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top brass

RECORDING BRASS & REEDS

Brass and reed instruments present some challenging problems to the recording engineer, whether played by soloists or sections. **Hugh Robjohns** offers some hints and tips.

Recording any musical instrument is a challenge if you want to capture a faithful rendition of the performance without distorting the tonal quality of the instrument or veiling it with undesirable mechanical noises. It seems to me that every instrument -- and I include the human voice in that description -- presents its own unique set of problems and solutions, and in this article I shall be looking at some of the techniques and pitfalls of recording brass and reed instruments, both as played by soloists and in sections.

As with any musical instrument, placing the microphone is much easier if you have an understanding of how the instrument works -- where the sound comes from, how it radiates from the instrument, and what its frequency and dynamic range is. So let's start with a brief look at the most common brass instruments to get a feel of what is involved.

The Brass Instruments

The full family of brass instruments as we know them today, including the cornet, trumpet, trombone, tuba, and euphonium, date from about 1850, by which time their designs had been optimised. The last major evolution was the invention of the valve as a means of introducing or bypassing sections of tubing and thereby allowing the performer to alter the tuning of an instrument whilst playing. Previously the only

means available was a slide (like the modern slide trombone), and although short-slide trumpets were popular in the 19th century, the valve offered a more practical solution.

The basic principle of the trumpet (and its cousins) is that blowing into the tube through taut lips sets up an audibly resonant vibrating column of air. Changing the tension of the lips and the air pressure allows different harmonic resonances to be stimulated, thus providing a limited number of alternative notes, with big gaps in the lower register and not all the available harmonics conforming to the diatonic scale. However, altering the fundamental length of the pipe (with valves or a slide) enables a full and accurate compass of notes to be generated. The tonal qualities of the instrument are determined by the metal alloys used in its construction, the shape of the bell and the bore size of the tubing -- the latter determining the balance of harmonics and the instrument's volume capabilities amongst other things.

A characteristic of brass instruments which everyone knows is that they are all very loud! However, their loudness varies with pitch, because it requires much more energy to force the tube to resonate at the higher harmonics. For example, measured at four metres, a trumpet can produce well in excess of 96dB SPL, and easily over 130dB within 0.5m of the bell! At low registers the quietest notes possible (without using aids like mutes) would be around 60dB SPL (at 4m) but high notes will not be less than around 86dB SPL -- the trumpet has about twice as much dynamic range at the bottom of its range than at the top. By comparison, a trombone is not only capable of around 5dB greater volume than a trumpet, but also has a wider dynamic range.

In terms of the frequency spectrum, brass instruments all tend to be rich in harmonics. For example, although the fundamental of a trumpet is centred around 1200Hz, it generates strong harmonic components beyond 8kHz for the upper notes, with the implication that the harmonic series continues well into the ultrasonic region. The harmonic balance also varies enormously with volume, the fundamental and first overtone remaining relatively constant but the upper partials exhibiting a much greater dynamic range. Thus the trumpet (see Figure 1 below) can sound quite mellow when played softly, but brilliant when blown hard.

The trombone, on the other hand, has its fundamental centred around 550Hz (see Figure 2), but can produce frequency components above 10kHz when played hard. When played more softly, however, the balance of harmonics doesn't change quite as much compared to the trumpet, so it retains much of its rich and bright quality even during quieter passages. The lowest brass instruments are the bass and contrabass tubas (and their relatives) which are capable of generating notes as low as 29 Hz (a low Bb), although the first overtones are generally much stronger than the fundamentals.

Reed Instruments

Reed instruments include the clarinet, saxophone, oboe and bassoon amongst others, but I will concentrate mainly on the clarinet and sax as these are the most common in popular music. However, the principles discussed here apply broadly to the whole family.

Like the brass instruments, the clarinet matured dramatically in the late 1800s, acquiring the complex mechanism of keys we know today -- modern clarinets are also a little brighter and louder than those of Mozart's period (because the reeds used tend to be larger and softer).

Blowing across the reed forces it to vibrate, and thus stimulate a column of air within the tube of the instrument to vibrate in sympathy. The effective length of the tube is determined

by the keys which reveal holes setting the acoustic length of the resonant pipe. The key mechanism is merely a practical method of allowing human fingers to cover and control the numerous widely spaced holes.

The clarinet produces a sound in which the odd-numbered harmonics tend to predominate over the even-numbered ones, although in the very highest registers the even harmonics become stronger. The prevalence of odd harmonics creates the characteristic 'hollow' sound quality, and these extend well beyond 12kHz for the higher notes. The clarinet probably has the widest dynamic range of any wind instrument, with the quietest notes producing around 35dB SPL (close to room ambience) and the loudest about 90dB SPL (at 2m). However, like all wind instruments, the dynamic range reduces in the higher registers because there is a minimum level below which it is not possible to 'blow' a note.

The saxophone is, by any standards, an odd instrument combining a conical brass tube vaguely similar to that of a trumpet, with a reed mouthpiece like a clarinet's! It was designed for use in military bands by a very influential German instrument maker called Adolphe Sax who patented his Saxophone in 1846. The instrument's late arrival on the musical scene has precluded it from anything more than a rare appearance in the classical orchestra, although it is a mainstay of big bands, military (concert) bands, and of course jazz and pop music. Not surprisingly, it shares acoustic characteristics with both the brass and reed family, although it is closer to the clarinet than anything else.

Capable of a very wide dynamic range and possessing a rich combination of harmonics which extend well up to the 12kHz region and higher, the saxophone is, to all intents and purposes, a metal-bodied clarinet. However, the increased size of the pipe bore makes it capable of greater volume, and the bell means that it radiates sound differently.

Recording Brass Soloists

Figures 1 and 2 (on page 189) show how different bands of frequencies radiate from trumpets and trombones. The high frequency harmonics tend to beam directly to the front of the bell, with the lower frequencies being radiated over a wider arc. Although it might seem the most obvious place to position a microphone, the most common mistake is to position microphones directly on-axis and far too close to the bell.

In a live PA situation, this may be the only possible solution to achieving enough isolation, but it certainly isn't the best technique for recording! Like most musical instruments, the sound generated by trumpets and trombones needs space for all the different harmonics to become properly balanced, and so the microphone needs to be positioned at a respectable distance from the instrument -- anything from, say, one to four metres depending on the acoustics of the recording environment.

I would recommend starting with a mic placed at about two metres from the bell and about 30 degrees off-axis. With trumpets it is usually easier to mic from above because most players angle the instrument downwards, but with trombones I would generally come in from below. As always, though, placement should be determined by the need to aim the dead side of the (directional) mic towards the sound sources you wish to reject. Moving the mic closer will tend to give a cleaner, tighter and brighter sound, whilst moving away will give a fuller and often more dramatic sound (dependent on the recording acoustics).

Another technique which can be

effective is to have the musician facing a wall or window whilst playing. A pressure zone mic taped to this surface at a suitable height to be out of the direct firing line does a remarkably good job of capturing a clean, detailed sound. This method also provides a lot of acoustic feedback for the musician, which can be an advantage.

Miking too close to the instrument distorts the tonal balance, exaggerating some elements and understating others. This produces what can only be described as a 'nasty' and unrepresentative noise which is very hard (if not impossible) to sort out with EQ. Similarly, placing the mic exactly on-axis to the bell not only exposes it to extreme SPLs and potential wind blasting, but also overemphasises the very directional upper harmonics. Although this gives a very bright hard sound, it will tend to vary a great deal in both level and quality if the musician moves the instrument while playing -- and they all do!

Sound levels increase dramatically with increasing proximity to the source, and a lot of microphones simply cannot cope with the sound pressure level if placed any closer than a metre or so. Most dynamic mics would survive and might even give an acceptable sound, as would any decent studio capacitor mic (provided it had a built-in attenuator to avoid overloading the internal preamp). However, electrets and ribbons would not fare so well because electrets don't generally have facilities for attenuators ahead of the preamp (which would almost certainly become overloaded). I have even known ribbon mics to suffer split diaphragms when placed too close to the firing line of trumpets and trombones! Having said that, a ribbon placed on-axis but at a safe distance can give a

Effects And Processing

I mentioned earlier how high notes tend to be louder than low notes on most brass instruments so, although the musicians should be able to balance their dynamics pretty well, it is not uncommon to have to use some compression to level things out a bit. Brass instruments and saxophones can also produce very peaky signals which benefit from some mild compression -- but avoid limiting as this makes the sound harsher.

The best results are usually achieved by compressing the recorded tracks during mixdown rather than compressing to tape (or hard drive) simply because you then know what you are dealing with and can optimise the threshold and time-constant settings. Generally, you will require pretty fast attack and release times, but listen very carefully as it is easy to destroy the attack and bite of brass instruments. In the case of saxophones and woodwind, excessive compression will also emphasise their mechanical noises.

The big, fat brass sounds common on a lot of American records typically employ a lot of compression, but this is only possible if the recording is very clean in the first place. Compressing a poor recording only makes it sound worse by emphasising spill, poor acoustics and mechanical noises, so take the trouble to get the best sound possible in the original recording.

Gating acoustic instruments (other than for effect) is rarely successful and usually damages the sound unacceptably before any worthwhile improvement in separation has been obtained. So I would suggest that if you are having problems with a lack of separation or with mechanical noises, the microphones should be repositioned or the musicians asked to improve their technique! Gating might reduce the spill between brass stabs, but will almost certainly remove the all-important attack as well. However, if you really do want to use a gate, make sure you insert it before any compression, or it will be impossible to set the threshold accurately.

If the right microphones have been positioned carefully, equalisation is rarely needed, although I have found that a little gentle tweaking at the extreme top can sometimes be useful. Digital recorders can suffer with brass instruments, as the high energy at high frequencies can cause aliasing artefacts which add an unpleasant edge to the sound (this is common on early machines with dubious filter stages). Other than using better A-D converters, the only solution is to record at lower levels, giving the filters a better chance to reduce troublesome ultrasonic frequencies.

These high harmonics can also affect comparisons between the sound directly from the console with that after A-D and D-A conversion from, say, a DAT, as they will be absent in the latter (assuming 44.1 or 48kHz sampling). Although subtle, this sometimes comes across as a lack in 'air' or brightness, but resist the temptation to boost the extreme HF as this will only increase the likelihood of aliasing distortion.

very smooth and natural sound indeed -- but it requires care!

In general, large-diaphragm mics work best, especially for instruments playing in the lower registers, but be careful about which microphones you select. Those designed primarily for vocals tend to have a presence lift in the 2-6kHz region to improve clarity, but this usually works against brass recordings, as it over-emphasises the upper harmonics lending an unpleasant 'piercing' quality.

The larger valved instruments such as tubas, euphoniums and the like can be mechanically noisy, although this is mainly down to playing technique. Since these instruments all fire upwards, good results can be obtained by miking from above and behind so that the player's body shields the mechanical noises from the mic.

Usually, the only processing needed for brass instruments and sections is the addition of a little reverb. The trick here is to keep it short (small room settings usually work best) and avoid adding too much or you will lose the attack and clarity. Try adding reverb until it becomes obvious, then pull the fader back between 5 and 10dB!

With bigger brass sections, sometimes the saxophones (and clarinets if included) have trouble competing with the trumpets and trombones. Hopefully this kind of difficulty would have been solved by altering the numbers of instruments playing at the same time, but if the adopted solution was to move the mics in closer to the weaker instruments there will almost certainly be a problem with the recorded perspective. Typically, when the saxophones and clarinets are balanced at the right level with the rest of the band they will sound too close and stand out too much. Pulling their level back won't cure the problem, just submerge the woodwind in the mix and the only hope is to compensate for the lack of perspective with a suitable early-reflection reverb program and around 10mS of pre-delay. Take the trouble to match the reverb as closely as possible with the studio's acoustic to replace the missing perspective, and adjust the delay to make the woodwind sections appear less prominent (taking advantage of the old proximity effect!).

Recording Reeds

The key to recording reed instruments is to be aware that most of the sound doesn't radiate from the bell, but from the body of the instrument. In the case of the clarinet and similar instruments the higher frequencies beam from the bell and rely on being reflected back from the floor to become properly balanced with the lower harmonics (see Figure 3 above). This means that to record both the direct and reflected sound, the best mic position is somewhere between one and two metres away, approximately level with the top half of the instrument and aiming at the holes towards the lower half of the body from the front. There is no point in miking near the bell as this will only capture a very weak, thin and nasty sound!

A common problem is excessive mechanical noise from the keys, but this is largely down to the skill of the player and there is very little that can be done with microphone position. One technique worth trying, though, is aiming the microphone from the side instead of the front -- experiment with both sides to see which is best, and then reorganise the studio layout to obtain the best spill-rejection from other instruments. The drawback with this technique is that the overall level and brilliance of the instrument will tend to drop off in comparison to a frontal position.

Again, the flatter the response of the microphone, the more natural and accurate the sound obtained. Mics with a peaky presence region are best avoided, as they will tend to emphasis the squawkiness of the instrument, which is hard to tame with equalisation. Most professionals favour large-diaphragm mics again -- typically AKG C414s or Neumann U87s. Small-capsule mics can sound too shrill if not positioned carefully.

The saxophone requires a slight variation in technique because the bell is curved upwards to project sound forwards instead of towards the floor. Miking the bell directly is a very

common technique but definitely not the best! As might be expected, the bell projects only the high-frequency components of the instrument, and so a very hard, bright, and characterless sound is obtained. However, the technique does provide good isolation from spill as the mic requires very little gain -- hence the popularity of the technique for PA purposes.

In the recording studio, a much better technique is to adopt a similar approach to that appropriate to the clarinet, with a mic aimed towards the middle of the instrument, towards the player's left hand. Position the mic between a half and one metre away, above and in front of the instrument, to capture direct sound from the body of the sax combined with the high harmonics from the bell. Adjusting the angle and distance of a cardioid microphone relative to the instrument allows the harmonic balance to be optimised.

Sax players are prone to wild movements as they 'get into the groove' and this can present huge problems for the recording engineer. With greater distance between mic and instrument, level and quality variations are minimised, but this is not always practical. I have found rigging a second close microphone three inches from the bell, and telling the player to keep the instrument immediately below the mic, is effective in helping to keep the saxophone relatively static!

Recording A Brass Section

A brass section is exactly that -- a composite of (usually) four or more instruments, and I will assume that it's occupying its standard role in supporting a conventional rock/pop/blues/soul line-up.

Since a brass section can be a mighty loud thing, recording it at the same time as the weaker instruments in a band can present serious problems. In a large studio, it might be possible to put the brass section in a separate booth, or gain sufficient isolation by the use of acoustic screens positioned in the studio for physical separation from the weaker instruments. However, separate overdub passes just for the brass can work very well and this is often the only solution in a small studio. The only drawback with this approach is in getting the section to play well to foldback, but that is usually quickly overcome with a couple of rehearsals.

The most common folly is to try multi-miking a brass section with one microphone per instrument. The multi-mic technique is supposed to allow control of the level of individual instruments from the sound desk, and demands very good acoustic separation between the instruments. This isolation is achieved with distance -- maximum distance between different sound sources, and minimum distance between each microphone and its source. However, in the case of most acoustic instruments, and especially with brass, very close miking produces a poor and unbalanced sound. Also, if the musicians are physically close to each other (as they usually prefer to be) there will be so much spill between the mics that the whole exercise becomes completely pointless -- all the faders will have pretty much the same noises on them with no independent control at all, and there will almost certainly be undesirable phasing effects between the mics!

In my experience the best section sound is achieved with relatively distant miking, say, a couple of meters, either with a single mic aimed to provide even coverage of all players, or with some form of stereo pair. In the latter case, the precise mic placement will depend on the size of the section and the kind of stereo spread required, but would typically be three

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metres in front and a metre or so above the instruments. It is worth experimenting with bringing the saxophones in a touch closer to the mic, and pushing the trumpets and trombones back a little. I'm only talking a foot or so, but it can make a big difference to the internal balance of the section.

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If only a few musicians are available, but you want them to sound like the Tower of Power, a couple of overdubs of additional parts can be a very effective technique -- especially if the musicians are relocated with respect to the stereo mic to increase the density of the stereo image. Compressing the final stereo track will also help to make the section appear more powerful, but beware of over-compressing as this will emphasise mechanical noises and any spill (including foldback leakage from the headphones).

With large brass sections, such as in a Big Band, the key to success is in the layout of the players. Try to have the cornets and trumpets facing the trombones across the studio so that their spill is on the back of each others' mics, and don't have any other musicians sitting in front of either section if it can be avoided. This is especially true for the trombones as they are extremely loud, and not only would it be an unpleasant experience, but it would be virtually impossible to get a clean sound from any other instrument against the trombone spill. Position mics at least two metres away from the instruments and aim to use one mic to cover every four musicians in the brass sections, with one between two in the woodwinds.

If you find you are having trouble getting the different sections to balance properly, try listening to the band again in the studio. If the problem exists there too, ask the musical director to have one or two players in the loudest sections sit out -- it is far more effective than having to add extra mics or move existing mics closer! SOS

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