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Exarchos, Michail ORCID: <https://orcid.org/0000-0003-1045-3540> and Skinner, Glenn (2021) Bass | the wider frontier: low-end stereo placement for headphone listening. *Journal On The Art of Record Production*, 12. pp. 87-103. ISSN 1754-9892

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Bass | The Wider Frontier:

Low-end Stereo Placement for Headphone Listening

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Introduction

The positioning and role of bass elements in a mix has seen significant development in the last sixteen years. Driven by changes in delivery, technological innovation and cultural and musical imperatives, mixers are now faced with an extensive range of options. Where previously bass staging was proscribed by the delivery methods, current trends suggest that there are no rules any more. Limitations imposed by both vinyl playback and loudspeaker response meant that, historically, bass tended to be dealt with quite conservatively in regard to placement. The move to digital playback in the 1980s, followed by the launch in 2001 of iTunes, signalled a shift in listening delivery. Though the Sony Walkman (Du Gay et al: 2013) and other mobile devices had initiated the phenomenon, within a short period the widespread adoption of the iPod heralded a migration from speakers to headphones. This has meant a paradigm shift in the role of the bass. In this paper we will examine the new role of low-end staging, investigate the history of bass placement, create a typology of current approaches, and then illustrate some of these approaches through two case studies. The aim will be to explore not only how low bass can go, but also how far and how wide.

Practice

Initially most early pop and rock and roll recordings were released in mono. Phil Spector famously made his “little symphonies for the kids” (Daley: 2002) using two or three bass players, such as Carol Kaye and Ray Pohlman, who would tune one bass up a fifth and play the same part at the same time. Additionally, the bass would be layered with a baritone sax. This can be heard

on many of Spector's productions such as 'Da Doo Ron Ron' (1963) by The Crystals and 'Why Do Lovers Break Each Other's Heart' (1963) by Darlene Love (Daley: 2002). As they were mixed to mono, there was little problem with reproduction.

As stereo vinyl started to become the norm in the early 1960s, producers and engineers began to experiment with bass staging in stereo. 'Paperback Writer' (1966) by The Beatles features the bass panned to one side, and the vocals and drums to the other. Pink Floyd employed an alternating left/right bass pulse on 'Welcome To The Machine' (1975), while Sly Stone split the output from Larry Graham's Vox bass into both inputs of the Mu-Tron Bi-Phase on 'Poet' (1971) (Rotondi: 2012). Tonto's Expanding Head Band used a number of stereo bass patches from a Moog Modular, and Oberheim SEM and ARP 2600 synthesisers on their seminal mid-1970s recordings such as 'Tama' (1975) (*The home of T.O.N.T.O.*, no date). However, vinyl mastering imposed certain restrictions on bass reproduction. Stereo bass frequencies can cause styli to skip due to large vertical movement and fears of complaints from the public meant most records from the 1960s and the 1970s restrain the bass to the centre (see the 'Literature' section below for further information on vinyl implications, including a respective discussion of Zagorki-Thomas's (2010) 'The Stadium in your Bedroom' article). Talking about the track 'Chameleon' (1973) in his recent autobiography *Possibilities*, Herbie Hancock provides an excellent account of stereo bass innovation in the face of technical restrictions:

After we recorded the piece, I started to think that the bass line I'd laid down wasn't punchy enough, so I decided to rerecord it, programming the Minimoog so the notes were shorter. The next day I took the tape to [producer] David Rubinson, but when he played that new bass line as an overdub, he forgot to turn off the original track. "Hold on, David," I told him. "Both tracks are playing." We didn't need both those bass lines...but they actually sounded kind of cool together.

Normally it's impossible to have stereo bass, because the lower the frequency, the more difficulty the ear has in perceiving direction. That's why you can put subwoofers in any part of the room: Your ear can't tell where low-frequency sounds are coming from. It's only when pitch gets higher that your ear starts to perceive directionality more clearly. Consequently, nobody ever records stereo bass.

But listening to those two tracks, I got an idea. “Hey, David, since those bass lines weren’t recorded together, they won’t be exactly the same sound,” I said. Couldn’t that function like stereo bass?” (Hancock and Dickey: 2014, p.180).

During the 1970s improvements in home Hi-Fi speakers and amps meant that low frequencies could be heard clearly. Consequently, producers were encouraged to feature the bass more prominently, and bass parts would begin to assume a more melodic and less functional role. Tracks like ‘Good Times’ (1979) by Chic and ‘I Wish’ (1976) by Stevie Wonder feature the bass as more of a lead instrument (albeit with substantial low register and low-end frequency content), but this musical invention could not be matched sonically due to the previously mentioned limitations of the vinyl medium. With the emergence of digital playback, producers began to employ a larger palette of processing to the low end.

Hip Hop producers using track samples often face the problem of adding a more powerful bass element to a historic loop containing a bass part. The resulting muddiness is problematic. Kanye West solves this by applying mid/side processing to the sample, thus creating ultra wide stereo with a significant dip in low end frequencies in the middle of the image. Into this he places low bass, often only occupying the sub-bass spectrum. A good example of this is ‘Sunshine’ (2004) by Mos Def: the careful application of the mid/side processing allows for acceptable mono reproduction, whereas simply reversing the phase of one side would not achieve the same result. One of the most typical contemporary bass placement techniques has indeed grown out of hip-hop. With the multi-layering of beats in the genre, kick drums have become much more active and genres such as Trap and EDM have adopted this methodology. ‘New Rules’ (2017) by Dua Lipa exemplifies this: the trap-style hats and multiple kicks fill the groove space leaving the bass to be a sustaining sub-frequency element. For this stylisation to succeed, it is imperative for the bass to obtain considerable stereo width with some modulation from side to side, in order to retain interest in the low end. However, in this application the bass is back to adopting a functionary role. Listeners *feel* the bass rather than *hear* it.

As will be discussed in the “Head-phonography” section below (a term we are coining here to describe the current era, where the predominant mode of music consumption is via headphones), the employment of sub-bass synthesis plugins such as Waves’ MaxxBass and Renaissance Bass can somewhat ameliorate the physical limitations of bass reproduction on small transducers. ‘Fake Friends’ (2017) by the Norwegian singer Sigrid makes good use of this technique. She utilises the same single-note-per-chord tactic as Dua Lipa on the chorus, but with extreme sub-bass synthesis as well as a wide stereo image. In the verse, the production adopts a different technique, with a shimmering ping-pong type delay applied to a subsonic throb that barely registers a note. Then when the chorus drops, the power of the low drone kicks the mix up a gear.

‘Electric Pow Wow Drum’ (2012) by A Tribe Called Red goes further by re-triggering a mono synth bass line twice and staging it to extreme panned tracks. The modulation wheel filtering is slightly different on each, creating an almost out-of-phase width. The bass is one of the main features of this instrumental track, so the subtleties of the cross modulation are not hidden by a lead vocal. ‘Dancing (Again!)’ by Eats Everything ft. Tiga vs. Audion combines a number of the above techniques. It has a twin-triggered signature ‘wobble’, panned hard left/right, a stereo drone and a conventional mono bass synth in the middle. This track, a hybrid dubstep/house track shows the sonic complexity of current bass production. There is little or no harmonic progression and the interest comes from a combination of bass production techniques intersected with polyrhythmic drum patterns. Though a long way from ‘Good Times’ and ‘I Wish’ the bass is still a main protagonist that commands attention.

Literature

Beyond a practice-based exploration of the position of low-end spectra in popular music mixes, it is also important to consider the theoretical context informing this analysis. A number of scholars have theorised on the placement of musical elements within the space of a popular music mix, and the concept of ‘staging’ has emerged as a useful theoretical notion. In essence, it suggests conceptualising a music mix as a ‘stage’ where the placement—but also the dynamic movement and manipulation—of musical elements (mediation) has thematic and narrative implications (meaning) for both listeners and producers. The concept was first introduced by Moylan (1992) with a focus on the spatial implications of mediation possible within a mix, while Lacasse (2000) explored it further, investigating the effect of textural and dynamic manipulation on the voice in rock production. Zagorski-Thomas has extended the definition to include “functional” (Zagorski-Thomas: 2006) and “media-based” (Zagorski-Thomas: 2009) staging, respectively taking into account “the function to which the recorded output will be put” but also the effect of “technological mediation” (Zagorski-Thomas: 2010, p.252). Holland (2013) has expanded the concept to include the use of acoustic spaces captured in tracking as a form of staging mediation. Liu-Rosenbaum (2012) has responded to both Zak (2001) and Zagorski-Thomas (2010), tracing musical (and narrative) meaning in recording studio aesthetics and offering “an analytical example of an expanded notion of staging which applies not only to the voice, but also to instruments.” Although Liu-Rosenbaum (2012) does consider the role and function of the (electric) bass—and the kick drum somewhat—in this context, he admits that its function is supportive rather than ‘protagonistic’; analysing Led Zeppelin’s ‘When The Levee Breaks’ (1971), he explains: “The bass guitar, by virtue of its low register in lock-step with the rest of the section is more felt than heard, but when the levee breaks, it makes its presence known”. He also maps the increase of low register in the mix to an observed tendency for low-end prominence in songs dealing with dystopian themes (Tagg and Collins: 2001); finally, he

observes how the unusual for the time (farther kick) drum recording technique has allowed for a ‘bigger’ sound that supports the threatening (river) implications of the ‘pounding’ rhythm section (ibid.).

But beyond these level/amplitude-based observations there has not been a systematic study focusing on bass or low-end staging. Nevertheless, Zagorski-Thomas (2010) does make a number of important observations relating to bass from the perspective of ‘function’ and output ‘media’ in his article ‘The Stadium in your Bedroom’. Key to this investigation is that he notes “a gradual increase of bass on records” in the 1960s and 1970s due to “the thickness of the vinyl and the depth of the cut” used, but also—for the disco era and clubs—due to “the introduction of the 12” single, which allowed deeper grooves with wider spaces between them” (2010, p.253). Furthermore, he informs us that in their study on stereo staging of rock music “Moore and Dockwray (2009) ... point out that ... the central positioning of the bass that became normative in the 1970s was, in all likelihood, related to the technical needs of stereo groove cutting rather than the positioning of musicians on a stage” (ibid., p.255). He also notes the implications of club acoustics on creative decisions relating to low-end in mixes (function), impacting on both recording techniques and mix processing choices attempting to minimise low-end ambience through close-miking, gating and spatially separating the kick drum (dry) from the snare (wet) (ibid., pp.253-254). Finally, he maps culturally constructed notions of high-fidelity with the production of both mixes and technology that can deliver expanded frequency curves (and ranges); a practice that is pertinent to the current headphone-consumption era, creating both aesthetic expectations and pragmatic challenges for contemporary music producers and mixers:

(E)arly hi-fi enthusiasm ... added features to the culturally constructed notion of a high-quality recording that go beyond the technical specifications of dynamic and frequency range to include: exaggerated bass and treble frequencies to enhance the experience of a full range of frequencies by making the extreme ends of the audible spectrum more noticeable (Zagorski-Thomas: 2010, pp.261-262).

To this observation we should add the impact of sound system culture on the elevated focus on—and prominence of—bass spectra in both the aesthetic evolution of particular genres (the remix, EDM) and the hand-in-hand development of consumption technologies that were capable of reproducing them.

The Era of Head-phonography?

As noted above, the launch of iTunes on the 9th of January 2001 signified the first of a number of inflection points that marked a significant shift in listening modes of music consumption (see Figure 1 below). Although, at the time, iTunes represented a tectonic shift in music consumption modes by signaling the end of physical phonographic products (for many) and the beginning of digital music ownership, seen from the very perspective of ‘ownership’, perhaps a more significant shift followed; that of a form of services that replaced *downloading* with *streaming*. This was exemplified by the launch of YouTube (media streaming) on the 14th of February 2005, and Spotify (music streaming) on the 7th of October 2008, until Apple Music eventually embraced the streaming-*and-social-media-and-downloading* model on the 30th of June 2015. As Spotify licensing director Guillaume Arth remarked in conversation with the author at the time: “It’s now about access, not ownership” (Arth: 2015). What this meant for audiences, however, was that although headphone listening was not new, ‘access’ to (new) music would from now on be mostly acquired via personalised modes of consumption such as smartphones, and tablets. Zagorski-Thomas (2010, p.255) delineates *ideal* (live concert) from popular (living room playback of LPs) forms of consumption for rock music in the 1960s and 1970s, highlighting the “idealised or stylised” implication this has had for rock production and mixing (particularly in relation to mimicking large ambiences and staging spatial effects). Equally, an era preoccupied with headphone listening as the predominant form of consumption has its own set of implications for the production of music. If seen in conjunction with the

elevation of ‘bass’ to a focal point in the music (and the mix) as a result of both technological affordances and stylistic evolution, the ‘new music’ (requiring a prominent low end for most popular music styles) and the ‘new listening technology’ (headphones) create a dynamic that puts producers, consumers and manufactures in a noteworthy cause-and-effect triangle.

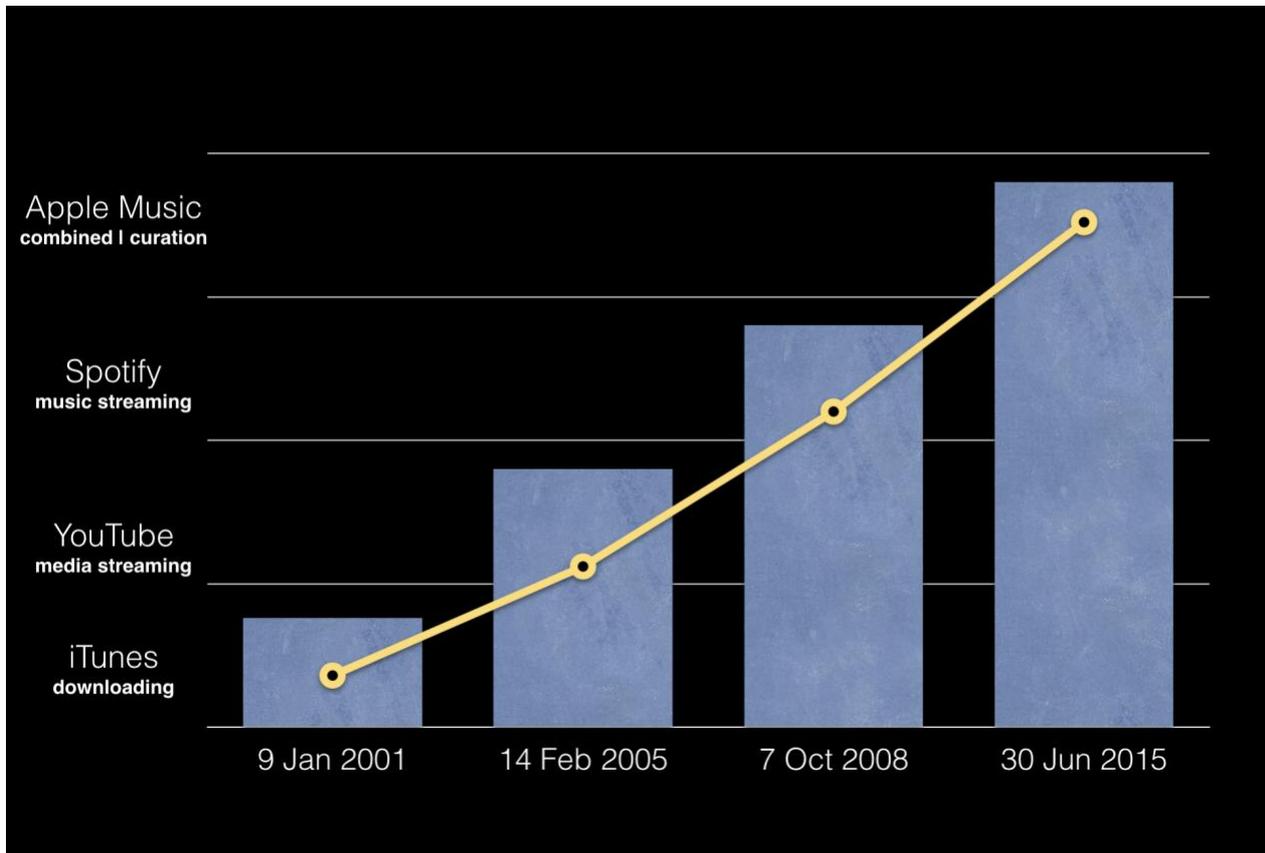


FIGURE 1. A TIMELINE OF KEY INFLECTION POINTS RELATED TO CONTEMPORARY CONSUMPTION FORMS OF MUSIC.

This is exemplified by the attempts of (and collaboration between) producers such as Dr. Dre and Jimmy Iovine, and manufacturers such as Monster Cable (Beats’ partner from 2008-2012), to create headphones that enhance the bass. Effectively, letting you “hear your music the way the artist would play it back—specifically, the way hip-hop and rap artists, like Dre, would want to play it back: with a lot of bass...” (Sharp 2014). There is a lot of speculation about the technology that actually enables this, ranging from questioning the published detail on designer Robert Brunner’s cryptic patents, to equating the ‘Beats Audio profile’ technology to just a

“fancy name for (an) equalizer setting” (Kiger 2012). A technical analysis is beyond the scope of this paper, nevertheless the technical challenge of reproducing enhanced (loud) bass on small speakers has remained a focal point for manufacturers for a number of years, and Beats headphones represent only one such highly popular alternative for a generation of headphones that have managed the feat. As early as 1999, in an AES convention paper entitled ‘The Effect of MaxxBass Psychoacoustic Bass Enhancement on Loudspeaker Design’, authors Ben-Tzur and Colloms (1999) discussed the effective application of the MaxxBass signal processing algorithm as a means of extending the perceived range of low frequencies against physical property limitations. Citing Beranek (1993), they explain how “bass notes are supplied physiologically or psychologically because several of their harmonics are present in the signal”, and suggest applications in loudspeaker design exploiting the phenomenon of the “missing fundamental” (Ben-Tzur and Colloms 1999: p.3). What is interesting about technologies such as MaxxBass is that they represent both a technical solution to enhance bass perception in loudspeaker design *and* a software plug-in that can be used in production.

Of course, different kinds of headphone design—circumaural (around ear), supra-aural (on-ear), earbuds or in-ear—take advantage of a range of further physiological affordances to produce the sensation of low or sub frequencies adequately: from bone conduction for the around/on-ear designs (Buroojy: 2009), to various degrees of coupling directly onto the ear canal for the earbud/in-ear variety (Maya: 2017). This brings us face to face with the production conundrum of when and how (much) to apply such bass-enhancement processing. In a more general sense, mixers are tasked with creating low-end in their outputs that will not only work effectively on a range of systems, but will also translate well on technologies (headphones, speakers) that already utilise bass enhancement technology, physiological resonances or equalisation processing. Although it is still the norm to master differently for vinyl, for most other purposes a producer and mixer will attempt to create a single sonic product (file) that

represents the music vision successfully on a range of systems and consumption scenarios: from bass-enhancing headphones connected to a streaming device, to a club with digital-file playback facilities, to a living room speaker-dock connected to a consumer's smartphone (physically or wirelessly). Below, we will attempt to describe a number of approaches to working with contemporary 'bass' with these productions aims in mind, looking at a number of representative examples from recent discography, and subsequently analysing case studies from the authors' own professional practice.

Theorising | Typology

By way of analytically systematising approaches to producing bass for contemporary styles and forms of listening, we suggest that the practice could be initially explored from the perspectives of low-end source *creation* (capturing and synthesising) and then mix/master *processing* (timbral, dynamic, spatial). The range of examples offered in the practice-based background section above, on the one hand, portray a number of approaches related to providing low-end source content: from the capture of electric and acoustic basses (and kick drums) with microphone and DI techniques (e.g. 'Poet'); to the sampling of previously captured live content (e.g. 'Sunshine'); to cutting edge synthesis (e.g. 'Electric Pow Wow Drum'). On the other hand, the (mix/master) processing approaches that can be deduced from aural analysis of these works suggest harmonic, dynamic and spatial enhancement techniques, which require further triangulation from practitioner testimonials (interviews/ethnography) and creative practice research (auto-ethnography). For this initial research into the topic, we deploy the latter method so as to objectify the aural findings, but we recognise the need for further ethnographic work to extend the investigation into contemporary low-end production and enrich the proposed typology. Figure 2 below provides a schematic representation of contemporary bass creation and processing approaches, delineating further categories related to these respectively, such as: microphone,

recording, tracking, arrangement, synthesis and sampling techniques (in terms of *sources*); and equalisation, filtering, phase, panoramic, stereo enhancement and spatial effects techniques (in terms of *processing*). The following practical case studies will map findings to these classifications, and it is important to note that—in practice—a number of these techniques can be deployed in parallel to achieve the desired results. As such, we have opted for examples that demonstrate a range of approaches simultaneously.

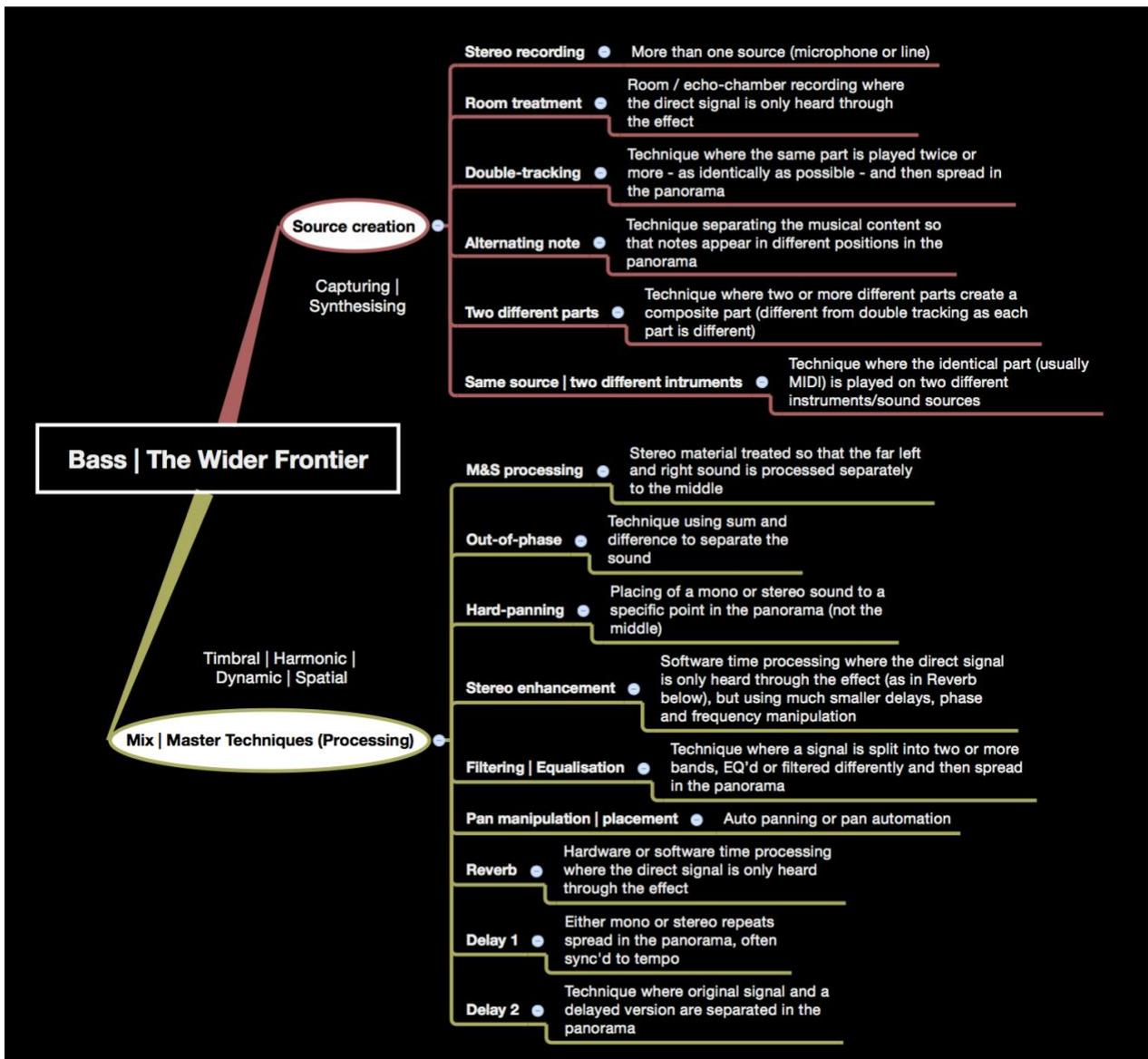


FIGURE 2. A SCHEMATIC REPRESENTATION OF AN INITIAL TYPOLOGY DELINEATING STEREO BASS TECHNIQUES AS USED IN CONTEMPORARY POP MUSIC PRODUCTION.

Case Study 1—Glenn’s Pop: ‘Freak For You’

‘Freak For You’ is a song recorded and mixed in November 2017 for a University of Westminster student band called “The Bench”. They are a five-piece live outfit featuring drums, bass, guitar, keys and vocal. As an unsigned act, it is envisioned that nearly all of their exposure will come through streaming and listening on headphones, small Bluetooth speakers or via laptop speakers. The Bench have tight, well-arranged songs, but are relatively new to recording as a band. In order to keep the live feel and groove that exemplifies them, it was decided, in consultation with the band, to record the track in a traditional way. As a result, the tempo, keys, arrangement and parts were refined in rehearsals, with the aim of developing the live-performance arrangement to one more suitable for a recording. The parts were then cut live using the university’s Solid State Logic Duality mixer via Orpheus Prism converters. Using Pro Tools HD, the Fender Precision electric bass part was recorded using a DI, a Neumann U 67 microphone (approximately six inches away and off-axis from the speaker), and a Sontronics Sigma ribbon microphone (around twelve inches away from the speaker and perpendicular to the U 67); the bass was amplified using an Ampeg BA-115 featuring a single fifteen-inch Celestion driver (see Figure 3 below). The mono ribbon source was recorded onto two tracks, which were panned hard left and right with the left channel phase-reversed.



FIGURE 3. NEUMANN U 67 AND SONTRONICS SIGMA RIBBON MICROPHONES POSITIONED IN FRONT OF AN AMPEG BA-115 BASS AMPLIFIER WITH A SINGLE CELESTION SPEAKER.

Stylistically the song is reminiscent of 1970s disco—in the manner of Chic or Kool & The Gang—and, as such, one of the key components of the track is the bass line, which includes both fingerstyle and thumb techniques. The acquired bass performance gave the recording an appropriate stylistic signature, which could be further enhanced dynamically by using mid/side and other stereo enhancement techniques on the thumb parts, but leaving the finger parts centred.

The bass rig was setup in an isolation booth to avoid drum spill, while an assistant adjusted the distance of the ribbon microphone to obtain the best phase relationship with the U 67 (see Figure 3 above). Both microphones went through Neve 1073 pre-amps, followed by the

separate sides of a Tube Tech LCA 2B compressor (with a medium threshold setting and a ratio of 3:1) to counteract the noticeable dynamic disparity between the fingerstyle and thumb parts. The DI was recorded without processing, through the SSL pre-amps. Once the tracking had been completed, a composite master part was edited from a small number of takes, before the comp was divided and copied to separate DAW tracks for the fingerstyle and thumb sections. For the fingerstyle parts, the ribbon microphone tracks were not deployed, and both the U 67 and DI tracks were set to the centre aiming at optimum balance. Conversely, for the thumb parts, the U 67 was centred and adjusted in level in relation to the ribbon tracks to obtain the required stereo image, while the DI tracks were muted. To further enhance the stereo field, the left side of the ribbon recording was equalised with some low-pass filtering, removing most frequencies above 2KHz. This had the effect of positioning the thumb parts more to the right of the stereo image, which allowed complimentary panning for the busy rhythm guitar slightly to the left. Though stylistically incompatible with this track, a similar approach could be taken with an upright bass, splitting the part onto different tracks, and placing the high-end elements in the out-of-phase setup whilst maintaining mono integrity for the low parts.

To cater for the envisioned streaming potential of the track, the Waves Renaissance Bass plugin was used in parallel for both parts as a way of enhancing (synthesising further) the harmonic content of the bass, but as the production of the chorus arrangement became more busy, it became difficult to retain some sense of staging for the verse bass parts. The Waves PS22 Mono to Stereo enhancer—a psychoacoustic spatial enhancement plugin—was thus inserted on the DI recording (opting for an LF spread greater than 2.00 and a frequency of approximately 10 sweeps) to acquire an artificial bass spread, which would, however, fold down to mono effectively without significant artefacts (despite the considerable use of phase and small delays in the plugin). Finally, the Dear Reality dearVR plugin was inserted in the middle-eight section of the song, placing the composite bass part around five (virtual) metres back from the centre sweet

spot, and creating simultaneously a sense of both depth and pseudo-panoramic staging. Throughout the bass processing experiments, the aim was to accentuate the bass as a focal element in the track, illustrate some of the typologies identified and highlight their use in strategic staging concepts. To ensure that headphone monitoring, speaker listening and mono playback were compatible, a range of monitoring scenarios were deployed as references, including Beyerdynamic DT 200 headphones, Yamaha NS 10 M speakers with a Mackie bass sub, and a mono Avantone MixCube. The isolated composite bass part and full instrumental mix for the track can be heard using the links below:

Isolated bass: <https://soundcloud.com/user-562957398/freak-for-you-bass/s-ZED3x>

Instrumental mix: <https://soundcloud.com/user-562957398/freak-for-you-instrumental/s-Kt6Q1>

Case Study 2—Stereo Mike’s Hip-hop/Electronica: ‘Psakse’

As part of a wider research project exploring the interaction of vintage production techniques and contemporary sample-based hip-hop, a number of pieces have been constructed starting from the creation (writing, performing, recording and engineering) of original music referring to older music forms (blues, soul, funk, rock), which are then sampled and manipulated further as part of a hip-hop compositional/production process; this often entails the addition of further sample-based or synthesised sources. The work functions as both work-in-progress content for the author’s independent current album-offering—following solo releases with EMI Music Greece under his Stereo Mike alias—and as practice-led output for ongoing doctoral research (a video blog of the developmental process entitled ‘Hip Hop Time Machine’ can be found at <https://goo.gl/N2Cb1N>). For this example, the live performance phase has involved the recording of a 30-minute semi-structured improvisation of acoustic drums, electric bass, electric guitar, keyboards and vocals in a loosely industrial rock aesthetic, which was then sampled in smaller sections and brought into an Akai MPC (X) for further ‘chopping’ and manipulation.

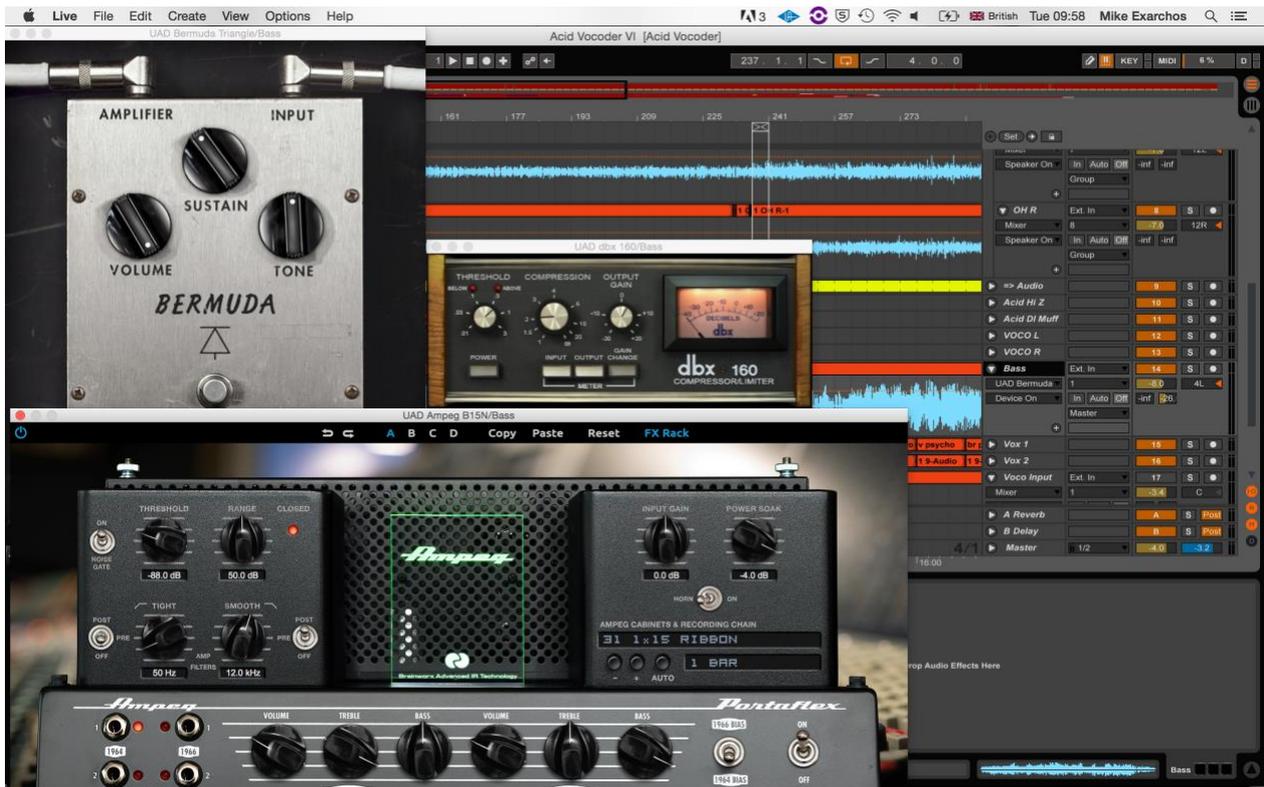


FIGURE 4. SOFTWARE PLUG-INS UTILISED ON A SPECTOR EURO 4LX DOUG WIMBISH ELECTRIC BASS GUITAR DI RECORDING.

The Spector Euro 4LX Doug Wimbish electric bass was DI'd through a Universal Audio Apollo Twin interface in mono and run through distortion (Bermuda), amplifier (Ampeg B15N) and compressor (dbx 160) UAD software emulations (see Figure 4 above). The aim for the bass was to mimic an analogue tracking aesthetic, infusing it with a sonic footprint that will be important to consider in terms of its interaction with further low-end elements in the subsequent hip-hop production phase. The same applies to the recording of the acoustic kick drum, which was captured on a Prism Orpheus interface with an AKG D 112 microphone through a Focusrite Platinum VoiceMaster pre-amp with some compression applied during tracking. One of the keyboard parts featured made use of a TB-303 arpeggiator emulation on a Korg RK-100S keytar run through an Electro-Harmonix Bass Big Muff distortion pedal, also DI'd through the Apollo interface. All recordings were made using the Ableton Live 9 Suite DAW. The hip-hop production elements relating to low-end spectra involved Roland TR-808 kick drum samples

triggered from the Akai MPC and analogue synthesiser bass (courtesy of a Make Noise 0-Coast semi-modular synthesiser). The synth bass was sequenced on the MPC but recorded as audio using its ‘looper’ function, to allow for both control-voltage automation and live manipulation of its modifier and control-signal source parameters (see Figure 5 below).



FIGURE 5. AN AKAI MPC X SAMPLER/DRUM MACHINE AND MAKE NOISE 0-COAST SEMI-MODULAR SYNTHESISER USED FOR SAMPLING, DRUM-PROGRAMMING AND SYNTHESIS FOR THE HIP-HOP/ELECTRONICA CASE STUDY.

Throughout the process, the bass layering of and interaction between 808 kick samples, acoustic kick drum, and electric and synth basses, were monitored on studio monitors (active Blue Sky ‘Sky System One 2.1’, Focal CMS 40 speakers and Avantone Mixcube mono speaker) but also on a range of headphones (Audio-Technica ATH M50 and Beats by Dre urBeats³). Parallel to the stylistically-driven juxtaposition of rock/electric versus trap/synthetic bass lines

(and Roland TR-808 versus sampled/acoustic kick drums), the aim had been to make the numerous low-end elements sonically co-exist in the mix, while providing an enhanced headphone experience that can also work on speakers. Particular attention was paid to how stereo imaging translated from any layering achieved on headphones (and dampened control rooms), to untreated or common environments. Referencing focused on previously unidentified bass resonances, blurring of definition in the bass/kick layers, and merging of panned bass information farther from the speakers (the track had been performed in Stockholm's Royal College of Music 'Lilla Salen', but also played as a work-in-progress mix out of a variety of consumer systems in multiple home environments). To achieve this, a number of tasks were undertaken. Firstly the acoustic drums were chopped as 'individual hit' samples (kick drum, snare drum and hi-hat) on the MPC and re-programmed mimicking the performed patterns. This was done in order to retain some of the live feel but avoid 'flamming' with the programmed/808 beats, also allowing for further micro-temporal phase alignment between—most crucially—acoustic and synthetic kick drums. As such, the acoustic kick drum would function as a sampled layer for the more predominant 808 kicks.

Furthermore, the distorted electric bass was spread in stereo using an onboard flanger insert effect on the MPC, before being sent—rather heavy-handedly—to a short stereo auxiliary reverb. Excessive low/sub frequencies were avoided by virtue of the distortion and flanger effects, allowing sufficient space in the frequency spectrum for the electronic elements to come (this could be secured further with high-pass filtering, which in this case was not deemed necessary). The aim here was to both widen the electric bass but also stage it further 'away' on the depth axis as a sampled element that would provide 'space' (both panoramic and ambient) for the added, synthetic basses.

Finally, arguably the most striking bass feature for the track, came from the synthesis and then manipulation of multiple takes of the pattern triggered from the 0-Coast bass synthesiser; on

the one hand, aggressively filtering the overtone content of the designed patch and, on the other, triggering rhythmical LFO-style modulations by altering—in real-time—the shape of a cycled envelope. The live manipulation aimed at achieving varying degrees of rhythmic modulation over variable base sonic spectra to provide numerous ‘takes’, some of which would function as extreme versions of the pattern placed hard left and right in the panorama. The synthesis of the base spectra was aimed at an aggressive type of lead bass, without much sub-sonic information, which sits well with the prominent and sub-heavy 808 kick drums (this can be heard in many current ‘bass’ music styles such as Trap, Dubstep and various hybrids thereof)—but also as a complimentary layer to the electric bass. The example illustrates a number of techniques identified in the contemporary examples above and highlighted in the typology (double/multiple-tracking, two/more different parts/instruments, room treatment, hard-panning, time-based effects such as phasing or flanging, and spatial effects such as reverb and delays), providing insight into the inner workings of the practice. It also highlights a mixing-whilst-producing/composing workflow, which is congruent to the type of low-end sounds that are created for contemporary styles, *and* headphone consumption. The complete track as performed live at ARP 2017 (Bourbon and Exarchos: 2017) can be heard using the link below:

‘Psakse’ live at Lilla Salen: <https://soundcloud.com/user-562957398/psakse-live-at-lilla-salen>

Conclusion

The paper has provided a brief historical synopsis of stylistic and technological developments affecting the evolution of bass creation and production in popular music mixes, before contextualising theoretical problematics about bass placement against literature dealing with the notion of staging in the musicology of record production. Our proposed typology for the analytical study of bass production for contemporary music styles and forms of listening suggests an initial delineation between low-end source creation, and timbral, dynamic and spatial mix

processing. These have been further categorised—respectively—into bass recording, sampling and synthesis techniques on the one hand, and harmonic, dynamic and spatial mix enhancement techniques on the other. We recognise that our mixed-methods (predominantly auto-ethnographic) approach to this investigation, consisting primarily of creative practice and intertextual and phonographic analysis, requires further triangulation from other perspectives. The proposed typology and theoretical findings can thus be enriched by further practitioner testimonials, interviews and ethnographic work, as well as other contemporary practitioners' own reflexive research. As such, much needed practice-based perspectives can be brought to the musicological study of contemporary bass creation, which seem especially necessary at a time when the low-end has become an inter-stylistic focal point across all popular music production. Nevertheless, our research demonstrates that contemporary forms of music consumption and an interrelated shift in stylistic foci have opened up ample creative opportunity in bass staging techniques. These strategies necessitate a heightened awareness of—and balanced approach to—the relationship between technical considerations and expressive sculpting of low-end spectra for music producers. The evolving delivery landscape means continuing reappraisal of low-end reproduction is likely. Far from either a historically conservative or polarised route to bass production in the stereo panorama, low-end sources can now be enhanced or conceived of in dynamic, subtle or uniquely expressive fashion; a notion that we only begin to explore theoretically given the new opportunities in immersive sound and the increasing stylistic domination of Bass Music worldwide.

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