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Optimising Live Performance Sessions: Techniques in Recording, Mixing, and Mastering for Enhanced Audio Quality

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Abstract:
This paper delves into the complex process of optimising live performance sessions, focusing on the techniques used during recording, mixing, and mastering to enhance audio quality. The study underscores the significance of critical elements in sound production, such as microphone placement, room acoustics, equalisation, dynamic range compression, and panning. It also highlights live environments' unique challenges, including fluctuating sound levels, ambient noise, and room reverberations. Each section offers detailed best practices, providing technical insights and creative approaches to manage and overcome these challenges. For instance, the correct placement of microphones can prevent sound distortion and ensure accurate audio capture, while room acoustics considerations can significantly impact the overall quality of the final mix. Additionally, equalisation techniques, dynamic range compression, and stereo imaging are discussed in-depth as essential tools for shaping the tonal balance and spatial dimension of a recording. By emphasising the need for technical precision and innovative sound engineering methods, this paper offers crucial insights for sound engineers and audio professionals. It is a relevant and valuable resource for producing high-quality audio in various settings, including live concerts, studio recordings, and video broadcasts.

Keywords:
Live performance recording, microphone placement, room acoustics, audio mastering, equalisation, dynamic range compression, stereo imaging, sound engineering, mixing techniques, live audio quality.

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I. Introduction

Giovanni Vuolo presents a selection of essays that reflect the full range of perspectives, from music and pyramid science experts to proponents of topics that go unnoticed within traditional academia (Mills, 2020). Each of the essays is intended to give readers a sense of the background and chosen topic, how this branch of science has been overlooked or mistreated and provides a direct solution in the form of new research opportunities that resonate well with the chosen approach of both the Roundtable project more broadly and the whole event convened at the Petrie Museum (Sargan, 2024). Essays in this collection aim to challenge the neglect of non-English areas of impact for antiquarian scholarship, also linking the so-called "Greek Miracle" with new socially engaged understandings of "science" and ways of knowing (Fewster, 2020). Additionally, as part of the Roundtable's collaborative attempt to integrate the principles of de- and reconstruction and the compilation of the rejected or impossible paper contributions, we also welcome some tongue-in-cheek reflections by two model individuals on their failed bids to author papers for the original event and the reasons these were rejected (Walsh-Beauchamp, 2021).

These papers will be further developed within the two subsequent events, particularly on whether the proposed research trajectories evoke fresh critiques (Baker, 2020). In the next section, Giovanni outlines the trappings of clinical trials and modern practices in treating contemporary mental health maladies, resuscitating old debates about questions of embodiment, nature, and culture. That much is uncontroversial – that these debates represent "returning" points to the long haul of Western logic, at least since the death of Socrates, if not farther back into other forms of "Greek" reflections on what it might mean to be whom. Impudence and rude imposition often depict medicine within the world as it is: resolutely cold, a mirror set before phenomena, silences, and symptoms. I, by contrast, want to think about a psychiatry cure that inflicts regression on us all – by importing forms of treatment into bodies that could only happen if they could fancy a sense beyond sense.

II. Understanding Live Performance Sessions

Live performance sessions – fundamentals

Capturing the energy and sheer vibes put forth by musicians is one of the noblest things a producer can do (Neuvonen, 2023). Understand this, though: production vibes should sync with the artists' vibes. That could lead to optimistic sparks, fostering creativity (Atherton, 2020). It is just that simple. To be able to work on live performance sessions, however, you need to understand and fully embrace some rules and situations. Many people disagree with this – but you will find that a staggering number tend to agree with some of my views (Koozin, 2024). First, you cannot mix as you would normally do because there is not much flexibility – all the live renditions of the song must maintain the energy, zest, and spontaneity. That cannot be matched to "upwards of 120 takes." "Cannot" is an overstatement of monumental proportions; "are not" would be more like it. Overdubbing... Ah, a mighty complex equation. The mix must closely resemble the sound of whatever you did at the gig, and you must record in a somewhat convoluted way (discussed later) (Fells, 2024). Any beat correction (excessive beat correction) may result in glitches (or video instability). You must stop living by the mantra of "we can fix that in the mix" because sometimes, you just cannot. Routing to FX, compression, and EQ upon recording is advisable. Always put the fader at 0dB and trim accordingly. It is not a simple thing per se, with two mics into two bottleneck pre, is *into* a hardware PT (or Pyramix, or iZ debugger). Decent-sounding equipment is indispensable. There are no two ways. Do not compromise on your mics. Word.

Know that the further one is from a microphone, the thinner their presence will demonstrate, which can be slightly detrimental, especially in a setting where the artist is strumming miles off the hole under a clamshell. Always ensure that the prominent artist's direct vocal is higher than a vocal through a speaker in behaviour via the Peavey's gate for sidechain purposes. Always. Always, and did I mention always? Go in with some monitoring system methodology. Not doing this is like recording without mics – plain suicide. Oh, and try to keep the amount of hardware routing to a minimum. Routing independently is, again, safer than the regular two covert sends, which can very well translate itself to software. Always (and finally, here is that all-important rule) work on the arrangement and syncopation at the rehearsal – it will save much time and marathon retakes. Safe expeditions, and yes, this is the best! It is the best decision you will ever make. The vibes at the sound check are a good enough idea. Anything beyond that, you would probably need marshmallows. Good God. Good. There is no satisfactory atmosphere. As far as this formula is concerned, it is the best decision ever. Very underrated. Fix the sound at any time.

III. Recording Techniques

A high-quality recording is the first step in ensuring an excellent final audio product (Corbett, 2020). There are a few tricks to optimising a recording of a live performance that are unique to these kinds of sessions. Since microphones (mics) are the tools used to capture audio, placing the mics relative to the instruments will be the most crucial consideration when it comes to capturing sound (An et al., 2021). Placing the mics too close to the performers will cause them to lose space in the room, and placing them too far away might introduce too much reverb, thus causing the clarity of the audio to be lost. A good rule of thumb is to place the mics one or two feet from the sound source to get around this. For vocals, place a pop-filter shield a few inches from the performer with the mic on the other side to avoid plosive sounds. For drums, use a mic on each piece and overhead to catch the room noise (Wang et al., 2021). Consider the timing of the plucks on the gourd-rattle and shake of the shekere, as they tend to translate well with a good mic placement. Capturing the ambient sounds of the room is one technique that can be taken advantage of in the live performance setting to add another layer of sound and depth to the overall mix (Dawson et al., 2022). Room sounds can be dampened with heavy, insulating curtains or increased with reflective surfaces. Once the space material is evaluated and modified appropriately, avoid using any data-compressed file format when capturing and recording the final mix. Consider using three formats to contribute to an optimal mix: .wav or native format recording for sound editing, .wav for the final assembled soundtrack, and a .mp3 for promotional use.

To capture video, this means uploading to two separate online video hosting platforms and saving at least one copy to a hard drive. Several platforms, including FaceTime and Zoom, are data-compressed, making your finished product sound modest. If you have access to a dedicated camera with a large SD card and a professional microphone, consider these recordings as well. Improved sound quality is expected, with premium mics available for rent or purchase at local music shops. Wireless microphones will prevent the necessity of dealing with excess cable, as it is expected to use an additional guitar and fiddle mic that you would otherwise not need in a studio setting. Dual channel systems can be purchased or rented, allowing two different frequencies to avoid interference. Purchasing rechargeable batteries for the wireless mic packs will cut costs in the long term. If various effects such as reverb are planned for mixing in the edit, they are also encouraged to be added during recording.

3.1. Microphone Placement

Microphone placement is crucial when recording anything; recording a live performance is no different (Corbett, 2020). To best capture the performance, one must take an ad hoc approach to placement, ensuring that the specifics of the performance are taken into account. For instance, the classical guitarist may require placement outside the guitar's body to pick up the sound without dead zones apparent when recording (Grond et al., 2022). Every musician's instrument and every vocalist's voice has specific demands about recording. Proper microphone placement is a must for good sound. The first step in setting up a recording in a live venue is to choose the microphones. Deciding which microphone to use can depend on many factors, such as cost, harshness of the stage, and the sound pressure level (SPL) of the sound projected by the performer (Lee, 2021). Adjustments for those microphones selected can be speedily undertaken, such as pad adjustments. This allows one to fine-tune on the fly rather than recalibrating the entire microphone position. On the other hand, many soundboard operators may want some say about the stage's microphones, in which case communication becomes essential. The best position to place the microphones is at the edge of the stage close to the floor, and if possible, hung in stereo. Often, there are the added issues of time and space. Unfortunately, this can include time to perform the sound check, as a spike during live brag productions can be seen as bad form, causing even more problems.

However, Microphone placement is essential for live recordings (Corbett, 2020). Figure 1 shows a drum kit with mics capturing different elements, such as overheads for cymbals and a front mic for the bass drum's low end. Proper placement ensures accurate sound capture, avoiding dead zones (Grond et al., 2022).

Figure 1: The Glyn Johns technique mic setup

3.2. Room Acoustics Considerations

Acoustic considerations must be considered throughout the production chain, from recording to mastering and final publishing (Berzborn & Vorländer, 2021). The sound may have exaggerated high-frequency content if recorded in a bright room. If recorded in a room with increased reverberation times, the post-processing to add more reverberation later would be less accurate due to convolution (Keränen et al., 2020). The performance of a recording can vary with the room it is recorded in, and considerations can be made to optimise the room in both acoustic and video recording situations. Understanding room acoustics may provide more insight into decision-making processes (Čurović et al., 2021). If possible, one should record in an environment that provides the desired sound and does not involve room acoustic artefacts, allowing less time to be spent correcting or accenting the same room acoustic character. Room acoustics modify the frequency content of the original signal differently for different positions in the room, affecting the perception of sound source distance and azimuth (Götz et al., 2022). They affect the energy decay rate, causing the direct-to-reverberant energy ratio before and after compressing the signals to be different when changing the position of an instrument or aural microphone array. Such changes in wet/dry signal balance add artefacts to the point of the final stage of dynamics processing, and they will also affect downstream treatments such as reverb extensions.

Figure 2 shows a room with sound-dampening panels and diffusers on the walls and ceiling to control reverberation and frequency balance. A microphone stands near instruments like drums, guitars, and a piano, capturing diverse sounds. Reflective surfaces like hardwood floors or glass panels help achieve acoustic balance. Heavy curtains or foam padding minimise echoes and harsh frequencies, demonstrating how room acoustics affect sound waves. This setup ensures high recording quality, reducing the need for post-production corrections.

Figure 2: The room acoustics professional recording studio.

IV. Mixing Live Recordings

One of the final stages required to produce a live audio recording ready for distribution is balancing the various local sound sources (Qian et al., 2020). The principal purpose of mixing is to balance the levels between the multiple signals to obtain the correct blend of them and remove any off-stage noise that may or may not have been picked up by the local microphones. Most balance decisions will be made based on the balance of the local sound source, but in some cases, a few direct and early reflections might be brought in with local microphones (Ji et al., 2020). Another essential part of mixing is setting out panning—balancing microphone levels in each channel differently. Panning can be designed to create the sense of a unified space in the recording. In the tracking phase, depth panning was used to control the mind stage width and make space between the listener and the sound source (Ciaburro & Iannace, 2020). It is even possible to use a three-channel microphone configuration to create a sense of depth in addition to width. Creating a sense of space with a stereo image is also possible. In stereo recording, significant mixing tasks started with stereo mastering or carrying out stereo imaging. Stereo width adjustment has become a prominent part of mastering techniques for mixing down film and television post-production.

In mixing live concert recordings, these steps might be approached as a continuation of the stage panning processes by increasing the width to include complete audience immersion as an additional technique either in the recording or in final mastering to help improve the listener's sense of experiencing the live performance (Turchet et al., 2021). The preference for panoramic positioning will depend on the mixing engineer's aesthetic sensibility and the desired experience of the listener's typical playback. In Western pop recordings, the trend is to place rhythm section instruments at the centre or to play shorter, more incisive lines on the sides, which mainly softens the distinction of music "inside" (in width). Classical orchestral recordings use width panning as an artistic tool to control the perception of soloists, instrumental section balances, and leading music versus background signals. Our focus is applied mainly to designing balanced recordings that emulate concert hall performances but primarily prioritise live concert reproduction. In these recordings, the audience must be placed in a vast panorama to help raise interest in replication. There are several ways to achieve stereo emittance placement in live stereo recordings: one that builds it into the original recordings, which continues with stereo multi-channel recordings and requires special post-processing. The latter includes stereo-to-stereo conversion of early sound fields via commercially available tools, with more limited offerings, as described in more detail here.

4.1. Balancing Levels

Balancing levels, whether on the recording console, during later mixdown, or mastering, is a critical aspect of mixing. If levels are not set correctly, tracks will become cluttered, and clarity will decrease. In addition, a listener's first impression of a session is often the quality of the sound or dynamic. The practical result is that proper balancing of levels is the first step in the mixing process before other functions, such as equalisation or panning, are even considered. This applies to both studio and live recordings. Balancing levels after recording focuses on setting the instrumental levels at the correct heights so that they can be heard correctly and in balance with the other instruments. This balancing portion can be challenging in live sessions due to the lack of a rehearsal with the house speakers and variables such as room size, reflections, and standing waves. After recording, an engineer should balance levels on a mixdown. This requires a good listening environment and quality monitoring equipment (headphones, studio monitors). One theory of mixing that is often considered in live recording sessions

is that each track represents a unique opportunity for dynamic expression. Enough stereo tracks are available on mixers so each instrument can be allocated its track. Panning can also provide more clarity. For the separation and placement of instruments in the final mix, it is suggested that complex pan groups of related instruments, such as drum input channels, be slightly placed on each side of the stage. For the drum channels, it might be a good idea to separate the kit's instruments into separate tracks to provide greater control during mixing. Bass instruments can often be panned naturally, such as when two violin players are in the string section, or woodwind musicians are positioned throughout the stage.

4.2. Panning and Stereo Imaging

Panning and stereo imaging offer solutions that, when combined with time-based effects, further enhance the listening experience (Lim & Nam, 2024). Imbuing a panning depth gradient in your live performances can effectively mimic the temperament of your mix. At the top of a 'panned' live mix, uncompressed and unaccented musical elements can be perceived in their entirety, while dynamics control the depth of each sound source. At the bottom of a 'panned' live mix, the listener perceives only the after-effects of all dynamics due to the full stereo width (or lack of any stereo field/artefacts) with which the sounds are rendered and aligned (Baxter, 2022). Spatial width and stereo depth parameters should be leveraged to simultaneously depict the tonal quality of each sound source in tactile and spatial dimensions. For example, leveraging stereo-imaged 'distance' attenuation, the sound sources at the top of one's 'panned' mix might appear to retreat physically, imparting depth from the listener to the stage, while top-row sources appear distant. Using parallel compression – dynamic range control – can additionally guide performance techniques (Rafaely et al., 2022). Buildings and spaces can capture and release sound in fundamentally different ways – even a tightly gated soundstage will initially reflect some transient 'smeared' reverberation from the original capture point.

V. Mastering Live Recordings

Several loudness monitoring and control systems are available, ranging from traditional analogue VU meters to an array of modern RMS meters and loudness units (Evangelidis et al., 2021). However, one of the primary monitoring tools in digital practices is the file waveform display, meter, and histogram, which are available in all modern digital audio workstations via outboard digital control software. It is essential for live mixing sound engineers to have a working understanding of all of the various loudness monitoring and control systems listed here so that the resulting mix will be optimised for the most significant number of environments, be they club, radio, streaming, broadcast, or mobile-based (Goodwin et al., 2020). Disturbances utilise dynamic range equipment such as compressors, expanders, limiters, and transient shapers. However, it is also essential to thoroughly understand equalisation to correct tonal issues accompanying live recordings (Wu et al., 2020). Step capturing live parlays in a live stream session without being overly technical or convoluted in their structure. It is important to remember that while people generally want to hear a balanced recording when capturing material with one microphone or several microphones in a room with a live artist (as opposed to direct input or as part of a multi-faceted mix as in live sound reinforcement or events such as the Super Bowl), the environment can be a significant part of the recording process. If done poorly, it can ruin the resulting recording, especially if there is a live and attentive studio audience. In such cases, damage reduction plugins such as Expander/Gate are usually most effective before any amplification stage. The section above with plugins for Downward Expansion would provide information on adequately organising and optimising the band's inserts for down-solo processing of constraints/compression as a band request.

5.1. Dynamic Range Compression

The most crucial starting point in preparing an audio program for delivery is dynamic range compression – very effective in this area, but when overapplied, it is damaging (Hill et al., 2021). Dynamic range compression is about volume levelling. Levelling the volume of a piece of music with many fluctuations in level, even at a moderate sensitivity ratio, constitutes compression. Dynamic range is simply the ratio of the lowest to highest volume for any recording, and it applies over time (minutes or seconds) (Ebenezer et al., 2024). Compression is a powerful tool when used wisely, especially on live recordings. Compression damps down the peaks, thereby levelling out the sounds, and enables you to bring up lower sounds – also called fills. A live recording may have uneven levels. Dynamic range compression can even out these sounds while allowing all participants to be clearly understood. Compression is not about making a soft passage louder or a loud softer; it is about making it sound closer in volume, producing clear car-to-car communication or a band performance for a mass-market release (Helmrich et al., 2020). It is about giving performers mid-level impact. The rules of signal processing can sometimes lead to a harsh sound, a cavity in the sound. Harsh-sounding dynamics are impervious, dry, not vibrant, or impinging with strong rival but quite evocative transients. A not-too-fully compressed, broad-open, and noticeable transient sound – giving vocalists their proper entire space to breathe – combined with a nicely expansion-approved mid-level sound will produce a cosy and gentle ambience, give music a lovely directness and

thus encourage complete personal surrender. Relaxing vocal exercises can complement compression exercises quite well. 4:1 compression, or reduction of the average speech level by 15 dB, will significantly improve the intelligibility of any average offstage live speakers, specifically modern microphones and picking compression and expansion ranges – not forced into the last and loudest or the first and highest. Setting 'Threshold' – for better intelligibility, do not have the 'amplitude below the SIVI (al') ' the 1' 'i US - 5VLI (1) 4:I'. Minimise any mild compression – provide enough acoustic energy so that amplification is not necessary for everyday live sound for off-stage voiceovers; complete refinancing will sound too quiet. Bud Finale has been unused for at least years. This technique is not being experimented on; it works very well. Naturally, it will even out imbalanced level performance.

5.2. Equalization Techniques

The equalisation is a powerful mixing tool that shapes the tonal balance of entities by enhancing or limiting the level of specific frequencies and modifying their spectral characteristics in the process. The effects of equalisation on the amelioration of clarity in dialogue intelligibility and vocal presence have been extensively discussed in the existing literature. It is reasonable for equalisers to become helpful in producing clarity and warmth while minimising the influence of adverse factors in live performance sessions. Closing down severely deficient drum frequencies has lent "clarity to the top end" in drum kit recordings. Combining high shelf boost and selective reduction is a common technique for drum overhead microphones. Other techniques for drum recordings include boosting the fundamental frequency in kick drums while mildly reducing "the click" and enhancing the "thud". Meanwhile, boosts in the 3-5 kHz range of snare drums dominate other live sound equalisation techniques.

Vocals are most typically dealt with using equalisation in live sound. Many recording engineers prefer to roll off the low-end using a high pass filter, sweep through the upper mid-range frequencies to single out any unwanted "honk" or "boxy" sound and reduce the level of the problematic frequencies by 3-5 dB before utilising a notching technique to reduce the "sibilant frequencies" by 2-4 dB. Following that, a sheer boost can be applied between the 10 kHz and 15 kHz range for nasal vocals and at 8 kHz or 12-15 kHz for "thin" female and boyish voices. In the "fine art" of equalisation, clarity is linked with presence, brightness, airiness, breathiness, and sibilance, while clarity combats muddiness, excess warmth, boxiness, nasality, roomy sound and background noise. Fine equalisation can make the sound thicker, more present, or more careful sonic space.

The digital audio workstation (DAW) screen in Figure 3 displays frequency adjustments, highlighting the process of enhancing clarity and presence during mixing. Studio equipment like mixing boards and speakers are also visible, contributing to the professional setting.

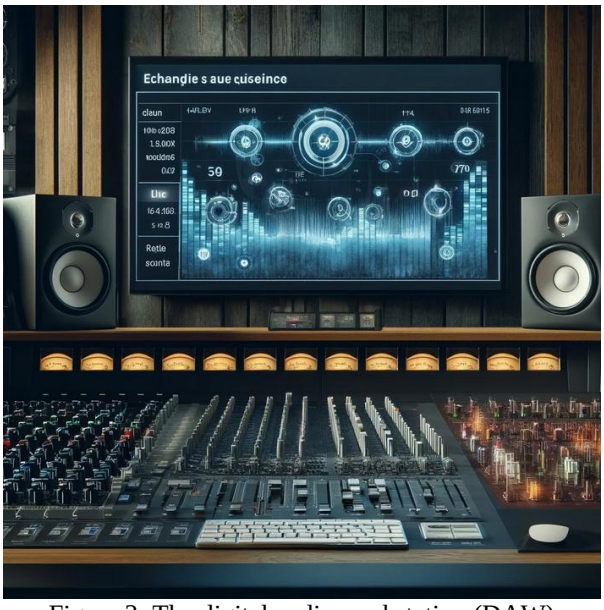

Figure 3: The digital audio workstation (DAW)

VI. Conclusion

In conclusion, recording an audio signal of a live performance is as challenging as recording a video signal. Recording an event regarding future audio reproduction about the performance experience and the listener's need for subjective quality is essential. If audience noise is perceived as part of a critical live musical experience, capture the event with an audio technique that includes the listener, such as multichannel or binaural recordings.

If transparency distances the listener from the event, employ techniques that reduce external noises, such as spot and stereo or 5.1 microphone techniques. Recordings for television and radio broadcasts require a combination of techniques that, at minimum, provide flexibility in post-production. An audio capture should be able to customise the amount of hall or room ambience of the final mix. This will give the most options during post-production and the best result for large television or radio audiences listening in stereo over speakers in real-time, recorded and compressed, or gain-matched between programming.

Advanced recording techniques that include time-of-arrival fidelity, time-coherent signals, and direct signals will allow the performance to 'record itself' – giving the highest perceptual quality for diffusion for virtual reality medium. Innovative methods presented in this essay include the synchronised control of multiple mobile live recording kits for multi-perspective broadcasts and 3D sound field first- and higher-order Ambisonics recordings in an outdoor or immersive VR environment; these capture the environment and the event. To further investigate which of these new methods results in the most 'qualitatively natural' high-quality live sound reproduction, listening tests with professional and non-professional experts are currently being conducted. Mixing is the sum of decisions and actions from the choice of microphones, the positioning of the microphones, editing, selecting takes, choosing parameters for EQ and processing, monitoring and hearing audio cues, and finally getting to the final stage – the mastering EQ. All stages need an understanding of the output device and a knowledge of the final transmission rate. The room finished in mastering EQ depends on whether 5.1 or stereo is the output goal. The final mastering must satisfy a nonlinear transducer; therefore, it is only possible to judge the audio quality subjectively, although these have been quantised. Only one can decide if it needs to go to the final stage of being mastered while presented with questions on PQ codes for live applications such as commercials and jingles recorded with one microphone, for example, on location, and would only go on air equalised using Dolby A. The proof of professional audio quality is evident in how these services have increased the lifetime of the Russian aeroplane engines that are extremely popular in critical areas such as helicopters where size and especially weight govern the cabin layout since space-voltage transducers have to be sacrificed for the best tactical performance.

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