually) to an assigned destination. The user does not always want to produce the same number of copies, nor to make those copies on a single format. To do this involves physically patching one machine to another with cables—a lengthy and tedious task which is almost by definition unreliable.

Secondly, manual duplication control creates quality problems. There are a number of reasons for this not least the arbitrary monitoring of different machines in play/record, by an operator who can usually sequence through the bank (or banks) of VTRs to make a visual check on picture quality.

Here it should be remembered that VTR behaviour is different when recording to when replaying. While the operator can watch a recording being made, he will still need to replay after recording (usually by random sample) to check the copy.

Quality control during real-time duplicating is always a problem. Perhaps this computer system, developed by SNV for the video industry, points the way for the future?

Monitoring during recording is really monitoring of the source signal. If the operator is attentive he will notice some simple errors. For example, a badly degraded picture is usually picked up, and if there is no sound this may be identified as well. Arbitrary monitoring via a single monitor is unacceptable anyway: if an operator has, for example, 60 VTRs to monitor he will by definition only be looking at each VTR for one second in every minute. During random sequencing this means a maximum of about 2% of running time, a very poor sample indeed.

Thus the operator is presented with a series of problems. No matter how competent his ability to identify faults he is limited to visual checking for both VTRs and picture. If a machine indicates visually that it is in 'play' he would not be aware of a mechanical problem like a tape jam, nor indeed that it was not recording because the 'write protect' button on the video cassette had not been removed.

The SNV response to the problems is to use the external access to the VTRs to operate remote control and monitoring through two micro computers. The first task was to institute an alternative to the cumbersome routing switch panel by substituting an electronic matrix. At a stroke this eliminated any possibility of misrouting signals from master sources to slave units, as system designer Jeffrey Johnson explains.

"The operator does not have to understand what is going on either within the matrix or the machines, any more than a driver needs to understand the working of a combustion engine. Switching is done electronically rather than mechanically. Simple computer graphic displays interface the complexity of the system with the operator. It should be remembered that while a dub from a given machine to a given source is simple to describe it is not as easy to achieve. With our approach the level of engineering expertise demanded of the operator is minimised because the difficult work is done for him. One computer actually switches machines on and off and rewinds tapes while another monitors the system, looking at the signals to check they are acceptable."

Monitoring

The monitoring process covers a wide range of error conditions both in the machines and on the tapes. The proprietary hardware includes computer controlled distribution amplifiers which both route and amplify signals at the same time, and a plug-in monitoring board on each VTR. A sophisticated communications system allows the computer to 'talk to' both control hardware and to the board in every VTR.

In the first instance monitoring assesses the level of chroma in a dub. Since PAL colour signals are based on black and white pictures, colour can be lost to leave a black and white picture behind. An error of this kind is rarely spotted during operator visual monitoring.

A key advantage of the system is its suitability to handling recycled tape—an important consideration in networks of the kind operated by Barclays and Nat West, where tapes will be re-recorded several times. Using old tape brings attendant problems that are well known: general degradation inevitably produces varying degrees of dropout. Although there are technical definitions of what constitutes dropout, the unpleasant snow on the picture remains a subjective invasion. Lines

SNV's UK computer quality control system

splats and holes will result from creasing in a tape but how bad can these be before they distract or irritate the viewer?

Frank Spurr, managing director of VDS, describes the problem as a complex, dynamic phenomenon that is difficult to calibrate.

"All used tapes have some degree of dropout—hence the dropout compensators you find built into most VTRs. One of the key quality control advantages of the system is that it will identify those tapes with dropout. The graphics display monitor indicates dropout during the run, and at the end of the run a master computer interrogates subordinate monitoring boards to extract an error report on every machine in the run. This printed report is immensely valuable from an engineering point of view, since it identifies those machines which are causing problems and will give a preliminary diagnosis of the fault. Over a period of time you can identify those VTR's which require a disproportionate amount of maintenance and so replace them. This not only improves quality but also cuts maintenance costs."

Actual error conditions notified through the eight-colour graphics display differentiate between record and playback. In record, these conditions include: no signal, no sound, no picture, play but not record, no tape, machine not in play/record mode. During playback, warnings are given of low sound, low chroma, no signal and, of course, dropout.

Machine condition monitoring is made possible by the on-board VTR devices which already respond to certain error conditions. When a damaged tape jams a machine, the machine will respond to avoid major damage by locking itself. VTRs have inbuilt checks, like the ability to identify the beginning and end of a tape, and this in turn offers the possibility of remote controlled auto-wind, start and stop. If the record write protect button has not been removed, then this known condition is identified and reported to the operator through the graphic display. Without such monitoring the machine would appear to be functioning perfectly. Error reports mean rapid response and a higher level of acceptable recording throughout the run.

Image control

The Image Control duplicator actually uses BBC micros. Jeffrey Johnson says that people often had strange ideas about computers, failing to understand that a systems choice was based on functionality and cost. "It is a well documented computer with good teletext graphics. These have the advantage of giving full, eight colours and delivering them very cheaply. It is a communications computer with many ports—parallel ports, a printer port and a user port. It has many ways of communicating with the world and this helps keep costs down."

The innovative thing about the system is not the computer itself but the computer program: "It is the system design approach which really matters. Computer control is only part of a system that involves people as well as machines. If you send a good tape to the wrong place the quality control becomes pointless."

The Image Control approach has not imposed one system on either Barclays or Nat West but delivers a system which is appropriate to the individual customer. As Frank Spurr sums up: "We are not locked into something absolute. People interface with machines in specific environments, which means that each one of these computer controlled duplicators is tailor made for a given customer through custom software. The system is modular, so certain hardware features and some elements of the programme will be identical but at the heart of the matter is the ability to adapt to different requirements."

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Low-cost digital audio comes of age.

The Sony PCM series has now been available for several years. In this time recording and broadcast organisations, government, educational and industrial establishments, as well as individual users have all acknowledged the unique value of these units, and made them a new standard. It is the superlative quality of Sony PCM digital, coupled with extremely low cost that has brought about this professional acceptance of the range. This is borne out by the number of new ancilliary products from other manufacturers, that have further increased the flexibility and versatility of the range. Examples of these products are the 'CLUE' logging and editing system from HHB, as well as various interfaces which allow digital communication with the PCM 1610.

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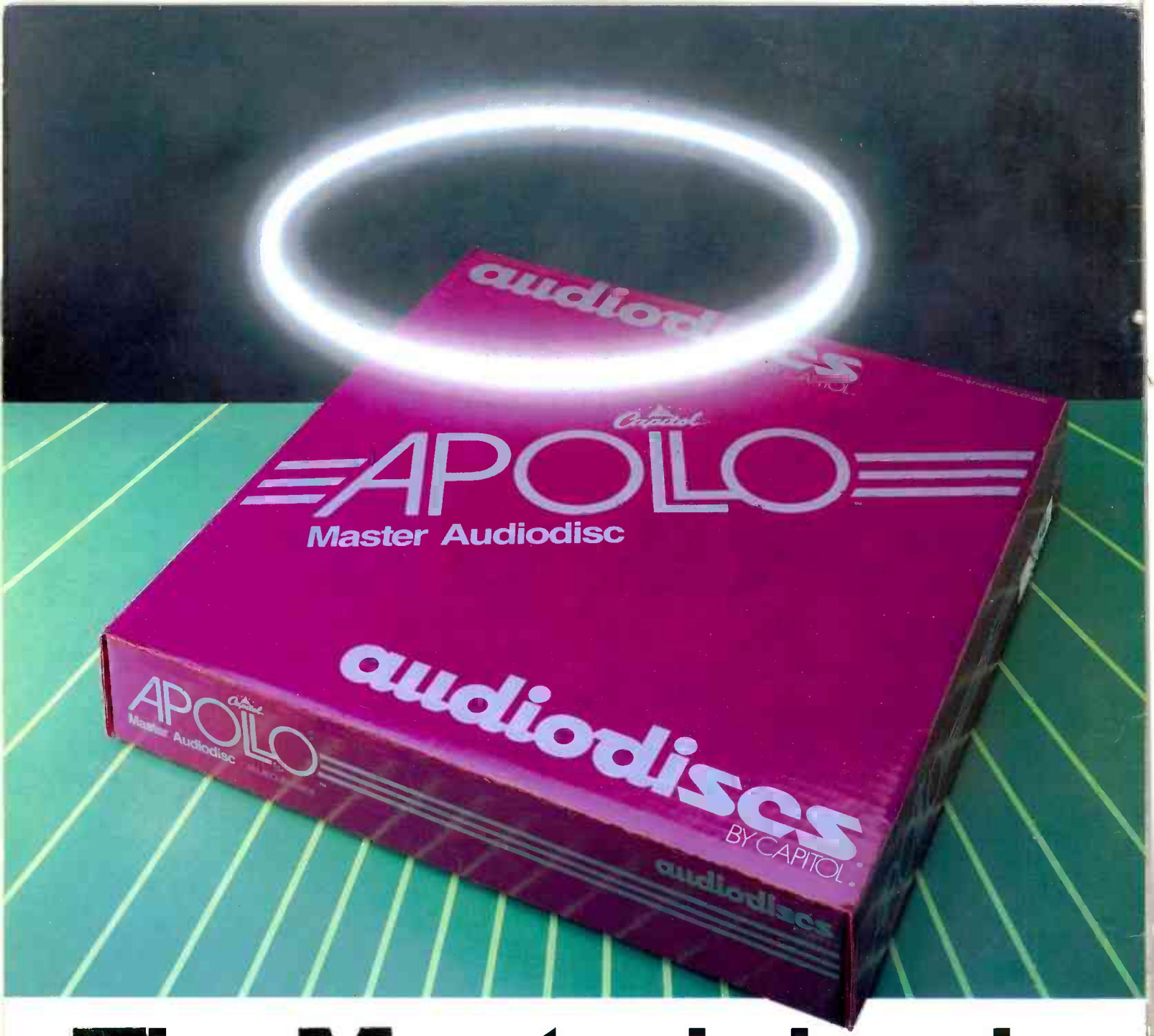

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