STUDIO EQUIPMENT SELECTION

This Technical Note is written to provide an elementary overview of the equipment most frequently found in an on-air studio. A station should find the descriptions useful in responding to the queries of non-broadcasters who wish to understand the need for particular items. The objective of this list is to provide some recommendations of equipment and indicate some of the more cost effective choices available.

For every item listed, the reader (and author) can doubtlessly substitute a less expensive "consumer" model, which may appear to offer similar qualities. As in so many specialized fields, broadcast equipment purchased at the lowest possible price can easily become the most expensive. Broadcast conditions are very different from "consumer" ones, as they require continuous use of the equipment. Broadcast CD players often see more use in one week than a consumer unit would see in one year. Survival rates under these conditions are often parallel the price.

- **Studio Furniture**

The furniture that a station chooses should conform to the equipment requirements and not vice-versa. Certainly there is inexpensive standard furniture available from a number of sources, but it will not necessarily perform adequately. Determine equipment requirements prior to deciding on furniture requirements. Never purchase equipment without first determining a studio layout and equipment locations. Function, strength and durability should be foremost in the determination of furniture requirements, not appearance. A good furniture supplier will be able to provide drawings and configuration information based on your needs and equipment list. T.E. has some standard studio desk designs that can be adapted for many standard installations. Remember that the management will want to see some results from the money they put into the station and a professional layout and furniture package will really reflect well on the station.

- **Audio Console**

The audio console is the heart of the studio, providing switching, mixing and control over all of the various input devices. An audio console is truly a key item and represents a significant investment. One which has limited growth capability or which might become a maintenance problem would be a bad choice. There are dozens of manufacturers out there so ask questions and ensure that the console has been designed for radio broadcasting, is simple and functional to operate, is robust and reliable, is easy to maintain, preferably with local support and has the correct capacity and facilities to meet your needs.

T.E. (PNG) Ltd offer and support the Elan Audio range of broadcast consoles. These consoles are available in 5 levels of design, the Harrier, Kestral, Hawk, Falcon and Merlin.

Harrier is the top level of console and would normally be used in a main network studio or in a situation where a lot of tailoring for special functions is required. An application example is the TAB racing studios in Western Australia which required feeds and control functions to many race tracks. The Harrier is a modular, dual bus console normally supplied in a 16 Channel or 12 Channel frame which can be configured to suit individual requirements. The dual programme bus allows material to be recorded while a different programme is being broadcast. All normal professional broadcast mixer facilities such as 'On-Air' Light, Delay and Delay Dump switching, Loudspeaker Muting, remote machine control, telephone mix-minus and talk-back are provided, plus many optional tailor made facilities.

Kestral is also a modular, dual programme bus console available with 16 or 12 input channel frame sizes. This console is also used in main network studios or in regional studios requiring the facilities of dual programme bus and modular construction to facilitate maintenance. It is a natural choice for talks studios where a larger number of microphone input modules are required. Kestral consoles are used in PNG at NBC, FM100 and Catholic Radio Network studios in Port Moresby. Available input modules comprise Microphone(with optional Phantom power), High Level Line and Telephone inputs. High level inputs 1 & 2 are supplied with 5 input pre-selection switches provided on the riser to enable the selection of additional inputs. All normal professional broadcast mixer facilities such as 'On-Air' Light, Delay and Delay Dump switching, Loudspeaker Muting, remote machine control, dual telephone mix-minus and talk-back facilities are provided.

Hawk 12 is professional broadcast mixing console designed for 'on-air' presentation, news and general broadcast production. The Hawk 12 is provided with 8 High Level stereo inputs, a Telephone Hybrid input and three Microphone inputs. The high level inputs 1 & 2 also have 5 input pre-selection switches on the riser to enable the selection of additional inputs.

Hawk 8 is a smaller desk with 5 High Level inputs, Telephone Hybrid input and 2 Microphone inputs. Both desks use a minimum number of printed circuit boards with all interconnections using plugs and sockets. All normal professional broadcast mixer facilities such as 'On-Air' Light, Delay and Delay Dump switching, Loudspeaker Muting, remote machine control, telephone mix-minus and talk-back facilities are provided.

Falcon 10 is a professional basic broadcast desk for a small 'On-Air' studio or for use as a news or production desk. It has 5 High Level input channels, one telephone hybrid channel and two microphone channels. The first high level channel has 5 input pre-selection switches on the riser to cater for additional inputs. Normal professional broadcast mixer facilities such as 'On-Air' Light, Delay and Delay Dump switching, Loudspeaker Muting, telephone mix-minus and talk-back facilities are provided. Machine remote control functions are available as an option by installing an additional Printer Circuit Board.

Merlin is the smallest and most recent addition to the range of Elan Broadcast Mixers. It is still manufactured to the same professional standard as the larger mixers but has 6 channels and is intended for a very small community station, a school radio station or for a small news, OB or production facility. It has 4 High Level inputs that are designed to operate with unbalanced 300mV inputs from domestic style replay devices. In most instances, professional CD and tape recorders can still

be used (which we recommend) because this equipment is also fitted with unbalanced 300mV connectors. High Level channel 1 also has balanced input connection via RTS phono sockets. The remaining two Channel 5 & 6 inputs can be configured either as both microphone channels or as one microphone channel and one telephone hybrid channel with mix minus output. Basic broadcast features such as automatic speaker muting and 'on-air' light control are provided. All connections to this mixer are by standard plugs and sockets instead of screw terminal connections as in all of the other larger mixers.

All of the above mixers have announcer and guest headphone outputs, cueing, programme and 'off-air' monitoring and selectable phantom power on the microphone channels. All mixers have an external power supply and have distortion and signal to noise figures that exceed the requirements for professional broadcasting.

- **Turntables, Tonearms, Cartridges and Preamplifiers**

The days of playing vinyl recordings on air are all but over. It may still be worth having a professional record player in the Production Department to transcribe the odd record to tape, CD or Hard Drive. The most popular professional record player, containing turntable and tonearm, is still available due to the demand of the DJ in the disco market and it is the Technics SL1200 MKII. This unit matched with a good quality Shure or Stanton Cartridge will adequately meet broadcast requirements.

The magnetic cartridge requires an external preamplifier to increase the gain of the mixers line input channel and also to equalize the frequency response of the signal. Equalization is required to compensate for the equalization applied to the signal during the recording process and also to compensate for the constant velocity characteristics of the moving coil cartridge. Elan Audio produce a RIAA compensated stereo preamplifier for use with their mixing consoles.

- **Compact Disc Players**

There are consumer level CD players available that lack the features and longevity required for broadcasting. Much debate exists over whether it is better to purchase cheap consumer models and replace them annually (or more often), or to pay the initial expense and get a more durable broadcast model. Consumer models are unbalanced 300mV output and will not interface as well to professional balanced input broadcast mixers. We strongly recommend against consumer models as they are far more prone to failure and damage. When they fail, it is inevitably on the air, and the resulting stalls and/or skips embarrass both the DJ and the station. The current professional CD player is rugged and it's lazer is designed to play CDR/RW discs which is an important consideration these days. The professional CD player also has connections to extend the remote start and stop signals to the start buttons on the mixer.

Today, even Compact Discs are being played on air much less than a few years ago with the shift to computerized playout systems and music storage on hard disk. When the radio station relied on the CD for all of it's music requirements, CD cartridge players were highly recommended. The CD was locked in a plastic container, similar in size to a CD Jewel Case which plugged into the player thus totally protecting the disc from scratches and damage. The disadvantage was the cost of the cartridges, one for each disc. Typical of such players were the Denon DN-915FA and the DN-970FA cartridge CD players.

If the radio station is going to use computer storage and replay for the bulk of it programming, we recommend the Denon DN-C635 or, for small community stations, the DN-C615 CD players as these are robust and readily serviceable. They are tray type players and do not use the CD cartridge.

- **Tape Recorder/Players**

Reel-to Reel
This format is now rarely used in radio stations. Occasionally some archive material may need to be transcribed, but depending on the stations needs, it may not require a reel-to-reel recorder. If it is required, it would normally be located in the production area, were the material would be transcribed to CD or Hard Disk on a computer.

Cassette Analogue

The common analogue tape is not generally considered a professional format for broadcasting. However in Papua New Guinea, it has long been the media of choice for the consumer market, particularly for locally produced music and may be the only source of some such music available. Cassette tape is inconvenient to use on-air because of the difficulty of cueing, but, because of it's common usage, DJ's have mastered this to a high level. It would be advisable to transcribe cassette tapes in the production area to either CD or Hard Disk but there may well be the occasion when it will be required to be played on-air. Due to the international decline in popularity of the cassette, professional cassette recorders are becoming difficult to procure. We recommend either the Marantz PMD-502 single deck or the Denon DN-780R dual deck as the most suitable cassette recorders currently available. Cassette tape recording is still found as a robust and reliable field recording medium for interviews and news gathering. It is slowly being overtaken with solid state flash card recorders.

DAT Cassette
The DAT digital format has been popular with the recording studios and production studios for some time but is not so often seen now in broadcasting in PNG. Much like the Reel-to-Reel, it may be worthwhile having one machine in the production area, but most smaller studios would not require this. The same material can generally be requested to be supplied on CD these days. DAT is a high quality professional format, but in the tropics it has reliability problems due to the climate causing the tape to sweat and stick outside of an air-conditioned environment. The humidity can also cause fungus growth which ruins the heads of the recorder.

DCC Digital Cassette
This is a format that appeared briefly but was not popular in PNG.

Cartridge Tape
Cart Machines were a standard and indispensable part of the radio broadcasting industry up until a few years ago. They were frequently used for short segments such as commercials, station ID's or public service announcements. Currently they have all but gone the way of the reel-to-reel tape and can generally be relegated to history.

Mini-Disc
The Mini-Disc format is a consumer format that found favor in the broadcast industry, particularly for field recording and interviews. The machines are again becoming difficult to obtain and the manufacturers surge on to the next format of digital flash card recorders. Although a convenient and reliable format, it is on its way out and not recommended for new stations.

Digital Flash Card Recorders.

This is the new kid on the block and prices are still relatively high. They will be forced onto the market place by manufacturers reducing production of machines for the older formats. When used with computer audio editing, these solid state digital recorders provide the opportunity to record, edit and store the completed programme in the digital domain resulting in minimal quality loss. As there are no moving parts in the recording process, the reliability of these Flash Card Recorders should prove to be extremely high. Currently we would recommend the Edirol R-1 (about to be superseded) and the Marantz PMD-660 and PMD-670 (about K4,500) recorders. These models record digitally on removable Flash Cards with current capacity up to 4GB (although some recorders are still restricted to using 2GB cards). The recorders can record in WAV uncompressed format at the

expense of recording time or MP2/MP3 (and more to come) compression formats. The digital files can be directly downloaded to computer for editing and storage on hard discs or to be copied to CD.

- **Computer Editing, Programme Storage and On-Air Play Back.**

Editing

Most radio stations have now adopted some degree of computerized audio editing, audio storage and/or audio playout on-air. We recommend that you give this option serious consideration because it has many benefits to offer. In the production, a suitably equipped computer with a professional audio card and audio editing software can produce very efficient and high quality programme editing. This software can improve the quality of audio material by removing noise, correcting levels or applying precisely controlled limiting, frequency equalization or effects and producing extremely accurate editing. The resulting edited programme material can be recorded onto suitable media, such as recordable CD or alternatively stored on Hard Disk for replay by an on-air computer automation system. As the programme material remains in a digital format, from editing to replay, there is virtually no quality deterioration other than that caused by any compression algorithm applied to the waveform. A very intuitive, powerful and efficient audio editing package recommended by T.E. for radio production is Adobe Audition V1.5. This software can produce commercials, station ID's and stingers as well as edit news, sports and programme material, very quickly and only requires minimum training to get started. As the computer now becomes the heart of your radio station, it is strongly advised that you discuss your requirements with experts in this field to ensure that you have a correctly configured computer and a suitable professional sound card to produce professional and trouble free results.

HDD Storage and Automation

The next stage that goes hand in hand with digital editing, is computerized audio storage on the hard disc drive and automation of the on-air playback of the programme material. If you store all of your station's audio files on computer hard disc drives, it becomes very easy to control the music format that is played on the station and to operate the station under full automation in low traffic hours. There are many considerations to take into account when selecting automation software, computer hardware, professional sound cards and configuring the system to function reliably in a broadcast station. An effective, economical and powerful automation system that we recommend is BSIUSA Simian. All of this detail is beyond the scope of this brief article, but we would be happy to discuss and design a system for your station.

- **Microphones**

Choosing a microphone can be an intimidating task. Prices range from K250 to many thousands of Kina and a variety of confusing terms abound through this price range. There are directional and omni directional microphones, dynamic and condenser microphones. A directional microphone is especially suited for areas where background noise may be a problem – audience noise on a stage, equipment noise in the studio, echoes in a voice booth etc. The window in a studio can reflect the announcer's voice which would be picked up by an omni directional microphone. Dynamic microphones are constructed like a miniature speaker, the sound vibrations being picked up by a diaphragm and causing a voice coil to vibrate in a magnetic field. The small voltage induced into the coil provides the electrical output of the microphone. Condenser microphones comprise insulated thin foil plates mounted close together to form a condenser (or capacitor). A polarizing voltage is applied between the two plates via a high resistance. The sound waves cause the thin plates of the capacitor microphone to vibrate, changing the value of capacity and hence the potential across the plates. The voltage changes are amplified by a high impedance amplifier and provide the output signal from the microphone. A voltage supply is required for this type of microphone which is derived from the studio mixer. This voltage supply is known as a phantom voltage supply and is available from most professional mixers.

A wide variety of sizes and styles are available from many manufacturers. For budget conscious community stations we recommend Shure PG58 or PG57 microphones and for professional stations, the Shure SM7. Alternatives would be AKG 1000S, AKG 3000, EV RE-20 or RE-27. We would be pleased to make a recommendation for any specialized applications a station may have, such as live music or remote interviews. High quality microphones can mean the difference between night and day in broadcasting. A top model microphone will pick up brightness, subtlety and range in a voice that no amount of processing could hope to produce. But it will also set the station back several thousand Kina.

Microphone mounting in a studio will have to conform to the contents and desired functions of that studio. There are a variety of stands and booms available to match up with any need. We have available the K & M desk top boom arm stands with several mounting options. This type of mounting allows the microphone to be placed over the mixer, in front of the announcer and can easily be adjusted to suit individual requirements. A shock mount is also recommended for any sensitive microphone to prevent bumps against the boom from getting into the microphone pickup. Microphone mountings are required in all stations.

- **Digital Telephone Hybrid**

It is often required to connect a telephone caller to the studio mixer so that the caller's voice can be transmitted over the radio station. The digital telephone hybrid is required to separate the voice signals on the 2-wire telephone line into received audio (the caller's voice) which is connected to the input channel on the studio mixer and transmitted audio (the announcer's voice or station programme) so that the caller can be broadcast with minimum quality loss and can also hear the announcer to participate in the programme dialogue. The studio mixer is required to have a special telephone input channel and a mix - bus to enable the hybrid to be connected. In PNG the only form of telephone line connection available is a Plain Old Telephone Service (POTS). This device can also be used to send programme from the station to another station via a dialup telephone line. The quality of the connection is limited by the telephone circuit but it is an economical connection when only voice is required for sports or news for example. We recommend the Telos One digital hybrid for a single line or the Telos One Plus One if two telephone lines are required. More sophisticated means of programme transfer at much higher quality are available over a POTS circuit using equipment such as "Tieline", but this requires special expensive equipment at each end of the line.

- **Audio Processors**

Whenever one processes an audio signal they make changes to the original programme. Although this may be artistically incorrect, it is technically advantageous and necessary to compress the audio dynamic range, and limit the maximum volume level of the audio fed to the transmitter. Programme level variations are automatically adjusted by the processor so that the listener does not have to continuously adjust his volume level on the receiver. State-of-the-art audio processors offer very successful and sophisticated processing techniques, at a price.

Some stations equalize their audio in addition to compression. They may add bass boost for the additional "richness" of sound, treble boost for "brightness" or mid-range boost for "loudness". Please keep in mind that you can only equalize a poor audio so much. Excessive equalization can lead to listener fatigue and may not suit all of the material broadcast on the station, so my recommendation is to use it very sparingly and with care. Money spent on good microphones, consoles, sound cards and quality music library is better spent than on equalization of a poor audio feed. Make sure everything else sounds right before you process it!

In the case of an FM station, an FM processor MUST be used which applies pre-emphasis to the audio prior to limiting. The limiter is legally required to prevent the transmitter from over-modulating and exceeding the channel bandwidth allocated for the station. Many better class processors for FM stations include the stereo generator to produce a stereo MPX signal suitable for a composite Studio-Transmitter-Link (STL).

Compression of the audio dynamic range allows an increase in the modulation level of the transmitter and makes the station sound "louder" than others. Limiting the audio peaks allows the modulation level to be held higher, because the fear of sideband splatter and over-modulation on the transmitter with occasional volume peaks is eliminated. Compression and limiting provide an increase in the average modulation of the station which can be abused in a broadcaster's zeal for the "loudest" signal in the market. Done to excess the results can be quite unpleasant. T.E. recommends the Inovonic David III or the Omnia 3 FM processors and the Inovonics 222 AM processor. A limiter or processor is necessary for all stations.

- **Speakers**

Most audio consoles offer an external monitor or off-air position to allow the announcer to monitor both visually and audibly, the audio output of the station. The console operator should be the most critical of the on-air sound. Because of this it is highly recommended that a quality pair of monitor speakers be used in the studio. The critical aspect is not the size and power, but the clarity and accuracy. A quality pair of monitors such as Landmark LM-1 or Energy C3 cost about K3,500.00. Monitors designed for studios offer much more accurate reproduction of your sound.

The monitor speakers will require a separate monitor amplifier of studio quality such as the Elan Audio RMA-01 studio monitor amplifier. The amplifier may be preset and mounted in the control room rack outside the studio to avoid the monitors being used as a disco.

In budget conscious community stations we sometimes use self-powered bookcase type speakers which are somewhat less in performance than ideal. Monitor speakers are recommended for all studios.

- **Racks and Patch Bays**

Equipment rack mounting is incorporated into the studio furniture provided by T.E. to securely mount all of the equipment in the studio such as CD players, Cassette recorder, Telephone Hybrid, Programme Switches, etc.

In studio installations involving more than one studio, or where additional facilities such as OB Lines, STL's and patching flexibility are requited, a separate equipment rack or racks are provided to house all of the common equipment that does not require adjustment by the announcer. Typically this rack is mounted in a secure area to house patch jackfields, distribution amplifiers, delegation switcher, monitoring amplifiers, Studio Transmitter Link, audio processor, off-air monitoring receiver, OB lines, additional programme source equipment (satellite receivers), digital encoder for satellite uplink, modems etc..

All cabling to the Master Control Rack, studios and outside sources is normally terminated on a Krone Master Distribution Frame, which a flexible interface point allowing reconfiguration of the cable routing to allow for future development in the station. These facilities are recommended for advanced stations.

- **And Finally…**

The first step in designing is to determine how much money you have. Using that as a basis try to figure out what percentage will go to the studio and what will go to the music. If the studio is to be on air 24/7 you will need to cater for production facilities to record, edit and prepare programmes, commercials, promos, station ID's etc. You may require a separate facility for preparing news and sports programmes. Do not forget to allow a budget for your transmission equipment and the equipment or services to distribute the programme to the different centers in the case of a network. (*I will address the transmission aspects of a radio station in a separate article.*) This will of course, not be the easiest thing to do. It is best not to put any of these numbers in concrete. After you have a rough idea of the budget for your studio try to assemble a list of the types of equipment you want, in order of priority. It would be great if you could afford 2 DAT machines, a 24 track production Digital Audio Workstation, etc... , but realistically, you probably can't - at least not on day one. Even if you can, you might want to look at your staff critically and see if they can operate the equipment in an effective, careful and capable manner. If not, spend the money on more music instead. Here is some simple advice for designing your new studios : ASK FOR HELP! Don't be afraid to ask everyone in the industry for an opinion. Even if you ignore all of their ideas, you may find a few people who have more experience or can guide you through the process. Call T.E.(PNG) Ltd, we'll help (and we won't try to sell you gold plated equipment!), we've certainly got the experience but you have to give us some idea of what it is you are looking to achieve. Visit your local stations, call other broadcasters, try to go and see a few studios. The more information you get the more practically your final design will be. You are determining the future of your radio station with this design - Don't do it alone!

T.E. (PNG) Ltd

PO BOX 1388 BOROKO - PAPUA NEW GUINEA
PH: (675) 3256322 - 5 lines FAX : (675) 3250350
Website: www.tepng.com Email: wwilson@tepng.com

2006