Legend Acoustics Kantu 6

Loudspeakers

It's more than a decade since I reviewed the very first Kantu from Legend Acoustics. It was 'way back in 1997 and Dr Rod Crawford had set up Legend Acoustics in Canberra only two years earlier, after returning to Australia from Scotland, where he'd been gainfully employed as the Senior Acoustic Designer at Linn Products. I recall back then that I had accused him of trying to cash in on his Linn connections with the name of his new speakers, because the word 'Kantu' was a homonym for 'Kan II', which was one of Linn's most popular speaker models at the time.

As happens more often than I'd like, I was wrong. I'd missed the significance of the kangaroo logo that is a feature on all Legend's brochures and on its website. Crawford had decided to give the names of all his models an Aussie flavour by naming them after kangaroos, so other models that followed were called the 'Joey', 'Kanga' and 'Roo'. As for 'Kantu', it certainly means kangaroo (or wallaby) in some Australian aboriginal languages, but in the Murri language, it means 'dance'. (There's also a Kantu Gorge, out near Uluru, in the Northern Territory.)

Since the original Kantu was a three-driver, two-way design, I was a little taken aback to find that the Kantu 6 has now evolved into a four-driver, three-way design, via the addition of a 100mm midrange unit that operates between 250Hz and 3kHz. However, apart from this, none of the other changes seem to have been anywhere near as dramatic—at least externally! The cabinets look as good as they ever did, and Crawford is still using his unique frameless elastic-rimmed speaker grille to ensure maximum sound dispersion and a complete absence of grille-frame reflections... because there's no grille-frame.

The Equipment

One of the most interesting aspects of the evolution of the Kantu is that because Crawford is constantly evaluating new drivers, he has changed the ones used in the Kantu at least twice to my knowledge—and maybe even more. In the first Kantu, the two bass/midrange drivers were made by Audax and the tweeter by Scanspeak, but later versions replaced the Audax drivers with models from Scanspeak. By the time the Kantu 5 came around, Legend had switched to using Peerless bass drivers, but now, in the Kantu 6, the two bass drivers are Scanspeak 8545s. What's completely new (apart from the midrange driver, which is made by Audax) is a new soft-dome tweeter made by SEAS.

This ability to 'upgrade' drivers in a design is one of the beauties of being a 'boutique' speaker manufacturer. Large manufacturers, once they have signed off on a particular design, then put in orders for hundreds (or thousands!) of the drivers they've specified in order to get the best possible pricing and to ensure they don't get caught short during a production run. However this effectively locks them into using those drivers for long periods of time, so if something better comes along, they can't use it. There's also the added complication that incorporating new drivers usually involves re-designing the crossover, changes in box tuning and sometimes changes in tooling on the production line.

A small company such as Legend Acoustics, however, can react very quickly to improvements in technology and drivers to incorporate even quite major design changes 'on the fly.' The only downside for small speaker manufacturers is that because of their lack of buying power, they have to pay more for their drivers and cabinets, so they don't make as much profit on their speakers as the larger companies.

The two Scanspeak 8545 drivers in the Kantu 6 have paper cones fitted with paper dust

caps. The suspension surround is made from rubber. (Rubber is in my opinion a far better choice than the more popular foam that's often used, because in Australia's harsh climate rubber surrounds last for far, far longer than their foam counterparts). The overall diameter of each driver is 178mm, but the Theile/Small diameter is 137mm, which puts the piston area (Sd) at 147cm². Naturally, because there are two bass drivers, we need to double this to get a 'system' Sd of 294cm². This means that if Crawford had used a single bass driver for the bass, rather than a pair, it would have to have had a nominal overall diameter of around 240mm to move the same amount of air.

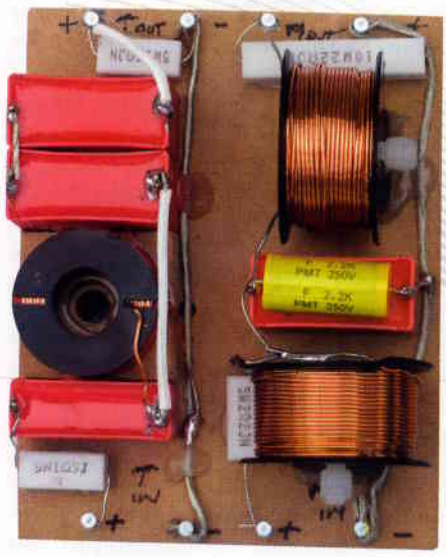
So why did Crawford use two drivers? The obvious reason is that the smaller drivers are faster, and therefore can extend further up into the midrange, so the dedicated Audax midrange driver can be rolled on well into its passband, rather than struggling with frequencies at the bottom of its range. The less obvious reason is that the smaller diameter means that the width of the front baffle can be narrower, for improved dispersion. However, there's a third reason, which is that it allowed Crawford to 'load' the two drivers differently. I realised that he'd done this quite early on in the review, after I'd pressed in each of the cones gently, to get an idea of their travel. To my surprise, the cone of the upper driver was quite stiff under my touch, whereas the lower one moved freely, so their compliances were completely different while the drivers themselves were supposed to be identical. What was going on?

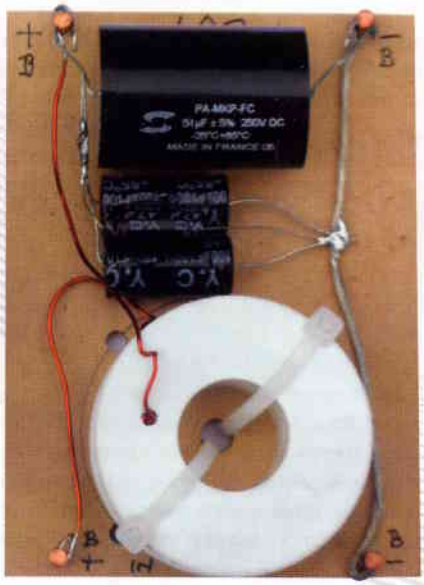
It turned out that the top driver is housed in its own completely sealed enclosure and the bottom driver is in a separate bass reflex enclosure that is ported to the rear. Crawford told me that he only arrived at this design after listening to dozens of variations in enclosure sizes, cabinet alignments, port sizes and port locations, and with the speakers placed at various locations in his listening room. After countless sessions, he decided that, in his words: *'the current form seemed the best compromise for most situations—though the bottom port can be plugged if necessary.'*

As I said earlier, the Kantu 6 is the first three-way Kantu, and because of this, it's worth pointing out some of the advantages of having a separate driver that is dedicated to producing only midrange frequencies. For me, the most important advantage of a three-way is that there can be no Doppler distortion of the midrange sound. Doppler distortion occurs in all two-way designs because the same driver has to produce bass and midrange notes simultaneously. This means that while the cone is moving back and forth relatively slowly in order to reproduce bass notes, it at the same time has to also make smaller back-and-forth movements to reproduce the treble. The result is frequency-shifting of the midrange notes, better known as Doppler distortion. Also important is dispersion-matching, because in this aspect of performance, a small midrange driver is a far better match to any tweeter than a larger bass (or bass/midrange) driver. The inclusion of an extra driver also takes the pressure (literally!) off the tweeter by allowing a higher crossover frequency which not only gives better sound quality, but also higher sound pressure levels.

Although I was ecstatic to see the Kantu 6 is now a three-way design (I'm a big fan of three-ways, as you've no doubt guessed) I was less than ecstatic that the midrange driver had been located alongside the tweeter. In the past it's been my experience that speakers with this driver configuration could sound wonderful on-axis, but sound rather less so off-axis, due to interference as the sound waves from the tweeter passed 'across' the midrange driver. This only happens if you're listening off-axis, of course, but it seemed so unusual that I thought Crawford must have had a specific reason for mounting the drivers in this way, and emailed Legend to make enquiries. It turned out that Crawford had adopted this geometry to get all the drivers as close together as possible, to simulate a perfect 'point source' and that in doing so, he'd had the same thoughts as I had, and so had done extensive research into the likelihood of any possible deleterious effects, after which he'd decided that the advantages of this geometry far outweighed any potential disadvantages—in this case most particularly because the Kantu 6 design has also been optimised to minimise any such effects. Dr Crawford very kindly provided me with a simplified summary of his research and findings, so rather than giving you my potted version, I have included his complete comments in a separate side-panel to accompany this review (see page 27).

Inside the Kantus I discovered that Crawford has reduced the potential for interaction between the crossover components (an issue with inductors, in particular) by splitting the components in the crossover network across two completely separate boards. The one for bass is just above the terminals at the bottom of the cabinet: the other for the midrange and treble is behind the lower bass driver in the middle of the cabinet. The crossover points





- Superbly balanced sound
- Very efficient
- Extended warranty

- High centre of gravity

Legend Acoustics Kantu 6 Loudspeakers

Brand: Legend Acoustics
Model: Kantu 6
Category: Category
RRP: $5,990
Warranty: Seven Years
Distributor: Legend Acoustics
Address: PO Box 448
Huonville, TAS 7109
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W: www.legendspeakers.com.au

are at 250Hz (2nd-order) and 3.2kHz (3rd-order electrical/4th-order acoustic). All internal wiring is via Cardas Reference Litz cable. (It's nice to see that Crawford is using high-quality cable inside the Kantus: You'd be surprised at just how many speaker manufacturers who are keen to sell you expensive cables don't actually use those cables inside their own speakers!) As you'd expect given the split crossover network, the Kantu 6s are bi-ampable and bi-wirable, with two sets of huge, gold-plated speaker terminals on the rear terminal plate. Did I mention they're huge? What's so great about these terminals is not just that they mean there's an enormous contact area (for minimum contact resistance) or that you can use really thick speaker cable (for minimum cable resistance), but also that no matter what cable you use, it won't 'twist' or 'bundle' as you tighten the locking nut. The only problem I had with this connector is that it's so large, and thus so easy to tighten, that it's possible to exert an incredible amount of down-force on the cable, so be warned that if you overtighten the nuts, you can actually cut through some of the strands of your speaker wire!

At just over a metre high (1020mm) the Kantu 6 design is quite tall and, because all the (heavy!) drivers are at the top of the cabinets, the cabinets are therefore a bit top-heavy, so you'll need to position them where they can't be bumped accidentally. I was pleased to see that Legend Acoustics is continuing its generous policy of offering a lengthy 7-year warranty on its speakers.

Listening Sessions

I found that positioning the Kantu 6 speakers in my listening room was remarkably non-critical... with one single exception, and that is that I found it was essential to have the speakers so that when you're listening, the tweeters are located to the 'inside.' A speaker positioning diagram in Legend Acoustics' *Owners Manual* makes this clear, but the accompanying instructions say this geometry is only 'recommended'. In my sessions, I found that it was quite easy to hear when the left and right speakers were swapped around so the tweeters were on the 'outside'—particularly when the speakers were positioned so they faced directly up the room. From what I could hear, the differences were confined exclusively to the extreme treble. With the tweeters on the inside, the high frequencies not only had a purer character, but were also somehow more 'cohesive'. Funnily enough, this effect was only clearly audible at average sound levels—I found it much harder to hear it at very low listening levels and almost impossible to hear it at very high levels. However, if you position the speakers correctly—so the tweeters are to the inside, it's immaterial, because the effect doesn't exist.

As for toe-in, I think this will mostly depend on your room. In mine, where the side walls are relatively close to the speakers, I found the sound of the Kantus improved when I toed the speakers in so they faced more towards the listening position until I reached about a 30° toe-in, after which there were no further improvements. However, unlike some speakers, I would recommend against 'over-toeing' the speakers so that the direct paths cross in front of the listening position.

As fate would have it, I had to hand at the time of my auditions an advance copy of an absolutely fabulous CD for demonstrating the advantage of a three-way design. It was 'The Messenger' now only recently released by Matt Joe Gow (and the Dead Leaves) on Liberation (Mushroom). You'll hear why it was absolutely fabulous from the very first track which reveals Matt Gow's very distinctive voice, which is all the more so because of a very slight 'waver' he sometimes uses, depending on pitch and singing volume. Listen to The Messenger on a two-way speaker and you won't really hear the true nature of his voice—more a parody of it. Listen on the Kantu 6 and you'll appreciate that you're listening to a unique vocal talent. And once you've got past that realisation, and start listening to his lyrics and music, you'll also realise that an important song-writing talent has been flying under the local music industry's radar for a few years now.

On about my third run through The Messenger, I realised it was actually nearly a completely definitive demo disc for the myriad virtues of the Kantu 6, from the way the speakers reproduce the crisply recorded percussion (especially that kick drum!), through the sounds of the various acoustic guitars (Midnight Oil's Jim Moginie guests on this album, but he plays so many instruments, I couldn't pick which one was him!) and pedal steel, right down to the piercing harmonica (listen particularly to the closing moments of *The Light*). Gow also has a very good vocal range, amply demonstrated on *I Let You Be*.

In order to try out the Kantus with some rawer, louder music, I loaded up Red Riders' 'Drown in Colour' [www.redriders.net], which is the follow-up to their amazing debut album 'Replica Replica'. There's lots of frenetic bass energy on this disc, and the detailing revealed by the Kantu 6 speaker is exceptional, especially on tracks such as *Over Again*, where you can hear the complex bass riffs beautifully etched against the mix, as well as the tunings of the drums. This recording is a little 'grungy' (a deliberate choice on the part of the producer) but thanks to the dedicated midrange driver the vocal line always punches through, unsullied by all that's going on elsewhere across the audio spectrum which... on this disc, is lots!

For me, no audition is ever complete without finding out how the speakers handle solo piano, and I find Glenn Gould's recordings perfect for this, not only because I'm a fan of GG's musical interpretations, but also because I love the way he captures the sound of the piano on his recordings, which is from the pianist's perspective, rather than the audience's.

LAB REPORT

Readers interested in a full technical appraisal of the performance of the Legend Acoustics Kantu 6 should continue on and read the LABORATORY REPORT published on the following pages. Readers should note that the results mentioned in the report, tabulated in performance charts and/or displayed using graphs and/or photographs should be construed as applying only to the specific sample tested.

This means that Gould's recordings have a much harsher, more immediate and more percussive tonal quality, with a 'janglier' treble and more background 'mechanical' noises from the keys and pedals (not to mention his own tuneless singing along as he plays!). The Kantu 6s delivered all this complexity beautifully, while at the same time revealing the full, rich sound of the piano, and not some shadowy facsimile of it.

As an aside on the topic of recording, you can hear the exact opposite technique of recording the piano on Teldec's '100% Beethoven' which is touted as being the world's first 'purely digital' recording, thanks to the use of Neumann microphones fitted with DA converters, so the sound captured by the mic capsules was converted immediately into digital format. It's a superb recording, but Mari Kodama's outstandingly crisp and considered playing is somehow 'sanitised' and rendered overly orchestral, despite the obvious clarity of her keystrokes and immaculate timing, by the mic pick-up arrangement used for her piano. But I guess that if your husband's the conductor, you don't make waves. Despite this, when the DSO (Deutsches Sinfonie-Orchester Berlinorchestra) musters its considerable forces, as in the *Allegro con brio* of the *Piano Concerto No 2 in B-flat major*, the Kantus deliver not only the power of the orchestra, but also the underlying atmosphere of the performance itself.

Conclusion

Transforming the Kantu into a three-way was a masterstroke on Rod Crawford's part and one that, with the benefit of hindsight, was probably the only way to improve what was already a mature speaker design.

No doubt many audiophiles will mourn its passing, but now that the Kantu is dead: long live the Kantu! ***greg borrowman***

Test Results

The frequency response of Legend Acoustics' Kantu 6, as measured by *Newport Test Labs*, was very flat, as you can see for yourself in the composite spliced response shown in *Graph 1*. Here, the averaged result of nine individual frequency sweeps using pink noise at a test stimulus has been manually spliced (at 400Hz) to a gated measurement of the tweeter's response. This graph shows the Kantu 6 response as extending from 62Hz to 30kHz ±3dB. You can see that the 'plus' and 'minus' variations are evenly distributed, so there's no noticeable spectral 'tilt' in any particular direction, but there are some smaller variations within the overall response such as the very minor (–1.2dB) low-Q suck-out between 400Hz and 1.2kHz and an equally minor (+1.3dB) high-Q 'bump' between 3kHz and 4kHz. The tweeter's response rolls off slowly above 15kHz to be –3dB at 30kHz.

Graph 2 shows an expanded and more detailed view of the Kantu 6's high-frequency response, measured using a gating technique so that it shows the response that would be obtained if the speakers were measured in an anechoic chamber. This time, however, the response is shown with the grille off (black trace) and with it on (red trace). You can see that the Kantu's grille is absolutely and completely acoustically transparent below 11kHz, while above this frequency although the cloth attenuates the level of the high frequencies by about 0.9dB, it does so equally for all frequencies, right up to 30kHz. Legend Acoustics is obviously using a superior fabric. The lack of anomalies between the two responses also shows the advantages of not having a grille frame. Also notable on this graph is the overall smoothness of the high-frequency response: there are none of the micro variations in level that I often see.

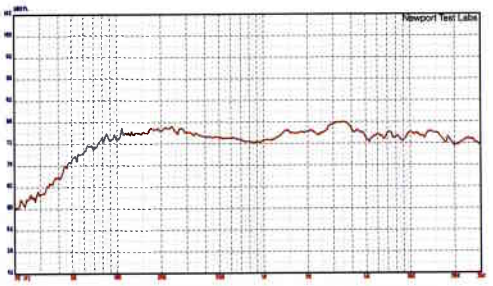
The low-frequency performance of the Kantu 6 is shown in *Graph 3*. All traces were acquired using a near-field technique that simulates the response in an anechoic chamber. The only problem with this particular measuring technique is that it becomes less accurate as the test frequency becomes higher, hence the 500Hz upper limit of the graph. You can see that the response of the lower woofer (traced in light blue) has the classic 'bass reflex' shape, so that it extends slightly lower in frequency than the response of the upper driver, but when it does start rolling off, it does so very quickly. You can see from this trace that the enclosure is tuned to around 33Hz, a tuning frequency confirmed by the saddle in the impedance modulus at this same frequency, as shown in *Graph 4*. The response of the upper driver (dark blue) reveals the sealed nature of the enclosure from which it is operating. Its bass response starts rolling off earlier than the other driver (at 100Hz) but the output rolls off far more slowly. The output of the rear-firing bass reflex port peaks at 40Hz and has a low Q so there is substantial re-inforcement for the bass over quite a wide range of frequencies. Note that there's no unwanted high-frequency output from the port at all, which is a superb result. The black trace on this graph is the midrange driver's response, and the mauve trace a third-octave smoothed version of the pink noise response. (Note that although it appears that the 'crossover' from bass to midrange is at 200Hz, this isn't the case: the midrange trace is actually at the incorrect level on the graph because *Newport Test Labs* did not re-scale to compensate for the difference in radiation area between the midrange and bass drivers.)

The shape of the impedance curve reflects the complexities of the Kantu design, though somewhat surprisingly given this complexity, the phase angle is superbly controlled. Perhaps the significant point to note from this graph is that the impedance of the Kantu 6 remains below 4Ω from 20Hz right up to 250Hz, and actually drops below 2Ω between 90Hz and 130Hz. This means that to extract the best bass performance from this design, you *will* need to use an amplifier that is comfortable driving 2Ω loads. This isn't difficult: Any well-designed audiophile amplifier will be capable of this. Other significant points to note from this impedance graph are that it shows that the Kantu cabinet is completely free of resonances, and that the left and right speakers are almost perfectly matched.

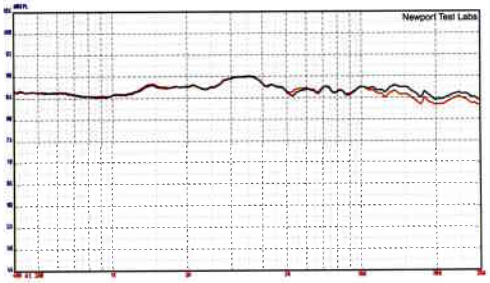
The final graph in the series shows the Kantu's high-frequency response with a pink noise stimulus. (The low-frequency response using pink noise has already been shown in *Graph 1*.) This response shows more accurately how the ear would perceive the frequency balance across the midrange and lower high frequencies and you can see that the bump that was evident at 3–4kHz has almost totally disappeared, along with the slight suck-out slightly lower down. This has the effect of extending the low frequencies down a little further, to put the measured anechoic –3dB point at around 54Hz. (In a room, bass would be extended further again, due to boundary reinforcement, but of course the extent of the reinforcement would vary from room to room.)

Newport Test Labs reported that the efficiency of the Kantu 6 design was remarkably high, reporting a tested figure of 89.6dBSPL at a distance of one metre under the lab's standard stringent test conditions. Since this is almost exactly the figure claimed by Legend Acoustics, and also well within the realms of measurement error, it's obvious that Legend isn't 'gilding' its sensitivity specifications as so many other manufacturers are prone to do.

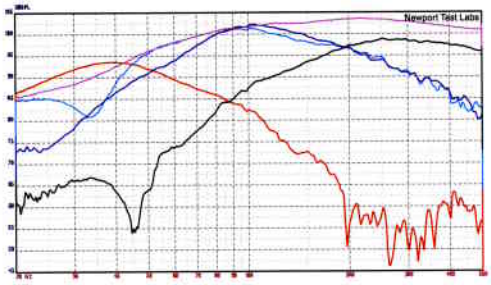
Steve Holding



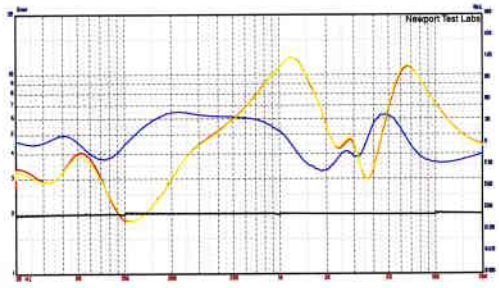
Graph 1. Frequency response. Trace below 1kHz is the averaged result of nine individual frequency sweeps measured at three metres, with the central grid point on-axis with the tweeter using pink noise test stimulus with capture unsmoothed. This has been manually spliced (at 400Hz) to the gated high-frequency response, an expanded view of which is shown in Graph 2.



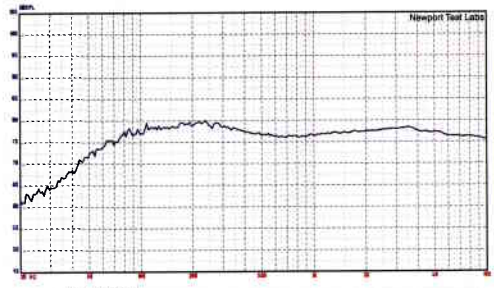
Graph 2. High-frequency response, expanded view. Grille on (black trace) vs grille off (red trace). Test stimulus gated sine. Microphone placed at three metres on-axis with dome tweeter. Lower measurement limit 400Hz. [Legend Kantu 6]



Graph 3. Low frequency response of rear-firing bass reflex port (red trace), lower woofer (light blue), upper woofer (dark blue) and midrange driver (black). Nearfield acquisition. Port/woofer levels not compensated for differences in radiating areas. [Legend Acoustics Kantu 6]



Graph 4. Impedance modulus of left (red trace) and right (yellow trace) speakers plus phase (blue trace). Black trace under is reference 2 ohm precision calibration resistor. [Legend Kantu 6]



Graph 5. Averaged frequency response using pink noise test stimulus with capture unsmoothed Trace is are the averaged result of nine individual frequency sweeps measured at three metres, with the central grid point on-axis with the tweeter. [Legend Kantu 6 Loudspeaker]

Legend Acoustics Kantu 6 White Paper

As noted in the review of the Legend Kantu 6, the tweeter is located alongside the midrange driver, so Australian Hi-Fi Magazine asked Legend's designer, Dr Rod Crawford why this geometry was used in the Kantu 6. In this 'White Paper' he details his reasons...

I have been asked to explain why I put the tweeter next to the midrange unit—rather than above or below it as is more conventional. The main advantage was to try to keep the drive units in as small an area as possible. This leads to them looking more like a single source from the distance of the listening position and leads to better imaging etc. It is the reason that Linn (after I left) developed the '2-K array' (where the midrange and tweeter are held on an arm in front of the bass unit) and that Greg Borrowman found in a review gave very precise imaging. Of course the ultimate form of driver compactness is concentric drivers but these are difficult to achieve in a three-way speaker. Even a two-way dual-concentric driver has serious problems caused mainly by the tweeter being surrounded by a strangely shaped baffle (the bass/mid unit) which is also vibrating.

The main possible disadvantage of putting the tweeter next to the midrange unit is its effects on the horizontal dispersion of the sound, particularly the possible 'lobing' of the sound which might give rise to changes in amplitude (flatness of response) if one is not listening 'on axis'—that is with the speakers/drivers aimed at the listening position. The same effect occurs if the two drivers are aligned vertically but the lobing could then occur vertically where it might only be a problem if one stands up.

'Lobing' of the sound amplitude occurs only at the crossover region where both drivers are on simultaneously. The waves from any two sources combine (interfere) as they move into the space around them. They will do so constructively (good for our case) at A where the waves are in phase and destructively (bad for our case) at B where the waves are out of phase. These phase differences will occur if the listening position is different path lengths from each source. If point B is moved perpendicular to the page then the path lengths (and phase differences) will change and so 'lobes' of constructive combination separated by areas of destructive combination form complex patterns in 3D space no matter which way the sources are oriented. The only certainty is that if you want the waves to be in phase and to combine then the ears must be on the plane bisecting the sources (this is contrary to the oft-given advice for the ears to be in line with the tweeter) to counter tweeter dispersion.

If the sources are much closer together than the wavelength the waves cannot get sufficiently out of phase—thus the lobing effects only tend to become noticeable when the separation of the two sources becomes greater than the wavelength of the waves. At the ~250 Hz crossover between bass and mid of the Kantu 6s, the wavelength is greater than 1m but the total separation of the drivers is less than 0.3m so no lobing will occur. However, at the ~3kHz crossover between mid and treble where the wavelength is about 10cm while the driver separation is about 9cm there is the potential for lobing.

To determine how much of a problem it would be I ran some measurements on the speakers as shown in *Figures 1 to 3. Figures* 1 and 2 are pseudo-anechoic results taken by sending multiple impulses to the speakers in my work room; measuring their output with a calibrated microphone; truncating the measurements to remove wall/floor reflections; then calculating the frequency response (by a technique called inverse Fourier analysis). Because of the truncation (in this case the first reflection was from the floor) the measurements are limited to above 300Hz. Some small (1–3dB) ripples of about 500Hz width still occur because of reflections from my workbench—these could not be eliminated without smoothing too much other detail in the plots. The measurements were taken at 15° intervals in a horizontal plane level with the mid and tweeter; firstly with the tweeter on the inside *(Figure 1),* then on the outside *(Figure 2).*

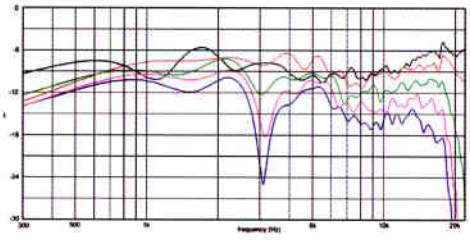


Figure 1. Kantu 6 pseudo-anechoic measured at ~15° intervals—tweeter on inside (3 dB/division vertically) (black = 0°; orange = 15°; green = 30°; purple = 45°; blue = 60°).

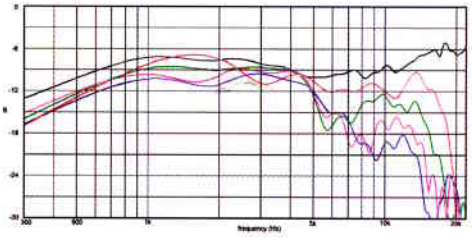


Figure 2. Kantu 6 pseudo-anechoic measured at ~15° intervals—tweeter on outside (3 dB/division vertically).

It can be seen from *Figure 1* with the tweeter on the inside that lobing cancellation (or suck-out) is quite severe at 45 and 60 degrees but non-existent at 0 and 15 degrees and minor at 30 degrees. *Figure 2* with the tweeter on the outside is similar, except that the lobing has ended by 60 degrees. This difference between the tweeter being on the inside or outside of the midrange unit is probably due their positions relative to the edges of the baffle. (The asymmetry relative to the leading and back edges of the baffle also probably causes the different frequency responses off-axis at high frequencies as well as the dip around 1kHz). Given that the 60-degree response is not generally important and that the high frequency off-axis performance is generally better with the tweeter on the inside this is recommended for listening.

It is also noted that even where the suck-out occurs it is narrow, reflecting the 4th-order (24dB/octave) acoustic slopes of the mid/treble crossovers in the Kantu 6s. They should therefore in any case cause minimal effect on tonality. Some designers believe in using low-order slopes to reduce phase effects at crossovers, however from the above, it is evident that they can have major effects on tonality. In any case, the ear evolved to pick up phase differences only at low frequencies—and amplitude differences at high frequencies—for spatial localisation. ■

Dr Rod Crawford

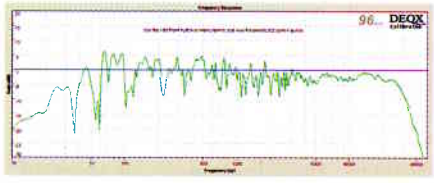


Figure 3. This graph shows a non-truncated measurement measured in-room at the listening position (2.5m, 15° inside tweeter; 5dB/division vertically). The sharp peaks and troughs (particularly at the lower frequencies) are due to standing waves in the room but the overall ('eye-ball' smoothed) response is quite uniform, extending above 30kHz and with a useful room response to below 30Hz. Note that Floyd E Toole (well-known for his research activities at Canada's National Acoustics Laboratory) found that uniform direct response plus uniform room response at the listening position was a good predictor of consumer preference for tonality.