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# STUDIO SOUND

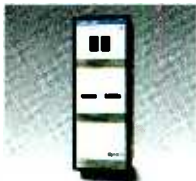
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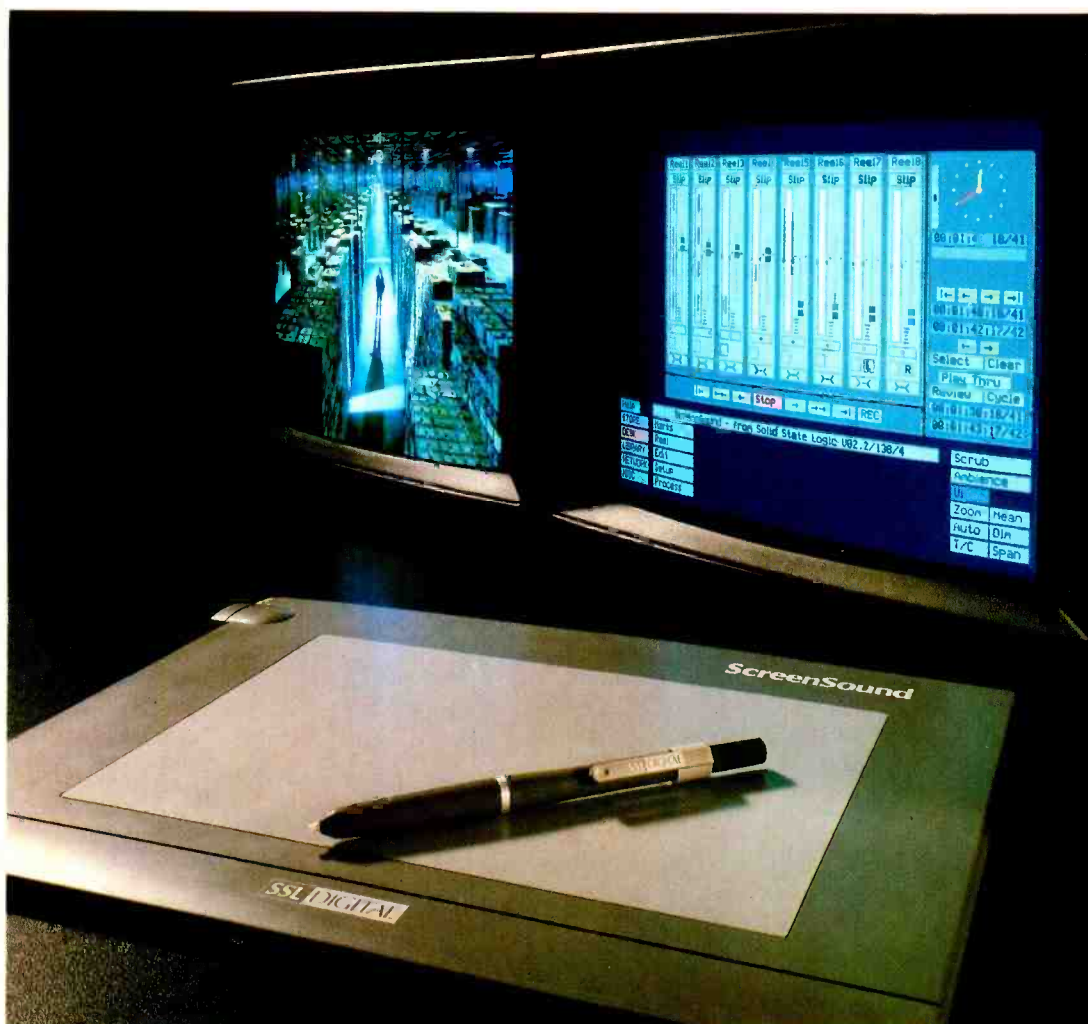
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Recording Architecture Black Box acoustic panels installed at CTS Studios

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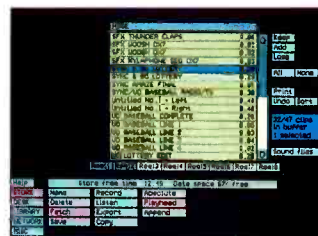
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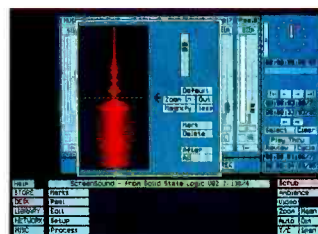
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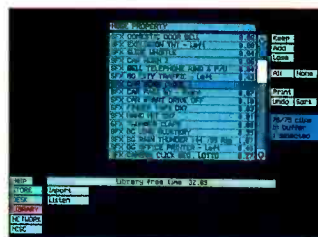
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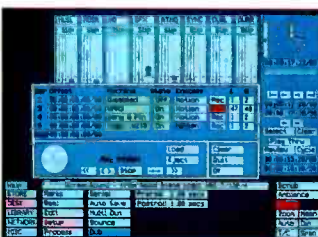
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# STUDIO SOUND

AND BROADCAST ENGINEERING

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## Mix marriages

There are two qualities that would help make a good editor of a technical trade magazine such as this—knowing something about your magazine's subject area and being blessed with a degree of intuition. Luckily, the first requirement you can work on but the latter comes difficult. Of course, familiarity with your subject allows you to pick trends, know the background to a topic and make predictions but such mundane predictive abilities are limited and frequently proved wrong. Natural accurate intuition is in short supply.

My point behind this preamble is that circumstances sometimes occur that do not seem to be predictable or leave a puzzle.

Hard disk recording/editing systems have matured and now form a justifiable part of most studios' operations although they have probably not purchased one yet. It has become clear what they are good at—signal manipulation—and painfully obvious what they were not suitable for—multichannel (16 plus) recording and upload/download of material, although maybe the former can be overcome with large amounts of money. The rather futile debate of tape versus disk of a few years ago was easily recognised as a red herring as it bypassed the issue completely.

It had become clear that multichannel tape machines were cost effective even in the digital domain. We settled down to a period of parallel development although not without the technologies being able to talk to each other. Everything seemed settled. At least until the disk recording media overcame certain limitations as to capacity and removability. For once quality was not a factor.

The change began last year when the Sony PCM3348 became available and it had that 22 seconds of RAM memory resident in the machine. The concept of the hybrid recording system seemed to gel even though RAM had been present in digital 2-tracks as part of the reel-to-reel editing system.

Last autumn Studer acquired IMS and renamed the company Studer Editech while the *Dyaxis* hard disk system became widely marketed with mooted close development with the tape formats.

Digidesign and Otari reached an agreement to jointly develop products that suggest mixing the two technologies.

Recently Mitsubishi, despite having mentioned their own hard disk system in development have reached a marketing agreement with Steinberg to distribute the *Topaz* system in the UK and Ireland as the *Diamond* workstation.

There are many rumours surrounding Sony's plans but they will not be repeated here.

And so it goes on. Exactly why the tape machine manufacturers and HD makers should choose now to collaborate we can only speculate as there does not seem an extremely good reason—at least not for a fervour that almost smacks of panic.

Could it be that we are now totally over populated with hard disk equipment makers as companies have rushed to develop their own system or have formed companies around them? The winners to date are those that either built to a cost (high or low) and those that applied themselves to their interface. With around 50 different systems now in existence many must now be looking for partners to distinguish them from their neighbours. It is, however, a fact that most of the tape machine manufacturers are now spoken for.

It is a puzzle. I have not received any real answer from the manufacturers involved other than that the combination of two companies offers greater possibilities, although the speed at which the companies acted looks rather more than that, yet I cannot detect a reason and, certainly, it wasn't predictable.

Keith Spencer-Allen

Cover: Meyer HD1 monitor. Photography by Tony Petch

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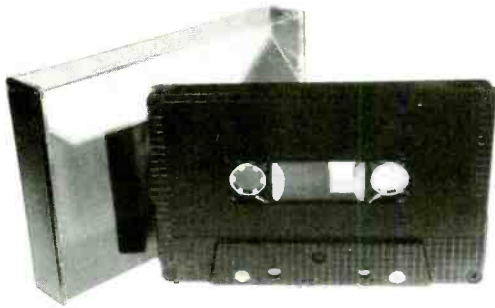
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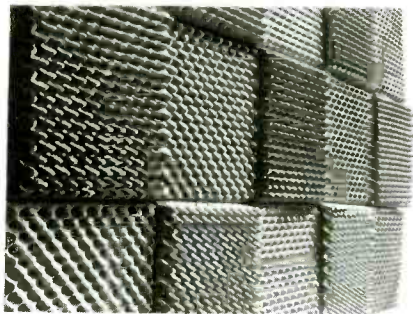
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## Berger leaves Joiner-Rose to form consultancy

Russ Berger has announced the formation of the Russ Berger Design Group with offices located in Dallas, Texas. The new company specialises in areas including recording and broadcast studio design and planning; architectural acoustics; and noise and vibration control. Russ Berger was vice-president of the Joiner-Rose Group and director of the studio division and he is continuing all in-progress projects with the full support and co-operation of the

Joiner-Rose Group. The two companies plan to collaborate on future projects. Initial contracts for the new Group include ABC's new audio and video post rooms and renovation of NBC's Brooklyn studios. Russ Berger Design Group Inc, 4004 Beltline, Suite 110, Dallas, TX 75244, USA. Tel: (214) 661-5222.

## New Euro-Japanese company

Soundcraft Japan Ltd, AKG Acoustics Vienna and Neutrik AG have announced the formation of a joint distribution company in Japan to be known as SCJ & AKG Ltd.

At the end of '89 Japanese founders of Soundcraft Japan completed a management buyout from Soundcraft Electronics and have spent 6 months in preparation for the new company.

SCJ & AKG Ltd will distribute Soundcraft consoles, AKG and Neutrik products as well as lines currently distributed by Soundcraft Japan including GML, Rane and Apogee Electronics. The chairman of the company will be Hisao Takagi, previously president of AKG Japan, while the position of president will be taken by Takashi Saito, president of Soundcraft Japan.

## Formation of European Synclavier owners' club

German company MM-Technology is currently founding the Synclavier Owners Club of Europe (SOCE). MM-Technology are a facility/hire company with three Synclavier and two Direct-to-Disk systems of their own. The club will be open to owners, operators and users of New England

Digital products—anyone involved with a Synclavier or Direct-to-Disk system as long as they are based in Europe. The aim of SOCE is to pass on knowledge and experience of NED products including a sharing of sounds and skills, etc. The club plans to meet twice a year at different locations throughout Europe and will also publish a bi-monthly newsletter for its members. Invitations to the meetings will be issued also to

## Proposals to change MU film/TV agreements

Proposals from the Independent Programmes Producers Association (IPPA) and the British Film and Television Producers Association (BFTPA) to change the agreement that the film and television industries have with the Musicians Union have been met with a cautionary welcome by the MU.

Dennis Scard, general secretary of the MU, has said that the proposals will be looked at, but, "The current TV and film agreements must not be undermined."

The MU had promised to revise the agreements 2 years ago but no revision has yet been put forward. Bringing things to a head, the IPPA and BFTPA have now submitted two surveys jointly financed by the associations, Zenith Productions, Paramount and the CTS Group of companies. The first survey was simply to find out how many of the association's members had recorded abroad last year and were intending to record abroad this year. Their findings were of concern as last year the figure was 25% of the response and this year it's 35%.

These figures became a catalyst for the second survey, which involved a visit by association members to all the foreign recording areas previously mentioned by the first survey's results. The IPPA and BFTPA are still compiling the second survey (a 125-page publication) and intend to distribute it to all members as a guide to recording abroad.

At the same time the independents have drafted this new report to the MU, as they feel the amount of work going abroad will make the British film and TV musician an endangered species. Basically the main points of the proposal to the Musicians Union are: 1. One agreement for film and television; 2. £25 hourly rate with a minimum 2 hours call instead of 3 or 4 hour sessions; 3. A supplement of £10 for appearing in-vision; 4. The ability to acquire all rights in all media and an end to the restrictions on the recording of music, subject to payment of an additional fee rather than being held to 20 mins of music for each session of recording; 5. A sliding scale of percentage reductions to encourage the engagement of more musicians; 6. The ability to rehearse without attracting residuals.

Recent losses to Britain of film and TV work include the movie of *The Phantom of the Opera*, which is being filmed and scored in Budapest, Hungary, and Rome, Italy and *Batman II*, whose new location hasn't yet been named.

Julian Mitchell



Composer and musician Ron Geesin demonstrating the Tune Tube, a musical instrument played from the inside by the human body breaking laser beams. The Tune Tube has been developed by Geesin with control equipment supplied by Live Wire and sound systems supplied by Roland. The instrument is being shown at the Art Machine exhibition in Glasgow until August 26th.

## News from the AES

As we enter the summer, the AES British Section takes a brief holiday from its monthly meetings until September. To help future planning, the dates, speakers and titles of our forthcoming monthly meetings are listed below (more details will be available on each nearer the time).

Sept 11th  
**BBC Control Room at BH**  
 George Legg

Oct 9th  
**AGM and Annual Dinner**

Nov 13th  
**Digital Audio in Professional Video Recorders**  
 John Watkinson

Dec 11th  
**Room and Loudspeaker Correction using Digital Equalisation**  
 Peter Craven

Also in the autumn one of the major audio events of the calendar

takes place—the **US AES Convention**. This is being held in Los Angeles between 21st and 25th September 1990 at the Los Angeles Convention Centre. A full programme of Papers and Workshops is promised, together with a large exhibition of the latest in audio technology.

The Papers are now available from the last AES UK Conference which was on the subject of **Hard Disk Recording**. This brings the number of Proceedings from AES UK Conferences to four. These are **Sound with Pictures** (May 1988), **Sound Reinforcement** (May 1989), **AES-EBU Interface** (Sept 1989) and **Hard Disk Recording** (May 1990). They are priced between £10 and £20 and are available from the address below.

For further details on any of the above or information on joining the AES, please contact:  
**Heather Lane, AES British Section, Lent Rise Road, Burnham, Slough SL1 7NY, UK.**  
**Tel: 0628 663725. Fax: 0628 667002.**

## Address changes

• **Sinec Ltd** have moved to Postweg 2, CH-5012 Schoenenwerd, Switzerland. Tel: (0)64 413 747. Fax: (0)64 415 321.

• **Arup Acoustics** have moved to Parkin House, 8 St Thomas Street, Winchester, Hants SO23 9HE, UK. Tel: 0962 69111. Fax: 0962 67270.

## People

• As part of their recent expansion and acquisition efforts, Neve have appointed Rich Hajdu as VP of sales and marketing for Neve North America and has promoted Lisa Vogl to the position of Director of Advertising and Promotions.  
 • **WaveFrame Corporation** have announced the appointment of Igor Saulsky as sales and application manager with WaveFrame's LA office. Since going to the US 10 years ago, Saulsky has worked as an independent producer and engineer on projects for CBS, NBC and National Geographic among others.  
 • Peter Goldsmith has been named as managing director for **Ampex**

Great Britain following Terry Radford's promotion to vice-president Europe Africa Middle East.

• **BBE**, USA, have recently announced the appointment of Rob Rizzuto as assistant sales manager.

• **Alpha Audio** of Richmond, Virginia, has named Richard Foate as national sales manager.

• Terry Radford has been named **Ampex** vice-president for Europe, Africa and the Middle East. Radford was formerly managing director of Ampex Great Britain.

• Keith Beal has joined **I P Kinloch** as a project engineer. Beal joins from BBC Television's Planning and Installation Department.

## In brief

• **Tyne & Wear, UK:** Following their introduction of 19 inch wine racks for studio use, **Canford Audio** are now offering, through their audio catalogue, a selection of fine wines from California, New Zealand and Australia. The selection includes red, white, dessert and de-alcoholised wine.

• **Royston, UK:** **Thatched Cottage** have introduced two new MIDI-based courses, beginners and advanced. The first course covers basic theory, uses, sequencing and timecode, the advanced looks in detail at the MIDI studio and includes use of controllers and system exclusive with an analysis of MIDI messages. More information on 0223 207979.

• **Southall, UK:** **Fostex**, who began their own independent UK company in May, have now signed up a new dealer network for the UK.

• **Darmstadt, West Germany:** **BTS Broadcast Television Systems** who carry out project management and systems engineering for future television studio projects in video, now adds the ability to handle the audio aspects. The audio expertise required is being supplied by employees taken over from the Sound Studio Equipment Product Group of ANT Nachrichtentechnik.

• **Connecticut, USA:** **Texas Instruments** have honoured a group of engineers from Neve's Digital R&D department with an award as 'ASIC Design Team of the year'.

• **Atlanta, Georgia, USA:** **HDTV** experts representing 16 countries from Europe, the Americas and Asia Pacific have met and agreed on additional parameters for the development of HDTV standards. During the meeting new approaches were developed that will enhance the prospects for complete harmonisation of broadcast and non-broadcast applications of HDTV.

• **Toronto, Canada:** The recent restoration of the 1,500-seat **Elgin Theatre** in Toronto, Canada, includes the first theatrical installation of a new, computer-based, multichannel Reverberation and Sound Enhancement System (RSES).

• **Bloomington, IL, USA:** **Carle and Associates Inc.** have completed an agreement with **3M Corp** to buy 3M's International Tapetronics plant and operations. International Tapetronics Corporation is well known in design and manufacture of audio tape cartridge equipment and audio switching systems for the radio

and television broadcast industry.

• **London, UK:** **Clive Green & Company**, manufacturers of the **Cadac** range of theatre sound consoles, is celebrating 6 years of association with the musical **Starlight Express**. The production has used a specially developed **Cadac** console to control the sound mixing of the past 2,400 performances. The **Cadac** broke new ground as the first audio mixing system in the West End to use computer control.

• **Bloomington, IN, USA:** **Indiana University School of Music** is now offering a 4-year Bachelor of Science degree in Audio Recording. This is in addition to the 2-year Associate of Science in Audio Technology degree, offered since 1981. The new programme seeks to fill the need of many students for a 4-year Bachelor's degree and addresses the musical aspects of recording, particularly the special requirements for recording classical music.

• **London, UK:** Home Office minister David Mellor has announced restrictions on the ownership of the **privatised IBA transmission system**. The proposals will limit the shareholding of the current ITV franchises, and the future channel 3 and 5 licensees, to 20%. The measure has been introduced to restrict vertical integration within the broadcasting industry and to encourage greater competition.

• **Berkshire, UK:** **Pete Townshend** has signed an exclusive deal with The Mill recording studios to manage bookings at his own riverside studios, Eel Pie. Pete Townshend commented on the new situation, "I have just re-equipped the Eel Pie studios but we have reduced space for administrative staff. The Mill are handling all bookings, admin and session logistics on our behalf. As new owners of large Neve VR desks both companies are consolidating their sales efforts and taking advantage of the tremendous interest in the console."

• **Van Nuys, CA, USA:** **Studer Revox America** has relocated its Western regional sales office to larger premises in the San Fernando Valley. The 32,000 ft<sup>2</sup> of space at the new office complex has been divided into a new showroom and demo area, enlarged office space and fully equipped service centre. The new address is Studer Revox America, 16102 Hart Street, Van Nuys, CA 91406, USA. Telephone and fax numbers remain the same.

The drive units at the heart of every new Turbosound enclosure are built by Precision Devices Ltd.

A company specifically established by our parent company, Edge Technology Group, to develop drive units with unsurpassed reliability and audio performance.

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Finally, the components come together in a modular assembly process, with testing at every step, before being fitted into enclosures that have been built with equal precision.

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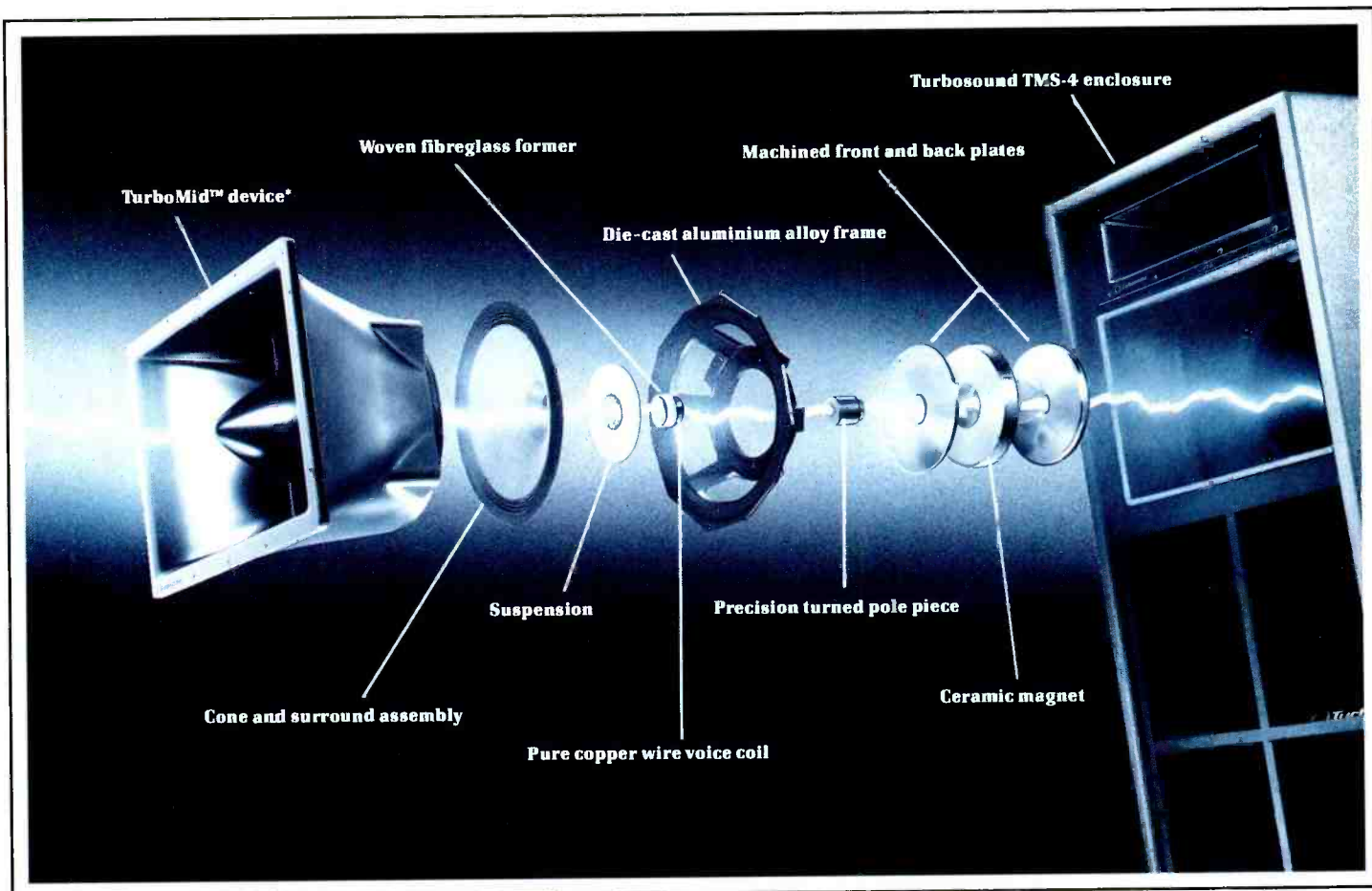
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And what makes Turbosound enclosures so exceptionally reliable.



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Turbosound Patent Information: Australia: 515, 535 Canada: 1,076,033 Japan: X113424/77 UK: 1,592,246 & 1,598,310 U.S.: 4,215,761 & RE 32,183 West Germany: P2742600/2 Other patents pending

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## Exhibitions and conventions

**August 19th to 22nd** Video Expo '90, Palacio Das Convencoes do Anhembi, Sao Paulo, Brazil.  
**September 9th to 12th** 90 Light and Sound Show, Olympia 2, London, UK.  
**September 21st to 25th** International Broadcasting Convention, Metropole Conference Centre, Brighton, UK.  
**September 21st to 25th** AES 89th Convention, Los Angeles Convention Center and Los Angeles Hilton, Los Angeles, CA, USA.  
**October 3rd to 9th** Photokina, Cologne Fair Grounds, Cologne, West Germany.

**October 4th** Sound Broadcasting Equipment Show, Albany Hotel, Birmingham, UK.  
**October 13th to 17th** SMPTE, Los Angeles, CA, USA.  
**November 15th to 17th** InterBEE, Nippon Exhibition Centre, Japan.

1991

**February 19th to 22nd** AES 90th Convention, Palais des Congres, Paris, France.  
**April 15th to 18th** NAB, Las Vegas.  
**June 13th to 18th** International Television Symposium, Centre de Congrès, Montreux, Switzerland.

## Agencies

● HHB Communications have announced that they are now the exclusive UK distributors of the **Digital Audio Technologies** *Stelladat* portable RDAT recorder. HHB Communications. Tel: 081-960 2144.  
 ● **ARX Systems**, the Australian-based manufacturer of professional audio electronics and processor controlled loudspeaker systems have announced the appointment of Mike Rolands Music Service as their German distributor. Mike Rolands Music Service. Tel: (61) 742 3433. Fax: (61) 742 3499.

● **Turbosound** have announced that AKG GmbH have been appointed their distributor for the whole of Germany. AKG GmbH, Brunhildengasse 1, A-1150 Vienna, Austria. Tel: (43222) 95 65 170.  
 ● Hayden Laboratories and **Dual GmbH** have agreed to terminate their agreement. With immediate effect Peter Ratchford and John McDonald have left Hayden Labs to form their own distribution company, RAM Projects, and their first agency will be Dual products. RAM Projects. Tel: 061-866 8101. Fax: 061-866 8118.

## Contracts

● HHB Communications have won the contract for the design and installation of audio and video facilities at ITN's new London headquarters. The contract includes the integration and installation of two **Solid State Logic 5000** series consoles.  
 ● Recent **ATC** contracts include *SCM200s* to The Mill studios in Cookham, UK; *SCM50s* to movie scorer Shawn Murphy in Hollywood; *SCM300s* to Ground Control studios on the US West Coast; *SCM100s* to Australian Spectral Broadcasting; *SCM20s* to Nimbus Records, Autograph Sound Equipment, Lansdowne Studios and Thames TV, UK.  
 ● **Cedar Audio** have orders from Brussels-based CD mastering company DigiPro for the supply of the first two standalone *CEDAR* sound restoration systems. They will be installed in studios in Paris and Brussels for the cleaning-up of recordings prior to CD mastering. Up until this point *CEDAR* has only been available as a bureau service from *CEDAR*'s Cambridge UK base.  
 ● **WaveFrame Corporation** have announced deliveries of an *AudioFrame* digital audio production system to Doppler studios in Atlanta, GA, and US country artist Charlie Pride.  
 ● Metropolis studios, London, have taken delivery of two further **Otari MTR-100A** 24-track analogue tape machines. The new machines, ordered through Stirling Audio Systems, will be featured in Metropolis' new rooms.  
 ● **Neotek** have announced the sale of a 56-input custom film dubbing console to Magno Sound in New York City. Magno's console features

Neotek's film monitor section and is also fitted with a moving fader automation system.

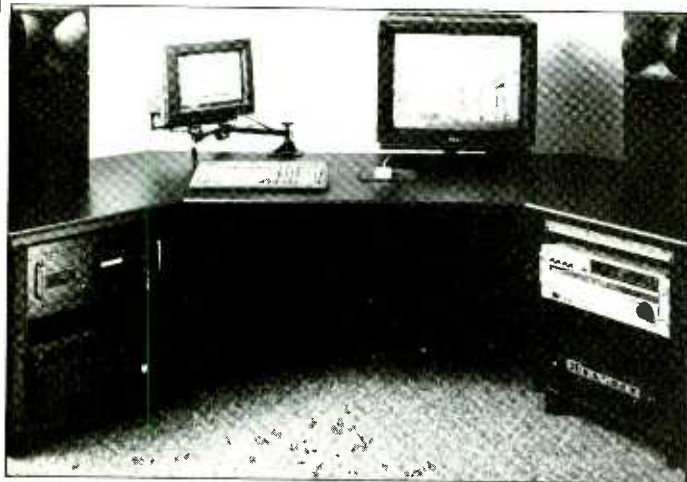
● **Mobius Music** are the first studio to install **Studer's A827** multitrack recorder in the San Francisco area. A *Studer A827* 24-track recorder is the latest addition at Hummingbird Recording in Nashville, TN. Three *Studer A820* 24-track recorders equipped with *Dolby SR*, an *A820* 2-track mastering machine with timecode and six CD players were delivered to Soundworks West in West Hollywood, CA.  
 ● **Pro-Bel** have received their largest ever order for component video routing switchers as part of a £1.5 million contract to supply all the central routing matrices at ITN's new London headquarters, due on air in December 1990.  
 ● **KYXY-FM**, an AOR station in San Diego, CA, have bought an **AKG Acoustics DSE 7000** Digital Sound Editor through Allied Broadcast Equipment. The *DSE 7000* includes an 8-track digital recorder, a 10-input mixer and a 2-track digital mixdown deck.  
 ● Three **Mitsubishi** 32-channel *X-880* digital multitracks with Apogee filters and three *X-86* 2-channel digital recorders have been delivered at The Enterprise Studio A in Burbank.  
 ● **Lyrec's** latest deliveries of their *FRED*, free editing tape recorder, include 30 units to the BBC and one to the Audio Visual Department of the British Science Museum in London's Kensington.  
 ● Puk Recording Studios, Denmark, have announced the purchase of a brand new **Neve VR 72**-channel console with flying faders, video

recall and events switching. The console will replace the Calrec console in Studio One.

● **Soundtracs** have announced the sale of a *Quartz* production console to Hastings Music of Munich after a visit at the Frankfurt Musik Messe.  
 ● Recent **Fostex D20** DAT recorder sales include Videosonics, Quantel, Legend TV, the Rolling Stones Mobile, Thames TV, Capital Radio, the BBC Film Unit and John Wood Studios through pro-audio supplier Raper and Wayman.  
 ● A further two contracts for **KFA's The Box** have been installed at Swansea Sound radio station and RTM community radio station.  
 ● **Versadyne International** have delivered a 1500 series high-speed duplicating system to Chic Studio in Voiron, France, located at the base of the Alps near Grenoble.  
 ● **Clive Green and Company** have announced the recent delivery of a 66-input *E-type* mixer for the New York production of the musical *Aspects of Love*. The new console features a computer controlled programmable routing system.  
 ● Planet Wave, one of Hamburg's leading video/film post-production studios, have purchased a 4-channel **DAR SoundStation II** for their new recording/editing complex.  
 ● Swanyard Studios, London, have purchased a **Motionworks Motionworker** for Studio Two, its SSL equipped remix and post-production room. The *Motionworker* will take over from the studio's existing SSL synchroniser/MTS system.  
 ● Soundville recording studios in Lucerne, Switzerland have installed a new **Studer** 48-track digital recorder. The machine has been placed in

Studio A, the new Tom Hidley designed room.

● **Media Products** audio and video patch panels have been chosen as standard equipment for ITN's new headquarters in Grays Inn Road, London, which is due to come into service during 1990. The audio patch panels are custom designed to ITN's specification, giving a 3U high unit having four rows of 24 prewired BPO jack sockets spaced as stereo pairs.  
 ● Barclays Bank have purchased an 8-channel *SoundStation II* for their in-house video production facility in Teddington, London. The in-house facility produces information, promotional and training programmes for the Bank and associated companies.  
 ● **Michael Stevens & Partners** recently undertook the modification to add the VCA control option to a batch of *Quad 520F* amplifiers destined for the BBC. The units were supplied via Philip Drake.  
 ● The BBC has placed an order with **Pro-bel** for the supply of video and audio routing systems for Stage Five of the corporation's new post-production facility due to be commissioned in early 1991.  
 ● **Michael Stevens & Partners** have supplied a further four customised **Soundcraft 200BVE** consoles to Central TV Birmingham. Three 8-channel and one 16-channel unit underwent a straightforward modification to bring them into line with the Soundcrafts already supplied by Michael Stevens.  
 ● **Bruel & Kjaer Pro Audio (UK)** have now sold 100 series 4000 mics to the BBC following an order from the BBC OB unit for 10 omnis.



## Mitsubishi hard disk workstation

During the APRS exhibition the Mitsubishi Pro Audio Group UK announced a distribution deal with Steinberg Digital Audio that enables Mitsubishi to market the Steinberg *Topaz* hard disk workstation, initially in the UK and Ireland, as the *Diamond* workstation. The basic configuration offers up to 30 minutes of stereo recording using 2 Mbyte of RAM and a 320 Mbyte hard disk under the control of an Apple *Macintosh*.

Mitsubishi said that announcements are expected in the near future with reference to the 'marriage' of the system with the

Mitsubishi digital multitracks. The *Topaz/Diamond* workstation offers facilities for processing two channels including editing, EQ, Time and Pitch warp, Level adjust, sampling and interface with the Steinberg *Cubase* MIDI sequencer package  
**Mitsubishi Electric Corp, Mitsubishi Denki Building, Marunouchi, Tokyo 100, Japan.**  
**UK:** Mitsubishi Pro-Audio Group, Travellers Lane, Hatfield, Herts AL10 8XB. Tel: 0707 276100.  
**USA:** Rupert Neve Inc, Berkshire Industrial Park, 7 Parklawn Drive, Bethel, CT 06801. Tel: (203) 744-6230.

## WaveFrame CyberFrame

The CyberFrame is an 8-track, hard disk editing/recording system designed specifically for film and video applications. Although manufactured by the WaveFrame Corporation it has little in common with the *AudioFrame* with the design criterion having been to create a system that functioned in a way familiar to those currently sound editing to picture.

The system comprises the Edit Controller and the Modular Disk Recorder, which are installed in a workstation desk that also provides space for ancillary equipment. The Edit Controller is an IBM compatible 20 MHz 386 computer that provides the user interface and controls the system with mouse, keyboard and monitor. The Modular Disk Recorder allows 8-track recording on either 600 (model 2E) or 1200 Mbyte (model 4E) hard disks to provide up to 2 or 4 on-line track hours. The system is equipped with eight analogue A/D and D/A converters and eight digital I/O channels and runs at 44.1 kHz, 16 bit. Back-up is tape cartridge and there are two SCSI channels. There

is also provision for hard disk expansion.

Editing capabilities allow manipulation of multiple tracks simultaneously, together with single keystroke control of split, slip, lay-in, sync-up, shape and fade. Auditioning of differing combinations of pre-mixes are possible before final dubbing. Spotting sheet tags are automatically transferred to the cue sheets, which are created and automatically updated during editing. The *CyberFrame* allows control over ADR and Foley work including the printing of ADR/Foley sheets and direct recording into the system. Atmos loops can be created and synced to picture. The *CyberFrame* also has administrative capabilities helping plan and keep records such when work is divided and scheduled between multiple editors.

**WaveFrame Corporation, 2511 55th Street, Boulder, CO 80301, USA. Tel: (303) 447-1572.**  
**UK:** Stirling Audio Systems, Kimberley Road, London NW6 7SF. Tel: 071-624 6000.

## MTR direct injection boxes

Following in the steps of the *DI-1* direct injection box, which sold well worldwide, MTR have introduced the *DI-3* that features a flatter frequency response, a DC input socket for external 9 V power supply and a battery low LED. Housed in a die-cast box with jack input and jack link sockets, a balanced *XLR*-type

output socket, a 3-way ground lift and a 3-way attenuator for input level matching. MTR have also added the *DI-2*, which is a stereo version of the *DI-3* in the same size case.

**MTR Ltd, Ford House, 58 Cross Road, Bushey, Herts WD1 4DQ, UK. Tel: 0923 34050.**

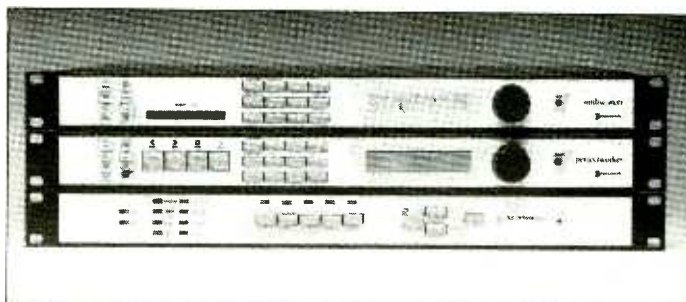
## Motionworks Midiworker and Perfectworker

Motionworks have added two new products to their established *Motionworker* automation and synchroniser systems interface. The *Midiworker* is a MIDI event controller principally designed to work with an SSL console from which it takes data from the existing SSL Event software to provide MIDI event and macro firing to timecode. Up to 140 timecode points can be programmed from which MIDI events can be triggered with each MIDI macro controlling up to 32 MIDI functions. Additionally the unit offers up to 32 conventional event relays. It is possible for *Midiworker* to run standalone using its internal timecode reader together with facilities for manual timecode input. MIDI preset or macro data and relay programme information is held on removable memory cards.

*Perfectworker* offers one of the most used facilities of *Motionworker*, the virtual machine in a stripped down form. It is available in two versions—*Pro-Perfectworker* and *Perfectworker*

with the latter being a still further stripped down version for use in less complex applications. The virtual machine is a tape machine emulation and enables the control of console automation systems from an external timecode or MIDI timecode source. This allows timecode driven automation systems to be operated from a hard disk based recorder or MIDI driven system without the need for a tape machine running to provide timecode. *Pro-Perfectworker* also offers facilities such as single machine control via Sony 9-pin or Ampex *VPR3* protocols, and emulation of a video machine offering compatibility for those hard disk systems which already have control interfaces for Sony or Ampex machines.

**Motionworks, The STEP Centre, Osney Mead, Oxford OX2 0ES, UK. Tel: 0865 790577.**  
**USA:** Martin Audio Video Corp, New York. Tel: (212) 541-5900. 21st Century Ltd, Los Angeles. Tel: (213) 463-4718.



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- (C) RMX 16 Digital Reverberator
- (D) A/V Sync Auto Compensating Audio-for-Video Delay



For information and literature contact...

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## Numark dual CD

Numark Electronics have introduced a CD player with a dual drive transport. The *CD6020* consists of a transport module and a control unit both of which are 19 inch rackmount. Each CD drive has separate transport controls together with  $\pm 8\%$  varispeed also on each. For synchronising the beat of two tracks the *CD6020* has a Beat Sync and Integrate function

that automatically and simultaneously matches the beat structure of both tracks and crossfades between the two. The electronics are described as '18 bit technology with 8x oversampling'.  
**Numark Electronics Corporation,** 503 Newfield Avenue, Raritan Center, Edison, NJ 08837, USA. Tel: (201) 225-3222.

## Klark-Teknik audio lay off recorder

Designed to ease some of the problems involved in editing stereo audio for video programmes, Klark-Teknik have introduced the *DN735* solid state recorder which records and plays back short passages of stereo audio in synchronisation with other devices against externally applied timecode. Adding two extra tracks of audio to standard VTR machines simplifies editing when audio is required to crossfade from scene to scene. Plug-in memory cards are available to increase the record time up to 175 secs of stereo as well as the unit being able to operate in mono and so double storage time.

The *DN735* incorporates an *RS422* interface with a protocol compatible with current broadcast serial control

equipment enabling it to be controlled directly from a VT editor, operated via the front panel or via the remote control supplied as standard. The menu allows various modes of operation to be selected by the user. KT say that any international frame rate can be selected with a fast response time for full lock-up and that it may be achieved from any position within the recorded section.

**Klark-Teknik Research Ltd,** Klark Industrial Park, Walter Nash Road, Kidderminster, Worcs DY11 7HJ, UK. Tel: 0562 741515.  
**USA:** Klark-Teknik Research Ltd, 30B Banfi Plaza North, Farmingdale, NY 11735. Tel: (516) 249-3660.



## In brief

• **Mitsubishi** have added a chase synchroniser for the *X-880* digital multitrack. The *CS-1* consists of a plug-in card for the *X-880* transport, which then offers intelligent chase synchronisation, and a remote unit, which can be mounted on the autolocator. There is also an optional 19 inch rackmount version that allows the *CS-1* to be integrated with Mitsubishi *X-850* and *X-400* recorders. Synchronisation accuracy is claimed to be to the digital sample with the ability to offset the slave machine against the master in single sample steps.  
**UK:** Mitsubishi Pro Audio, Hatfield, Herts. Tel: 0707 278747.  
**USA:** Rupert Neve Inc, Bethel, CT 06801. Tel: (203) 744-6230.

a set of contemporary sounding tracks to complement their *Gold* and *Platinum* series. Each selection is of 'industrial length' with alternative mixes, 30 and 60 second versions. The second is a Christmas Music set—*Sounds Like Christmas*—which includes traditional and original music as well as seasonal sound effects such as sleigh bells, etc.  
**27th Dimension Inc,** Okeechobee, FL, USA. Tel: (813) 763-4107.

• **Allen & Heath** have introduced a 24-track version of the *Saber* console with patchbay, metering and monitoring for 24 channels. There is now capacity for 36 tie-lines for external patching via multipin connectors. This version of the *Saber*



**Allen & Heath's 24-track Saber console**

• **Neumann** have added a new capsule for the *KM100* series of microphones. The *AK31* is an omnidirectional patterned capsule but with a flat (direct field) response. The capsule response is flat for incident sound forward of the mic giving a flat response at short distances. The *AK31* differs from the *AK30* omnidirectional capsule as that has an on-axis 7 dB rise at 10 kHz in the freefield.  
**Georg Neumann GmbH,** Berlin, West Germany. Tel: 030 2 59 93-0.  
**UK:** FWO Bauch Ltd, Borehamwood, Herts. Tel: 081-953 0091.  
**USA:** Gotham Audio, New York, NY. Tel: (212) 765-3410.

is available in frame sizes of 28, 36 and 44 inputs and 28 and 36 with a patchbay. There is also a choice of bargraph or vu metering.  
**Allen & Heath, Brighton, Sussex,** UK. Tel: 0273 23346. Fax: 0273 821767.  
**USA:** Allen & Heath, Orange, CT. Tel: (203) 795-3594. Fax: (203) 795-6814.

• **27th Dimension** have released two new music/effects CD packages. The *Champion* production music library is

• **BBE Sound** have announced a simple low cost version of the *Sonic Maximizer* known as the *BBE 322*. It is described as a full stereo unit with the same sound quality as the other models but with a simplified control system.  
**BBE Sound Inc,** Huntingdon Beach, CA, USA. Tel: (714) 897-6766.





TRUTH...

OR  
CONSEQUENCES.

If you haven't heard JBL's new generation of Studio Monitors, you haven't heard the "truth" about your sound.

**TRUTH:** A lot of monitors "color" their sound. They don't deliver truly flat response. Their technology is full of compromises. Their components are from a variety of sources, and not designed to precisely integrate with each other.

**CONSEQUENCES:** Bad mixes. Re-mixes. Having to "trash" an entire session. Or worst of all, no mixes because clients simply don't come back.

**TRUTH:** JBL eliminates these consequences by achieving a new "truth" in sound: JBL's remarkable new 4400 Series. The design, size, and materials have been specifically tailored to each monitor's function. For example, the 2-way 4406 6" Monitor is ideally designed for console or close-in listening. While the 2-way 8" 4408 is ideal for broadcast applications. The 3-way 10" 4410 Monitor captures maximum spatial detail at greater listening distances. And the 3-way 12" 4412 Monitor is mounted with a tight-cluster arrangement for close-in monitoring.

**CONSEQUENCES:** "Universal" monitors, those not specifically designed for a precise application or environment, invariably compromise technology, with inferior sound the result.

**TRUTH:** JBL's 4400 Series Studio Monitors achieve a new "truth" in sound with

an extended high frequency response that remains effortlessly smooth through the critical 3,000 to 20,000 Hz range. And even extends beyond audibility to 27 kHz, reducing phase shift within the audible band for a more open and natural sound. The 4400 Series' incomparable high end clarity is the result of JBL's use of pure titanium for its unique ribbed-dome tweeter and diamond surround, capable of withstanding forces surpassing a phenomenal 1000 G's.

**CONSEQUENCES:** When pushed hard, most tweeters simply fail. Transient detail blurs, and the material itself deforms and breaks down. Other materials can't take the stress, and crack under pressure.

**TRUTH:** The Frequency Dividing Network in each 4400 Series monitor allows optimum transitions between drivers in both amplitude and phase. The precisely calibrated reference controls let you adjust for personal preferences, room variations, and specific equalization.

**CONSEQUENCES:** When the interaction between drivers is not carefully orchestrated, the results can be edgy, indistinctive, or simply "false" sound.

**TRUTH:** All 4400 Studio Monitors feature JBL's exclusive Symmetrical Field Geometry magnetic structure, which dramatically reduces second harmonic

distortion, and is key in producing the 4400's deep, powerful, clean bass.

**CONSEQUENCES:** Conventional magnetic structures utilize non-symmetrical magnetic fields, which add significantly to distortion due to a nonlinear pull on the voice coil.

**TRUTH:** 4400 Series monitors also feature special low diffraction grill frame designs, which reduce time delay distortion. Extra-large voice coils and ultra-rigid cast frames result in both mechanical and thermal stability under heavy professional use.

**CONSEQUENCES:** For reasons of economics, monitors will often use stamped rather than cast frames, resulting in both mechanical distortion and power compression.

**TRUTH:** The JBL 4400 Studio Monitor Series captures the full dynamic range, extended high frequency, and precise character of your sound as no other monitors in the business. Experience the 4400 Series Studio Monitors at your JBL dealer's today.

**CONSEQUENCES:** You'll never know the "truth" until you do.



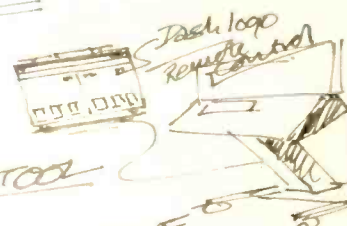
JBL Professional  
8500 Balboa Boulevard  
Northridge, CA 91329

**Our advertising agency said  
 "You can't say everything about  
 the PCM-3348 in one ad."  
 ...this time they were right.**

ADVERTISING BRIEF PCM 3348

OBJECTIVES

- ① ESTABLISH 3348 AS ULTIMATE MOST DESIRABLE MULTI-TRACK.
- ② DEMONSTRATE 3348 AS A CREATIVE TOOL (NOT JUST A RECORDER).
- ③ POSITION 3348 AS PREFERRED ALTERNATIVE TO 32 TRACK RECORDERS.
- ④ REINFORCE SONY POSITION AS MARKET LEADER.
- ⑤ EMPHASISE COMPATIBILITY WITH OTHER DASH DEVICES.

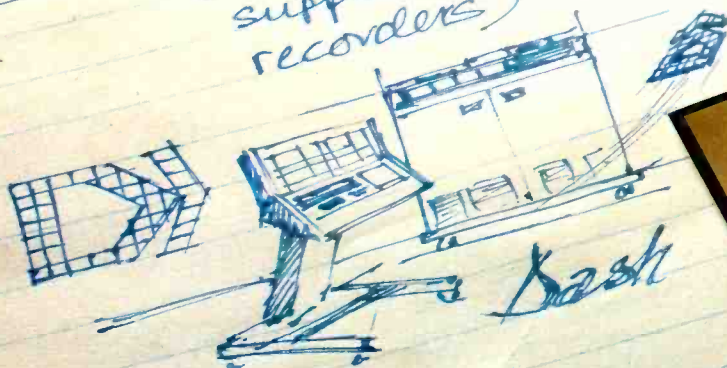


PCM 3348

- \* 48 track digital audio
- \* DASH format
- \* Most sophisticated on market
- \* The only 48 track production model.
- \* Market: AUDIO RECORDING STUDIOS (SONY is the major supplier of Digital recorders)

KEY FEATURES

- \* Outstanding high-spea transport system (me clutch between capstan motor)
- \* Digital 'ping pong' (u
- \* Sound memory (u



**SONY**

For further information contact:  
 Athens 2818273 Basingstoke, UK 0256 474011 Brussels 7241711 Cologne 59660 Copenhagen 995100 Dubai 04-373472  
 Helsinki 50291 Jeddah 6440837 Lisbon 573046 Madrid 7290988 Milan 02 6128221 Netherlands 02968 81215 Oslo 303530  
 Paris 49454000 Rome 06 5920139 Stockholm 7736100 Vienna 61051 Zurich 7333311 Eastern Europe - Vienna 554606  
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# DASH WORLD

## SH climbs

of "DASH WORLD" confirmed that sales had soared just the

SONY  
PCM 3348

4 RECORDEES OUTSELL OTHER MAJOR FORMATS BY 3 TO 1.  
48 HAS MORE FEATURES, FASTER, BETTER SOUND PERFORMANCE, MORE TRACKS THAN COMPETITION.  
UNRIVALLED REPRESENTATION IN PRO AUDIO (& VIDEO)

SONY DEDICATED TO PRO AUDIO  
SONY COMMITTED TO DASH (LONG TERM)  
AESTHETICS: 3348 IS & LOOKS THE BEST.

**RESPOND FOR DEMO**

IMPORTANT

tape  
signal  
capture  
all to SONY  
relations.

348

### USER BENEFITS

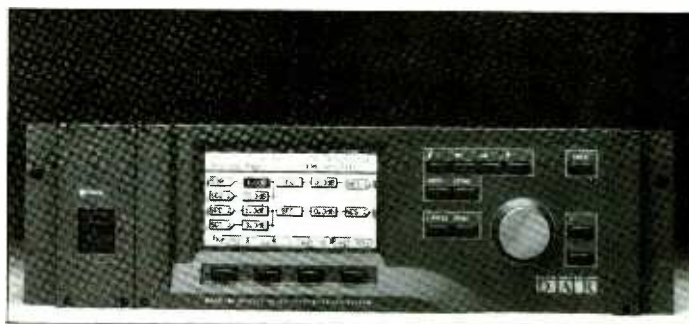
1. Faster throughput
2. Full compatibility with other 24/48 track machines
3. Creative tool for innovative engineers
4. Revenue earning investment.



## Digital Audio Research DASS 100

DAR recently launched their first product not connected to the *SoundStation*. The *DASS 100* is a digital interfacing system housed in a 19 inch rack. Operationally the user connects up the digital devices to be

interfaced to the rear panel and then turns to the front panel to set up the system and any internal processing required using the backlit LCD screen display, cursor controls and the on-screen labelled soft keys.



## TC 1280/1380

# Give us an inch...

... a foot or a meter and the new TC digital audio delays will give you precisely calculated delay times. Of course you can enter delay times as you would on any delay, choosing increments clear down to 5 microseconds. The group delay and Left-Right phase linearity are absolutely outstanding.



The TC 1280 (Stereo) and TC 1380 (3 Tap) delays are based on the technology that made the TC 2290 the most sought after delay unit in the recording industry. We have kept the superb frequency response, low distortion and noise free signal path and added the features most needed in critical applications.



Frequency response: 20-20 KHz +0/-0.5 dB 25 KHz -3dB, Dynamic range: > 100 dB, THD: < 0.05 % 1 KHz, Analog group delay: 20-20KHz (30 microS, Group delay linearity: 20-20 KHz +/- 5 microS, Stereo synchronization: +/- 1 microS (1280), Max output: +22 dBm.

... If you are a professional in the disc mastering, broadcasting, sound reinforcement or recording fields check out these latest additions to the TC family. Call for the location of your nearest TC dealer.

OF DENMARK

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**INTERNATIONAL HEADOFFICE:** T.C. Electronic A/S, Grimhøjvej 3, DK-8220 Brabrand, Denmark. Ph. 45 86 262800, Fax 45 86 262928 • **USA:** T.C. Electronic USA Inc., North Hollywood, 818 503 0404 • **UK:** T.C. Electronic UK Ltd, Oswestry, 691 658 550 • **GERMANY:** T.C. Electronic of Denmark GmbH, Detmold 05231 32972 • **AUSTRIA:** T.C. Electronic of Denmark GmbH, Detmold, 49 523 132972 • **AUSTRALIA:** East Coast Audio, Melbourne, 03 241 2244 • **BELGIUM:** James B International, LE Cap af IJssel (HOLLAND), 0031 10 4588166 • **CANADA:** T.C. Electronic USA Inc., North Hollywood, 818 503 0404 • **FINLAND:** Studiotec, Espoo, 90 592055 • **FRANCE:** Phase Acoustic, Marseille, 91 498728 • **GREECE:** Lyrikon, Athens, 3628541 • **HONG KONG:** Jolly Sound Ltd., Kowloon, 3620202-5 • **HOLLAND:** James B International, LE Cap af IJssel, 010 4588166 • **ITALY:** CD Videosuono S.P.A., Milano, 02 50841 • **JAPAN:** Orantec corp., Tokyo, 03 332 3211 • **NORWAY:** Musikk og Elektronikk A/S, Tønsberg 033 26798 • **SINGAPORE:** Team 108, Singapore, 748 9333 • **SWEDEN:** Elfa Studio AB, Solna, 08 734 0750 • **SPAIN:** Ear Pro SA, Barcelona, 91 212 7050 • **SWITZERLAND:** Riverside Music, Losone, 091 352794

Facilities offered include sampling rate conversion (32, 44.1 and 48 kHz) in or out with automatic compensation for varispeed rates up to ±10%; format conversion between AES/EBU, SPDIF, SDIF-2, Pro-Digi, DMP7D and Sony multitrack standards with control of emphasis; sample synchronisation; mixing and routing of any of the four inputs; gain adjustment; DC removal; pre- or de-emphasis; sampling clock generation and digital test signal generation. Up to eight system configurations can be stored in the system memory.

Digital Audio Research, 2 Silverglade Business Park, Leatherhead Road, Chessington, Surrey KT9 2QL, UK. Tel: 03727 42848.

USA: Digital Audio Research, 6363 Sunset Boulevard, Suite 802, Hollywood, CA 90028. Tel: (213) 466-9151. Fax: (213) 466-8973.

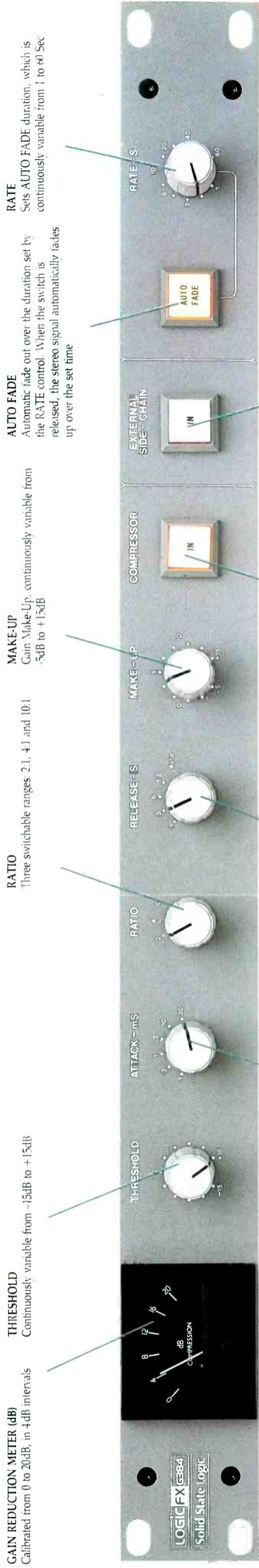
## Citronic expander compressor

Citronic have added a 2-channel expander/compressor/limiter, the *SPX3-51*, to their range of signal processors. Each channel features separate controls with channels able to function in stereo mode, discrete 2-channel or as slaves to another *SPX3-51*. Expansion controls include variable ratio, threshold, attack and release, side chain input and function bypass. Compression includes the same features but with the addition of a variable 'knee'. On the limiting section the threshold is variable and there is a bypass switch. There are LED indicators for the operation of the dynamic functions as well as the other user selectable functions.

Citronic Ltd, Bowerhill, Melksham, Wilts SN12 6UB, UK. Tel: 0225 705600.

The Solid State Logic G Series Master Studio System is the world's most advanced studio production console. Its reputation is built upon SSL's design excellence and advanced electronic engineering. Above all, it is the sound quality of the G Series that sets it apart - a quality which has been praised by many of the recording industry's leading engineers and producers.

LOGIC FX provide the advantages of G Series electronics in a stand alone form for the first time. Each unit can be used to extend the capability of existing SSL systems, or to provide G Series levels of performance to systems made by other manufacturers.



**GAIN REDUCTION METER (dB)**  
Calibrated from 0 to 20dB, in 4dB intervals

**THRESHOLD**  
Continuously variable from -15dB to +15dB

**ATTACK**  
Six switchable ranges: -0.1, 0.3, 1, 3, 10 and 30 mSec

**RELEASE**  
Three switchable ranges: 2.1, 4.1 and 10.1

**MAKE-UP**  
Gain Make-Up, continuously variable from -5dB to +15dB

**AUTO FADE**  
Automatic fade out over the duration set by the RATE control. When the switch is released, the stereo signal automatically fades up over the set time

**RATE**  
Sets AUTO FADE duration, which is continuously variable from 1 to 60 Sec

**ATTACK**  
Six switchable ranges: -0.1, 0.3, 1, 3, 10 and 30 mSec

**RELEASE**  
Switchable between 0.1, 0.3, 0.6 and 1.2 Sec or to Auto. If Auto is selected, the release time is dependent on the duration of the signal peak

**COMPRESSOR IN SWITCH**

**EXTERNAL SIDE-CHAIN IN SWITCH**

An earth lift switch is provided on the rear panel

A 9-way D-type Remote connector allows external metering and remote operation of AUTO FADE

## LOGIC FX G384 STEREO COMPRESSOR

**SIX ELEMENT LED LEVEL DISPLAY**  
LED's illuminate at line levels of between -30dB and +20dB based on the amplitude of the signal at the Insert Send point

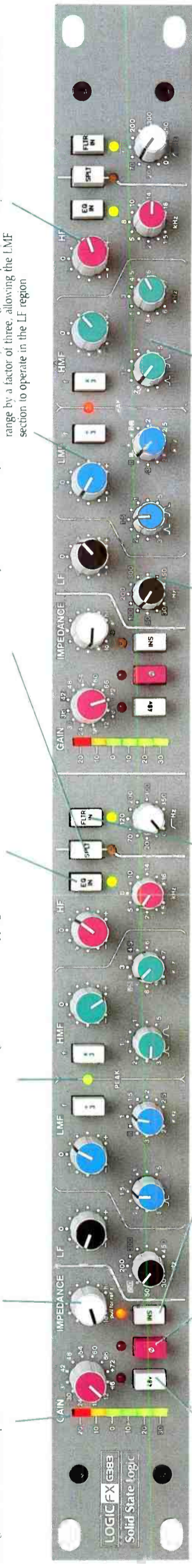
**VARIABLE IMPEDANCE INPUT**  
Input impedance can be varied from 600 ohms to approximately 6kOhms

**PEAK INDICATOR**  
Overload detection circuitry monitors signal level at output of EQ section and drives Peak LED when signal is within 3dB of clipping

**FOUR BAND EQUALISER**  
The equaliser can be switched into or out of the signal path

**SPLIT OPTION**  
The Split button allows the Filter stage to be split from the normal position (pre EQ) and inserted immediately after the Channel Input section to operate in the LF region

HF comprises a 12dB per octave shelf filter with variable cut-off frequency and a boost/cut control. The cut-off frequency can be set anywhere between 1.5kHz and 16kHz



**PHANTOM POWER SUPPLY**  
+48V switch provides phantom powering of microphones through each channel input

**PHASE REVERSAL SWITCH**  
Reverses the phase of the associated channel input signal. A red LED indicates that phase reversal is active.

**INSERT SEND AND RETURN**  
Insert switch breaks input signal path at Mic Amplifier and activates Insert Return connector on the rear panel. This allows external devices to be patched into the input signal. Insert points are balanced line level signals

**HIGH-PASS FILTER**  
The High-Pass filter can be switched in or out. When active it has a slope of 18dB per octave, with the cut-off frequency variable up to 350Hz

**LF** comprises a 12dB per octave shelf filter with variable cut-off frequency and a boost/cut control. The cut-off frequency can be set anywhere between 30Hz and 450Hz

**HMF** comprises continuously variable filter bandwidth, gain and centre frequency controls. The x3 button modifies the action of the HMF section by multiplying the frequency range by a factor of 3, allowing the HMF section to be used in the HF region

## LOGIC FX G383 DUAL MIC AMPLIFIER AND EQUALISER



# LOGICFX

PERFORMANCE SPECIFICATIONS

## G384 STEREO COMPRESSOR

<b>Input:</b> XLR Electronically balanced Impedance: 20 KOhms	<b>Key Input:</b> XLR Electronically balanced Impedance: 20 KOhms
<b>Output:</b> XLR Electronically balanced Impedance: 40 Ohms	<b>RATIO:</b> 12:1-4:1:1:0
<b>Frequency Response:</b> 20 Hz to 20 KHz $\pm 0.2$ dB	<b>ATTACK:</b> 0.1, 0.3, 1, 3, 10, 30mSec
<b>Max. Output</b> +24 dBu	<b>RELEASE:</b> 0.1, 0.3, 0.6, 1.2 Sec, plus AUTO
<b>Noise:</b> < -85 dBu (-90 dBu typical)	<b>THRESHOLD:</b> -15 to +15 dB
<b>THD + N %:</b> < 0.008% R.S. 20 Hz to 22 KHz	<b>MAKE-UP:</b> -5 to +15 dB
<b>Crossstalk:</b> < -95 dB	<b>AUTOFADE:</b> 1 to 60 Sec
	<b>Gain Reduction Meter:</b> Moving Coil, 0-20 dB gain reduction
	<b>REMOTE Connector:</b> Autofade switch, external gain reduction meter
	(Note: 0 dBu corresponds to a signal level of 0.775 V RMS)

## G383 DUAL MIC AMPLIFIER AND EQUALISER

<b>Mic Amp</b> Frequency Response: 20 Hz to 20 KHz $\pm 0.5$ dB	<b>EQ Section</b> (measured from insert return to output) THD: < 0.008% RMS
<b>Headroom:</b> > +25 dB at 6 dB gain > +28 dB at all other gain settings	<b>Noise:</b> < -73 dBu
<b>THD:</b> < 0.008% RMS	<b>Crossstalk</b> Between Channels A and B: No measurable or audible crossstalk
<b>Noise:</b> -53 dBu at 72 dB gain -86 dBu at 6 dB gain	<b>From Insert Send to Main Output:</b> < -65 dB to 20 KHz
<b>Input:</b> Electronically balanced Impedance: Variable between nominal 600 $\Omega$ and 6K $\Omega$ (calibration detect at nominal 1K $\Omega$ )	<b>Insert button pressed, insert sending at +20 dBu, 20 KHz, both channels set to 72 dB gain, EQ and filter switched in and set flat, insert return terminated with 600<math>\Omega</math></b>
<b>CMRR:</b> -80 dB at 50 Hz -70 dB at 10 KHz	
<b>Output:</b> Electronically balanced Impedance: 75 $\Omega$	

# Solid State Logic

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 1 rue Michael Faraday, 78180 Montigny le Bretonneux Tel: (1) 34 60 46 66 Fax: (1) 30 15 29 30  
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 As Research and Development is a continual process, Solid State Logic reserves the right to change the features and specifications described herein without notice or obligation.



# LOGICFX

## Amplifiers

**Altec:** Altec Lansing, OK, USA. Tel: (405) 324-5311. **UK:** Shuttlesound Ltd, London. Tel: 081-871 0966.

*9446A:* 2-channel unit rated at 400 W/channel into 8  $\Omega$ .

**Australian Monitor:** Australian Monitor Pty Ltd, Gladsville, NSW, Australia. Tel: 2 816 3544. **UK:** Smart Acoustics Ltd, Newport, Gwent. Tel: 0633 252957.

**USA:** c/o Grafton Sound USA, Marina Del Rey, CA 90292.

*AM1200:* 4-channel unit configured as two stereo MOSFET amps. Rated at 200 W/channel into 8  $\Omega$  or bridged at 800 W into 4  $\Omega$ .

**BGW:** BGW Systems, Hawthorne, CA, USA. Tel: (213) 973-8090. **UK:** C Hawkins, London. Tel: 081-671 9494.

*Model 200:* 2-channel amplifier rated 200 W/channel into 8  $\Omega$ . *Model 350:*

2-channel amplifier rated 400 W/channel into 8  $\Omega$ .

**Carver:** Carver Corp, Lynnwood, WA, USA. Tel: (206) 775-1202. **UK:** HW International Ltd, London. Tel: 071-607 2717.

*PM-120:* 1U 60 W/channel into 4  $\Omega$ . *PM-300:* 1U 150 W/channel into 4  $\Omega$ . *PM-600:* 2-channel amplifier into 4  $\Omega$ . *PM-900:* 450 W/channel into 4  $\Omega$ . *PM-1200:*

600 W/channel into 4  $\Omega$ . *PT-1250:* 625 W/channel into 4  $\Omega$ . Replaces *PM-2.0* and designed as a lightweight touring amplifier.

**Crest:** Crest Audio Inc, Hawthorne, NJ, USA. Tel: (201) 423-1300. **UK:** Crest Audio (UK) Ltd, Royston, Herts SG8 7RQ. Tel: 0763 82465.

*4801/6001:* electrically identical units to *7001/8001* but down-rated in power.

*FA1201/FA901:* low cost models rated at 680 W/channel and 440 W/channel into 2  $\Omega$  respectively.

**FM:** FM Acoustics Ltd, Wadenswil, Switzerland. Tel: 01 780 64 44. **USA:** FM Acoustics USA, Benicia, CA 94510. Tel: (707) 745-4444.

*FM 1000-1:* single-channel amplifier capable of driving loads below 1  $\Omega$  supplying power peaks up to 2500 WRMS. *FM 801A:* successor to the *FM 801*.

**Furman:** Furman Sound Inc, Greenbrae, CA, USA. Tel: (415) 927-1225. **UK:** Shuttlesound Ltd, London. Tel: 081-871 0966.

*SP-20:* half rack 20 W/channel stereo power amplifier.

**Hill:** Hill Audio Ltd, Maidstone, Kent, UK. Tel: 0622 880555. **USA:** Hill Audio Inc, Tucker, GA 30084. Tel: (404) 934-1851.

*LC400:* 2-channel amplifier rated at 120 W/channel into 8  $\Omega$ . *LC800:* 2-channel amplifier rated at 250 W/channel into 8  $\Omega$ . *LC1200:* 2-channel amplifier rated at 350 W/channel into 8  $\Omega$ . *LC1600:* 2-channel amplifier rated at 500 W/channel into 8  $\Omega$ . *ML200:* single channel amplifier rated at 120 W into 8  $\Omega$ . *ML400:* single channel amplifier rated at 250 W into 8  $\Omega$ .

**JBL:** **UK:** Harman (Audio) UK Ltd, Slough, Berks. Tel: 0753 76911.

*6300 series:* four amplifier range designed specifically for the European touring market. Completely new design including *Speakon* connectors and RS422 interface.

**Peavey:** Peavey Electronics Corporation, Meridian, MS, USA. Tel: (601) 483-5372. **UK:** Peavey Electronics (UK) Ltd, Corby, Northants. Tel: 0536 205520.

*DPC 750:* lightweight 350 W/channel MOSFET Digital Energy Conversion design in 1U format.

**QSC:** QSC Audio Products Inc, Costa Mesa, CA, USA. Tel: (714) 645-2540. **UK:** Music Lab Sales, London. Tel: 071-388 5392.

*MX 700:* 2U amp rated at 150 W/channel into 8  $\Omega$ .

**Ramsa:** **UK:** Panasonic UK Ltd, Bracknell, Berks. Tel: 0344 853176. **USA:** Panasonic Professional Audio Division, Secaucus, NJ. Tel: (201) 348-7000.

*WP-944:* 2-channel amplifier rated at 350 W/channel into 8  $\Omega$ .

**Rolec:** Rolec, London, UK. Tel: 071-281 4776.

*Mini-bloc:* single channel unit in extruded aluminium casing for attaching to speaker cabinet.

**Third Generation:** Third Generation Ltd, Southend-on-Sea, Essex, UK. Tel: 0702 420645.

*HP200:* 1U 2-channel amplifier rated at 100 W into 8  $\Omega$ .

**Altec:** Altec Lansing, Oklahoma City, OK, USA. Tel: (405) 324-5311. **UK:** Shuttlesound Ltd, London. Tel: 081-871 0966.

*Maestro M300:* 2-way system with studio playback applications with 75 W handling. *Maestro M600:* incorporates a 604 drive unit with a rated handling of 150 W.

**AR:** **UK:** Hayden Pro-Audio, Chalfont St Peter, Bucks. Tel: 0753 888447.

*Red Box II:* European-designed speaker system based on the original *AR 18* which found applications for studio reference applications.

**ATC:** Loudspeaker Technology Ltd, Stroud, Glos, UK. Tel: 0285 76561

*SCM20:* 2-way passive studio monitor of compact dimensions.

**Axys:** Duran Audio, CB Zaltbommel, The Netherlands. Tel: 04180 15583. **UK:** Palm Audio Systems, Birmingham. Tel: 021-200 1771.

*Repro-1:* 3-way active medium sized farfield monitor with soft dome tweeter.

**BNS:** BNS Professional, AX Loon op Zand, The Netherlands. Tel: 041 662434. **UK:** Protape, London. Tel: 071-267 9336.

*A-3:* active 2-way compact design using ribbon tweeter and narrow vertical dispersion to minimise reflections from consoles etc in nearfield. *A-4:* active 2-way compact design for general purpose use—foldback, nearfield etc with switchable compensation for flush mounting.

**Canford:** Canford Audio, Washington, Tyne & Wear, UK. Tel: 091-415 0205. Compact active speaker in diecast casing for general purpose applications.

Amplifier rated 10 W.

**Eela:** Eela Audio, DB Eindhoven, The Netherlands. Tel: 040 424455. **UK:** Dyer Audio Systems, Hoddesdon, Herts. Tel: 0992 468674.

*Active 1:* small stereo monitoring system, 2-way active—one cabinet containing amp and the other the PSU. Rated 30 W.

**Electro-Voice:** Electro-Voice Inc, Buchanan, MI, USA. Tel: (616) 695-6831. **UK:** Shuttlesound Ltd, London. Tel: 081-871 0966.

*Sentry 30:* compact 2-way monitor with magnetically screened casing.

**Genelec:** Genelec Oy, Iisalmi, Finland. Tel: 77 13311. **UK:** SSE Marketing, London. Tel: 071-387 1262. **USA:** Quest Marketing, Auburndale, MA. Tel: (617) 964-9466.

*1034A:* high powered active monitoring system, a smaller version of the *1035A*.

**JBL:** JBL Professional, Northridge, CA, USA. Tel: (818) 893-8411. **UK:** Harman (Audio) UK Ltd, Slough, Berks. Tel: 0753 76911.

*Control One series:* new additions include *Control 1+* up-rated version of the *Control 1*; the *Control Micro* smaller version of the *Control One*; and the *SB1* and *SB5* complementary sub-bass units.

**Klark-Teknik:** Klark-Teknik Research Ltd, Kidderminster, Worcs, UK. Tel: 0562 745371. **USA:** Klark-Teknik Electronics Inc, Farmingdale, NY. Tel: (516) 249-3660.

*Jade One Mk II:* 2-way active reference speaker system suitable for nearfield or as main monitor in medium sized control rooms. Adjustable LF and HF compensation.

**Meyer:** Meyer Sound Laboratories Inc, Berkeley, CA, USA. Tel: (415) 486-1166.

**UK:** Autograph Sales Ltd, London. Tel: 071-267 6677.

*HD-1:* active 2-way nearfield reference monitor capable of producing 118 dB SPL peak.

**PAS:** Professional Audio Systems, Harbor City, CA, USA. Tel: (213) 534-3570. *TOC Studio Monitor 3:* high power handling full range monitor with active 3-way crossover network. Twin 15 inch LF units.

**Peavey/Audio Media Research:** Audio Media Research, Division of Peavey Electronics Corporation, Meridian, MS, USA. Tel: (601) 483-5372. **UK:** Peavey Electronics (UK) Ltd, Corby, Northants. Tel: 0536 205520.

*PRM 206:* compact 2-way nearfield reference monitor. *PRM 225:* 2-way nearfield reference monitor, dual LF unit. *PRM 308SL:* 3-way nearfield with switchable reference or equalised response modes.

**Quested:** Quested Monitoring Systems Ltd, London, UK. Tel: 071-731 7434.

*H410:* passive 3-way with four LF units and 3 inch and 1 inch soft domes.

**Radian:** Radian Audio Engineering Inc, Anaheim, CA, USA. Tel: (714) 693-9277.

*MS-8:* nearfield monitor, 2-way using dual concentric driver. *MM-8:* compact nearfield monitor using same drivers as *MS-8* but in a smaller cabinet.

**Tannoy:** Tannoy Ltd, High Wycombe, Bucks, UK. Tel: 0494 471177. **N America:** Tannoy North America Ltd, Kitchener, Ontario, Canada. Tel: (519) 745-1158.

*System 2 NFM:* compact monitor, 2-way, bi-wireable. *System 8 NFM:* 2-way monitor with dual concentric drive unit, bi-wireable. *System 10 DMT:* 2-way dual concentric monitor (10 inch) with adjustable HF response. *System 12 DMT:* 2-way dual concentric monitor (12 inch) with adjustable HF response. *System 15 DMT:* 2-way dual concentric monitor (15 inch). *System 215 DMT:* 2-way dual concentric monitor (15 inch) with secondary 15 inch LF driver.

**Westlake:** Westlake Audio, Los Angeles, CA, USA. Tel: (213) 851-9800. **UK:** Britannia Row Sales, London. Tel: 071-226 5396.

*BBSM-4:* 2-way reference monitor with three drive units. □

## Monitors

**AESD:** AESD sarl, Colombes, France. Tel: 01 47 60 28 13. **UK:** AESD Ltd, London. Tel: 071-323 5748.

*Monitor 6:* nearfield reference system, active 2-way. *Monitor 8:* nearfield reference system, active 3-way. *Monitor 12:* active 3- or 4-way high power monitor with optional *Bass 15* active auxiliary sub-bass unit. *Monitor 15:* active 4- or 5-way high power monitor with optional active *Bass 18* sub-bass unit.

# Hard disk recording— London AES conference report

The AES conference on hard disk recording took place on May 16th and 17th at the IBA in London. Delegates included manufacturers, users and potential purchasers. There were representatives from France, Spain, Sweden, Switzerland, the Netherlands and the USA. Conference chairmen were John Watkinson, an independent consultant, and Francis Rumsey, of the University of Surrey, and speakers with a wide range of experience gave presentations from disk drive technology to broadcast and music editing applications.

## Disk Drive Technology

Chaired by Jeff Baker, BBC Television, consultant John Watkinson's presentation covered the development of the hard disk drive from the mid 1940s to current technology.

Earlier disk drives tended to wander in operation due to rotation and their large physical size. Watkinson pointed out that the main problem of the disk drive designer has always been in the positioning mechanism of the disk head just above the hard disk platter. The achievements of today's mechanism were likened to 'flying a jumbo jet 4 inches above the runway while keeping the wheels straddling the white lines in the middle!'

It was also pointed out that cleanliness in disks was more important than godliness. Because the gap between head and hard disk is so small, a single human hair is far too thick to enter the gap but smaller pieces of debris resting on

the disk surface will sandwich themselves between head and disk and, due to the high speed of the disk, can 'spot weld' themselves to the head with detrimental effects. This explains why hard disks are sealed in the drive unit and cannot be removed. Removable disks such as floppy and optical should therefore be stored under the cleanest possible conditions.

With regard to optical disks, Watkinson described the various methods of writing data to optical and reading data from it, explaining why optical was slower to access than hard disk. In view of this, he maintained that hard disk would remain as the predominant medium in tapeless recording for the foreseeable future.

## The Disk Drive as an Audio Recorder

This included a history of the technical development of an historical precedent for the tapeless system.

Francis Rumsey, University of Surrey, outlined the principles of random access sound file storage, discussed the pros and cons of contiguous and scattered disk file formats and showed how various replay requirements determined the effectiveness of storage strategies. He also showed the need for buffering between disk and output with RAM in order to provide a continuous output of audio from a discontinuous source. This was likened to a bucket with a hole in it being filled in 'squirts' at a rate fast enough to maintain a sufficient level of fluid to ensure a continuous output of fluid from the hole.

He then showed how access times and transfer rates between disk and RAM limit the number of simultaneous channels (or holes in the bucket) being supported by a single disk. In order to increase the number of simultaneous channels available, Rumsey discussed how disks can be used in parallel. A delegate asked whether there was any standard terminology he could use to ask manufacturers whether a system's output structure was based around a single disk or disks used in parallel. Rumsey replied that there was not and that it was hard to label systems' structures since many of them used a combination of both.

## An Introduction to Systems and Applications

Yasmin Hashmi, Sypha, commenced with a brief history of how the market had evolved from just three systems 5 years ago to the present number of over 50. Hashmi pointed out that while there are currently around 12 multitrack systems on the market, the largest increase by far has been in the stereo range, particularly in systems that employ a PC as the user interface. The most recent growth in the market has been of plug-in cards for the PC, which allow recording to the PC's hard disk along with basic editing. Examples of typical system configurations were given along with a general idea of cost and capability. Hashmi then discussed the advantages of both the PC-based and dedicated user interfaces and examples were given of how audio can be edited using a variety of methods.

Hashmi moved on to applications including examples of where tape and tapeless systems can be effectively used together. Synchronisation with other studio equipment using timecode and MIDI was discussed as

well as the need for digital interfaces. She projected that the erasable optical disk would be increasingly used as both a recording and an archiving medium since the ability to remove the disk was extremely attractive to users—a point which seemed to strike a chord, in particular with delegates who were users/potential purchasers.

During the question time it became apparent that the problem of archiving is of real concern to users and is an area that still proves a challenge to manufacturers. Hashmi pointed out that a number of systems are capable of performing background loading and/or have integrated high speed backup systems, while others simply provide a digital interface and recommend backup, in realtime, to DAT.

In addition, concern was voiced over the issue of after sales service, particularly of imported products. In her advice to potential purchasers, Hashmi stated that a number of overseas produced systems do have effective distribution in the UK. Where possible, the potential purchaser should review the system in house or take some typical material to the demo facility and ask to have it recorded, edited and transferred to a master. This would illustrate whether the system performed all the necessary functions and how easy it was to use. As far as after sales service was concerned, the potential purchaser should talk with other owners of the system in question although this was not always possible.

While covering the area of digital signal processing, Hashmi mentioned that a couple of systems employed data compression techniques in order to increase the amount of recording time available on disk. This sparked off a lively debate over the pros and cons of data compression. John Watkinson, who chaired the session, pointed out that compression was virtually transparent if used for straightforward recording, however, if compressed audio were to be edited, the results would have a perceivable effect on audio quality. John Melanson of WaveFrame added that it will probably be necessary to employ limited compression for backup purposes, particularly when using optical due to its relatively slow write times.

It was only a question of time before delegates began debating the number of bits per sample and sampling rates. Neil Gilchrist of the BBC Research Department



Conference chairmen Francis Ramsey (left) and John Watkinson



# Do You Know these terms?

**Monitor** — a reference loudspeaker system for the mixing and mastering of recorded music.

**Standard** — a reference from which qualitative judgements can be made.

**Tracks** — (noun) channels on a multi-track recorder (verb) accurately reproduces the audio qualities of another transducer.

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maintained that there was no obstruction to mastering at 48 kHz but he would like to increase the resolution to 22 bits. Matt Saunders of the Royal College of Music felt that 16 bit, 44.1 kHz was fine for domestic audio but there was an argument for 18 bit, 48 kHz recording in professional audio. Tony Batchelor of Tam Studio was happy with current sampling rates but would like to see an increase in resolution. Notwithstanding the number of bits, there was general agreement at least, that it was not necessary to go beyond 48 kHz as the sampling rate.

**An Introduction to Hard Disk Editing Operations**

John Gluck, AMS, demonstrated editing operations with the *AudioFile*. He discussed the philosophy behind the user interface, explaining that the design and operating methodology has been deliberately aimed to reflect tape editing to present familiar and intuitive control to the user. He showed how recordings can be made, edited and stored as Cues within the system's directory where they can be located easily for placement purposes. The Cue assembly page was shown, which includes tape representation of 8 channels (or tracks), across which Cues can be assembled, as well as an events list that reflects the sequence of playback numerically.

He then showed how the *AudioFile's* transport controls could be used to control an external video machine to which the *AudioFile* was slaving. We were shown how Cues could be triggered on the fly into the events list against incoming timecode as well as being placed in non-realtime into the track display. Gluck stressed that editing was non-destructive and that placing any particular Cue or edited version of that Cue into the playback sequence more than once only required the original Cue to be stored once on disk.

**Applications 1 Post-Production**

Derek Lancaster, BBC, gave a brief resumé of the BBC's development and use of the SYIPHER system (SYnchronised Post dubbing with Helical scan and Eight-track Recorder). The system uses a low band U-matic video with timecode in picture and on audio track 1, with guide audio on track 2. This is locked to a 1 inch 8-track ATR with original VT sound recorded on tracks 3 and 4. This pair of tapes is used for preparation of effects and possibly



Photo: Tim Douglas

**John Gluck of AMS gives his presentation**

track laying in a low cost preparation room before the actual dubbing process where the final mix is laid into two further tracks of the 8-track, in a fully automated suite. Dolby A noise reduction is used throughout. The final soundtrack is then reviewed and laid back to the master videotape.

Before the BBC used hard disk, rapid spot effects sequences were achieved using the Programme Effects Generator (PEG) in conjunction with SYIPHER. The PEG machines used small cassettes containing a length of 1/4 inch tape with a hook attached to the end. When played, the tape travelled past a replay head until the play button was released, at which point the cassette would rewind rapidly. A bank of up to six PEG machines was used in SYIPHER, being faster than NAB cartridges.

Lancaster then went on to explain how the *AudioFile* has replaced the PEG machines and is also used for Cue and events editing, track slipping and manual triggering of Cues. Examples were given of how the system has been used in making programmes and Lancaster demonstrated the removal of some unwanted noise, replacing it with atmosphere using crossfades and looping. He also explained how the system's time compression/expansion facility can be used to fit a good take of a piece of dialogue (a word) over one which had to be removed because of extraneous noises underneath.

**Practical workshop**

The informal evening session consisted of hands on experience of a range of tapeless systems including *AudioFile*, *AudioFrame*, *SoundTools*,

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*SoundStation II*, *PostPro* and the new Akai *DD1000*.

NED brought along their new *PostPro SD* system, the *SD* standing for Sound Design (basically the *PostPro SD* contains a *Synclavier*). This system somewhat resembles the *AudioFrame* in that both hard disk recorder and sampling module are integrated within one hardware unit. Editing of hard disk recordings is achieved via a PC for both systems and both can support an optional MIDI keyboard for playing sampled sounds. Unlike the *AudioFrame*, however, whose routing of hard disk recordings and RAM samples can be freely allocated to make use of any of the system's outputs, the *PostPro* does not allow hard disk recordings and RAM samples to share each other's outputs. Yet the *AudioFrame* cannot assemble hard disk recordings and RAM samples within the same sequencer page whereas the *PostPro SD* can.

Getting back to similarities, it seems that the multitrack tape analogy display containing Cues that can be graphically edited is becoming something of a standard. Considering the great variety of multichannel systems each with their own editing and operational methods, it's interesting to note that *AudioFile*, *SoundStation II*, *AudioFrame*, *Opus* and now *PostPro* all use this type of display.

Stereo systems were represented by *SoundTools*, which demonstrated music editing and non realtime filtering by means of a PC front end, and the Akai *DD1000*. This was the only system to use erasable optical disk as the recording medium, which provides 30 stereo mins per side of recording time (at 44.1 kHz). Unlike most other stereo systems, the *DD1000* does not use a PC as the user interface. Instead the whole system is packaged in a rackmountable unit with an LCD display surrounded by various hard and soft keys and a jog wheel. Although the system demonstrated still had a couple of teething problems, it was capable of creating Cues, chaining them and assembling them into an events list by both non-realtime placement and realtime manual triggering.

In addition, a system called the *MATLAB* data acquisition toolbox was demonstrated. This system is a set of hardware and software that runs on an IBM PC compatible and allows recording of analogue signals for analysis and/or processing by the *MATLAB* data processing package.

Up to four channels may be recorded simultaneously (with variable sampling rates up to 50 kHz with 12 bit samples) or simultaneous 2-channel record and replay.

#### Flexible, Cost-Effective System for Recording, Playback and Processing of Analogue Signals on a Digital Computer

Chris Pickering, ISVR, began by describing how the Institute of Sound and Vibration Research had tried out various mainframe systems, installed a multi-user network and developed a suite of data analysis and processing programs that were made commercially available. Due to increased and differing requirements, many of their users turned to off-the-shelf solutions, which often resulted in additional costs in adapting software due to incompatibility.

Their data acquisition toolbox can be run as a standalone or networked. It takes advantage of the *MATLAB* package, which permits third party application-specific programs to be developed and is facilitated by a number of application-specific toolboxes. Future developments intended for the system are pre-triggering of the acquisition cycle, 32 channels of input, increased throughput and AES/EBU digital interfacing (once demand for this is sufficient to justify development costs).

When asked how this system could be applied to the professional audio world, Pickering replied that the system allowed access to high speed digital logging, quick development of applications programs and that the extensive software tools could be used for prototyping applications and systems.

#### The Akai DD1000 Optical Disk Stereo Digital Recorder/Editing System

Steve Howell, Akai, began by pointing out the advantages and disadvantages of mastering onto tape. The disadvantages included the drop-out, noise, wow and flutter of analogue tape, the difficulties of editing digital tape and the questionable reliability and stability of DAT in particular. The advantages included low cost and portability. In the case of hard disk, Howell argued that it is the most suitable medium for editing but has the drawback of being non-removable. This explains why Akai have designed their new system around the removable Sony magneto-optical disk. Other manufacturers have been deterred

from using the Sony magneto-optical as the recording medium because of its slow access time but Howell insisted that the *DD1000*'s access time was instantaneous due to Akai's proprietary software techniques (which he was not prepared to divulge).

He then went on to describe the ideology behind the user interface, which is aimed at remix engineers, dubbing mixers and professional disc jockeys, and covered the editing capabilities of the system. When questioned about the write times of the optical, Howell stated that the disk cannot be overwritten directly—an erase pass had to be made before a record pass. John Melanson of WaveFrame added that general problems of erasure time for opticals could be eased by doing it in the background. Howell was also questioned about the long term robustness of the optical. His reply was that simulated tests suggest that the optical is as robust and reliable as tape but unlike tape, is not affected by stray magnetic fields such as in the underground system. It was also pointed out that the lifetime of an optical's disk surface, before it deteriorates is around 10 years, or 100,000 rewrites.

#### Applications 2—Music Editing

Ben Turner, Finesplice, concentrated on 'serious' music editing, emphasising the importance of crossfades. He included aural examples showing the effects of using edits with crossfades of different lengths and shapes, which he had prepared on the *Sonic System*. It was demonstrated how edits can be made undetectable by carefully choosing the right crossfade. Turner conceded, however, that editing is never perfect and as digital reproduction systems improve so will the listener's powers of aural scrutiny.

He added that artists have been quick to pick up on the technology, with the result that nowadays they often do not strive for a perfect performance when recording, taking it for granted that mistakes can be corrected afterwards. It is not surprising then that a typical classical CD will contain between 120 and 150 edits and sometimes as many as 400. This, he commented, raises the question of where does substitution stop and creating begin? When asked whether he had any problems in terms of time taken in uploading material onto disk, Turner said that the answer lay in good uploading management—you know

the material that you want to edit so you only upload that.

#### Applications 3—Radio Station Automation

Peter Jackson, Capital Radio, explained the necessity of having a centralised storage system for commercials and promotional trails to be transmitted on Capital FM and Capital Gold (on AM) radio stations. Before using a hard disk system, adverts and trails were stored on NAB cartridges, of which many copies had to be made for backup purposes and to provide different studios with copies to be transmitted. It therefore made sense to have a centralised storage system that could be randomly accessed by the various studios. Since up to 600 different commercials would be stored in the on-air studios along with 50 promotions or programme trails, the storage system would need to have a capacity of at least 300 stereo mins.

The DAMS system was chosen to provide simultaneous multi-user access and familiar operational terminology for disc jockeys/technical operators. The system allows control through a touch sensitive screen or simple dedicated controller and allows simple logging (or sequencing) of spots to be played. Jackson pointed out that since the playback sequence is automatically actioned by the system, problems such as one advert beginning before the previous one has quite finished or unwanted gaps between adverts do not occur.

When asked whether the cart is now redundant in Capital Radio, Jackson replied that it is still used for trailers, promotions and the odd audio drop-in. In addition, disc jockeys like to play their own mixes of jingles, etc, which cannot be done with DAMS since it only allows replay of one stereo pair—he commented that he hasn't yet seen a system that could replace a disc jockey's operation of carts.

#### Integration of RAM and Disk Technologies in Music and Post-Production

Nick Williams', NED, presentation concentrated less on editing of recordings and more on sound design. His argument was that disk and RAM based systems can be used together effectively—the disk based system for recording/editing and the RAM based system as a creative tool for performance as well as adding to the polyphony of the production in question. He gave examples of applications where both types of

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systems are used together and looked forward to the complete digital integration of all production processes such as sound generation, editing, mixing, processing and mastering within one system.

Using the *PostPro SD*, it was demonstrated how using RAM can allow instant pitch changing and polyphony of a single sound that was sequenced as a musical arrangement using the 76-note keyboard. Williams showed how the keyboard can be used to record 'expression' in the performance, playing a sound louder or softer depending on how hard the keys are struck. He also showed how a number of related sounds, such as car ignition, engine running, acceleration noises, etc, can be arranged across the keyboard and can be triggered manually against internal or external timecode.

Williams was asked whether NED had looked at other forms of controller that could be used in place of the musical keyboard, since this could be off-putting to those with a non-musical background. His reply was that they had but that the keyboard had proven to be the most effective solution even for their non-musical users.

**Synchronisation of Disk-Based Systems**

Mike Parker, DAR, began by discussing the increasing need to synchronise disk-based systems with other studio equipment. In video post-production, the interpolation of the eye means that some effects have to be located to a greater accuracy than one TV frame. In music editing, where sound from a disk-based system is remixed with phase-coherent sound from a multitrack tape machine, timing tolerances must be less than half the period of highest frequency in order to avoid cancellation effects.

Parker claimed that since they are incompatible, the various digital audio interfaces, such as AES/EBU, SDIF, SPDIF and now optical SPDIF have not helped alleviate interfacing problems faced by users—many of whom resort to the analogue domain when transferring audio. Apart from disadvantages such as loss of quality, this has the drawback of losing timing information—the copy will not be the same length in samples as the original.

A number of solutions to the problem of retaining timing information were discussed. This included asynchronous methods for equipment that cannot be locked or



Photo: Tim Douglas

**Just an audience or potential users?**

audio with differing sampling rates, and a common sampling frequency reference for all interconnectable equipment. Apparently there is an AES recommendation that there should be a separate timing input from the audio inputs so that continuity of sampling reference is assured. Parker explained that DAR's *SoundStation II* included this separate input and argued that all professional digital should follow the AES recommendation.

He then went on to discuss DAR's *WordFit* option. This automatically synchronises post sync dialogue with the original audio track by using time compression/expansion and event shifting. When asked whether the post sync signal suffered degradation as a result of having been *WordFitted*, Parker replied that it depended on how much the signal had to be compressed/expanded and in any case, degradation is not as critical to dialogue as it is to music.

**The Digital Audio Workstation—A Modular Approach**

Continuing on the theme of synchronisation, John Melanson agreed that a satisfactory solution to networking equipment must be found before real acceptance of hard disk recording occurs within the general studio environment. He maintained that some very complex issues arise if one wishes to network equipment that is not sample rate synchronised. He argued that if systems supporting a local area network (LAN) type of structure are eventually to replace systems built with multitrack recorders connected to mixing consoles, a reasonably simple and inexpensive solution would have to be found. He suggested that in order to increase the audio bandwidth that would be required, such a solution would be to have multiple and parallel audio networks.

Melanson then went on to propose

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- Hellios large wrap around console, 26 channels+4 FX returns in good working order, this console has been used to record many hits. £OFFERS
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that adopting a modular approach to the design and implementation of audio production systems can assist the manufacturer in providing a fit between the available technology and the needs of the marketplace. It can also enhance the manufacturer's ability to compete and allow hardware and software modules to be re-used in more than one product.

With respect to the *AudioFrame*, Melanson stated that many different system configurations can be made from a series of modules that are connected to the system's 64-channel, 24 bit/channel digital audio bus.

Modules available include analogue I/O (A/D and D/A converters), digital I/O (including sample rate and format conversion), hard disk recording (4/8 tracks), DSP (mixing, EQ and reverb), RAM based sampling and SCSI peripheral modules for storage and backup to Winchester disks, 8 mm tape and magneto-optical disk. He pointed out that to guarantee the final audio product has true 16 bit quality, greater than 16 bits is

required during intermediate processing and storage steps. He proposed that the evolving standard for audio processing is that all signals remain in at least 24 bit format between their initial collection and final conversion for listening.

#### Integrated Audio Using a Desktop Computer

Sean Culley's, Sound Technology, presentation addressed modularity on a smaller scale. He described how the *SoundTools* system consists of a processing card that slots into the *Mac II* computer along with software for controlling the card. The system takes advantage of Macintosh's *NuBus* architecture. This allows easy handling of multiple cards, which can be used by one or more applications simultaneously and allows the user to expand their system incrementally according to their means/needs. It was argued that the Macintosh environment is ideal for sound editing and synthesis due to its graphics interface. Culley commented

that although some delegates may be scared of using a mouse, they would soon get used to it and not many elephants used the system in any case!

He went on to explain that ideally, MIDI sequencers, mixing consoles, synthesisers, samplers and effects should be integrated into a portable package along with hard disk recording/editing. This would benefit those who do not have ready access to multitrack or portable systems on which to record vocals or solos in conjunction with sequenced arrangements. Culley saw no reason why multitimbral polyphonic synthesisers/samplers and automated mixers with realtime DSP should not be designed to fit on *NuBus* cards and slot into the computer. In this way all the pre- and post-production of an album could be compiled in a bedroom on a Macintosh computer with the finished product recorded onto DAT and sent to the CD pressing plant. When questioned about synchronisation, Culley replied that the system would slave to MIDI timecode to an accuracy of 1/4-frame.

#### Discussion forum

Panel: Francis Rumsey, Yasmin Hashmi, John Melanson, Neil Gilchrist (BBC)

The conference ended with a discussion forum during which issues raised included compatibility of optical formats, training, polyphony, terminology and dedicated controllers for PC front ends.

Concern was raised by potential users that removable optical discs would not be compatible between different systems. The reply was that there is a standard format but that this did not perform at the maximum capability of each manufacturer's drive. Naturally, each system manufacturer will be pushing their chosen drive to its limits, which means that recording formats used are unlikely to be compatible. In order to address this problem, an AES committee have presented a paper that deals with the preparation of a transparent protocol (general recording format) for optical media and it was suggested that it would be in everyone's interest to follow this.

Regarding training, it was generally admitted that such provision is not as good as it could be. Some manufacturers include training, some hold courses and a number of systems have on-line help systems. Manuals are usually difficult to keep up to date due to the evolving nature of systems. It was

suggested that some manufacturers should work with training studios or companies and install systems in these facilities for training purposes.

A member of the panel raised the question of how many tracks users would like a tapeless system to provide. Delegates' replies included 'four minimum for Ambisonics', 'eight but more routable outputs', 'no more than there are until they become portable or until a hard disk track is cheaper than a tape track'. This discussion also raised the issue of polyphony—there was obviously some confusion over the difference between a track and a channel due to the differing terminology used by manufacturers.

The panel agreed that a system that could playback eight different sounds simultaneously is an 8-channel system. A track is often confused with a channel because most systems normally have as many editing tracks as they have channels. However, some systems, such as *Opus* and *PostPro* have more tracks, across which sounds can be assembled, than there are channels. *Opus* for example, is an 8-channel system but provides 99 editing tracks, any eight of which can be selected for replay. Although the system has 12 outputs, the maximum number of different sounds which can be replayed simultaneously is still only eight. Once the difference had been explained it was suggested that tapeless terminology ought to be standardised.

It was also recommended that manufacturers of PC based systems should look at providing an inexpensive dedicated controller for performing basic functions. One suggestion was to look through the magazine *PC World* since there is a manufacturer who makes plug-in controllers. This came back to a point which John Watkinson made in his presentation—that the audio and computer worlds often 'borrowed' technology from each other and would continue to do so. It was also mentioned that a third party company is working with Digidesign to produce such a controller.

Finally, the prospective purchasers were asked whether they had been satisfied with the various points covered during the conference. One reply was that there seemed to be a lot of compromise regarding compatibility and interfacing. Another replied that their decision to purchase a particular system would be based on how easy it was to use.

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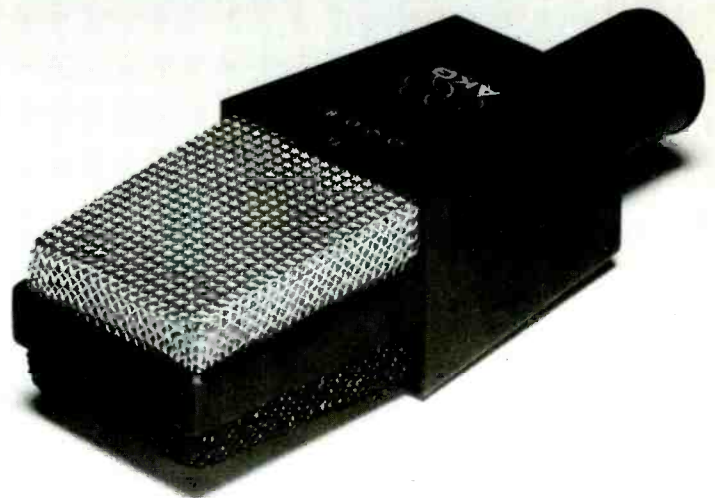
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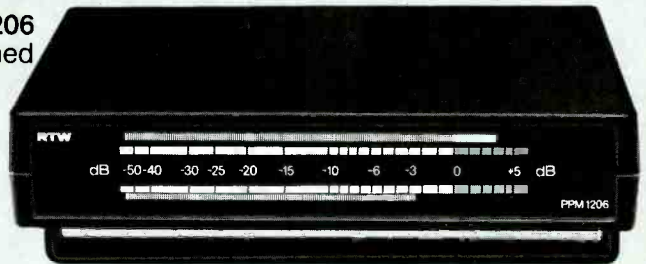


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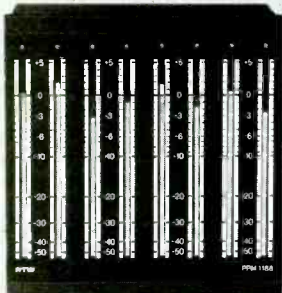
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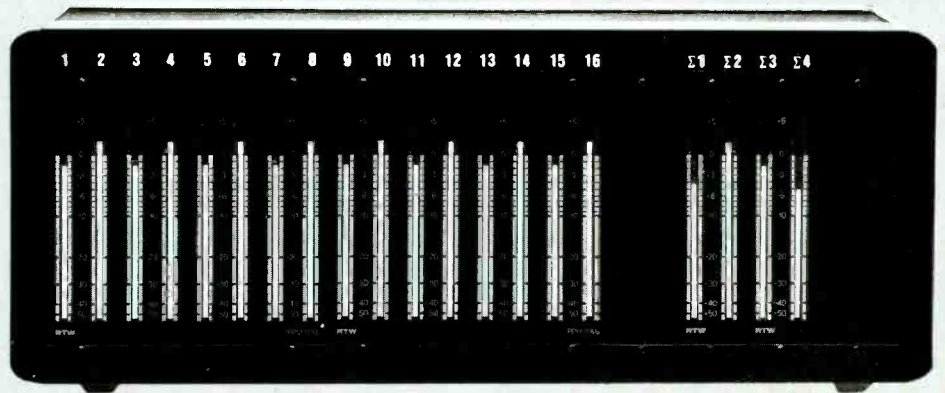
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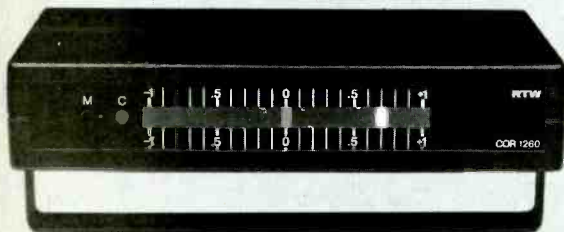


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# ONE WORLD ONE VOICE MANY FORMATS

David Mellor talks to engineer Stephen Tayler about the recording of different artists in different locations and putting them all together

**O**ne World, One Voice was the climax to 'One World Week,' a series of TV programmes promoting green issues and highlighting the effects of world poverty. The 50 minute film was shot on location around the world showing musicians adding their contribution to a backing track recorded in a different country, perhaps in a different continent. A total of 292 musicians took part in the project at 26 recording venues including studios, hotel rooms and musicians' homes. Stephen W Tayler was the engineer responsible, not only for collecting the sound but assembling it into a meaningful piece of music, with the assistance of producer Rupert Hine. A CD of the music was released shortly after the film was broadcast.

The originator of the project was musician and video director Kevin Godley who had the idea of a 'chain tape' (the musical equivalent of a chain letter) that would pass from country to country with each musician adding something of his own to tracks recorded elsewhere, or perhaps start off a new track with basic instrumentation, ready for embellishment by others.

Perhaps the first question that springs to mind, from a practical sound recording point of view, is what tape format should be used? Two inch analogue 24-track may be a fairly common standard but it is by no means universal, and would it be possible to bring all the musicians into a conveniently situated studio, wherever in the world you might happen to be? Stephen

Tayler had to solve the problem:

"Much of the work was going to be done out in the wild, or at least on location in unusual places, because we had to remember that this was going to be filmed for performance and also videoed for documentary. If we had chosen to do the whole project in recording studios it would have been a very dull visual experience, and with this being an environmentally linked project we would probably want to record in environments that suited the musicians and said something about the countries they were from."

The first thought was of a digital workstation since it would make it possible to juxtapose the many different takes and be a very visual medium. A digital workstation was in the end used for post-production, but it was considered just a bit risky to take one on the road, and that simple portable equipment would be a much better option. Tayler decided that the most important thing was to capture the performances as accurately as possible, and sort out the assembly at a later date. For recordings made outside studios, four Sony *TCD-D10PRO* portable DAT machines were taken. The original plan was to use one for playback, one for recording and to have two spare, but all four were at times used, unsynchronised, as a digital multitrack recorder. A small selection of mics was included: a couple of Sony stereo mics, Crown *SASS-P* (a stereo mic using *PZM* technology) and a pair of workhorse Shure *SM58s*. A small rackmounted 16-channel mixer, effects unit and a Tascam 238 8-track cassette multitrack recorder completed the setup with monitoring via a pair of *AR Powered Partner* loudspeakers with integral amplifiers.

Studio based recordings were to be made on whatever multitrack was available resulting in a wide variety of formats from 1/2 inch 8-track to 32-track digital. Obviously, this makes it impossible to add overdubs to a tape in a different studio unless the formats by chance coincide. Tayler solved this problem by deciding never to overdub onto a tape other than in the studio where it was first recorded. After each backing track was finished, a rough mix was made and the master sent directly back to Nomis Studios in London. The format problem was to be solved on Tayler's return.

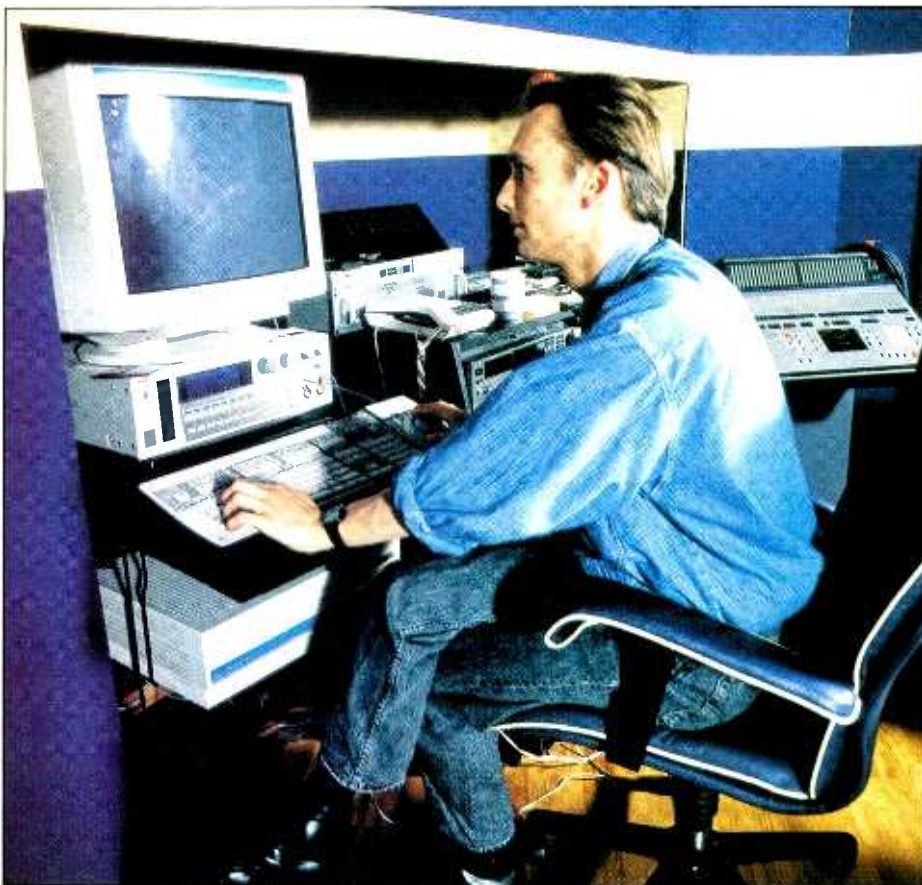
## New York

Of the 292 musicians involved, someone had to be first, and that was Sting. Tayler describes the first day's recording:

"Rupert had gone out ahead to New York where Sting was preparing a bass part and drum program on his *Synclavier* system. The day I arrived, that was already complete and we went to Hip Pocket studios where we transferred Sting's basic track from the *Synclavier* to Sony digital 24-track. Having done that, the first of the musicians started rolling in. Afrika Bambaataa and quite a few of his pals turned up so the first thing we got to record over this very basic track was three New York black guys, Nu Sounds, rapping about the environment. That was quite a good start, then Bambaataa himself sang a verse that he'd written, on a different part of the song.



Producer Rupert Hine and engineer Stephen Tayler in the control room at Nomis



Nomis engineer Mark Willie

So everybody's already got the little piece that they prepared specially. Nothing had been written for them, and we were starting to fill up the tape. The next person was Steve Stevens who did two wild solos that lasted for 8 minutes over this basic track. He also did 8 minutes of flamenco guitar as well. Rupert then had an idea about a vocal line so he went in with the lead singer from The Fixx, called Cy Curnin, and they put together this little vocal idea. Kevin (Godley) and the drummer from The Fixx also did some percussion. So here we were at the end of the first day in New York and we had 24 tracks full, and I thought, 'Oh dear, we have already got 8 minutes of really great stuff, how are we going to control this? We have got lots of countries to visit, lots of musicians to see', but even then we knew that we were going to pick and choose moments from each person's performance."

At the end of the first New York recording session, the backing track was rough mixed onto DAT and the multitrack tape flown back to base at Nomis. At subsequent sessions, the DAT would be transferred to whatever multitrack format was available and overdubs done to that. This procedure continued at Howard Jones' studio in Maidenhead. David Gilmour's floating studio on the Thames, Peter Gabriel's private studio at Real World and throughout the project.

"I was gradually accumulating rough mixes of every stage but I was never hanging onto the multitracks, they were being sent back home. So even if a multitrack had got a rough mix and one overdub on it, that multitrack was sent back to base. The easiest way to handle all of this was to keep one DAT tape per session. We were constantly having to refer back to different versions and different additions—different stages of the building of the sound. By the end of the first week, on the David Gilmour DAT there was a rough mix of the Sting piece, a rough mix of the

Howard Jones piece, a rough mix of the Peter Gabriel piece, etc."

## Rio

So far, the recordings had been studio based. In Rio de Janeiro, things were different and rather more basic. In case of customs difficulties with their own equipment, Hine and Tayler had arranged for backup equipment to be available, which turned out to be very useful. Together with the film and video crews they went to the home of musician and band leader Hermeto Pascoal who, as well as providing a contribution of his own, wrote band arrangements to overdub to earlier tracks.

"I didn't expect there was going to be such a lot of electronic equipment. I thought that going to South America there was going to be lots of acoustic stuff and quite ethnic, but they had a Yamaha grand piano, Fender Rhodes and DX7, drum kit, they were playing their saxes and flutes through a PA with contact mics—it was loud. We had this rented equipment, a Tascam 8-track, an 8-channel mixer on which I believe only six of the channels worked, some microphones, some cables, which I hadn't chosen but had just been thrown at me.

"This was the back up equipment. Rupert had said, 'Well, rather than the Tascam 8-track cassette, we should use all this stuff as we have got it.' But this gear came with the guy who owned it and he wanted to set it up. He was a bit slow unfortunately and it took ages but my main concern was to get stuff on tape. We got it onto tape and I took the Tascam back to the hotel room and transferred it to 8-track cassette so that we could return the backup gear. I was then able in my own time to put together a rough mix of the day's work through the little portable setup,

which worked like a dream. This was a scenario that we often encountered where I would be up half the night either doing rough mixes or cloning DAT tapes or doing cassette copies or DAT compilations for other people to listen to."

## A music shop in New York

Back in New York, several sessions later, Tayler found himself in a music shop recording Courtney Pine. The advance planning for this session was minimal:

"I managed to bribe one of the guys behind the counter to lend me a mic stand and a little battery powered practice amp to do playback through. So literally I just set up one DAT machine, one channel going out into this tiny amp and the other channel going into the left channel of DAT machine number two, the record machine. The microphone came into the right hand channel of DAT number two so I got Courtney's performance on one track and the backing track on the other. Courtney walked in and pulled out his sax, I turned on the tape and he started playing, it was totally spontaneous. Meanwhile business as usual was going on in this music shop. There were punters walking in and out, barging past the cameras and talking in very loud voices, but at the end of the take the whole crowd clapped and everything. On all occasions like this, I was having to give a feed to both the video camera and the Nagra which was tied up to the film camera. It usually meant me having to carry extra little mixers and transmitters strapped to my bag to send the sound to them, but it seemed to work—at least their rushes had sound on them."

## The Kodo drummers

The Kodo Drummers were recorded in the UCLA concert hall in Los Angeles using all four DAT machines, unsynchronised, as an 8-track recorder. Tayler had some serious thoughts about this:

"I thought, 'This is too crucial a sound I don't want to make any cock-ups here, I'm going to use all four DAT machines and all the mics I've got, I'm going to record lots of different angles on this.' So I put the SASS-P at the front of the stage, because I thought it would get good imaging. One of the guys who plays hand cymbals dances and jumps around the stage and the SASS at the front worked perfectly. I put the Sony stereo mic a few feet back, 30 ft or something. I placed the SM58s facing forwards and backwards to get some interesting ambience and the other Sony at the back of the hall. So I came away with four stereo recordings and I had no idea whether I would be able to reconstitute them as a sort of single recording but I had this seed at the back of my mind that I hoped I could sync up these recordings at a later date."

The Kodo Drummers' track ended up as the basis for the final piece of music in the film, as a rhythm accompaniment to the Leningrad Philharmonic Orchestra, recorded in their home concert hall.

"For that we had prepared a DAT that had a recording of the Kodo Drummers on one channel and a click track that Rupert had put together to make the beat a little clearer. And we decided we would feed this click track to the conductor

# A

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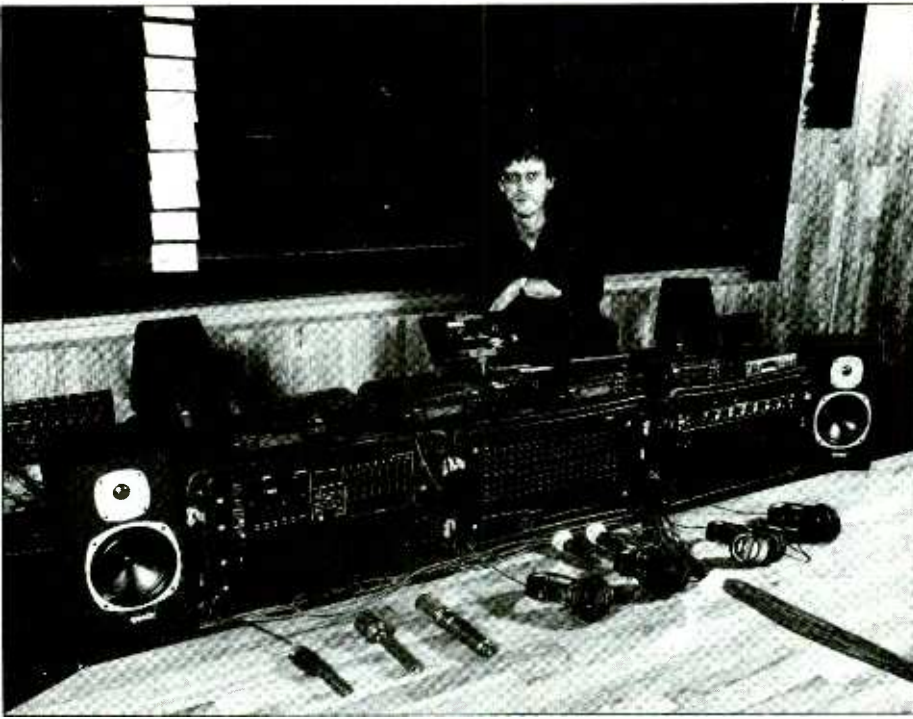
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# USER ACTIVATED!



Stephen Tayler with some of the equipment used for location recording

through a little Rane headphone amp so I could arrange different headphone mixes and also get the volume I needed because the orchestra was quite loud. I had been warned by the arranger that there were some internal woodwind movements that might need a little bit of help so I put one microphone in the middle of the orchestra to pick them up. I placed the SASS-P mic about 12 ft back from the conductor and the other Sony almost at the back of the hall because it was quite a nice acoustic. I used three DATs for recording and one for playback."

## Reconstitution

Two main problems faced Tayler on his return: a wide variety of formats and a large quantity of unsynchronised recordings. But the first task was to sort out what they had:

"The first thing Rupert and I did at Nomis was to sit down and to try and decide the sequence of events musically, so it meant we spent a couple of days analysing all the DAT mixes that we had, checking our tempos, checking our keys, looking at ways one piece of music could finish and another could take over. A lot of these were actually pre-planned. We had organised a lot of the people and musical moments to be at the same tempo or the same key, or at least have some link that would enable us to keep the music going.

"We knew just what we wanted to begin with and what we wanted to end with, but there was an awful lot more music and an awful lot of gaps that we had to try and work out. We experimented with some very integrated crossfades, starts and stops, and also one or two shock moments that seemed to work quite well. We gradually worked out the best sequence of events, and at that point it meant that we dropped out a couple of things that there didn't seem to be space for.

"By then we had a game plan, so the next thing to do was to make up a real list. To make this a little more manageable we divided the whole piece into four quarters. We had 22 musical sections so we started sticking up *Post-It* notes all

over the control room window so that we had a visual plan of what the basic pieces were in sequence, what the overdubs were in a vertical sense, and also I was able to write what format they were on. From this the picture began to emerge of what we had to do. The next thing to figure out was how to do it!"

The assembly of the tracks took place on a New England Digital *Direct-to-Disk* system with the assistance of Mark Willie and Ben Darlow. The procedure for putting all the tracks of each piece of music together, from digitally recorded sources, was basically this: the first multitrack tape would be submixed to a manageable number of tracks that were recorded into the *Direct-to-Disk* in several takes. Additional tracks from other multitrack tapes of the same piece would also be copied in. Because of the constancy of speed of digital recorders, there were no timing problems apart from finding the correct start point. With all the tracks loaded up, solos and vocals can be adjusted in time to come in at a suitable point and then be transferred, in multiple passes if necessary, to another reel of 32-track digital tape. Stephen Tayler expands on this:

"We took our Sting basic multitrack, which had 24 tracks full, but we made some choices and managed to get those choices mixed down to around 12 tracks, so that was three runs four tracks at a time because you can only do four tracks at a time into the *Direct-to-Disk*. We then offloaded those onto Mitsubishi. Then we looked at our Howard Jones 32-track, which had some overdubs from an Egyptian percussionist on two tracks on top of a DAT mix of Sting's piece, so again we took those off Mitsubishi onto the *Direct-to-Disk*. From that point it's really just a question of finding a start time, because we are working digitally at the moment so timing is not a problem, there doesn't seem to be any audible drift.

"All you have to do is to copy the guide rhythm track from the multitrack tape with the overdubs and compare that to the original basic track. You can edit with the trackball to line up the exact same bass drum beat on the guide track with the same bass drum beat from the master multitrack. All you are looking for is a SMPTE offset start

time then the overdubs will be in time as well. This worked perfectly for anything where the digital medium had been used simply because the tapes do run very accurately to speed. Unfortunately, the same is not true of analogue."

Tayler found that the speed of analogue tape is nowhere near as constant as digital. Once again, the original multitrack tape would be put into the *Direct-to-Disk*, then the guide track would be transferred from each other multitrack tape along with the overdubs. A start point would be worked out by comparing the guide track with the original rhythm track but very quickly the tracks would begin to drift apart. One possible solution would be to time stretch or compress the tracks to fit, but this takes a lot of computing time. The method chosen was to listen to the rhythm tracks until they became noticeably out of time, then step in and set up a new offset. A series of drop ins would transfer the overdub, with the correct offsets as judged from the rhythm track, to the new 32-track digital tape.

"I spent a lot of time listening to things phasing. When it drifted out of sync then I would stop and wind back and put a new offset in. Sometimes I was having to drop in segments for say 10 seconds and then find a break and drop in again. It's not noticeable in the finished product. You would get something that drifted maybe 50 ms in say 3 minutes that you would only start to hear the timing going after 45 seconds. So as long as you are re-offsetting every 30 seconds or so, then you can get round it without any audible problems."

This procedure was followed, building up four segments of approximately 15 minutes each onto four reels of 32-track tape. Then, each musical item was mixed into stereo onto two tracks of the *Direct-to-Disk* and then transferred yet again back onto another reel of multitrack tape, which with level changes and some small additions was then mixed into a final stereo master.

One other interesting point concerned the recording of the Leningrad Symphony Orchestra on three DAT recorders. Tayler had used one pair of mics in the middle of the orchestra, one pair behind the conductor and another pair at the back of the hall. In syncing these recordings up in the *Direct-to-Disk* he incorporated the actual time delays that there would have been, purely due to the distance between the mics, if the recordings had been made conventionally. It turned out that the sound was much better with the two pairs of mics nearest the orchestra synchronised exactly, with the delay for the ambience mics left as it should have been.

## Fearless

Clearly the experience of recording in such varied circumstances in several countries has left an impression on Tayler:

"One thing this whole project has taught me is that I have no fear of any recording situation whatsoever. We decided that the whole way that this project had to be put together was going to involve an open minded attitude to everything. If I had gone in with a very purist attitude I wouldn't have got past day one because the circumstances of recording dictated that one day you would be in one of the world's top studios and the next day you would be recording on a cassette. To me the important thing is to make sure that in the spirit of what we were doing the performance was captured." □

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**R**adio Clyde was only the third Independent Local Radio station in Britain when it went on air from an office block at the Anderston Cross Centre in Glasgow on the last day of 1973. Five years later it added multitrack facilities, partly in response to pressure at that time for local radio to employ Musicians' Union members in studio sessions or by staging concerts for broadcast. The new production studio featured one of the first MCI *JH-600* series consoles and a *JH-24* 2 inch 16-track recorder, soon upgraded to 24-track. It was used for quiz shows, discussions and (Sony Award winning) drama as well as music.

Just before its 10th birthday in December 1983 the station moved to purpose-built premises with acoustic design by Sandy Brown Associates at Clydebank Business Park a few miles down river from the city centre. On-air studios were equipped with Clyde Electronics *Alpha* series broadcast consoles but the existing MCI 36-channel console and multitrack were transferred to the new complex.

In the hexagonal building two mirror-image production studios (A and B) are separated by a corridor leading to the main multitrack control room. Originally this room was roughly triangular (effectively one segment of the hexagon) with the console in the middle, the balance engineer facing the entrance at the apex and triple glazed windows to the studios on either side.

"It turns out that triangular control rooms are not a good idea," observes chief engineer Grae Allan. So partitions were built across the two rear corners, making the room more pentagonal, both for acoustic reasons and to provide machine rooms for the MCI *JH-24* with multitrack Dolby in one corner and an MCI *JH-110* stereo ¼ inch machine, power supplies and amps in the other. "It's generally a much quieter, more

comfortable environment to work in and it certainly improved the acoustics."

The two studios are each around 39 m<sup>2</sup> (420 ft<sup>2</sup>) with a pleasant lively acoustic and easy double door access through airlocks from the car park. An area of carpet in one room can be lifted to expose the concrete floor for a brighter string sound. The isolation between studios and control room is so good that it was beyond the range of measurement used for IBA Code of Practice tests. Sets of mic sockets with cue and headphone feeds are spaced around the walls at hip height. Mics are the usual mix of AKG *C414*, *C451*, *D12* 'drum mic', Neumann *U87* (much used in on-air studios), Shure *SM58*, etc.

Both studios are wired for 36 mic lines and this takes up quite a bit of space on the jackfield so 3.5 mm (¼ inch) bantam sockets are used for high level plugging, providing 96 sockets in a 1U rack space. These are gaining popularity in broadcast facilities, particularly for high level signals, provided they are solidly made and 'self-cleaning'.

There were plans to equip a second control room for Studio B but most times both studios work together into the main control room, taking advantage of the total separation for drum kits. Occasionally two separate sessions have been handled using the mobile as a second control room.

## Amek installation

Three years ago Clyde decided to refurbish the multitrack control room and chose to install an early Amek *G2520* console with 28 channels. "One of the beauties of it was that we had to do very little to get everything on it that we want. It gives us a tremendous array of monitor inputs both for the control room and for the studio," Grae Allan records. "The monitor section was what sold us on the console originally—that and Amek's general reputation."

Very flexible monitoring is essential where a broadcast studio may be working with phone-ins, links to other studios or remote OB locations; needing to monitor outgoing clean feeds of mix minus selected sources as well as various cue programme feeds (with or without talkback) and off-air check receivers when live, or off-tape confidence monitoring while recording. The desk also provides for two separate headphone feeds carrying different cue programme mixes.

Being an early model there were some teething troubles with the monitor section. Radio Clyde devised an acceptable compromise but Amek still took the trouble to replace the whole monitor section electronics once the problem was solved. "That built tremendous confidence in Amek for us and made us well-

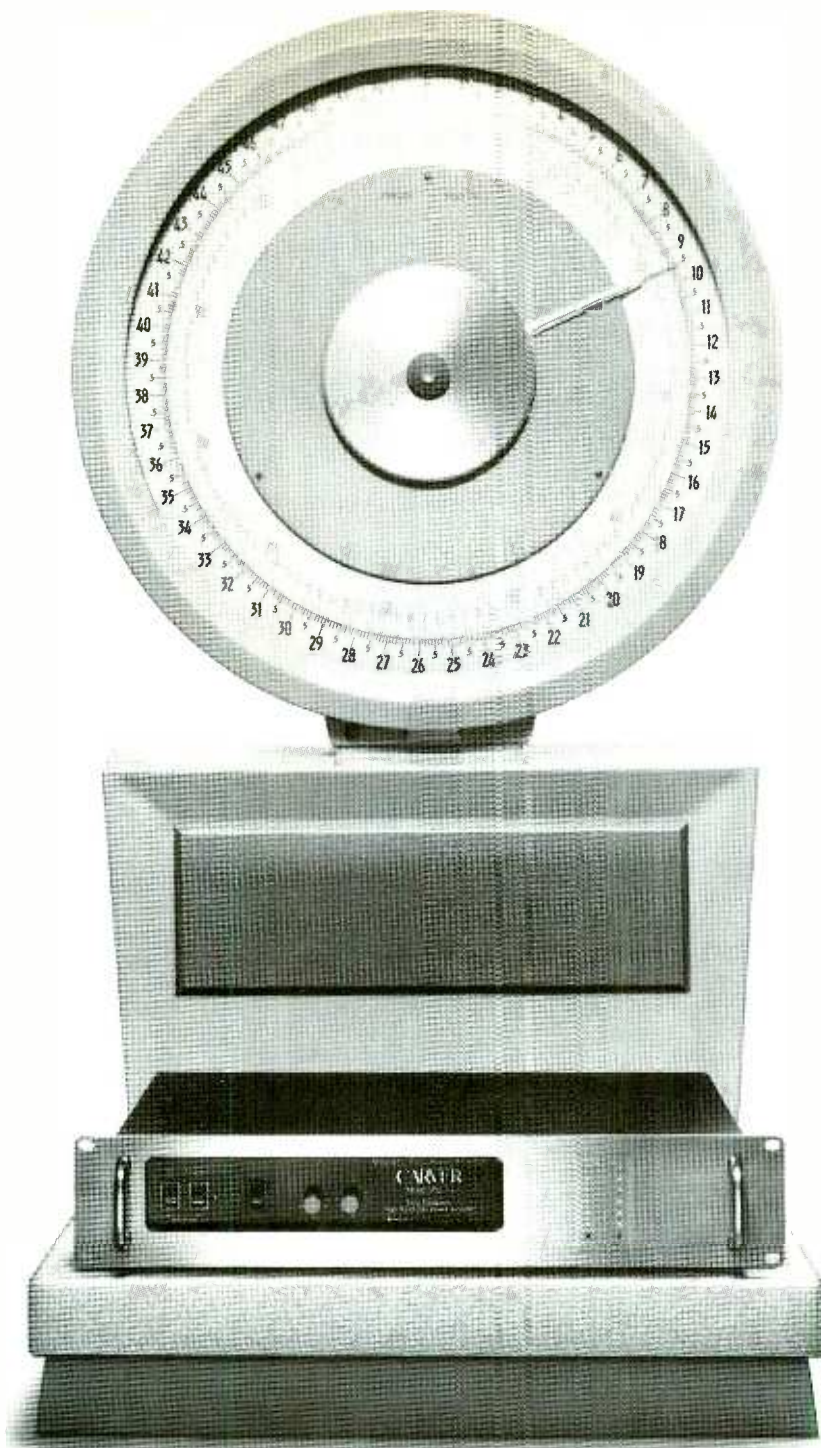
# RADIO CLYDE

Tim Leigh Smith visits Glasgow-based ILR station Radio Clyde with their music recording facility and mobile recording unit



Main control room





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disposed to go back to them for a second console to go into the mobile."

Another attraction of the Amek *G2520* was its operational similarity to the MCI *JH-600* series but with the added advantage of being able to work to multitrack or simply 28 channels straight to stereo: "The result is that we can put in less experienced operators to do relatively simple things in the studio; they don't have to understand the whole console." Clyde normally has two full-time balance engineers but radio operational work is also handled by production staff with varying degrees of technical expertise.

Each channel effectively has four inputs (mic, line, bus and tape return with all high level inputs accessible on the jackfield) and two separate EQ sections (filters and full parametric), each of which can be inserted in either the main linear fader path or the monitor rotary fader path. Channels have four mono and two stereo auxiliary sends that can be taken pre- or post-channel

¼ inch; for mastering and for handling material received via Satellite Media Services remote controlled DAT machine. "My only concern about DAT generally is the head clogging problem which you seem to get with no warning," Allan cautions. "You never know when they're going to drop out on you. You've really got to clean the machines every time you use them. I'm not a great supporter of DAT. When it works, it works extremely well but I feel that something like recordable CD will come along in the very near future and that's a non-contact process, which is much more robust for our purposes."

## Upgraded multitrack

Alongside the desk is an MCI *AutoLocator III* remote control for the 24-track machine. Clyde has two MCI *JH-24* multitracks, one in the production studio and the other in Mobile Two. Grae Allan describes them as the "middle generation" model. This had any early problems sorted out and included the DC servo controlled transport and *QUIOR* (QUIet Initiation Of Record) ramp bias system for gapless punch-in/out without suffering the mechanical problems of some later versions.

The electronics on the multitracks have been completely overhauled: "There were a lot of capacitors dried out," Allan explains, "they were underrated originally but they've been upgraded and the machines run extremely well now. We're in the process of refurbishing the motors. We extract the capstan motor and the reel motors and send them to the States to be refurbished. That's actually cheaper than replacing the motors and it gives them a new lease of life so we've no plans to replace those machines at the moment." Clyde has a full set of spares so both machines can remain in service while one set of motors is abroad.

As in many broadcast studios there is only a small selection of outboard gear. "A lot of what we're doing is for broadcast once or at most twice, rather than for record where it's going to be continually listened to and therefore listened to more critically. From time to time we have private clients in the studio and often they have their own personal tastes so we simply hire it in as it's required."

Basic gear mounted in the 'fairy dust' trolley includes A+D *F760X-RS* compex/limiter, *F769X-R Vocal Stressor* and *Scamp* rack with *F300* expander/gate and *S03* sweep EQ; *Drawer DS100* noise gates; *UREI 1176* (single) and *1178* (dual) peak limiters and *546* dual parametric EQ; *Eventide H910 Harmonizer*; *Bel BD-80* digital delay/sampler; *Deltalab Timeline DLA*; *Klark-Teknik DN 780* delay; and a couple of *Yamaha SPX90* (Mk I and Mk II) multi effects units. There is an EMT reverberation plate but "with modern electronic delay it's very rarely used."

Present speakers are *Tannoy SRM15* monitors biamped by *HH V800* MOSFET amps via *Tannoy* crossovers but these can be replaced by *UREI 809 Time Align* monitors (300 mm/12 inch driver with co-axial HF horn) slung from the ceiling fairly close to the console, similar to the monitoring in Clyde's multitrack Mobile Two. Nearfield monitors are the familiar *Yamaha NS-10M* driven by *Yamaha P2075* and a single *Fostex 6301B* mini to check mono compatibility.

In theory the multitrack studio is available for hire but outside bookings are quite rare. Sometimes bands who have done sessions for Clyde will ask to hire it and there are occasional mixdowns and overdubs for the likes of *Ca Va Studios* in Glasgow, who have a 48-channel Amek *G2520* so the EQ is familiar. "We're reasonably heavily committed with our own work so we couldn't readily let the studio out for a fortnight at a time," Allan admits. Current work includes a drama series telling the history of Glasgow with a 3 min episode going out twice each day, which requires several hours in the studio each week.

## Mobile too

Much of the live music coverage comes from Radio Clyde's refurbished Mobile Two, particularly as Glasgow is celebrating 1990 as the Cultural Capital of Europe. The original Clyde truck, Mobile One, was a semi-trailer, with acoustic design by Eastlake Audio, subsequently operated by Tape One Studios in



Inside Radio Clyde's mobile recording unit

fader or monitor fader. There is the usual fader reverse option and as each fader has pan and stereo assignment it is possible to use linear and rotary faders for separate inputs, so each channel can handle mic and line inputs simultaneously with some form of EQ available on every source. "The only additions that we've made to this console are the tape remotes, a gram stop and start, some studio cue lamps and four headphone sockets."

Repro sources include Technics turntable, several Pacific Recorders *Tomcat* cart machines and even a couple of *Denon DN-950FA* CD cart players borrowed from on-air studios to provide digital quality sound effects for drama. "They're quite good for production work. The search controls are fine enough to find spot effects quite accurately and they're very fast starting. We replaced all of the original *950F* machines with the *FA* version, a great improvement, it cues much faster and it handles disc errors much better."

The occasional Technics *SV-360* DAT machine is used for drama multitrack mixdown, prior to the final effects mix onto

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London and later sold as an empty shell to become the second Fleetwood mobile. Mobile Two, another semi-trailer, was designed and built in 1978/9 by the high-powered Radio Clyde engineering department, part of which developed desk building and installation for mobiles and studios as Clyde Electronics, eventually becoming a completely separate company but still doing regular business with the old firm.

Like the production studio Mobile Two began with an MCI *JH-24* multitrack and *JH-600* series console, replaced last year by a 48-channel Amek *G2520*, which fills the width of the truck ("a friction fit"). The rebuild required considerable investment but it was felt worthwhile for the station's ability to record and broadcast live events. For major multitrack events a 16-input Trident *Fleximix* (late of Mobile One and heavily refurbished) provides extra channels, an arrangement that has coped with everything to date.

An *XLR* patchbay (Canford Audio *Universal Connection Panel*) links 64 incoming multicore mic lines to desk inputs via *XLR* double-enders. "While we don't have the normalising that we would have on a jackfield, it's much more flexible and much more robust." The resistor colour code is used to identify each *XLR* link uniquely by the colour of its cable and plug sleeve, 10 colours of cable and 10 colours of sleeve giving 100 combinations (00 to 99). A set of toggle switches provide earth (ground) lift for every channel on the multicore cables to remove hum loops.

Suspended above the desk is an outboard equipment bridge including insert jackfield, A+D *F760X-RS* compex/limiter and *Scamp* rack as in the studio, a couple of dbx *165* 'over easy' compressor/limiters, Eventide *H910 Harmonizer*, Yamaha *REV5* digital reverb and *SPX90* effects. Outboard gear tends to be shared between the studio and mobile with the option of hiring in extra goodies when necessary.

"Small equipment is readily hired, both locally and if need be from London. The biggest problem is if people want a second multitrack for the mobile, which we normally operate with one. Hiring in a second machine for a couple of days could cost as much as hiring the mobile by the time it's been transported up

and somebody's come up with it to do the alignment so there's overnight expenses and accommodation."

In the original design tape machines and tape op were at the front of the vehicle, cut off from the balance engineer and production staff by the console. Now the MCI *JH-24* and a couple of Studer *A807* 2-tracks with centre-track timecode are in the production area at the back and the space in front is used for storage.

Various types of monitor speaker have been tried in Mobile Two over the years. The idea of having large speakers at the front of the vehicle, some distance from the balance engineer, proved unsatisfactory. "In an effort to achieve a sound that everyone's happy with we evaluated five or six sets of monitors when we refurbished. We eventually settled on UREI *809*, which are large bookshelf-type speakers, and we brought them very much into the nearfield; they're actually sitting on the bridge of the console. We tried them in the mobile and we also tried them in the studio and the clear conclusion from all concerned was that they gave the best results. Indeed we may yet put them in the studio as well because people were so pleased with them." The upgraded monitoring allows the mobile to be used as a mixdown area.

Between the two UREI monitors are a pair of Yamaha *NS-10M* nearfield monitors and a colour video monitor for CCTV links or a picture feed when working on television shows. A couple of monochrome monitors and a video patchbay (again Canford Audio) provide for up to three CCTV cameras. This patchbay also allows RF feeds such as radio talkback to be extended into a steel-framed venue.

Mobile Two provided multitrack facilities for two series of *Halfway to Paradise*, a music and entertainment show with stereo sound, produced in Glasgow for Channel Four Television, the mixdown to picture being done in Clyde's multitrack studio. Even BBC Scotland has hired Mobile Two for a TV show at the Pavilion, Glasgow. □

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In late April, *Today* newspaper ran a headline 'Hiss free cassette will wipe out CDs' and predicted that a new cassette tape, which takes the hiss out of recording, could end the CD revolution. Scientists, we learned, had developed a system which 'gives near compact disc quality for only a few pence more than an ordinary tape'.

The magic system—developed by Archie Pettigrew, a lecturer at Scotland's Paisley College of Technology—was, the newspaper reported, due to be unveiled at a conference in Birmingham that week and 'could be in the shops by Christmas'.

Further reports followed, for instance in trade magazines and *The Times*. Industry phone lines buzzed. Philips and Dolby were sceptical but hedged bets by saying they were 'looking at the system'. Most of the press reports contained curiously similar snippets of information. This was not surprising, because they had derived from a report put out by the Press Association on its wire news service. And this report had originated from a visit to Paisley College made by an apparently non-technical stringer who was following up a press release put out by the Paisley College's publicity department at the request of Archie Pettigrew.

It would be convenient to write off the Paisley invention, which Pettigrew calls Contour Biasing, as just another hype. But in the case of Contour Biasing, the foundation is much more solid. It is there to read in a paper which Archie Pettigrew delivered to the Eighth International Conference on Video, Audio and Data Recording held by the Institution of Electrical Engineers at the University of Birmingham towards the end of April. But Pettigrew's paper, titled 'Contour Biasing and AC Biasing, a Comparison' is a highly technical document, replete with high level maths.

In much plainer English a background publicity note from Paisley tells that Pettigrew has been a disk-drive designer with more than 18 years experience in the magnetic recording industry, that Contour Biasing is a 'fundamentally new process of making distortion-free analogue magnetic recordings' with 'signal-to-noise ratios and bandwidth dramatically improved' and that 'the innovation has evolved from a simple but radical mathematical analysis of the operation of AC bias first published in Copenhagen in 1974 (AES Conference, A new approach to magnetic recording)'.

The guts of Pettigrew's theory is that magnetic tape is extremely sensitive at low amplitudes of signal and not the converse as has previously been thought. He also says that theory predicts it is possible to make recordings with zero level distortion without AC bias, so eliminating bias erasure of high frequencies and modulation noise.

If Pettigrew has got it right, then BASF got it wrong 50 years ago and have been getting it wrong ever since!

Pettigrew is now offering prospective licensees the chance to see and hear a demonstration. He claims that his system not only gives compact disc quality from cassettes, but can be used to improve video, digital and instrumentation recording, too.

The inventor told me how he spent 2 years

## Barry Fox

### A new approach to magnetic recording

analysing tape recording between 1972 and 1974, then gave up the work for 12 years, taking it up again in 1988 when he went to the IEE's Conference at York and was surprised at how little progress the electronics industry had made in improving analogue recording.

Traditionally it has been thought essential to shake up the particles of a magnetic tape with a high frequency AC bias signal (of between three and five times the highest music frequency, eg around 70 kHz) to let them record low frequency audio signals (up to 15 kHz) more faithfully. One problem is that high frequency music signal also acts as bias for the lower audio frequencies, and if the sum total of bias is too great it causes distortion of the recorded signal and self-erasure of the high frequencies. Any irregularity of the bias signal arranges the particles in patterns that create hiss noise on playback. Hiss has been curbed by the various Dolby noise reduction systems. Bang and Olufsen of Denmark worked with Dolby Laboratories to develop *HX Pro*, which automatically varies the amount of bias in dependence on the music signal to avoid an excessive sum total.

Pettigrew now says that there should be no bias at all, because magnetic tape is extremely sensitive at low signal levels, the exact opposite to traditional thinking. According to Pettigrew, 'AC biasing has long been misunderstood' and there is a cubic relationship between the amplitude level of magnetic flux applied to a tape, and the level of flux retained by the tape. As the input signal rises by 20 dB, the output from the tape rises by 60 dB until the tape saturates and can hold nothing more.

"From the lack of literature on this most fundamental of measurements it would appear that few researchers have measured this relationship," writes Pettigrew in his paper.

To record a signal without bias, Pettigrew feeds the signal through a circuit, which takes its cube root up to a threshold equivalent to saturation. After this threshold, the circuit becomes linear and has no effect on the signal. This, he claims, puts a signal onto tape without either distortion or the hiss caused by AC bias. Also, because there is no bias, there is no self erasure of the high frequency music signal. So, much more high frequency or treble is recorded on the tape.

Contour Biasing can only be used with erased media, that is to say blank tape. With conventional tape recorders, each fresh recording erases anything already on the tape. Contour Biasing can be used to over-record an existing conventional recording, but if an attempt is made to make a Contour recording on a tape that already contains a Contour recording, mutual destruction of both recordings occurs. So recorders

that work on the Contour Biasing principle will need modified erase circuits as well as modified recording circuits.

Pettigrew told me that's why he will not give out demonstration tapes for anyone to try on their own tape recorders.

"There is too much treble on the tape. It is rising by 6 dB/octave with no flattening out," says Pettigrew. "I need to adjust the replay characteristic of the replay machine, just a resistor in the time constant circuit."

If tapes recorded on home Contour Bias decks will play back properly only on Contour decks, the system is commercially a non-starter for domestic use. The computer industry, in which Pettigrew works, is traditionally tolerant of incompatibility messes. The audio and video industries are not.

When I asked Pettigrew about a demo tape, he could only say rather vaguely that he will "need to adjust the system at the recording stage" to make Contoured tapes play back properly on conventional machines.

So, although no-one yet seems to have picked up the point, this makes Contour Biasing impractical for the record companies to use when duplicating music cassettes.

The public cannot be expected to pay for their tape players to be modified, or to buy new ones. If simply turning down the treble on replay worked well enough to create backwards compatibility with existing tape decks, why won't Pettigrew send out demo tapes? And if making a simple adjustment to the Contour recording circuitry does the trick, why after 18 years work and the decision to 'go public', has this simple adjustment not been made?

I don't doubt that the inventor can demonstrate dramatic improvements in quality when he uses his own hardware. But this means that what is supposedly a single-ended system is in fact a double-ended system; a recording made on a recorder with modified record circuitry is played back on a recorder with modified time constant. To make the system genuinely single-ended, so that demonstration recordings can be distributed for playback on existing domestic machines, Pettigrew must artificially limit the amount of high frequency signal recorded onto the tape. And this may well remove much of the benefit offered by Contour Recording.

It seems I am not alone in feeling sceptical about practical applications of the system. Philips in Europe subsequently confirmed that it first talked with Archie Pettigrew about his Contour Biasing system 2 years ago. "The system did not reach our expectations," says Philips.

Philips then talked with Pettigrew again in September 1989 but "there was no change—it still did not meet our expectations".

It's the old cleft stick problem that has trapped so many other audio and video system inventors: a straight choice between compatibility with existing machines (and reduced benefits) or full and dramatic benefits (with compatibility sacrificed). Without compatibility, the system is a dead duck; with reduced benefit, the system may, in practice, offer no advantage over Dolby *HX Pro* recording with Dolby A, B, or C noise reduction, or S-type or SR signal processing. □

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Black Box panel in place

## BLACK BOXED ACOUSTICS

A new system of acoustic treatment is investigated by Janet Angus

**W**e're not claiming to have rewritten the laws of physics. All we have done is strip away the mythology associated with studio acoustics: what you see is what you get."

Nick Whitaker of Nick Whitaker Electroacoustics is speaking of a joint venture with Recording Architecture, which has resulted in *Black Box* Acoustic Conditioning Systems. Not so much ready packaged off-the-shelf acoustics,

this system has established a quick and efficient method of implementing acoustic treatment to recording rooms with extremely attractive cost savings into the bargain.

Roger D'Arcy of Recording Architecture confidently predicts that this principle will "become like the 'Biro' or 'Hoover' of acoustics". Drawing on several years experience, treating and designing scores of rooms all over the globe, Whitaker and D'Arcy concluded that there was no

need to go to the expense and considerable inconvenience of burying acoustic treatment in the walls of a room.

"The beauty of it is that this is simply the bare acoustics," explains Whitaker. "There are no lizard skins or jiggery pokery hidden behind the walls."

The *Black Box* system, (not necessarily black, incidentally) is a principle by which each individual project is custom designed, incorporating the various acoustic treatments within 'boxes', which are then attached to a studio's walls and ceiling by whatever method is deemed most suitable to a particular building. Initial construction problems had to be worked through before 'mass production' could be considered. "Sealing of the boxes proved a bit of a poser, and stretching the fabric covering across the front, but we have got all that sorted out now and the two firms of joiners we use are very familiar with our requirements," says D'Arcy. "One advantage of having the boxes constructed offsite, apart from the obvious one of avoiding disruption and saving time, is that we are able to inspect the workmanship as it is carried out."

Materials used may be specified to blend in with room design although the cheapest and standard versions are sprayed MDF with metal trim. "The point is that you save a great deal of money working like this," says D'Arcy. "The major cost of a studio build or rebuild is the architectural work. In many cases you can avoid these completely. You thus save architectural design fees, building costs and studio downtime. We are also perfectly willing to provide consultancy for clients as to how to build their own acoustic shell and simply implement the acoustic treatment afterwards."

"We have tried to make buying acoustics more like buying equipment," Whitaker takes up the theme. "Most people haven't a clue what goes into acoustic treatment of their rooms. When you buy a mixing console you can see exactly what you're getting; the same goes for the *Black Box* systems. Most people are surprised by the relatively small amount of wall and ceiling space that needs to be covered."

Initial plans were to design a standard system that could be specified to treat any room. Realising that this was taking it a bit too far, D'Arcy and Whitaker finally settled on a basic principle whereby relatively standard units could be tailor-made for each project.

"The units are not that dissimilar. They could in fact be taken down and used somewhere else with a small amount of modification," continues Whitaker. "We use a standard approach. We haven't rewritten the physics books. We use membrane absorption, combined friction absorption, etc, but the important thing is where you put them in the room and in what quantities; making each item work in the most efficient way possible. You can make a bass absorber one eighth effective by mislocating it."

Tried and trusted methods of acoustic analysis are used. No more or less acoustic treatment is used than in traditional room design.

Nevertheless the *Black Box* designers maintain that they would now use the system even on a new studio build from the ground up—for speed. Measurement and evaluation of a room will take approximately 1½ days, using the Techron *TEF* TDS system. *Black Box* is particularly attractive as a quick and cheap means of correcting a problem acoustic. "It may be that you can just bolt a couple of boxes to the walls, in a matter of minutes, before the morning session starts. It's a very attractive prospect for a studio with

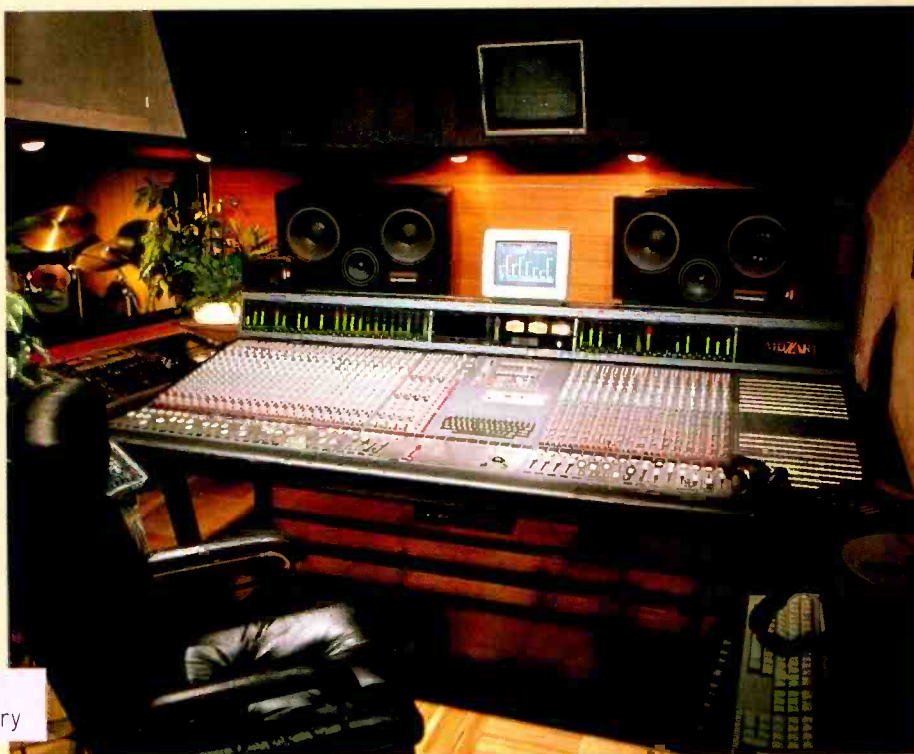


# MOZART

When we started looking for a new console there were various possibilities. But as an ANGELA user we already knew about the superior sonic quality of AMEK consoles.

Sound quality certainly being the most important feature, MOZART was obviously a very good candidate. However this factor, combined with all the other MOZART standards such as 16 Auxiliary busses, 12 Stereo Effects Returns, 4 inputs per module and split EQ, made MOZART the only realistic choice for us.

AMEK MOZART with AMEK/Steinberg SUPERTRUE automation fits our recording environment perfectly. Even our MIDI equipment is now controlled from the console. We can offer all our customers a perfect console system which is highly flexible. This will take us, as a top studio, through the '90's.



Stefan Raebel,  
CRISS TONSTUDIO, Elchingen, West Germany



When considering a new console for Mirage, I had to take into account the broad spectrum of clients who would be using the studio: everything from film and television post-production to major album projects has to be allowed for.

The reason I chose AMEK MOZART is that in my opinion this console is unsurpassed in its technical quality functions and comprehensive automation. All of this, coupled with the realistic price, beats any other competitive console and, in fact, some costing nearly twice as much.

Ar dy Hurley,  
MIRAGE RECORDING STUDIO, Oldham, England



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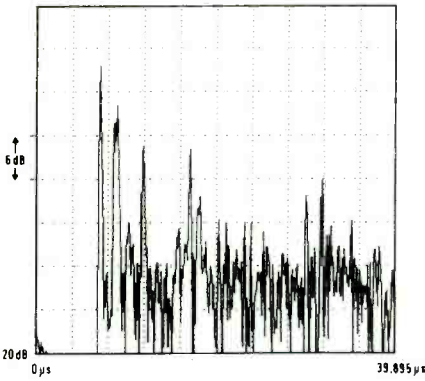


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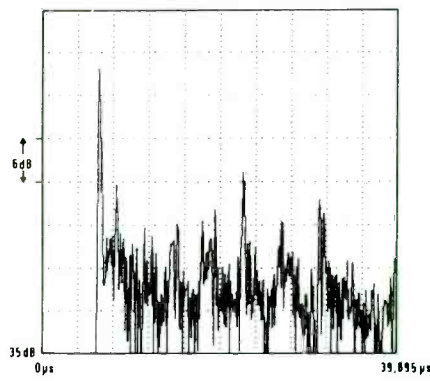
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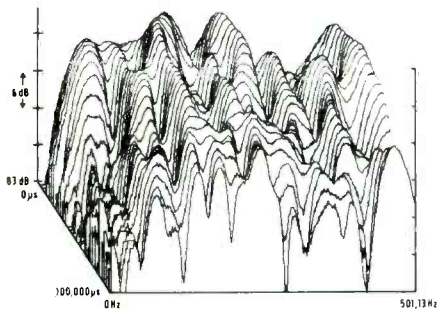


**Energy Time Curve before treatment**  
 0 dB is located at 0.99999E-6 V  
**Horizontal scale:**  
 3.7448E+00 m/in or 1.4743E+00 m/cm  
 10907  $\mu$ s/in or 4294  $\mu$ s/cm  
**Line spacing:**  
 99.9882  $\mu$ s or 3.43277E-2 m  
**Line width:**  
 135.984  $\mu$ s or 4.66857E-2 m  
**Sweep rate:** 1977.45 Hz/s  
**Sweep range:** 0.00 Hz to 10001.20 Hz  
**Input configuration:** Channel 1  
 balanced with 48 dB of input gain  
 and 9 dB of IF gain

The before and after ETCs show that the acoustic treatment has reduced secondary reflexions following closely on the primary signal

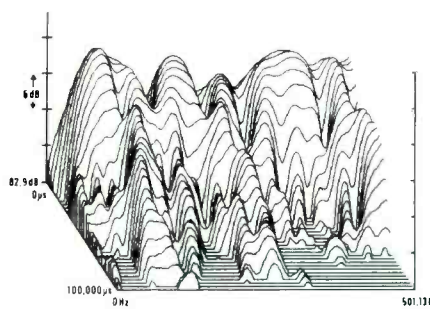


**Energy Time Curve after treatment**  
 0 dB is located at 0.00002 Pa  
**Horizontal scale:**  
 3.7448E+00 m/in or 1.4743E+00 m/cm  
 10907  $\mu$ s/in or 4294  $\mu$ s/cm  
**Line spacing:**  
 99.9882  $\mu$ s or 3.43277E-2 m  
**Line width:**  
 135.984  $\mu$ s or 4.66857E-2 m  
**Sweep rate:** 1977.45 Hz/s  
**Sweep range:** 0.00 Hz to 10001.20 Hz  
**Input configuration:** Channel 1  
 balanced with 24 dB of input gain  
 and 21 dB of IF gain



**3-D measurement before treatment**  
 0 dB is located at 0.00002 Pa  
**Horizontal scale:**  
 137.01 Hz/in or 53.94 Hz/cm  
**Resolution:**  
 6.8715E+00 m and 49.96 Hz  
**Time of test:**  
 100,000  $\mu$ s 3.4332E+01 m to 0  $\mu$ s  
 0.0000E+00 m  
 -3226  $\mu$ s/step or -1.107476609753 m  
**Sweep rate and bandwidth:**  
 199.85 Hz/s and 4.00 Hz  
**Input configuration:** Channel 1  
 balanced with 24 dB of input  
 gain and 21 dB of IF gain

The 3-D plots show improved uniformity of initial LF response and a much greater LF decay rate



**3-D measurement after treatment**  
 0 dB is located at 0.00002 Pa  
**Horizontal scale:**  
 137.01 Hz/in or 53.94 Hz/cm  
**Resolution:**  
 6.8715E+00 m and 49.96 Hz  
**Time of test:**  
 100,000  $\mu$ s 3.4332E+01 m to 0  $\mu$ s  
 0.0000E+00 m  
 -3226  $\mu$ s/step or -1.107476609753 m  
**Sweep rate and bandwidth:**  
 99.92 Hz/s and 2.00 Hz  
**Input configuration:** Channel 1  
 balanced with 36 dB of input gain  
 and 21 dB of IF gain

Measurements before and after treatment of a European studio as a test case (These findings do not relate to CTS who are discussed in this article)

problems with its sound."

D'Arcy: "The whole point is to get a balanced system. It is not intended to be like buying a dozen BBC boxes. You can't just go into a supermarket and buy a set of acoustics. It does need to be specified."

"Our expertise is knowing the distribution of acoustics and how to implement the treatment," agrees Whitaker. "The realisation of the acoustics is the difficult bit—making it work well, look good and be cost effective; determining the minimum areas which need to be covered."

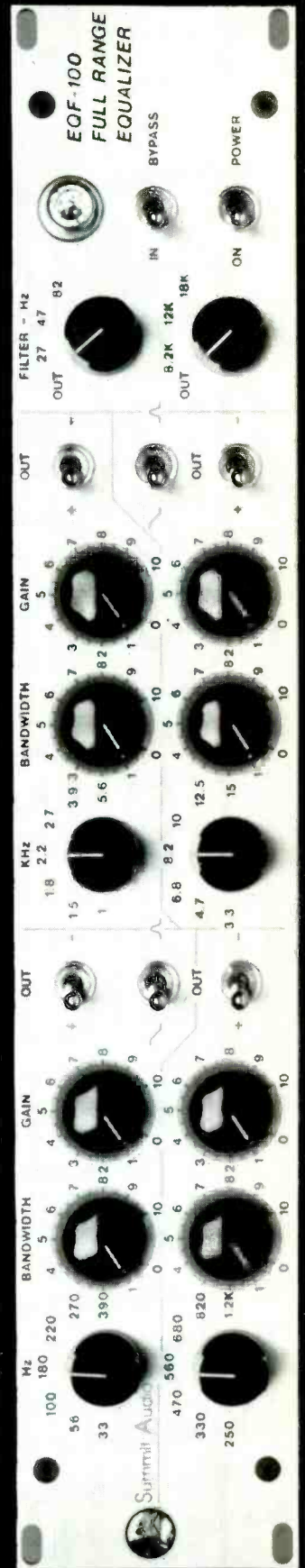
A point stressed again and again is the fact that this is a total acoustic treatment. "It is not like RPGs or acoustic tiles—it covers every aspect of a room's acoustics."

Whitaker is keen to make it clear that the acoustic aspects are not to be over-emphasised. "We haven't done anything different in that respect, it is simply the method of implementation."

The individual components are bass absorbers, providing low frequency absorption; wide band absorbers, which are combination membrane and frictional absorbers; hanging absorbers (low frequency efficient depending on positioning); and slatted elements, which provide mid frequency diffusion plus an element of low frequency diffusion dependent on location.

The surface area of these elements defines the quantity of absorption and diffusion present. The amount needed is calculated according to the size

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Black Box panels in Studio Two at CTS

and intended use of the room.

"The positioning of all the elements is particularly important to obtain the maximum efficiency available from each unit," explains Whitaker. "In particular, the hanging elements can be made to have an effective impact on the low frequency response of the room."

"The *Black Box* system is like a suit," says CTS studio manager Jonathan Miller, "but it can't be off the peg, it has to be tailor-made."

CTS is one of the company's most recent clients. Their Studio Two control room was stripped, refurbished and equipped with the system in a matter of 3 weeks.

"That included installation of the desk, all the wiring—everything. Installing the actual acoustic system took only 1½ days." Miller admits to being something of a fan having been the guinea pig for an embryo system as far back as 1987 when working for Pete Willis at his Blue Room studio near Sheffield.

D'Arcy estimates that had they approached the CTS project in the traditional manner, architectural fees alone would have been in the region of £5,000. "As it is we can do that work for a few hundred pounds."

Systems supplied include Paul Carrack of Mike and the Mechanics, Thamesmead Radio, Noisegate

Studios, the BMS, Parklands Studios, Vince Clarke's Erasure, Billy Ocean, Gem Studios, Oxford Digital and Harman UK.

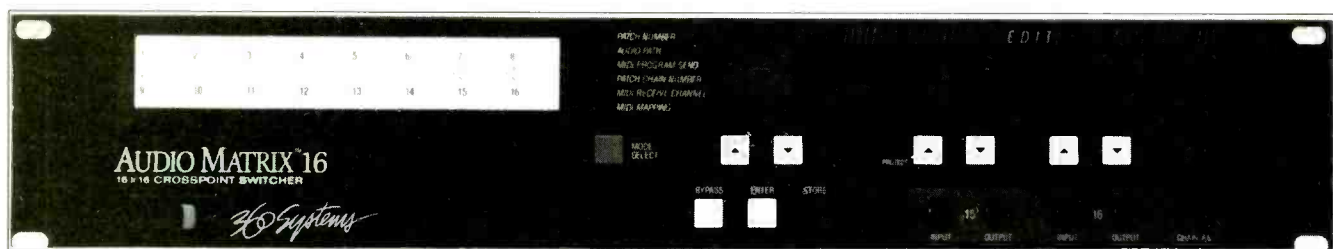
Most recent have been Konk Studio's famed Neve control room—reputedly one of the largest in London—and Double Trouble of Denmark Street, London. The Waterboys provided an interesting development when their record company contacted Recording Architecture requesting that they design a system for the country house in which the band are recording their latest album. As the property (located in Galway, Ireland) was being rented, it was essential that any treatment be removable without any damage to the building itself.

The system was duly designed and implemented in a single day. Special fixings had to be designed—ceiling treatments were hung by means of drilling holes through from the floor above and a combination of rods and hooks being suspended by means of metal plates. When the system comes to be removed these will simply be withdrawn and a series of small holes filled in and made good. What's more, the room treated is so large that there will be enough elements to treat two smaller studios when the project is over.

As Whitaker says, the acoustic elements are exactly what you would put into a full scale traditional project. "All we have done is hang them on the walls and ceilings. The possibilities are interesting to say the least."

In a recent development, the UK Department of Trade and Industry has listed Recording Architecture's consultancy under its Design Initiative. Under this initiative the DTI is able to make grants to British clients of listed consultancies by way of contributing to consultancy costs. □

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**I**t is interesting to speculate as to how some of the more oddly titled recording studios gained their names. It can be safely assumed that some names began as a joke, and stuck, and one such studio is Kitsch in Brussels, Belgium.

Kitsch was so named when it was upgraded from a 16-track home studio to a commercial facility in 1982. As money was so tight the owners chose to decorate it with items in the worst taste possible. Clients were encouraged to bring in souvenirs from Spanish holidays and curios picked up in flea markets, and the joke perpetuated throughout the first few years of operation.

The studio as it must have been then, bears little resemblance to the elegant facility of today, although the location has not

situated Studio B with control room and two studio areas; several offices for administration; kitchen and recreation facilities. A further room is rented out as a sound-to-picture studio.

Stevens started the studio in 1979 in the countryside before transferring it in 1982 to Brussels, where he was studying at film school. He teamed up with student of sound engineering Thierry Van Roy, and before long had transferred onto the same course. The 16-track studio was based in an outbuilding at the bottom of the garden and they used it for their own projects but soon clients started arriving at the door asking to use it.

"This was surprising," says Stevens, "as we didn't advertise it at all."

But they gained a reputation for attaining good sound with the basic Ampex tape machine, Soundcraft console and Tannoy monitoring package they provided.

As more and more clients arrived, Stevens and Van Roy decided to upgrade, and sold the 16-track tape machine to buy a 24-track. With the growing professionalism of the operation, Kitsch, the company, was formed in 1986. Concurrently the first SSL in Belgium was installed in the garden studio—a second hand console purchased from The Manor in the UK. The studio became so successful that 18 months later, a second SSL was purchased from Steve Winwood and installed in Studio B in the main building.

In 1988 it was decided that the back studio should be extended and redesigned and to this end, Andy Munro was brought in. "I liked what Andy was doing," explains Stevens. "I'm a great believer in the *Live End/Dead End* principle, so I asked him to design the studio to a budget.

Adrian Short, an interior designer renowned for his bizarre ideas came up with the finishing touches, namely a leather floor, lead surrounds for the monitors and rack equipment, copper panels and leather and rubber trim. Although the combination sounds unconventional and verging on the perverse, the end result is a room which, with its 20 ft high ceiling, has a spacious and tranquil feel to it. None of the décor is obtrusive in the slightest—all materials have been used with practicality and discretion in mind and almost have to be pointed out.

Stevens says, "You can feel it's different without considering it extreme. It sounds weird but it's actually very discrete and easy to work in.

"Ergonomics are the key to the studio—the engineer can do everything from his chair."

# KITSCH

## Caroline Moss reports from a Belgian studio with unusual decor

changed. Situated in the old part of the city in a tall, narrow building, the old architectural mouldings, panels, columns and statues throughout the building and garden contrast strangely with the hi-tech offices and studios, and reflect the studio philosophy of mixing the classical with the modern.

Studio owner Bruno Stevens still has a plaster Madonna in his office: her eyes follow you as you move about the room and on closer inspection you notice her head is concave. But all the other items of extreme kitsch have been put away in a box—though Stevens is considering putting them on exhibition—a monument to the studio's past. It would be difficult to find available space, as the Kitsch building is used to full capacity. Studio A is located in a garden building. In the main building is

New Genelec monitors were installed and according to Stevens they are delighted with the sound.

The control room, which was previously on a gallery overlooking the studio, is now on ground floor level and its spacious dimensions continue throughout the building, which includes a machine room and two new studio rooms, one of which has a 25 ft high ceiling. The two studios have tie lines through to the control room of Studio B in the main building, and likewise the two studios in the main building have tie lines to the garden control room.

The garden studio was completed a year ago but it was agreed that its success rate should be monitored before large investment was made in new equipment. It opened in January 1989 and was subsequently booked constantly throughout the year.

Stevens: "The SSL was getting too small for us because it was only a 40-channel and we wanted to go digital anyway to be in the same league as top recording studios. So we decided on a large console and two Mitsubishi digital multitrack machines because we wanted to allow our clients to switch to digital and not be stopped by compatibility—we now have two analogue and two digital multitracks, which are used between the two studios, though I would estimate that about 80% of our work is digital. We have moved fast since 1986 for such a small company."

When it came to the new mixing console, Stevens made a decision that was so extraordinary that it made the leather and rubber décor seem commonplace by comparison. He chose to install a Neve VR 60 console with GML automation in preference to the *Flying Fader* system advocated by Neve and, more unusually, by interfacing the desk with the SSL studio computer.

He explains: "We wanted the Neve because we thought it was an excellent console. At Neve I was shown the *Flying Fader* automation, which I think is a good system, but there were a few things we didn't like, for example it's a multiplex system so you've got data flying across the desk and I'd heard it can be a little slow. The proven reputation of GML automation in the US makes it a good moving fader system, which is what we wanted for the Neve. It was obviously more expensive, especially as Neve made us a very good offer on *Flying Faders*, but I think that they realise what a good system GML is and have never said anything against it.

"As far as the SSL studio computer is concerned, ergonomically I think it is the best available as it is the only true system in the studio world. The operational advantages of running it with the Neve are such that any sound engineer used to working on an SSL can begin work on the Neve within 30 seconds just by typing in 'cycle title', 'list track' and 'list cue' as on any SSL."

The SSL computer is being used for machine control, track, cue and title listing, with GML's own computer being used for the automation.

"One thing about housing two computers is that the SSL computer is driven by the timecode of the master, whereas I can use multitrack timecode with the GML automation. This wasn't possible with SSL and is extremely useful as we do video post-production as well as musical projects in the studio."

The track remotes of the console have been interfaced with the tape machines. As there were no dedicated switches the overdub buttons, normally used for cue switching, have been used and can now switch the multitrack machines from safe to ready track-by-track.

Stevens comments: "Since using our first SSL system 5 years ago we found that not having tape machines or an autolocator in the control room was extremely convenient and we did not want to go back to having an autolocator which was not inside the console. Also from a compatibility point of view, we wanted to be able to work in the same way as Studio B, an SSL studio, as we like to be flexible about working between the two studios. We didn't want any project to be tied up in one studio because of non-compatibility."

Stevens bought the SSL computer cards and interfaces directly from the company but went to UK manufacturer Pro Serv Audio (run by ex-SSL service director George Gilbert) for the computer frame, power supply and processor. This was a cheaper solution but meant that SSL didn't realise what he was up to until the system was installed and working.

"I think they were a bit surprised at first," says Stevens, "But



I've spoken to Colin Sanders about it. He's an intelligent man—he designed the system and he must have known that this would happen at some point, although I don't think he'd like it to become common practice.

"What I've done is perfectly legal—I haven't copied the design. All I've done is buy a commercially available SSL computer which I'm using as an SSL computer."

As a final touch, Stevens has fitted an Adams-Smith synchroniser into the centre section of the Neve to parallel the master transport of the Adams-Smith to the SSL computer so that the tape machine controlled by the SSL is always the master in the Adams-Smith system. However, Stevens explains: "It's all software driven so I can always decide which machine is master. The Adams-Smith is also a MIDI synchroniser so it gives us a counter in timecode, beats, frames and bars, we have a metronome within the console, what we can do with it is limitless.

"It all sounds very complicated having so many systems working together but the ergonomics are now perfect—all the engineers who've used it are raving about it and we're getting calls all the time from people wanting to try it out."

The SSL console was taken out of Studio A on December 20th, 1989, and the first session on the Neve took place on January 1st, 1990. The GML automation was fitted within 24 hrs and Stevens claims he had the SSL computer up and running within an afternoon. Since its installation the system has been consistently and successfully at work on a variety of projects.

But in the face of modern studio design and equipment, Stevens hasn't neglected the technology of the past, which has endured to complement equipment of today. A speciality of the studio is its unusual collection of 40 valve microphones, Fairchild compressor/limiter and de-essers and Pultech equalisers.

One of the noticeable things about Kitsch was the electric atmosphere created by many productive people working in the same environment; the musicians carrying their instruments up to the second floor studio for a classical session in Studio B; the rock artists who were working in the garden studio under the production of Tina Turner's keyboard player Kenny Moore; a photographer arriving with artistic shots of the studio's features (only a few of the usual equipment and control room shots featured among them); people calling up to enquire about the studio and in one case, arriving off the street in the hope that they could use the studio imminently.

"Atmosphere is very important to us," says Stevens, "we want to keep it good. The door is always open to everybody and we don't treat our clients as money providers—they become our friends. We are not a factory-type studio, we believe in ambience. We are always improving our facilities—there is never a time when the studio is finished, and our clients notice our level of investment."

Kitsch it may have been when it started life as a commercial studio but this professional and tranquil Belgian facility has long since left its tacky image behind.□

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# EVALUATING AUDIO OP AMPS PART TWO

Ben Duncan surveys developments from 1977 to date, as a prelude to performance tests performed on many of the models discussed

Part One of this series charted the initial development of op-amps and their fledgling application in pro-audio equipment. In 1977, Philips began making an op-amp called *TDA1034*. Probably intended for telephony/telecom equipment (Philips have a comic way of seeming to stumble on winning designs by accident), it wasn't long before *1034*s were being shipped out of Eindhoven to London, to upmarket console manufacturers. Packed in extruded aluminium tubes, the initial price was high (£5.00/\$8.00) but then the *1034* combined a host of features that were desirable for audio and not available in any other op-amps. For the first time, you could build a compact, very simple and respectably quiet mic amp without resorting to discrete transistors. Harmonic distortion (THD) was commendably low, well below 0.01% and the *1034* ('ten thirty four' to its friends) could drive a 600 Ω load without driving a distortion meter off-scale. Moreover, you could use a ±22 V supply to achieve a high headroom of above +24 dBu.

In 1978, production was switched to an ailing stateside IC manufacturer that Philips had recently bought out, called Signetics. The Mullard/Philips *TDA1034* was then relabelled as the Signetics *NE5534*. The *5534*'s price fell swiftly between 1980 and '82, after Raytheon and later Texas and other makers began to second source their own 'klones'. By now, the *5534* was poised to become the *de facto* standard for pro- (and much later, domestic) audio, a position it still holds 13 years later. It's the only IC op-amp designed in Europe that's met with any continued success. The introduction by 1980 of a dual version (*NE5532*) in an 8-pin package did a lot for the *5534*'s future popularity and utility. Today, *5534* and *5532* klones are widely second-sourced and cost below 50p (80¢) in manufacturing quantities.

The *TL071* and *LF351* mentioned in part one had come into widespread use with audio manufacturers by the early '80s. The introduction of 8-pin dual (*TL072* or *LF353*) and 14-pin quad (*TL074* or *LF347*) versions helped immensely. Particularly if you were designing graphic equalisers or active crossovers. They were also a must for 'analogue computing', alias the sidechains of compressors and other processors as well as supervisory circuits, where the *NE5534* was unsuited as well as being too pricey. The first dual op-amps had 14 pins and not much standardisation. Having no room for null (DC trim) or comp (compensation) pins to confuse matters all subsequent 8-pin dual and 14-pin quad

ICs have followed the leadout pattern established in the mid '70s by Texas' *TL* (and Nat Semiconductor's equivalent *LF*) series of op-amps.

Compared to discrete transistors where every conceivable leadout permutation occurs to frustrate manufacturers, an apparently accidental (or am I being too cynical?) act of standardisation has made it reasonably easy for different dual and quad op-amps to be tried out and/or substituted to facilitate production or upgrade the performance. Or retain existing performance while maintaining or reducing cost—all without changing the PCB pattern. The same is broadly true of all 8-pin single op-amps, except that the (normally unused) null pins on some devices are used for frequency compensation for others. In turn, it's not unheard of for adventurous, technically adept console owners to perform IC upgrades, particularly in the USA.

In the early '80s, National Semiconductor brought out an 'improvement' of the *LF351*. *LF411* had lower DC offset, achieved by alterations to the input and output bias circuitry. For the most part, the circuit is identical but some processes (the subtle bit of the 'circuit' they don't tell you about) would have been improved or tightened. The maker then apparently rationalised the *351*'s production by deriving them from batches of *441*s, which had less than 'A' grade DC offset specifications. The explicit data sheet specifications were maintained but the improved DC somehow altered the sonic performance. Along with Texas' competitive pricing, it may explain why Texas' Bi-FET op-amps have come to dominate budget (and not so budget) audio equipment where *5534*s and *5532*s are 'too good' or unsuited. The early '80s also saw the arrival of digital audio, opening up new but stringent applications for op-amps, as ADC and DAC interfaces. But devices that would routinely meet the special requirements were still being developed. An early example giving the rapid settling with impulse signals and high slew rate capability (>50 V/μs) needed for accurate A/D and D/A conversion was National Semiconductor's *LF400C*, introduced in 1982.

## Advances in noise reduction

In 1981, Precision Monolithics (based in 'Silicon Valley') had introduced something comparable to the *NE5534*, in the shape of *OP37*. PMI had previously excelled in making op-amps featuring

high DC precision and low noise for military, scientific and industrial instruments. They also published detailed data sheets that charted more facts than the competition. The *OP37* was the work of George Erdi, who had been designing ICs as long as Bob Widlar. It was 1 to 3 dB quieter than the *NE5534* (especially below 100 Hz) and unlike its rival, it could be used in high impedance and/or direct-coupled circuits. The *NE5534* can't because it 'pulls' a high bias current as a consequence of its low noise input transistors. The high current produces a correspondingly high voltage offset when the circuit resistance (through which the current is forced to flow) is high. Bias current compensation was pioneered by Bob Widlar to reduce offset in high impedance circuits in the late '60s. To allow DC precision to co-exist with large-geometry, low-noise input devices, Erdi devised a refined bias-current cancellation scheme that didn't defeat the object of the *OP37* by contributing excess noise. *OP37* also gave the wide bandwidth needed for quality audio and was later available in dual (*OP271*) and quad (*OP471*) versions. Sadly, it lacked the *NE5534*'s capability to drive 600 Ω at high levels (>+20 dBu), so it couldn't serve by itself as a pro-standard output stage.

In 1982, a new company was formed in California's Silicon Valley, to manufacture precision ICs. Linear Technology was founded with a new grouping of successful monolithic designers recruited from the giants of US IC manufacture. Linear's first step was to produce not klones but upgrades of other makers' op-amps and voltage regulators. George Erdi had joined and by 1983, LT had launched the *LT1037*, an upgrade of the *OP37*. The *LT1037* was slightly quieter, had tighter DC specifications and some irregularities with linearity at high frequencies had been fixed. In 1984, Derek Bowers (an expatriate keyboard player who graduated from the University of Sheffield with a BSc in Semiconductor Physics) devised an elegant compound IC, which combined two op-amps, large geometry transistors and a current source. Using a combination of current and voltage feedback, it squared a variety of engineering circles, combining a fuss-free, true balanced input with exceptional bandwidth, even at the high gain settings needed for mic amps. The original circuit topology could employ low noise, bipolar input transistors without the usual setbacks. It made its debut as PMI's *AMP01*, a high gain differential or 'instrumentation' amplifier IC, which was as quiet as an *NE5534*. Later, the same topology was adopted by SSM, who were then a small Californian manufacturer of specialist analogue ICs for electronic music. With large geometry, low noise (1.3 nV √Hz) devices at the front end, the *SSM2015* was 10 dB quieter than the *NE5534* (4 to 5 nV √Hz) and offered a realistic transformerless balanced mic input for less money than esoteric devices like the late Deane Jensen's *JE990*, a high specification op-amp made from discrete components.

By 1986, it was Linear Technology's turn to break the noise barrier. George Erdi's *LT1028* was the first monolithic op-amp to compete with exotic discrete transistors (like *LM394* and *MAT01.2*) for ultimate microphone amplifiers. The *1028* yielded a noise floor, which at 0.85 nV √Hz, the same as a pure, 50 Ω resistor and less than the thermal noise produced by most dynamic mics' own coil resistance. The *1028* also had a very low LF noise corner: compared to other op-amps and most discrete transistors, its midband noise spec remains true down to subsonic frequencies, below 3 Hz. The *1028*'s main problem

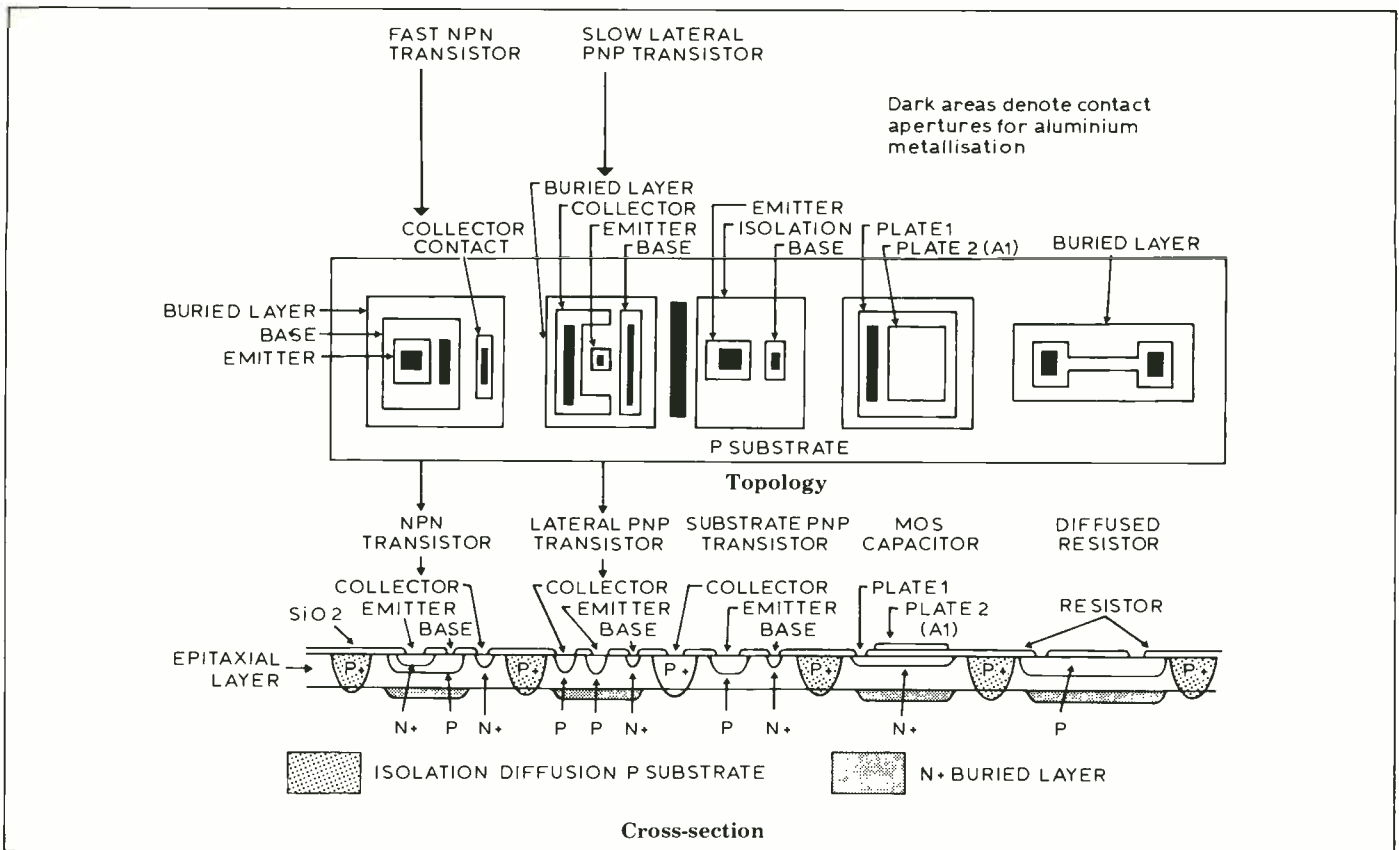


Fig 1: Structures of various components formed in the junction-isolation process

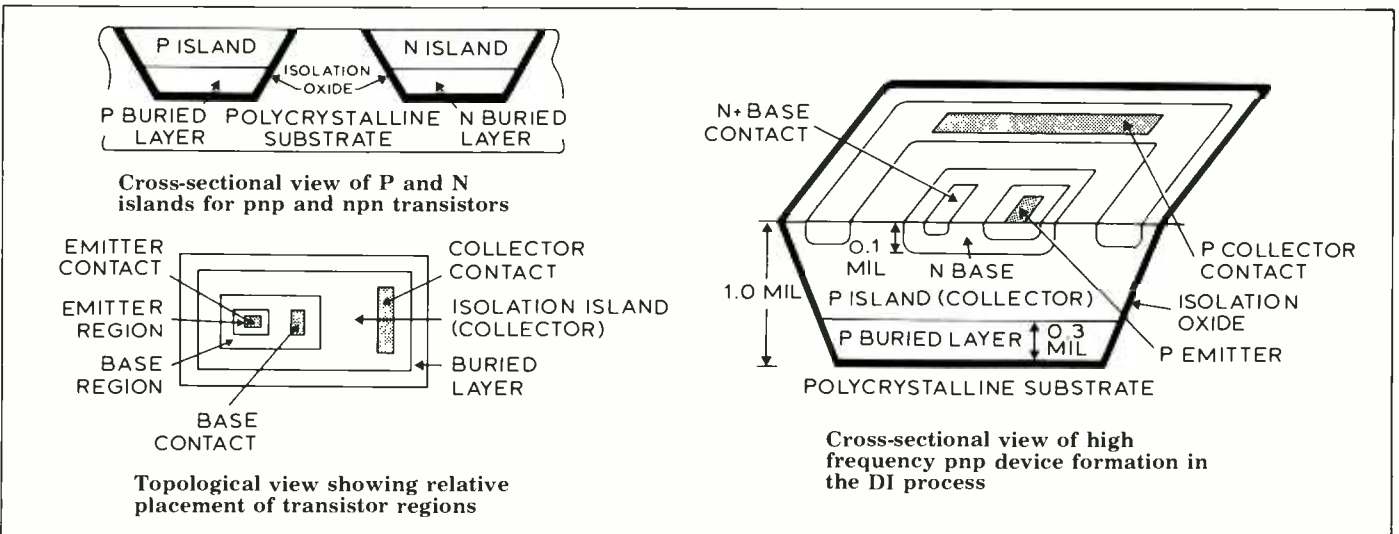


Fig 2: The high frequency process

was that it was a single op-amp and you couldn't use one on its own to create a balanced input without trading off its low noise'. At the same time, the specialisation required to attain such low noise had made the 1028 less of a universal building block than is usually the case, even with high performance op-amps. In 1987, SSM replied with their *SSM2016*, a development of the *2015*. Noise was squeezed down to  $0.8 \text{ nV} \sqrt{\text{Hz}}$ , and the new IC could operate on supply rails up to an unprecedented  $\pm 36 \text{ V}$  and drive into  $600 \Omega$ . These developments were ignored by highly cost-conscious console manufacturers. The new breed of super low-noise ICs may have cost a fraction of the money you'd need to buy a decent input transformer, yet they were still too costly when you could 'get away' with hanging low noise Japanese transistors onto the front-end of a *TL071*. Sadly, the comparison was evidently made on budgetary, not sonic grounds.

## Speeding up with DI

All the ICs discussed so far have been fabricated by a process of Junction Isolation (JI), where all the component 'parts' are diffused onto a common p type substrate (Fig 1). Until very recently, it has meant that op-amp designers have had to work with one hand tied behind their backs, because the fabrication of pnp transistors on the same substrate as npns is generally limited to lateral kinds. They are, frankly, bodes, a take-it-or-leave-it transistor with an abysmal current gain ( $\times 0.5$  to  $\times 10$ ) and miniscule bandwidth, often below 3 MHz. With few exceptions over the past 25 years, IC designers have had to live with the handicap, grinning. As a result, op-amp design has involved complicated manoeuvres and immense ingenuity to create quasi-symmetrical

circuits with npn devices alone; or else put npns in places where they couldn't do much harm.

Harris, another of the US-based high-performance IC op-amp fabricators, had a different approach altogether. Using a process they'd pioneered in the '70s called Dielectric-Isolation (where a series of mutually insulated layers are built up on the IC substrate shown in Fig 2), they were able to design circuits with almost matched npn and pnp transistors and much enhanced VHF performance. The outcome was a series of exceptionally fast slewing, wide bandwidth op-amps, which had applications in DACs and ADCs, as well as video. Harris' *2500* series was introduced in the mid '70s. An enthusiastic user at the time was the respected US console manufacturer Harrison (the inferred relationship is assumed to be purely coincidental!). By today's standards, the *2525* and its relatives weren't the quietest op-amps nor did

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they boast DC precision but along with high slew rates. They gave high drive capability and some models (eg 2640) could operate from high voltage rails, up to  $\pm 40$  V. Up to now, ordinary op-amps had been process-limited to sustaining  $\pm 18$  to  $\pm 22$  V at best.

In 1985, Harris introduced HA5137, which had the benefits of 10 years experience with DI (not to be confused with Direct Injection), together with low noise comparable to NE5534. Today, Harris' DI process can produce pnp and npn transistors with bandwidths of 400 and 600 MHz respectively. Since Harris' design rights expired in the mid '80s, small-scale fabricators like Elantec have gone on to exploit the DI process, second-source Harris' older op-amp designs, and bring prices down.

## The J-FET revolution

By the mid '80s, op-amps with J-FET front-ends moved on from the quantum advances made in the mid '70s. Analog Devices in Massachusetts developed AD711 and then AD744. Both were Unity Gain Stable (UGS) Bi-FET op-amps, with significantly higher slew rates, improved DC precision and wider bandwidth than the TL071. Meanwhile, Burr-Brown (one of the originators of the IC op-amp) were building J-FET inputs with the Dielectric Isolation process, yielding DI-FETs. In 1987, PMI brought out OP12 and OP44. Designed by IC veteran Jim Butler, they're examples of the new breed of 'super Bi-FETs'. Like the TL071, they have J-FET input transistors but bandwidth, speed (ie maximum slew rate) and DC precision have been increased and/or improved by one or more orders of magnitude. Their settling times were fast too, good enough to be used for 16 bit A/D and D/A converters. The dielectric isolation process, which was now used by several makers and which had initially been seen as a good hi-tech thing, was avoided, as PMI were concerned by the effects of the DI's parasitic capacitance, and the associated dielectric absorption<sup>1</sup>, which has the potential to degrade settling time and accuracy in the time domain.

In 1988, SSM joined with PMI. In the wake of the tie up, and not forgetting the downturn in global investment in military hardware, PMI has come to recognise the needs of pro-audio manufacturers, supplying 'audio' versions of many of their ICs at prices that reflect the relaxed DC specifications. DC precision is still considered immaterial for the vast majority of audio stages, providing the stage gain is low and/or that stages are linked together via DC blocking capacitors. More recently, Linear Technology has followed suit, offering LT1115 where the cost of the LT1028's DC precision can't be justified.

## Into the '90s

At the time of writing the IC op-amp business is going through a period of rapid change, with every major manufacturer introducing new products based on new processes. For the most part, they hinge on resolving old problems (like lateral pnps) and achieving performance objectives that were previously mutually incompatible, preferably without recourse to a relatively expensive process like DI, which use a lot of monolithic real estate.

In 1985, and not before time, Analog Devices

began to develop a process called 'CB' (Complementary Bi-polar). Analog Device's recently introduced 840 series has been its premiere, although the first complementary process (yielding matched pnps and pnps without recourse to DI) was developed at Bell Labs about a decade ago and original complementary technology has seen battle in dbx's VCAs<sup>1</sup>. Analog Devices has subsequently snatched the limelight in the past year with nine models ranging AD841 to 849. Of these, the AD845 is the first conventional op-amp that can operate at unity gain (0 dB) without needing frequency compensation, while simultaneously boasting a generous (100 MHz) unity gain bandwidth and slew limit of 100 V/ $\mu$ s.

National Semiconductor have recently launched something similar in their LM6118 and related models. The LM6118 employs VIP (Vertically Integrated pnp) transistors, to combine high speed (75 to 140 V/ $\mu$ s) with moderate supply current,

which at 7.5 mA, is little more than a 5534 draws. Meanwhile, Texas, who have been content with producing TL071s for the past 14 years, have also been busy developing new processes. In the interim, some 5 years ago, they developed LinCMOS, a series of op-amps with very low power consumption and somewhat downgraded audio specifications, which have nonetheless been a godsend for designers of battery powered systems, notably portable mixers and radio mics. Then in the past year, TL071 has been upgraded by the TL051, for improved DC precision and a slightly higher slew-limit. Signal and power supply breakthrough within the IC package has also been reduced by redesigning the layout. All this has come without significant extra cost. Texas have gone on to develop their own proprietary process yielding fast pnp transistors, called Excalibur. The new ICs are suffixed 'TLE' and provide a combination of speed, low noise, high output drive and DC precision that was

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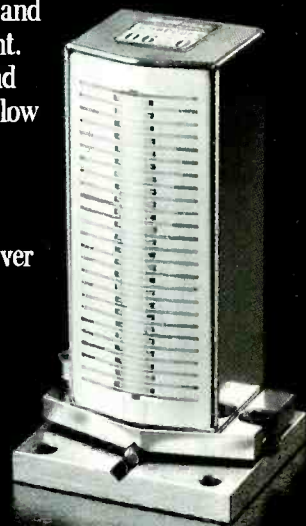
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TABLE 1 Tested op-amps

Model No	Maker	Year of introduction	Typical slew rate limit	Typical 1 kHz noise voltage density	Minimum stable gain
<b>Industry standards<sup>a</sup></b>					
NE5534	Signetics	1977	13 V/ $\mu$ s	4.5 nV $\sqrt{\text{Hz}}$	10 dB/ $\times 3$
TL071	Texas	1976	13 V/ $\mu$ s	18 nV $\sqrt{\text{Hz}}$	0 dB
LF351	National Semiconductor	1977	13 V/ $\mu$ s	16 nV $\sqrt{\text{Hz}}$	0 dB
<b>Industry standard-direct upgrades</b>					
SSM2134 <sup>a</sup>	SSM/PMI	1989	13 V/ $\mu$ s	4.5 nV $\sqrt{\text{Hz}}$	10 dB/ $\times 3$
TL051	Texas	1989	19 V/ $\mu$ s	19 nV $\sqrt{\text{Hz}}$	0 dB
<b>Low noise bipolar (for microphone and summing (mix) amps)</b>					
HA5137	Harris	1985	20 V/ $\mu$ s	3.3 nV $\sqrt{\text{Hz}}$	14 dB/ $\times 5$
HA5221	Harris	1989	25 V/ $\mu$ s	3.4 nV $\sqrt{\text{Hz}}$	0 dB
LT1007 <sup>b</sup>	Linear Technology	1983	2.5 V/ $\mu$ s	2.5 nV $\sqrt{\text{Hz}}$	0 dB
LT1037	Linear Technology	1983	15 V/ $\mu$ s	2.5 nV $\sqrt{\text{Hz}}$	14 dB/ $\times 5$
LT1028	Linear Technology	1986	15 V/ $\mu$ s	0.9 nV $\sqrt{\text{Hz}}$	6 dB/ $\times 2$
LT1115 <sup>c</sup>	Linear Technology	1989	15 V/ $\mu$ s	0.9 nV $\sqrt{\text{Hz}}$	6 dB/ $\times 2$
OP27 <sup>d</sup>	PMI	1981	2.8 V/ $\mu$ s	3.2 nV $\sqrt{\text{Hz}}$	0 dB
OP37	PMI	1981	17 V/ $\mu$ s	3.2 nV $\sqrt{\text{Hz}}$	14 dB/ $\times 5$
SSM2016 <sup>d</sup>	SSM/PMI	1987	9 V/ $\mu$ s	0.8 nV $\sqrt{\text{Hz}}$	10 dB/ $\times 3$
TLE2037	Texas	1990	7.5 V/ $\mu$ s	2.5 nV $\sqrt{\text{Hz}}$	14 dB/ $\times 5$
<b>Fast Bi-FET or Bipolar (for line level stages, buffers and D/A)</b>					
AD744	Analog Devices	1986	75 V/ $\mu$ s	18 nV $\sqrt{\text{Hz}}$	6 dB/ $\times 2$
AD845	Analog Devices	1988	100 V/ $\mu$ s	25 nV $\sqrt{\text{Hz}}$	0 dB
OPA606	Burr-Brown	1986	35 V/ $\mu$ s	12 nV $\sqrt{\text{Hz}}$	0 dB
HA2525	Harris	1978	120 V/ $\mu$ s	85 nV $\sqrt{\text{Hz}}$	10 dB/ $\times 3$
EHA2525 <sup>e</sup>	Elantec	1986	120 V/ $\mu$ s	-	10 dB/ $\times 3$ <sup>f</sup>
HA2548	Harris	1989	120 V/ $\mu$ s	8.3 nV $\sqrt{\text{Hz}}$	14 dB/ $\times 5$
OP42 <sup>g</sup>	PMI	1987	50 V/ $\mu$ s	13 nV $\sqrt{\text{Hz}}$	0 dB
OP44	PMI	1987	120 V/ $\mu$ s	13 nV $\sqrt{\text{Hz}}$	10 dB/ $\times 3$
SSM2131	SSM/PMI	1989	40 V/ $\mu$ s	13 nV $\sqrt{\text{Hz}}$	0 dB

#### Notes

<sup>a</sup> are improved 'second-source' devices (see text).  
<sup>b</sup> are compensated (UGS) versions of the device listed on the line below.

<sup>c</sup> is an audio version of the 1028 (see text).  
<sup>d</sup> is a compound monolith. All other devices are 8-pin singles.

previously considered unrealisable. Several models are recognisable as upgrades of Linear Technology parts.

Analog Devices' new family includes some trans-impedance op-amps, eg AD846. Their characteristics make them especially suited to ultra rapid settling I to V conversion at the output of audio DACs'. Current-mode op-amps are closely related and have received a lot of coverage recently<sup>6</sup> as they've become more commonplace. With current feedback, the amount of loop gain for error-correction remains almost constant up to very high frequencies, reducing the scope for RF intermodulation. However, the application of current-mode op-amps in everyday audio circuits won't happen overnight (even if the benefits are relevant) owing to the need to re-arrange all kinds of EQ, filtering and de-emphasis topologies, to meet a completely new set of operating and stability rules.

Over the past 18 months, PMI and SSM have taken a different approach, developing a series of specialist ICs that are purpose-designed to meet the needs of high performance audio. Examples include SSM2017, an 8-pin 'minimal' version of the 2016 described earlier; the 2141, a balanced output stage; and 2142, a one op-amp balanced line input with integral, close tolerance resistors. The SSM2134 is SSM's own upgrade of Signetics' 5534, with improved DC performance.

## Introducing the evaluation

Most op-amps cost under £5 (\$8.00), and the most used varieties cost under 50p (80¢), yet the specifications and technical data that accompanies them is often more detailed than the technical data supplied with mixing consoles containing hundreds of ICs. The standards of technical accuracy in op-amp makers' data sheets is unquestionably high. However, the charting of specifications of interest to audio are either

sporadic or more commonly, absent. As with audio equipment manufacture, some factors or parameters that are omitted are often 'not so good to know', while others are subject to wide and often unspecified tolerances. Some makers cite worst case figures (so real ICs are always better) whereas others only quote 'typical' figures. Will the clones (second-source op-amps) meet their implied specifications? The remainder of this series is dedicated to charting the results of audio measurements contrasting these with subjective data and explaining the ramifications, leading to the first global account of op-amp behaviour since Walt Jung's seminal work<sup>7</sup>. Table 1 categorises the op-amps being tested. Due to some late arrivals, not all the devices feature in all of the tests. □

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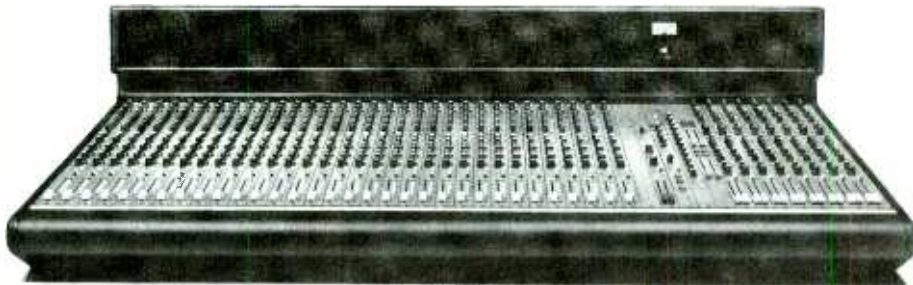
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Next month the series concludes with measurement results and a reconciliation.

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First, it seems to be the right time to take a look at several factors currently affecting and effecting the quality of life for audio practitioners. Secondly, it is equally time for audio people to clean up their collective camps and deal with issues of hygiene, pride and health. So you might say this column is dedicated to all these and other little 'nits' that singly do not constitute a major issue but which collectively impact all of us for the worst.

Nobody asked me but it really is time that audio people began to challenge the relatively low esteem with which they are held both in and out of the audio industry. The place to start is for some of us to discover the magic of underarm deodorant, matching socks and clean clothes. I even suspect that clean hair has some redeeming social values. Now I do not care if someone wants to look like the front window of a used auto parts store in Slough. But please, let's look like a clean auto parts store. The in-look among some audio practitioners is a cross between the homeless sleeping on grates off New York's Lexington Avenue and those who have just paid Thatcher's Poll Tax. It is not flattering and may indeed be one of the principal reasons that audio takes such a back seat to all other elements in production. At a recent production meeting, the representatives from the various crafts all looked like they had been sartorially corrected on Saville Row while the audio representative looked and smelled as though he were in search of the Zen enlightenment of Satori via the streets of Billingsgate fish market.

Now the point here is not to be randomly critical of our industry and those in it but rather to stave off the persistent attacks of those who are critical of audio and audio practitioners. If we look and act like working professionals then we will be treated and hopefully compensated as such. This is not to say that touring sound techs should wear three piece suits on the road with the Rolling Stones but it is fair to say that there is a middle ground and it probably is time for many of us to realise that we are not 18 years of age anymore and we probably shouldn't dress as if we were.

Nobody asked me but it seems that on-the-job loyalty among technical types in audio has slipped dramatically in the Western World recently. And why shouldn't it have slipped. Audio people remain the least well compensated for any technical job performed in the entire technology community. In addition, the current trend towards corporate consolidation has blown the morale for many an employee who suddenly finds his or her comfortable niche for the last 10 years has been eliminated.

In the case of audio design engineers, the recent climate of mergers, corporate takeovers, consolidation and the odd bankruptcy has left its mark on employee attitudes. The old concept of a job for life has fallen by the wayside for most engineers—not just the audio types. What makes that so remarkable is the fact that engineering

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Martin Polon

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## A few gripes are aired by our US columnist

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was a profession that was relatively 'bulletproof', historically, to the corporate mania for change. An audio engineer would sign on with a manufacturer out of college and stay the course 'until the gold watch came'. Today, it is not unusual to find an audio engineer who has had eight jobs in 15 years. Engineering turnover in the United States varies from a low of 10-11% in the Pacific Northwest to a high of nearly 20% in parts of New York state and in New England. Turnover in England is hovering around the 12% figure. Overall, nearly 200,000 have lost their jobs in the entire high technology sector since mid-1988 in the relatively interchangeable English speaking technical world of the US, Canada and the UK.

Other, non-certifiable audio practitioners have experienced similar problems. Engineers in the movie industry and television programme production have lived for years with the fallow period of the year known as the 'hiatus', when there is little or no production activity.

Audio personnel working live theatre or concerts/arenas have long known the term 'on the bench'. Workers who install sound systems in new buildings or renovate systems in existing facilities have 'swung with the punches' as the overall climate for the construction industry swells and then ebbs. But the fear of your employer going into bankruptcy or selling out has never been stronger according to many workers and leaves nagging doubts for all concerned.

The problem for many is that they are drawn into the audio field by a strong positive motivation—they love what they are doing. They get into a good job and stay in it for 17 years and then they hit the streets at 42. They find very quickly that many employers in live sound, music recording and other related venues would much rather hire a 25-year-old kid than make use of an older professional. The kid can be paid minimum wage or thereabouts. In many cases, the audio pro on the street has not taken care to commit to retirement plans or other kinds of financial planning for the future. The bottom line has to be that each person must take responsibility for planning his or her own future or no future will be available when the time comes and the money doesn't.

NAB—the big show! Who would have thought it? Nobody asked me but if I were you, I would mark 1990 well in your calendars for it is the year when the audio/video reunion captured the imagination of the audio industry. NAB has become the big show for audio because the future action in the audio business is intimate with the video side of

things and video hangs out at the NAB. More specifically, the AM, FM and TV broadcast community from the entire world goes to NAB: the movie, television and post-production shakers and movers; audio/visual and industrial TV; government agencies and bureaucratic entities; individual TV station managers and engineers; television networks and cable operators; schools and universities; the list is endless. This year's NAB show in Atlanta drew just over 50,000 attendees of whom more than 6,000 registered with international credentials—all to view in the range of 750 exhibitors and an HDTV exhibition covering 500,000 ft<sup>2</sup> (net) and to hear nearly 100 technical papers and US President Bush. No other show today can deliver such excitement plus a quantity and quality of customers, especially with available cash in hand.

This is not to say that the AES show has been eclipsed *per se* but rather that it has come to represent other segments of the audio business considered by many observers to be as equally lucrative in the '90s as the broadcast and TV/film production/post-production marketplace covered so well by NAB. That the NAB phenomenon has just sort of happened by a kind of unspoken conviction is confirmed by the number of major audio makers at the 1990 NAB show with their full line of products and in many cases every member of the sales, marketing and design staff on the floor. Each manufacturing entity of its own just decided that NAB was the show to be at. A curious coincidence this time around.

Nobody asked me but isn't it time for the music and audio industries to actively support higher education in the areas of audio/recording programmes and audio/music business programmes? It is an international shame that is coming home to roost at the beginning of the '90s. There is little or virtually no support for academic efforts in providing our industries with the leaders of tomorrow. I know that sounds like a soliloquy of homological pap best delivered by Basil Rathbone as Sherlock Holmes to the friendly ear of the good Dr Watson, to the tune of a patriotic dirge while fighters with 'our boys' fly overhead on their way to get 'the Hun in the sun'. Even for our faithful columnist, a new high in pontifical fervour, eh what?

What is happening is that administration after administration has begun to, or already has pulled the plug on any number of audio programmes offered at 4 year colleges and universities. The consistent excuse for such academic gerrymandering is that if the audio industry cannot afford to support the educational process, neither can the educational community. The feeling held by most administrators is that such instruction constitutes professional training and must have the active participation of the industry being served. Other industries, in fact almost any other industry, services the educational infrastructure with money, scholarships, equipment and temporary instructional support. IBM encourages technological and marketing volunteers to take a sabbatical for 6 months or a year to teach within



their area of competence and sometimes without—on full pay, of course. IBM donates so much computer equipment to needy instructional programmes that one wag suggested that \$100 billion strong IBM donated more equipment than the total sales of all pro-audio equipment makers. If IBM's largesse matched just 1% of its yearly gross income, that would indeed be the case. Ditto the steel industry, the funeral industry, the chemical industry, etc. for similar patterns of support. Not audio and not records. Their heartfelt response is the traditional. 'Don't call us—we'll call you!'

**N**obody asked me but it appears that whole body damage to humans from music 'overdoses' remains one of the most obvious yet well ignored facts of life in the pro audio business. A forthcoming study in the UK will again call attention to the problem of hearing damage while underlining the obvious bent of EEC regulation in the pro-audio workplace. It's time to really begin to 'be careful out there'. High level sound damages hearing; it is also capable of damaging the body—especially if it triggers a major response by the nervous system infrastructure.

And while we are at it, it might be time to see if the concerns about electromagnetic energy and cancer have any roots in fact. Recent studies in the US, the USSR and the UK have highlighted the fact that those working in electronics and especially in telecommunications and broadcast services have a significantly higher rate of cancer and leukaemia than the general population as a whole. How this translates to audio remains to be seen but clearly a long, hard look is in order.

**N**obody asked me but it seems that the current spate of comments about the skill and commitment of unionised audio practitioners is a tad ill-

intentioned. For example, one wag suggests that the attitude towards all union audio staff should be, 'Forgive them, for they know not what they do'. Other examples of current humour include:

How many union audio men does it take to change a sound booth light bulb? Six... You got a problem with that?

How can you tell if a union audio man is dead?—The sweet roll falls out of his hand.

How can you tell if a union audio person is a woman?—If they are in the union, they're not female. (Ditto minorities, etc.)

What do you call a union audio man in a Giorgio Armani suit?—The accused, the defendant or the business agent, or all of the above.

What is Jesus Christ supposed to have said to the union audio people?—Don't do anything until I get back!

How can you tell the children of union audio staff?—They will be the ones sitting on benches supervising the other children in the playground.

Unionised audio workers are viewed as either the wellspring of professionalism in the industry or else as the proverbial bottom of the audio manpower barrel. Some of the jokes currently circulating, as those above do, focus on union audio operators. They are quite illustrative of the broad range of attitudes towards union

technicians, held within the industry. Whether these jokes are really accurate remains to be seen. Of course, as always with this column, this is all being done herein with good spirits.

But good spirits are not what marks these jokes to the outside world, as it were. It is time for the audio industry to accept those union operators that frequently do the same job we do. The union operators can enrich the activities of our professional societies, swell the ranks of our audiences and lecturers on new industry topics and provide us with useful operational insight on new equipment and techniques. To paraphrase an old saying, 'We have met them and they are us!'

**N**obody asked me but why has it become fashionable not to pay your bills for studio time and services? Is it an industry-wide perception that recording studios are actually commercial lending institutions, extending unlimited credit to all concerned? I would hope not since these days have not been good ones for the financial condition of many big studios. The studios are being stiffed in any number of ways. Bogus purchase orders, phoney companies, phoney bank executives, rubber cheques, theft of all equipment within a studio, etc. The answer is equally simple. Get at least half your studio charges paid up front and by certified cheques. You may lose some business with such demands but it is a lot better than giving away the farm.

**N**obody asked me but if high technology is no longer as profitable, what is paying the bills for the current spending spree in Japan? Green tea? The exploitation of high technology in Japan for ultimate export has made the Japanese people, as well as the Japanese industrialists, wealthy beyond their fondest dreams. Despite the threats posed by a plunging Tokyo stock market and the concomitant threat of a greater East Asian recession, the Japanese are consuming gold, diamonds, luxury imported automobiles and other symbols of a success so overwhelming as to appear incomprehensible to the Japanese themselves. Gold, once an ancient trading staple, has now achieved the status of a condiment. It is sprinkled on sushi, spooned into \$350 cups of golden 'java' or coffee. For the tired businessman whose only thoughts are to return to his incredibly expensive home 2 hours outside Tokyo, Takashimaya Department Store will sell packets of gold for seasoning.

The population of Japan is just 0.02% of the world population, yet it consumes in a year about 35% of all diamond sales, is the world's largest importer of gold, imports 80% of all Luis Vuitton handbags, brings in significant numbers of Mercedes, BMWs, Jaguars and Porsches (about 70,000) and spends \$18.5 billion on jewellery purchases. This is not to mention the Japanese passion for platinum, with about 52 tons of the precious metal entering Japan in a year. This is double the consumption of the US and Europe combined. Platinum finds its way into jewellery, eye glass frames and a myriad of other uses. According to current reports, at least it is not being wrapped around sushi—yet.□



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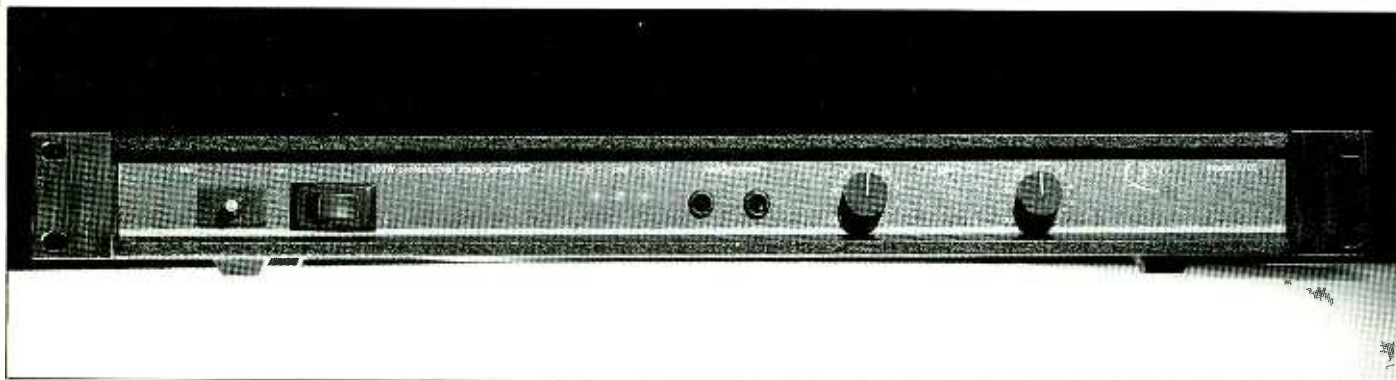
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# QSC 1100

Sam Wise gives a technical review of a compact power amplifier for use in recording and sound reinforcement

The QSC 1100 amplifier is a relatively new addition to the *Series One* range of power amplifiers from American manufacturer QSC Audio. This range is an offshoot of the heavy duty *Series Three*, first brought out about 6 years ago. The unit is marketed as a professional amplifier, for driving monitors in home, recording studio, or video post-production applications. Another use would be driving the HF section of multiway PA systems.

## Construction

The amplifier is housed in the obligatory black finished 1U rackmountable case. Construction is rugged. The output transistors are mounted to extruded heatsinks, which form the sides of the case. This extrusion continues forward and outwards to form the rackmounting ears, which are therefore not removable. A further strong aluminium extrusion creates a recessed front panel, which also serves to locate the case side extrusions. The panel label is plastic with printing on the reverse side, and so should last a

long time. The top and bottom/rear panels are of folded steel. The top cover is removed for maintenance by extracting nine self-tapping screws. All internal assemblies are removable from the top.

The overall effect is of sound construction and roadworthiness, and it is quite visually attractive. External detail is only let down by the cover mounting screws, which are countersunk type but stand proud of the cover surface.

## Internals

Most of the components are mounted on a 9x5 inch glassfibre single-sided circuit board with a high quality printed component legend. This is firmly held by a slot in the front panel and secured by three screws into the bottom cover. A rear panel mounted PCB containing the input connectors is secured by thoughtfully placed standoffs, ensuring there is no risk of damage due to forceful connector insertion. The remaining components, such as the toroidal mains transformer, are mounted directly to the bottom of

the case. All internal wiring is by Faston terminals or multipin connectors, making service access easy.

Close scrutiny reveals one or two niggles, however. Only one of the mains power connectors is protected by an insulating sleeve, being the 'live' incoming conductor to the circuit breaker. This terminal is perilously close to the sharp leg of a power transistor. A little vibration could allow the insulation to be cut through, producing a catastrophic short on the mains supply. Detail design changes would eliminate these small problems.

## Inputs and outputs

The amplifier power is connected via a captive mains lead of about 2 m in length. The case is internally earthed but unfortunately there seems to be no provision for lifting the audio ground. The mains section is protected by a thermally operated circuit breaker mounted on the front panel, set to trip at a continuous 1.2 A.

All audio connectors, except headphones, are mounted on the rear panel. There are three options for connecting audio inputs, two female 3-pin XLR sockets, two ¼ in stereo jack sockets, and a 5-way barrier strip. Thankfully, the XLR is wired pin 2 hot but for some reason the ¼ in socket is wired with the ring hot rather than the more logical tip. These connections are fed into an electronically balanced input, which of course can be driven from an unbalanced source without problems. The back panel is also equipped with an octal socket, which will allow the installation of an optional input transformer or other signal processing accessory. The function of the option socket is configured with an 8-way DIL switch block, accessed through the bottom of the case out of reach from the casual meddler. These switch functions are not labelled on the unit.

Another almost inaccessible switch converts the amplifier to bridge mode. This can only be selected when the amplifier is removed from the rack. This again makes the amp hacker proof but it may cause some confusion to the unwary. The documentation only drew attention to the presence of the switch, not its location and operation. It is actually accessed through a small hole in the base plate!

The outputs to the loudspeakers are via substantial 4 mm banana socket/binding posts. Unfortunately, they are so large and close

## Manufacturer's specification

**Continuous average output power (both channels driven):** All ratings over 20 Hz to 20 kHz bandwidth, 0.1% THD  
**Stereo mode:** 8 Ω—50 W; 4 Ω—70 W; 2 Ω—90 W  
**Bridged mode (mono):** 8 Ω—140 W; 4 Ω—180 W  
**Distortion (8 Ω):** THD, 20 Hz to 20 kHz at rated power shall be less than 0.1%; SMPTE-IMD less than 0.01% at rated power  
**Frequency response:** 20 Hz to 20 kHz, +0, -1 dB at 1 W  
**Power bandwidth:** 5 Hz to 100 kHz  
**Slew rate:** 14 V/μs  
**Damping factor:** 200 at 8 Ω  
**Dynamic headroom:** 2 dB at 8 Ω  
**Noise:** -100 dB below full output, A-weighted

**Sensitivity:** With gain control at maximum, 26 dB voltage gain; 1.0 VRMS for rated power at 8 Ω

**Input impedance:** 20 kΩ balanced or unbalanced non-inverting; 10 kΩ unbalanced and inverting

**Power requirements:** 110 to 125 VAC, 60 Hz  
**Power consumption:** 2.0 AAC at 120 VAC  
**Dimensions:** (whd) 19x1.75x8.7 inches  
**Weight:** 11 lb (5 kg) net; 15 lb (6.8 kg) shipping  
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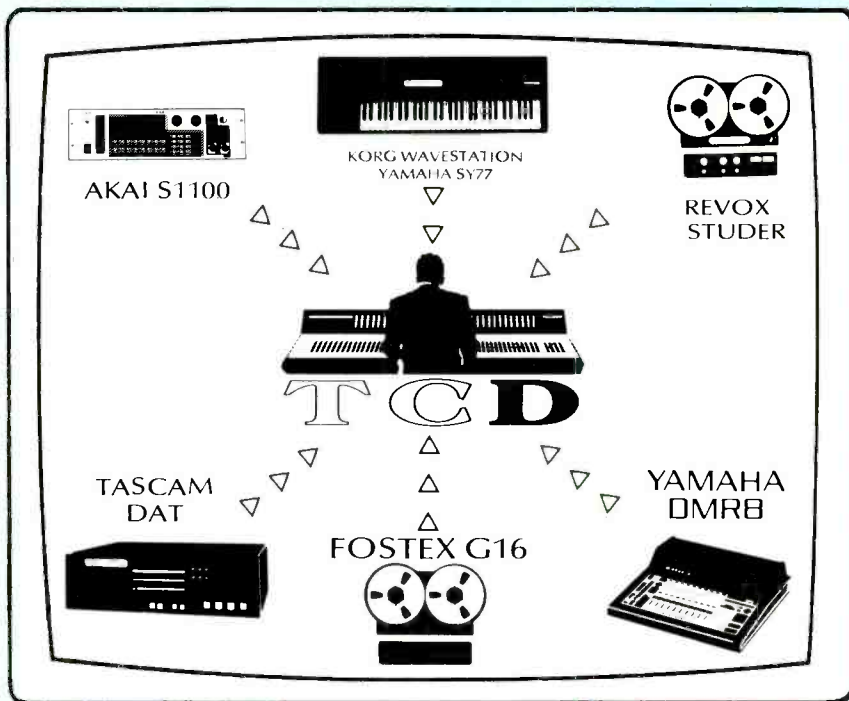
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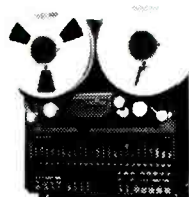
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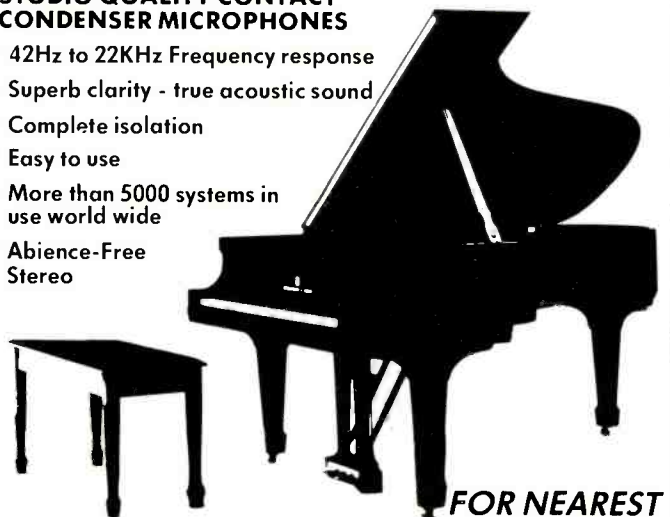
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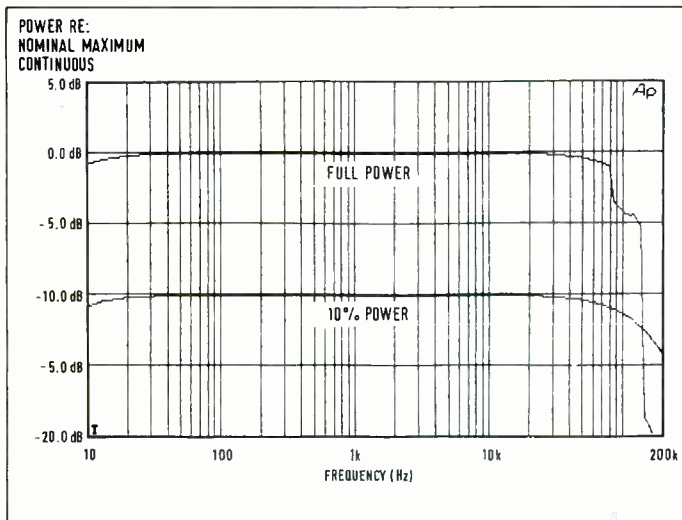
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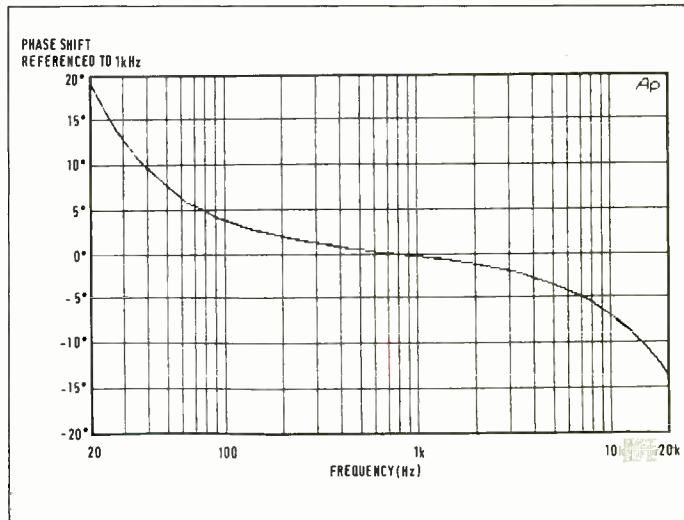
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**Fig 1: Frequency response channel 2, both channels driven into 8 Ω**  
Plot is calibrated ref rated output at 1 kHz



**Fig 2: Phase response both channels driven into 2 Ω at normal operating conditions (-10 dB ref rated output)**  
Channels are identical

together, that there is not enough finger space to tighten them up easily. The space shortage gets worse if the option sockets are in use. Internally, there is room to spread things out a little, should QSC decide to do so.

The front panel contains power switch and circuit breaker reset, two stereo headphone sockets and a gain control for each channel. The gain control is accurately calibrated from 0 to -24, with 0 dB corresponding to a sensitivity of 1 V RMS for rated power into 8 Ω. A green LED provides power-on indication while adjacent red CLIP LEDs flash on an overload on either channel.

## Circuitry

The circuit diagram supplied with the amplifier reveals fully complementary driver and output stages. One half of a dual high quality audio op-amp (NE5532) is configured as a differential input buffer, which then drives the other half, which is a voltage amplification stage via the channel volume control. There is a simple RC filter between stages to limit the bandwidth to around 200 kHz.

The power supply has separate secondary windings for the two channels, each with a bridge rectified unregulated DC output to its respective channel. Auxiliary circuits on the main PCB provide Zener diode regulated +/- supplies for the op-amps. A mute relay shorts out the input to the driver stage for a few secs after switch on, to minimise turn-on thump and prevent input signals from driving the amplifier until it has settled.

The circuitry also incorporates a simple but effective LED clipping indicator that monitors the voltage on the output of the driver op-amp. If the voltage exceeds a set level, the LED will light. The brightness of the LED reflects the severity of the overload. In tests, this LED faithfully indicated the clipping point of the amplifier at all times.

The circuitry is protected from long term

overload by the action of the main circuit breaker and also by an over-temperature cut out switch for each channel, wired in series with the transformer secondaries. Over-temperature in one channel will not affect the other.

## Sound quality

It never fails to surprise how different the sound from amplifiers can be. The 1100 was compared with a well known and recommended British hi-fi amp, driving a pair of small JBL monitors. This is the type of studio set-up that the amp would appear to be aimed at.

It was immediately apparent that the stereo soundfield was much deeper, wider and more stable with the QSC amp. It was also obvious that the QSC was better able to cope with the full dynamic range of compact disc recordings. The listening test was not formally controlled and the other amplifier was not measured, so I would not state that the QSC is the best but it is certainly good. This amp is totally quiet, having no cooling fan and no rattle and hum from the mains transformer.

## Technical performance

The amplifier turned in an impressive set of test figures. It withstood a whole day of being stretched on the test bench rack, without even so much as an overly warm heatsink by way of protest. The only problem arose due to the circuit breaker tripping at full output drive on both channels into 2 Ω. We suspect this is due to the failure of the designers to consider both the voltage and frequency differences in the transition to a European model and inter-European voltage differences. It was also noticed that the input filtering capacitor is rated at only 250 VAC, a bit close for comfort.

## Frequency and phase response

Fig 1 is typical of the frequency response, which over the audio band, deviates no more than 0.2 dB from ruler flat 20 Hz to 20 kHz at all power levels

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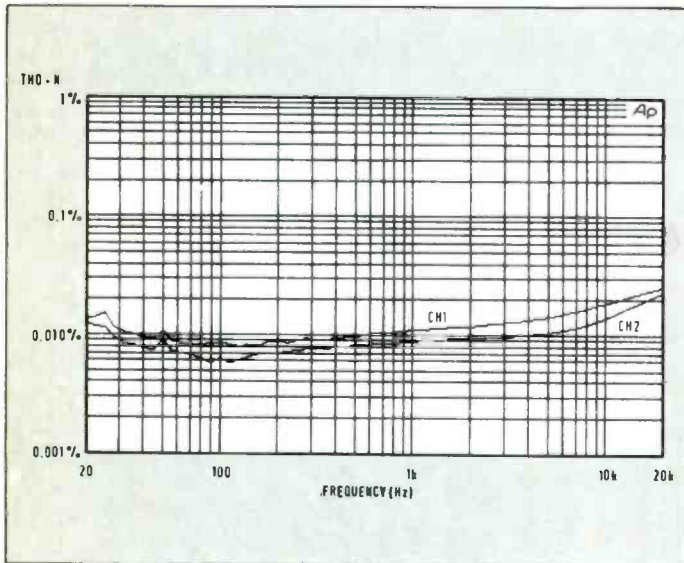


Fig 3: THD+noise response both channels driven into 4 Ω at rated operating conditions

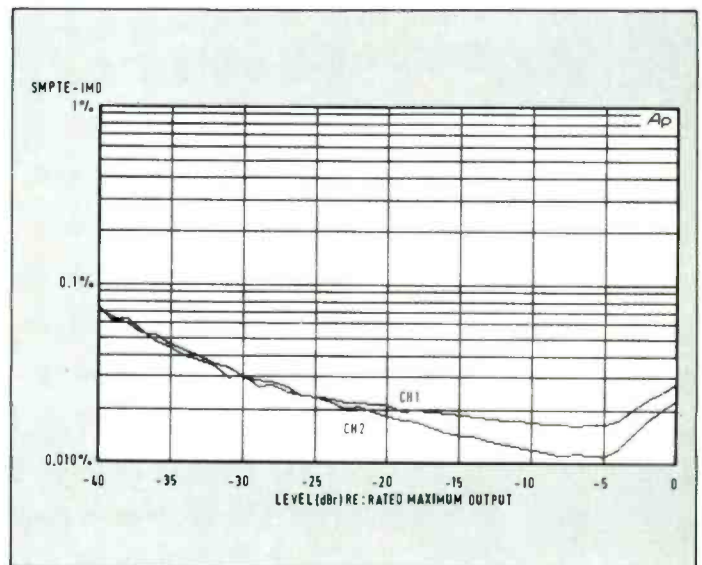


Fig 4: SMPTE 60 Hz/7 kHz performance both channels driven into 4 Ω VS output power  
0 dB=rated output

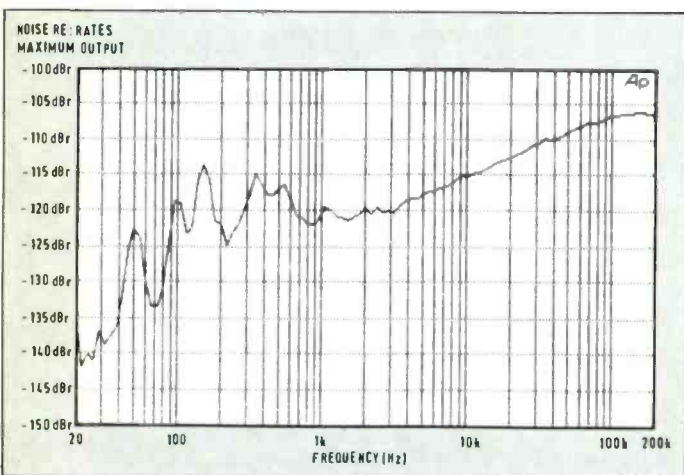


Fig 5: Noise referred to specified output level into 4 Ω (70 W) 1/2-octave swept filter. Volume control at full

**TABLE 1** Audio band noise measurements 22 Hz to 22 kHz measured dB below rated output power

Rectifier	8 Ω load		4 Ω load		2 Ω load	
	Ch 1	Ch 2	Ch 1	Ch 2	Ch 1	Ch 2
Unwtd avg	-106.3	-106.8	-105.2	-105.7	-104.6	-105.0
Unwtd RMS	-104.8	-105.7	-103.6	-104.5	-102.3	-103.6
Unwtd q-pk	-99.1	-101.4	-97.6	-100.2	-95.7	-99.5
CCIR wtd q-pk	-93.9	-95.8	-92.9	-95.0	-91.6	-94.3

into all (legal) load impedances. This is much better than specified. At full output above 80 kHz, there is an abrupt fall-off in response indicating slew rate limits. This is slightly less than the quoted power bandwidth of 100 kHz. So long as the amplifier is operated with a controlled bandwidth signal, no problem should arise from this. Heavy capacitive loading seems to have virtually no effect.

The phase response results as shown in Fig 2 are nearly identical for all power settings and loads, being a smooth curve from +18° at 20 Hz to -13° at 20 kHz.

## Distortion and noise

The amplifier was tested with a whole range of distortion tests. THD, CCIF, DIN, and SMPTE but nearly all the measured data was at the

60 Hz/7 kHz performance into 4 Ω, which slightly exceeds the specified 0.01% limit at just below 0.03% at rated output.

Noise measurements are as shown in Table 1. Assuming QSC have used an average or RMS reading meter and have limited themselves to audio band noise, the unit comfortably exceeds its 100 dB specified A-weighted dynamic range by over 8 dB. In any case, the results are better than current 16 bit digital audio products, confirming the amplifier's value for monitoring.

Fig 5 is a 1/2-octave sweep of the amplifier noise spectrum and shows that over the audio band, high frequency noise and low frequency mains harmonic products are about the same, with a dip in the 2 to 3 kHz region where the ear is most sensitive. A good performance for such a small package.

QSC have generally been conservative in their distortion and noise specifications, exceeding them only marginally on SMPTE measurements, with most results far better than they are claiming.

noise floor of the test meter/amplifier system. Only when the amp is on the verge of clipping does the distortion begin to amount to anything worth measuring. THD into 4 Ω at rated output measures better than 0.02% up to 10 kHz as shown in Fig 3. Fig 4 shows the SMPTE

## Input performance

The input impedance measures about 20 kΩ as specified. This is not affected by the level controls, which are located after the input buffer in the circuit.

Input overload occurs at +22 dBu, matching well with the normal maximum output levels from other professional equipment. When the level control is set for maximum sensitivity, maximum output power is reached for input levels from -1 dBu to +2.2 dBu depending on the load impedance. Assuming a nominal maximum sensitivity of +4 dBu is safe for all operating conditions. Once again, the QSC specifications are met.

Common mode rejection (Fig 5) is good on both inputs, being better than 75 dB down at 50 and 100 Hz, levelling off at just better than 50 dB down at the high frequency end.

The law and matching of the two level controls was checked and is shown in Fig 6. The two channels are so closely matched that the curves are nearly overlaid. This means that stereo programme material can be reduced in level by matching the front panel controls by eye and remain in balance—excellent. The calibrations are slightly out at the -8 and -12 dB settings but this is less important.

Crosstalk is shown in Fig 7 and is a bit disappointing, typically reaching -63 dB in the mid-band and low frequencies, while worsening at high frequencies. Increasing current by decreasing the load affects the HF crosstalk as well. These figures are acceptable if the amplifier is used for

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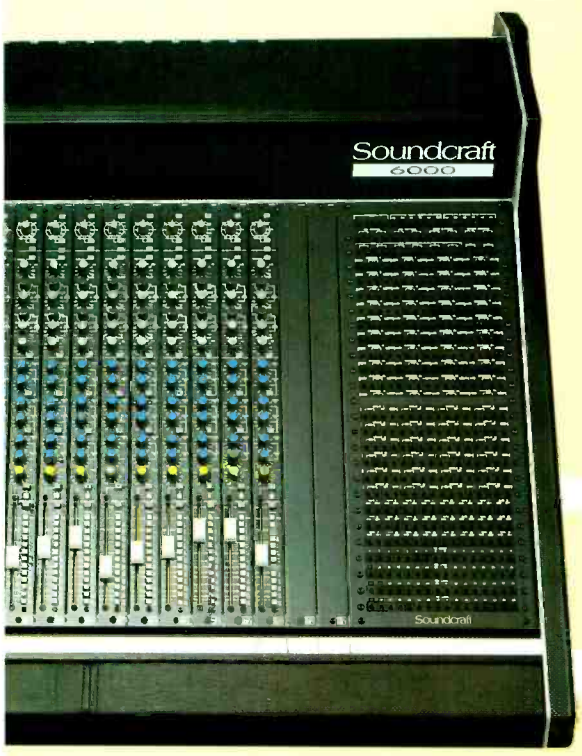
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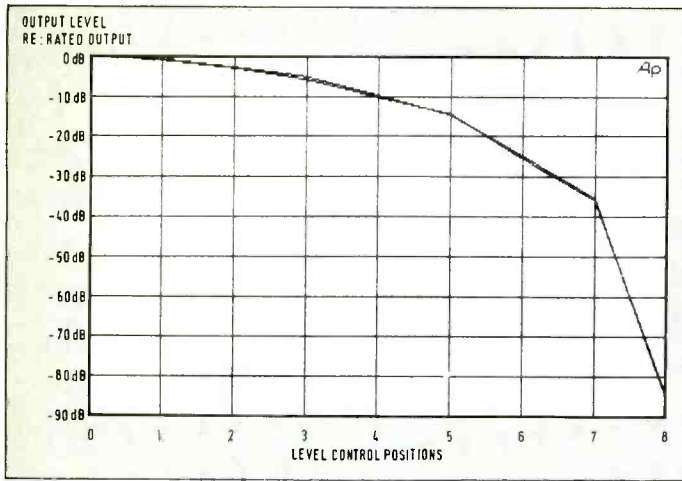
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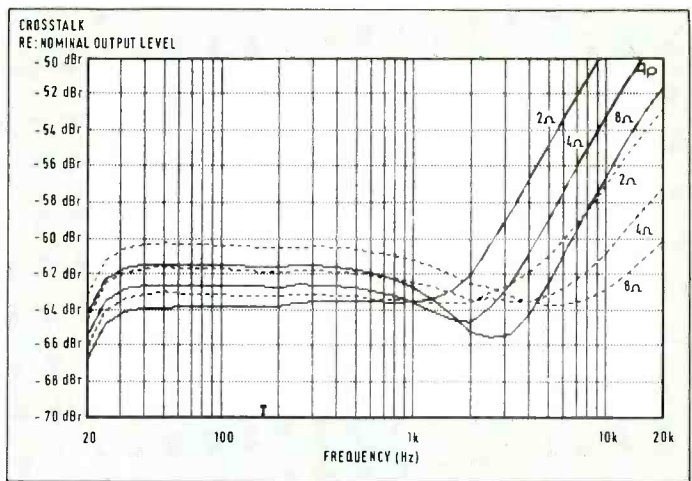
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**Fig 6: Level control law**  
 Setting: 0=0 dB 3=-8 dB 6=-24 dB  
 1=-2 dB 4=-12 dB 7=Unmarked  
 2=-4 dB 5=-16 dB 8=Off

These are the panel markings  
 Level in Off position is due to breakthrough not noise  
 Data 1—Ch 1; Data 2—Ch 2; note good matching



**Fig 7: Interchannel crosstalk**  
 Solid lines are A into B; dotted lines are B into A  
 A 1/3-octave bandpass filter is used  
 Measured in dB below specified output level

related signals as in monitoring but could cause some problems if the two channels were used for truly independent sources.

level is present for 20 ms, and the lower level for 480 ms, making a repetitive wave every 0.5 sec. Under these conditions, the amplifier dynamic headroom measured 1.7 dB compared to a specified 2 dB.

There was only one parameter that we were unable to verify according to RS-490. The continuous average power measurements must

0.04 Ω, giving a damping factor of about 200, exactly as specified.

## Output performance

Output power at 1 kHz is shown in Table 2. Note that the manufacturer's specifications are exceeded by about 1 dB for all loads at mid-band. At the band ends and driving 2 or 4 Ω loads, the maximum power drops but remains substantially better than specified.

The dynamic headroom specification used was not defined by the manufacturer, nor could we get an answer on this from the UK importers. Since most measurements conform to RS-490, however, we used this method. Dynamic headroom is defined there to be measured with a 1 kHz sine wave, alternating in level between a nominal level and a level 20 dB below that. The higher

**TABLE 2** Maximum amplifier power output levels (watts) measured at 0.1% THD+N, 1 kHz

Load (Ω)	Stereo mode One channel driven		Stereo mode Two channels driven		Bridge mode (mono)
	A	B	A	B	
16	36.1	36.3	34.9	35.1	
8	61.5	62.9	57.2	59.0	169.5
4	96.0	97.0	88.8	90.5	203.0
2	120.0	120.3	108.5	109.3	

operate for a continuous 5 mins. With a 2 Ω load, the overload circuit breaker would always trip after about 1 min. The amplifier was showing no signs of distress, so presumably, QSC may have miscalculated the trip level of the circuit breaker. However, there will probably be no nuisance trips for a real music signal at the rated power, since the average power will be much less.

Output impedance at 8 Ω was calculated as

## Conclusion

The QSC 1100 is obviously a well designed watt box that is built to last. It is packaged in an appealing variation of the 1U theme and built to a high standard. Not only does it look good, it sounds good too. Complaints are few but the phasing of the jack input seems peculiar and worthy of correction. No manual was provided with the unit, only a single two-sided sheet,

which is frankly inadequate to explain the dip and bridge mode functions to a less technical person.

The strength of the amplifier is in its all round quietness and freedom from distortion effects. It is a suitable unit to live in a quiet control room and to drive your nearfield monitors, which is, after all, what the manufacturers have designed it for. □

with AC mains plugs.

**4. Regarding 2 Ω operation...** Real world operation, even at 2 Ω will not require the amp to run at continuous full power. In regards to the circuit breaker tripping, the reviewer understands the absence of musical problems. Up rating the circuit breaker value would allow the possibility of the mains transformer burning during prolonged testing at 2 Ω, full power. This, of course would be a safety hazard.

**5. The lack of documentation...** It appears that the amplifier was unfortunately supplied to Sam Wise by our distributor without the normal accompanying information. The QSC 1100 comes with a complete 27-page owner's manual and the single sheet that was provided with the unit was only an addendum to the manual.

Greg McVeigh, QSC Audio Products

## Manufacturer's comments

I would like to thank you for the 1100 review which we feel is favourable to the amplifier but we would like the opportunity to try to respond to some of the criticisms that Sam had:

**1. Regarding the mains power connections...** Often what one person sees as a potential problem and what field failure rates indicate as a problem are two different things. Upon examination at the factory, we can see the connection the reviewer is questioning, but of literally thousands of units in the field, we have not had a failure due to that scenario.

**2. The 1/4 inch connector being wired with the ring hot...** As a practical matter, we feel that in most situations, it is of little importance to worry about overall amplifier polarity as long

as all of the speakers are matched, because the polarity of mics, mixers, etc may be unknown. For this reason we have used the safest or most stable assignment (inverting) for the input polarity of the 1/4 in plug to give users with unbalanced equipment the most stable connection without getting bogged down in very subtle nuances of reproduction. If the 1100 is being used by itself (as is usually the case for reference monitors), or is being used with other QSC amplifiers, this inverting connection will not be a factor.

**3. The five way binding posts are too close together...** We mount our speaker jacks on 3/4 in centres so that banana jacks can be inserted in the two 'hot' connectors for bridged mono applications. This spacing is fairly standard in the US where there is no conflict



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