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## The Generation Gap - Perception and Workflow of Analog vs. Digital Mixing

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### ABSTRACT

Are sound engineers showing preference for the mixing technology of their generation? We interviewed producer Ezequiel Morfi who owns TITANIO in Buenos Aires, and contrasted his opinions with those of four mixers based in Western Canada, who were required to use analog-only or digital-only mixing tools when preparing stimuli for this study. To ascertain the myths about which technology sounds superior, 19 trained listeners of ages 17-37 compared analog and digital mixing versions of eight pop-rock tracks in a double-blind listening test. The main results showed that the analog version of one track was significantly preferred by 79% of the listeners ( $p=.02$ ), and we observed a slight trend towards the significance of age on preference for the analog format ( $p=.09$ ).

## 1 Introduction

### 1.1 Analog vs. Digital: An Identity Statement

Before the Digital Audio Workstation (DAW) era, mixing engineers quickly adopted those technological advancements that offered superior sound quality or new production practices [1]. For instance, stereo was chosen over mono, and multitrack mixing over direct-two-track mixing without causing much nostalgia. The development of digital technology has divided the audio community between engineers who foster mobile and cheaper equipment and those who favor approved hardware. Researchers observed the same hard technological determinism trend among listeners, e.g. analog and

vinyl fetishism vs. the lo-fi movement and creative ethics placed in home digital recording [2][3]. In this cultural paradigm, a general interest for proven superior sound quality has weakened. In this paper, we argue that the Analog vs. Digital divide is influenced by one's generation, preferred musical genre, cultural and geographical background, and that it has become an identity statement that defines mixers' creativity and workflow. To discuss this argument, we highlight the practices of five mixers in their 20s and 30s from different parts of the world, and we report on the subjective evaluation of analog and mixing versions of eight pop-rock tracks by 19 trained listeners of ages 17-37 based in Western Canada. Results of the listening tests showed that *digital immigrants* slightly preferred the analog

versions, whereas *digital natives* slightly preferred the digital versions.

## 1.2 Background Research

In a recent study that highlighted cultural differences in mixing practices [4], five student engineers from the Paris Conservatoire mixed an electronic-pop track *in the box* although they had access to analog and digital mixing consoles in their school. Results from a peer-evaluation test showed that 13 students and one faculty from the same school, including the five student engineers, overall preferred the original mix of the track over the students' mixes. This original mix was produced with a combination of analog and digital mixing tools for summing and processing by a young engineer who graduated from the same school. This observation suggests a gap between two close generations of the same mixing culture.

Results from a comparative listening test of analog vs. digital summing versions of classical, pop and rock tracks showed that listeners' preferences depend on genre [5]. Specifically, digital summing was preferred over analog for classical, analog was preferred over digital for heavy rock, and no preference was observed for pop and country. These findings inspired us to focus on pop-rock genres for our study, as they "have largely developed with the process of recording and reproduction in a central position, and as such have allowed a recording-centric culture to emerge around them" [2].

An objective and subjective test of internal summing in five different DAWs revealed that changes in panning generated perceptual differences in source localization and up to 0.5 dB RMS differences in summation, despite each DAW's pan laws being set to the same value. These differences disappeared with the use of hard panning only. These results bring awareness to the potential non-linearity of DAWs.

## 1.3 Research Questions

Q1: Why and in which contexts do mixing engineers prefer using analog and/or digital tools, when economic questions can be put aside? And which tools?

Q2: Do trained listeners perceive differences between analog and digital mixing versions of the same track? If so: a) Which version do they prefer? b) Is there a correlation between the listener's age and their preference? c) What are these perceptual differences? d) Is there a correlation between preference and genre?

Q3: What is the future of analog mixing technology?

## 2 Methods

### 2.1 Mixers' Practices & Opinions

#### 2.1.1 Interview with producer Ezequiel Morfi

The second author (NT) conducted an in-depth semi-directed interview over a Facebook call in Feb 2019 with producer Ezequiel Morfi who agreed for his identity to be divulged. Based in Buenos Aires, Argentina, Morfi has been working professionally in the audio industry for 14 years primarily with pop-rock or rock-influenced artists, e.g. Cannas Verdes, Feel the Souls, and No Me Nombres Mas!, Olivia Viggiano and Rafael Asioli. He came to music production through the technical aspects of music, e.g. making mix tapes. After being credited as producer for the first time on a friend's band live album, he took audio engineering classes and became aware of the AES. Morfi is now a member of the Argentinian AES board. His first full-time audio job was at Andres Mayo Mastering until he founded his own studio, TITANIO, in 2015.

The interview lasted 120 minutes. The audio was recorded and transcribed for analysis. NT first asked Morfi to describe the positives and negatives of digital and analog mixing practices based on recent mixing experiences, and to report on the reasons that make him gravitate or prefer particular pieces of hardware or software. Then, Morfi was invited to specify whether in general he would process some instruments in digital or analog, and to which extent his choices depended on genre. Finally, NT asked Morfi's opinion about the future of analog audio.

### 2.1.2 *Mixing participants of the experiment*

All three authors from Alberta and France, and two University of Lethbridge (U of L) Digital Audio Arts (DDA) fellows, namely Layne Murdoch (LM) and Ajay Jameson (AJ) from Alberta and India, mixed tracks for the perceptual experiment. To deepen our reflections upon our own mixing practices and opinions, NT interviewed AP with the same questions as those he used for Morfi's interview, and he wrote down his own answers to these questions. Also, RCM collected written feedback from four of the five mixing participants regarding their experience of following the mixing constraints of the audio stimuli preparation for the perceptual experiment (see 2.2.1). Then, we contrasted this mixers' feedback with their usual mixing practices.

## 2.2 Perceptual Experiment

### 2.2.1 *Audio Stimuli Preparation*

The five mixers provided the team with a total of eight pop-rock tracks Table 1. Four tracks were mixed on the SSL Duality console [7] available in Studio 1 at the U of L (analog mix), and the other four were mixed using the Waves SSL 4000 Plugin Collection that were designed to emulate the E-EQ, G-EQ, and E/G dynamic section [8] featured on the Duality (digital mix). When creating their analog mix, mixing participants were required to use the SSL Duality channel strips only for panning, fader levels, dynamics, and either the E-EQs or G-EQs. When creating their digital mix, they were required to control panning and fader levels in Pro Tools (PT), and to use only the Waves SSL 4000 E-channel or G-channel plugins for EQ and dynamics. The use of editing, delay, reverberation and vocal tuning within PT was allowed for both analog and digital mixes as they would remain unchanged in the replication process. Unfortunately, the Master Bus Compressor could not be used as the Duality only features the E-version, and the Waves SSL 4000 Plugin Collection only includes the G-version.

Upon completion of the eight original mixes, all four analog mixes were replicated digitally using the SSL Plugin Collection, and all four digital mixes were replicated in analog on the SSL Duality, thus

providing us with two versions of each track. The SSL Duality  $\delta$  Control and Total Recall enabled us to copy and paste the exact values of Voltage Controlled Automation (VCA) fader levels into PT, and vice versa. The pan law within PT was set at -4.5dB to correlate with the pan law of the SSL Duality. To ensure the accuracy of the mix replications, all settings of the mixes were cross-checked by the mixers, who were working in pairs to eliminate any error. We matched the loudness of the analog and digital mixing versions of each track to ensure unbiased representation [9]. Finally, we created one-minute segments for each track to reduce the strain of listeners' attention, likely leading to more reliable results [4].

Track	Band/Artist	Genre	Original
The Hound	Sweet Boys	Pop-Noise	Analog
Rainy Drums	Sweet Boys	Pop-Noise	Digital
Acceptance	Layne Murdoch	Metal	Analog
Move	Layne Murdoch	Metal	Digital
Smart As You	Splash Zone	Garage-Punk	Analog
Esoterica	Splash Zone	Garage-Punk	Digital
Human Nature	Ajay Jameson	Pop	Analog
Thundercats Are Go!	Sophomore Jakes	Pop-Punk	Digital

Table 1. Genre and original mix of the eight tracks

### 2.2.2 *Listening participants*

RCM recruited 19 trained listeners, three females and 16 males between the ages of 17 and 37 to participate in the perceptual experiment. Listeners had an average of 6.8 years of audio engineering experience ( $SD=5.6$ ); they included fourteen U of L DAA students and one DAA faculty, as well as three musicians and a professional audio engineer from Southern Alberta. It should be noted that all mixers also participated in the experiment as listeners.

### 2.2.3 *Procedure*

RCM and LM conducted ten listening sessions with small groups of one to three participants in Studio 1 at the U of L - the same studio that was used for mixing. Each session lasted approximately one hour. To ensure the double-blindness of the test and a counterbalanced representation of the analog-vs.-

digital-version order among listening sessions, we prepared more than ten different PT sessions in advance, each featuring the same track order from softest to loudest but a different version order. A decoder spreadsheet of the version order of each PT session was created at this preparation stage. For each listening session, a PT session was chosen randomly.

During listening sessions, participants could manipulate the monitoring volume and switch between the nearfield and far-field speakers, i.e. respectively Dynaudio BM15-A and custom-fitted JBL speakers through Bryston amplifiers. Listeners were encouraged to play both mixing versions of each track as many times as necessary while writing their answers to the following questions: *Were you able to detect any discernible difference between mixes? If yes, please describe these differences. Between these two mixes, was there a mix that you preferred? If so, why? Did you feel that one of these two versions was more genre-appropriate than the other? If so, which one? And why?*

#### 2.2.4 Data analysis

The listening session questions above call for both quantitative and qualitative analyses. We conducted descriptive statistics on the listeners' preferences and we classified the verbal descriptions that translated their perceived differences and choices between the analog and digital versions into sound criteria. A one-way ANOVA between the age groups of listeners was conducted to assess the effect of age on the preference for the analog format. Also, we used spectral visualization of the excerpts to further explain listeners' verbal descriptions of differences in the frequency range.

### 3 Results

#### 3.1 Mixers' Practices & Opinions

##### 3.1.1 Producer Ezequiel Morfi

###### 3.1.1.1 Pros and Cons of Analog and Digital

Morfi is a strong believer and supporter of digital mixing overall, and especially of digital plugins.

Early in the interview, he stated: *"It has to be very clear that you can do whatever you can do on analog in digital if you know how to, and most people do not know how to. People will think that a digital plugin will automatically substitute an analog piece of gear and recreate it, but it doesn't work that way. But if you know your way around it [the plugin], you can get any sound you could out of an analog setup inside a digital domain."* Morfi went even further about the positive aspects of digital: *"It can sound just as good, if not better [than analog], absolutely problem-free, and is 100% recallable."* He also mentioned that plugins save space in his studio, and that digital can produce *"a very crystal clear piece of music sound with no noise floor, and very wide open stereo"*, which analog cannot. In terms of the negative aspects of digital mixing tools, Morfi spoke only briefly about a digital reverberation hardware that generates noise floor, which could be turned into an effect for specific genre applications.

Regarding analog technology, Morfi emphasized tactility as a strong positive aspect of analog mixing. For instance, he described mixing on a board to be similar as playing an instrument, the board being *"an extension of your hands that does not happen with a mouse."* He also referred to the romantic side of analog as an old way of doing things, thus tied to the feeling of nostalgia that may come from the tactility aspect of analog mixing and/or from the very specific sound quality that comes from certain pieces of equipment. On the negative side, he commented on the space that analog equipment requires. While he thinks that analog technology may still be popular and neither outdated nor fully replaced by digital in the next 20 years, he believes that people will seek out and invest in clones of well-known analog devices instead of the originals for economic reasons. In summary, Morfi prefers working with his plugins and a few pieces of digital hardware that he owns to achieve his desired result.

###### 3.1.1.2 Preferred Analog and Digital Tools

When asked about his preference for mixing tools, either analog or digital, Morfi first named the Klanghelm Audio Plugins that includes the SDRR saturation, the MJUC Variable-Tube and DC8C Compressors, the VUMT metering, and channel tools

whose Deluxe version he owns. He explained that he likes these plugins that “*sound so amazing and are so versatile*” because they are based on Klanghelm’s own design without aiming to emulate some analog effects. Morfi also stated that he often uses the Tokyo Dawn Labs plugins, in particular their EQ and limiter. Besides these two brands, he is pleased with the built-in plugins within Reaper, his DAW of choice.

In terms of hardware, Morfi praises two digital reverberation devices, i.e. the Roland SRV2000 and the Alesis Quadraverb. However, he rarely uses these devices, opting most often for plugins instead. Morfi did not shortlist any analog effect, but mentioned his preference for analog vs. digital DI boxes and preamps because they have a different “*flavour.*” While he agreed that genre could influence his choice of equipment, he admitted that most of the time, he would still mix in digital.

### 3.1.2 *Mixing Participants of the Experiment*

#### 3.1.2.1 *Pros and Cons of Analog and Digital*

Two of the mixers usually only work *in the box*, and two mix on analog consoles and use hardware when available. However, for the experiment, three of the four mixers preferred mixing analog than digital. They indicated that the tactility and physicality of the console enhanced their creativity and feeling of freedom in their workflow. Indeed, when mixing in the DAW after having mixed on the console, they felt that their workflow was disrupted because of the impersonal nature of a point and click interface, the lack of tactile contact as well as limited creative movement while mixing *in the box*. These three also mentioned that the Duality sounded better and warmer, that it enabled a greater frequency depth and breadth, and that it was more exciting and forgiving than the SSL Plugin Collection in PT. Two mentioned missing the “*vibe*” of the analog console when mixing in the DAW. However, three mixers insisted on the tedious recall process on the Duality, e.g. *The Hound* that features some heavy processing on more than 40 channels takes about 45 min to recall. In contrast, a digital mix can be recalled instantaneously, which enables quick changes and more precision without having to go to the studio.

One of the four mixers preferred digital to analog mixing for the experiment because of the ease of mixing *in the box* and the convenience of the point and click interface of the Waves SSL 4000 Plugin Collection. The precision, accuracy and overall sound of these plugins was also positively rated by another mixer. Additionally, all mixers agreed that analog and digital could both be advantageous in different genre contexts, e.g. digital can help mixers achieve a cleaner result than analog for a metal track.

#### 3.1.2.2 *The Replication Processes*

The process of replicating mixes from analog to digital or from digital to analog raised several challenges, mainly because the E/G-channels of the Waves SSL 4000 Plugin Collection did not feature the same exact settings than the Duality. Therefore, we first had to adapt the original mixes so that they could be replicated accurately into the other format. The use of the  $\delta$  Control to copy-paste the fader levels from one format to another also required some troubleshooting before it was reliable. Despite these difficulties, mixers mentioned that they had interesting insights on their mixing habits in both formats throughout these replication processes.

Two mixers described discrepancies in gain staging between the Duality and the DAW that could not be solved. Beside these discrepancies, they agreed that the replications sounded accurate in comparison to their original mixes. Nevertheless, all mixers could perceive differences between the two versions, which led them to state that the Waves SSL 4000 E-channel or G-channel plugins accurately emulate but do not totally equal the dynamics and EQs of the Duality.

### 3.2 Perceptual Experiment

#### 3.2.1 *Quantitative Preference Results*

Trained listeners reported that they could perceive differences between the analog and digital mixing versions 91% of the time. They were able to choose a preferred version 86% of the time. These results mean that for 13 out of 152 trials, they could not perceive a difference between the two versions, and that for 9 trials, they could perceive a difference but were not able to describe this difference clearly or state a

preference. Despite these high percentages, overall results do not show a clear preference for one format over the other: Analog versions were preferred 44% of the time vs. digital 42% of the time. Table 2 displays the distribution of listeners' preferences for each track, with information about the track genre and original mix format. A binomial test revealed a significant result only for the metal track *Move* ( $p=.02$ , two-tailed), for which 79% of the listeners preferred the analog version.

Results showed no effect in listeners' preferences between the original mixes and their replications, which confirms that our replication process and loudness match did not introduce obvious artefacts that biased the test. Also, we did not observe any interconnection between original format preferences and genres. Interestingly, the analog replication of the metal track *Move* was preferred over its original digital mix, although the young mixer community perceives digital as more precise in working on metal tracks.

Track	Genre	Analog	Digital	No Pref
Acceptance	Metal	26.3% (Orig)	68.3% (Rep)	5.2%
The Hound	Pop-Noise	57.8% (Orig)	21% (Rep)	21%
Human Nature	Pop	47.3% (Orig)	42.1% (Rep)	10.5%
Rainy Drums	Pop-Noise	36.8% (Rep)	36.8% (Orig)	26.3%
Move	Metal	79% (Rep)	10.5% (Orig)	10.5%
Smart As You	Garage Punk	21% (Orig)	68% (Rep)	10.5%
Esoterica	Garage Punk	63.1% (Rep)	31.5% (Orig)	5.3%
Thunder Cats Are go!	Pop Punk	15.7% (Rep)	57.8% (Orig)	26.3%

Table 2. Listeners' preference per track. Highlighted cell indicates  $p < .05$ , two-tailed.

Table 3 displays listeners' preferences based on age. A one-way ANOVA between these age groups showed a nonsignificant trend toward significance effect of age on the preference for the analog format ( $p=.09$ ). We observed that younger group of 17-22 did not prefer one format over the other; the group of 23-28 that could be considered as the oldest generation of *digital natives* slightly preferred the digital versions; and the group of 29-37 that could be

considered as the youngest generation of *digital immigrants* slightly preferred the analog versions. Specifically, in the 23-28 (*oldest digital native*) age group, one listener preferred the digital version for seven out of eight tracks, and did not hear a difference between the two versions for the garage-punk track *Smart as you*. Moreover, in the 29-37 (*youngest digital immigrant*) age group, one listener preferred the analog version for all eight tracks.

Age Group	N	Analog	Digital	No Pref
17-22	6	43.8%	43.8%	8%
23-28	9	38%	50%	22%
29-37	4	62.5%	28.1%	9.4%

Table 3. Age groups' preferences. N = the number of listening participants for each group.

### 3.2.2 Sound Criteria from Feedback

We extracted 264 phrasings from the collapse of listeners' descriptions of their perceived differences, reasons for preference between mixing versions, and comments on genre appropriateness. We then classified these 264 phrasings into 10 sound criteria, namely Presence/Clarity (51 phrasings); comments related to the Drums (38); Mix Cohesion (36); more High frequencies (36); comments related to the Vocals (25); comments related to the Guitar (24); more Mid frequencies (17); more Low frequencies (11); Brightness, (9) and Warmth (9). Figure 1 presents the distribution of these sound criteria with an indication of whether the descriptions concerned the analog or digital versions. We observed that the predominant criteria Presence/Clarity, more High frequencies, and comments related to the Vocals were mainly mentioned for analog versions. In turn, more Mid and Low frequencies were more often attributed to digital versions. Mix Cohesion was almost equally addressed for analog and digital versions. We looked at the possible effect of original mix vs. replicated versions, using the hypothesis that Mix Cohesion could have been damaged by the replication process: of 39 phrasings, 21 concerned the original mixes and 19 the replicated versions, which means we cannot draw any conclusions.

We looked at the distribution of the sound criteria among tracks. We noted that differences in High and

Mid frequencies were mentioned for all eight tracks, and differences in the Low-end for six out of eight tracks. Although each track maintained a degree of common pop-rock instrumentation, i.e. primarily drums, bass, guitar and vocals, listeners emphasized particular instruments - guitar, vocals and drums but not bass - for specific tracks, mostly in terms of the positioning of the instrument within the mix, or its Presence/Clarity in relation to another instrument and/or to genre appropriateness. For instance, comments on drums and vocals for the pop-noise track *Rainy Drums* were mentioned alongside Presence/Clarity and Brightness, e.g. “*Version A [Analog] sounds clearer to me. I don't know if there is more top end overall? Vocals sound more intelligible in version A [Analog]. Drums sound more forward plus brighter.*” Still for *Rainy Drums*, a listener who was also the mixer of the track explained their difficulty in stating any preference because the analog (replication) version personified the sonic intention of the musicians and their sonic intention as mixer, but the digital (original) version pleased them more as listener: “*Hard question because sonically I prefer version A [Analog], sounds more polished, Version B [Digital] made me more excited about listening, especially when it built up.*”

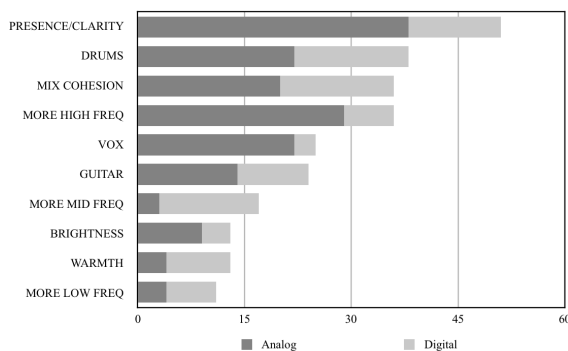


Figure 1. Distribution of sound criteria for analog and digital versions in listeners' verbal descriptions.

For the metal track *Acceptance*, comments on drums and specifically guitar - the lead instrument of this track - were expressed in relation to significant changes in the frequency range, e.g. “*Version B [Digital] has more presence in midrange. Version A [Analog] seems more representative of frequency*

*range. Version A [Analog]'s mix was more proportionate; the other mix was too mid heavy.*” Other comments on *Acceptance* addressed the metal genre, with clarity being considered less important than feel.

We kept the distinction between more High frequencies and Brightness, and between more Mid frequency and Warmth, according to the wording in the listeners' answers because the sound criteria Brightness and Warmth are commonly associated with digital and analog, respectively. Interestingly, we noticed that the analog vs. digital distribution of phrasing for these two criteria did not align with our preconceived expectation, with Brightness being mentioned more often for analog versions and Warmth for digital versions.

### 3.2.2.1 Complementary Spectral Analysis

To complement our qualitative findings regarding trained listeners' perception of frequency range, especially bright vs. warm sound for both formats, we compared the spectral visualizations of the analog and digital versions of three tracks whose comments largely addressed the frequency response. Looking at the entire pop-punk track *Thundercats Are Go!* (Figure 2), we noticed a higher density of high frequencies from 10kHz for the analog (replicated) version. Zooming on one beat of the pop-noise track *Rainy Drums* (Figure 3), we observed a higher density and longer duration of high frequencies for the analog (replicated) version. Finally, zooming in on one beat of the metal track *Acceptance* (Figure 4), we could see a more pronounced definition of the high-end for the analog (original mix) version. The spectral analysis of these three tracks highlights a consistent and identifiable discrepancy in the high-end, with more high frequencies in analog versions, which would affect the sensation of Presence/Clarity, Brightness, and Warmth, and the perception of instrument positioning. The differences found in the spectral analysis did not depend on whether the original mix was analog or digital.

## 4 Discussion

### 4.1 Mixers' Practices and Opinions Regarding

### Analog vs. Digital Mixing

Findings from producer Ezequiel Morfi's interview and mixing participants' feedback show that the mixers' decision to use analog or digital tools is mainly driven by the convenience of digital recall or the creative physicality of analog hardware. Also, their choices were influenced by practical criteria such as studio space and subjective feelings such as nostalgia or familiarity. Since our interview guide and mixing constraints for the study purposely removed the usual – but crucial – financial arguments, these findings suggest that the new generations of mixers in their 20s and 30s consider both types of technology to be valuable in terms of sound quality.

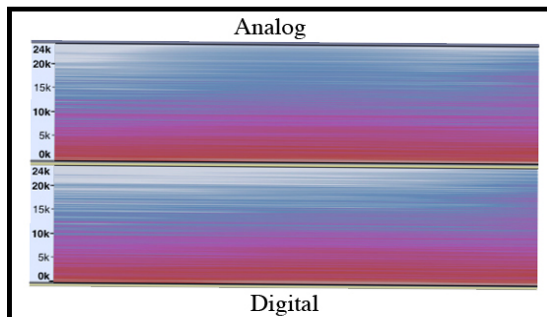


Figure 2. Spectral analysis of the pop-punk track *Thundercats Are Go!*, originally mixed in digital.

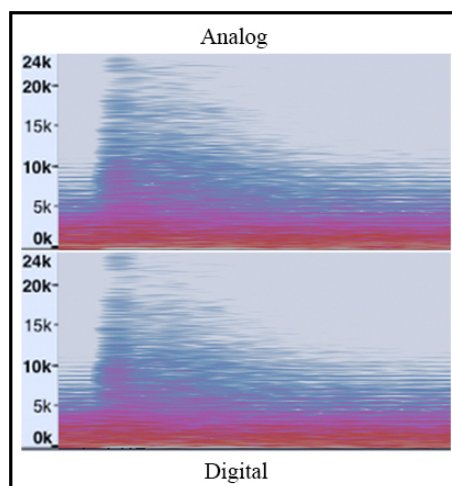


Figure 3. Spectral analysis of one beat from the pop-noise track *Rainy Drums*, originally mixed in digital.

While Morfi listed his favourite mixing tools, mainly based on plugin collections, the mixing participants of the study were required to use specific mixing tools, i.e. the SSL Duality that they had access to in their work/study environment and the Waves SSL 4000 Plugin Collection that they purchased for the purpose of the study. Therefore, it is not possible to compare these five engineers' mixing habits and tool preferences fairly. Nevertheless, the discourse of all five demonstrated a high ability to use digital plugins in an adaptive way in order to reach a desired sound. In contrast, they always referred to pieces of hardware, either analog or digital (Morfi mentioned a digital reverberation device) when they wanted to bring a specific *flavour* to their sound. In summary, these mixers praised the versatility of digital plugins and the distinct sound of hardware devices. They also agreed about the limitations of digital emulations of analog effects. These conclusions complement Stuhl's thesis [2] in the sense that beyond fetishism and technological determinism, mixing engineers value expensive tools for their "personality" and "aesthetic quality," and digital plugins for their "flexibility and fidelity."

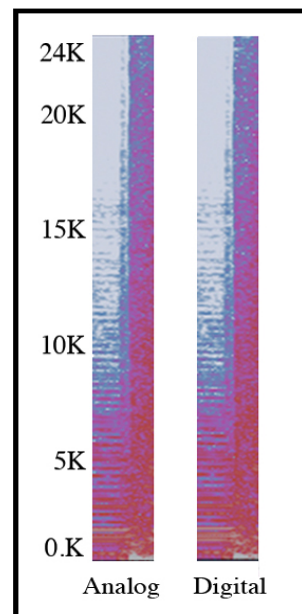


Figure 4. Spectral analysis of one beat from the metal track *Acceptance*, originally mixed analog.



The preceding discussion focuses on sound creation possibilities and does not include the freedom that is perceived differently for both types of technology, strongly impacting mixers' workflow and life style. While an analog console offers a framework that enables mixers' freedom in their *performance*, plugins allows mixers to work from anywhere at any time. An analog console and a DAW, as two distinct mixing *templates*, also differ in relation to precision: Mixers mentioned that DAWs emphasize clinical perfection whereas consoles enhance creative, intuitive and forgiving gestures.

#### 4.2 Perceptual Differences Between Analog and Digital Mixing Versions

Both the quantitative and qualitative results from our double-blind listening test highlighted contradictions between common beliefs and actual perception. For instance, analog was perceived as brighter, clearer and more precise, and digital as warmer. These differences impact other aspects of the mix such as mix cohesion and instrument balance. Indeed, vocals were most likely to be clearer in analog versions, and guitars to be present in digital versions. A complementary spectral analysis confirmed these findings as we could visualize distortion in the high frequencies that was introduced by the SSL Duality. However, we cannot make conclusions for all analog and digital tools as the sound criteria that we found draw from the specific technology that we used.

Overall, we observed a balance in trained listeners' preferences for one format over the other, which suggests that both formats can be as valuable in terms of their sound quality. This finding is in keeping with young mixers' opinions about both types of technology. Interestingly, we identified a slight trend towards the significance of age on a preference for the analog format, with the *oldest digital natives* slightly preferring digital versions and the *youngest digital immigrants* slightly preferring analog versions. While this finding calls for more listening participants to achieve significance (or not), it suggests a change in taste between two close generations of mixers, similar to the change in mixing culture that was observed in the Paris study [4].

#### 4.3 Future of Analog Technology

Our findings imply that analog technology has a future, thanks to its creative physicality. Indeed, Morfi stated that analog devices, especially consoles, extend the body of the mixer like a musical instrument. Also, the mixing participants of the study emphasized that their creative workflow was enhanced by the SSL Duality. Morfi and the mixers agreed that "tactility, vibe and feel" cannot be easily replaced by mouse-controlled plugins. The alternative of using digital controllers that emulate the physicality of analog consoles was not discussed in this study.

Mixers' opinions and results from the double-blind listening test show that analog technology introduces audible artefacts, such as distortion in the high frequencies for the Duality. Beyond analog fetishism [2], these flavours may still justify the cost of analog equipment in the long run for wealthy studios and music professionals. While many plugins such as the SSL 4000 Plugin Collection aim to emulate these *flavours*, findings from the mixers' opinions and the listening test agree in the sense that these supposed clones can be accurate and sound good, but they are not (yet) equal to the analog effect. Also, plugins do not (yet) emulate the analog summing in the DAW.

### 5 Conclusion

This study brings new knowledge to discuss the dichotomous polarization between analog and digital mixing preferences within the audio community, in practice and in perception. Thanks to the SSL Duality  $\delta$  Control and Total Recall features, we could assess the extent to which the Duality analog dynamics and EQs could be emulated by the Waves SSL 4000 E-channel and G-channel plugins. While our listening test results showed that the plugins could not fully emulate the console effects, mixers pointed out that it may not be the real goal of these so-called clones. Nevertheless, our results call for more studies that compare analog hardware to various digital plugin emulations. Also, it would be great to compare the E-version of the analog SSL Master Bus Compression with a plugin emulation.

Our findings from the different parts of the study suggest that the real difference between analog and

digital is not so much about sound quality but mainly about physicality and practicality. Further work is required to investigate the extent to which digital controllers that emulate the analog console template provide mixers with satisfying performance tactility.

Our study proposes an innovative methodology that combines qualitative interviews with a perceptual experiment to examine studio practices and audio perception of different technologies. In addition, we designed a mixed-method approach for our perceptual experiment with multiple choice questions and open-ended questions to collect details on trained listeners' perception and preferences. This methodology allows researchers to consider both sound engineers' cultural identity and listening taste.

Our results highlighted a potential effect of age on technology preference. The gap within two close generations of mixers needs to be investigated further with more participants to reach statistical significance. Recruiting mixing and listening participants from all generations would provide the audio community with a better insight on the effect of age and familiarity on technology preference. Also, we carried out a listening test with pop-rock tracks only; it would be interesting to extend the concept to other musical genres. Finally, while we brought a global perspective to our study by collecting the practices and opinions of mixers from different parts of the world, the geographical scope of this approach should be broadened to more countries to identify the impact of the globalization of digital audio technology on mixing practices and listening taste.

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