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Analysis of the subgrouping practices of professional mix engineers

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ABSTRACT

Subgrouping facilitates the simultaneous manipulation of a number of audio tracks and is a central aspect of mix engineering. However, the decision process of subgrouping is a poorly documented technique. This study sheds light on this ubiquitous but poorly defined mix practice, and provides rules and constraints derived from a questionnaire that could be used in intelligent audio production tools. We prepared an online questionnaire consisting of 21 questions testing nine assumptions and identifying subgrouping decisions, such as why a mix engineer creates subgroups, when they subgroup and how many subgroups they use. We analysed responses from ten award winning mix engineers. Thematic analysis enabled us to discover five themes; Decisions, Subgroup Effect Processing, Organisation, Exercising Control, and Analogue versus Digital. By analysing the themes and each respondent's quantitative data we were able to show that eight out of nine assumptions could be accepted to be true.

1 Introduction

At the early stages of the mixing and editing process of a multitrack mix, the mix engineer will typically group instrument tracks into subgroups [1]. An example of this would be grouping guitar tracks with other guitar tracks or vocal tracks with other vocal tracks. Subgrouping can speed up the mix workflow by allowing the mix engineer to manipulate a number of tracks at once, e.g., changing the level of all drums with one fader movement instead of changing the level of each drum track individually. Subgrouping also allows for processing that cannot be achieved by manipulation of

individual tracks. For instance, when nonlinear processing such as dynamic range compression or harmonic distortion is applied to a subgroup, the processor will affect the sum of the sources differently than when it would be applied to every track individually [2]).

There have been a few mix engineering related studies in recent years, but none have looked specifically at subgrouping. Subgrouping was touched on briefly in [3] when the authors tested the assumption "Gentle bus/mix compression helps blend things better" and found this to be true, but it did not give much insight into how subgrouping is generally used. [4] explored

the potential of a hierarchical approach to multitrack mixing using instrument class as a guide to processing techniques, but a deeper understanding of subgrouping was not the aim of the paper. Subgrouping was also used in [5], yet as with [4] this was only applied to drums and no other instrument types were explored.

Previously, we analysed a number of multitrack mixes to determine how mix engineers created subgroups, how they apply subgroup effect processing such as equalisation (EQ) and dynamic range compression (DRC), and if there was any link between subgrouping and mix preference [2]. We had access to actual multitrack project files and were able to analyse exactly how each participant had constructed subgroups and what effect processing had been applied. However, the mixes that were analysed were created by three separate groups of music production students, so their level of mix engineering experience was contentious [6].

In [7], we determined a set of audio features that could be used to automatically subgroup multitrack audio by using a machine learning classifier for feature selection. Automatic subgrouping based on grouping similar instrumentation was then performed using unsupervised machine learning. This showed how subgrouping could be achieved autonomously, but little was to be learned from this study on how mix engineers approach subgrouping.

Subgrouping is poorly documented in audio engineering literature [8, 1, 9], yet it is used extensively throughout audio production. This implies that there may be unwritten rules applied when a mix engineer makes use of subgrouping. By investigating these practices we hope to develop rules and constraints that could be used in intelligent mixing systems such as those described in [10, 11, 4, 12]. The next section describes the methodology used in this report. We describe the questionnaire, our hypotheses, how we approached the qualitative and quantitative analysis. Following that, we present the results and our analysis. We discuss participants, coding and theme development, and then analyse each theme in the context of the questions on the survey. In the final section we discuss the results and analysis in relation to our hypotheses and make recommendations based on our findings.

2 Methodology

2.1 Survey Questionnaire

Before the survey was conducted we proposed a number of assumptions about how mix engineers subgroup, and many survey questions were designed to test these assumptions. The assumptions are listed in Table 1. These assumptions were developed from audio engineering literature [8, 1, 9], from discussions with other mix engineers, academics and from past experiences in the field.

Table 1: Subgrouping assumptions

Assumptions	Description
A1	Mix engineers subgroup to achieve subgroup effect processing
A2	Mix engineers subgroup to create individual submixes
A3	Mix engineers create their subgroups based on the genre being mixed
A4	Mix engineers subgroup to make the mix process less complicated
A5	Mix engineers create subgroups within subgroups (<i>Hierarchical subgrouping</i>)
A6	Mix engineers subgroup based on instrument family
A7	Mix engineers subgroup to maintain good gain structure
A8	Mix engineers subgroup to reduce auditory masking
A9	The most common subgrouping effect to apply is dynamic range compression

The survey consisted of 21 questions that allowed the respondent to provide both qualitative and quantitative responses. Similar to [13], we sought to probe their knowledge based on the assumptions rather than lead the respondent with them. We also tried to identify subgrouping habits and how those habits changed over time. Quantitative analysis of survey results are summarised in tables and figures throughout this paper.

2.2 Thematic Analysis

Thematic analysis [14] was used to analyse qualitative survey data. It involves familiarisation with the data

and then coding sentences, paragraphs or statements from each respondent. This allows themes to be formulated and concepts or repeated ideas to be identified. The thematic analysis used here is mostly deductive, where analysis is driven by our particular analytical interest in the area. Due to the lack of subgrouping literature, we employed inductive thematic analysis, where survey responses allowed us to develop themes not directly related to the questions. We also took a latent approach to our thematic analysis [15], where the analysis goes beyond the semantic content to look for underlying ideas or thought processes. We followed the six phases of thematic analysis [14] to guide the analysis.

3 Results and Analysis

3.1 Survey Questionnaire Respondent Data

The survey was provided via a web form, where respondents could complete it in their own time and come back to it later if needed. To ensure high quality answers representative of skilled practice, all ten respondents were distinguished, professional mix or mastering engineers, and had received a recognised award such as a Grammy or achieved a number one hit in the commercial music charts. The mixing background varied in terms of genre. The most common responses for genre of music mixed was Pop, Rock and Electronic music, but some were also involved in Jazz, Classical, Techno/IDM and World Music. Their average age was 49.3 (SD: 8.13) years. The least amount of mixing projects a respondent was involved in a year was 5, the most was 100 and average was 40.8 (SD: 46.15).

3.2 Coding

Figure 1 gives an example of the manual coding applied to each respondent's answers to question one of the survey questionnaire. It illustrates how we broke down each respondents answer in to individual codes, which subsequently led to developing themes. The coding process generated 72 codes in total for all the respondents answers.

Q1 How would you define subgrouping?

A1:

Putting audio tracks with some commonality into a group. - **Similar instruments, Commonality**

It is a combination of discrete audio tracks mixed together under a collective term, but not the final stereo mix. - **Combination of similar tracks, Collective Term**

Taking instruments with similar sounds i.e., all guitars or all horns and grouping together for the purpose of effecting or adjusting the level of the entire group.. - **Similar sounding instruments, subgroup effect processing**

Routing instruments or groups of instruments into individual busses that then feed to the mix buss. This is done for purpose of processing, balancing or simply for organisation and ease of monitoring particular groups (soloing). - **Similar instruments, organisation, ease of monitoring of particular groups, soloing, effect processing, balancing.**

A way of dividing multiple tracks of audio into separate groups, this makes large complicated mixes easier to manage, essential for live mixing, but can also be incredibly beneficial for mixing in the studio. - **Simplification, diving multiple tracks into groups, reduces complexity, essential for live mixing, beneficial for studio mixing**

Fig. 1: An example of coding.

3.3 Theme Development

Five main themes arose from the thematic analysis; *Decisions, Subgroup Effect Processing, Organisation, Exercising Control, and Analogue versus Digital*. They were developed by exporting coding details in the form of nodes and edges from QSR Nvivo¹, and visualised in Gephi². Figure 2 illustrates one of the visualisations that were used to develop our thematic map, where each code is clustered based on the Pearson's correlation coefficient of the similarity of each of the coded text extracts. We used the graph in Figure 2 to decide what codes were related to each other and what codes had the most text references. The strength of Pearson's correlation coefficient is given in Figure 2 by how thick each graph edge is. Figure 3 shows the resultant thematic map with the main themes in red and one sub-theme in bold.

The theme Decisions arose mainly from responses to survey questions based on particular mix situations. This was the largest theme and was expected due to the types of questions we asked. It contained a *Genre* sub-theme because it became apparent from the data that many mix decisions have a genre dependency.

The Subgroup Effect Processing theme was expected since a number of survey questions were based around this theme. It was one of the largest themes and was mentioned often with respect to audio effects like EQ, DRC and to a lesser extent Reverb. In this theme we try to understand how and when subgroup effects are applied.

¹NVivo is a qualitative data analysis (QDA) software package.

²Gephi is an open source graph visualisation platform.

The Organisation theme covers what mix engineers would typically put in a subgroup, how many subgroups they would create relative to the amount of audio tracks available and why they would organise subgroups in a particular way. It is related to the themes of Decisions and Subgroup Effect Processing since a mix engineer needs to decide on how to organise a multitrack and this needs to be decided before any subgroup effect processing can be applied.

Exercising Control was not directly related to any of the questions on the questionnaire, but was foreseen. It relates to the mix engineer being able to control many audio tracks at once and simplifying the mixing process.

The final theme Analogue versus Digital, was not anticipated. We assembled this theme in the context of how subgrouping has changed for each respondent over a number of years. Since this was induced from the data itself we do not have an assumption related to it.

3.4 Survey response analysis and final theme analysis

Respondents were first asked how they would define subgrouping. Items mentioned included subgrouping tracks by similar instrumentation, combining tracks for subgroup effects processing and simplifying the mix process. Quotes used to define subgrouping were as follows,

“Sub mixing different sets of audio (drums and percussion, strings, guitars etc.) in order to give them a global audio treatment, often compression and eq.”

“Routing instruments or groups of instruments into individual busses that then feed to the mix bus...for purpose of processing, balancing or simply for organisation and ease of monitoring particular groups (soloing).”

They were then provided with a definition of subgrouping and asked if they agreed;

“Subgrouping can be defined as when you sum one or more audio tracks into a bus with the idea of creating a submix.”

All agreed, but some provided further alternate definitions. This implies that our proposed definition may have been too brief and did not capture all aspects of the subgrouping process.

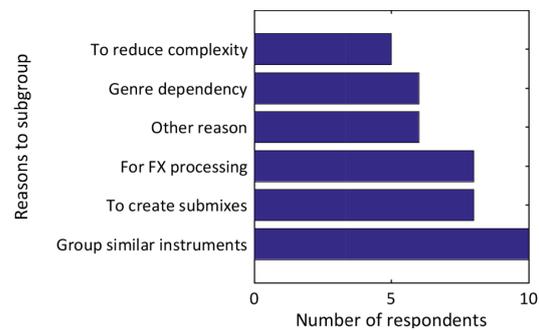


Fig. 4: Respondent results based on how they subgroup.

Respondents were asked if specific reasons to subgroup applied to their workflow, depicted in Figure 4. Other reasons given for subgrouping included the need to create stereo stems from mono recordings, it being easier to fine-tune an instrument group and combining large amounts of backing vocal tracks. Applying distortion was also mentioned and creating subgroups within subgroups (hierarchical subgrouping). One respondent stated that there should be no set rule and subgrouping should be used creatively. The respondent gave an example of how keyboardist Herbie Hancock has many subgroup routings for different types of keyboard modulation.

3.4.1 Decisions

Decisions appeared to be the core theme as it is interlinked with all the other themes developed. Also, much of the data accumulated was based on how a mix engineer would act in certain mix situations, allowing us to determine patterns or habits typical of a professional mix engineer’s workflow. Decisions was the only theme that had a sub-theme, the sub-theme being Genre.

We were interested to see at what point in the mix process the respondents normally consider putting audio tracks into subgroups. Table 2 summarises these results, where we used median ranking for each mix process over all respondents.

Overall panning is most important, but subgrouping is considered as important as applying EQ and DRC. However, when we examine some of the statements provided in relation to this question we get a different representation;

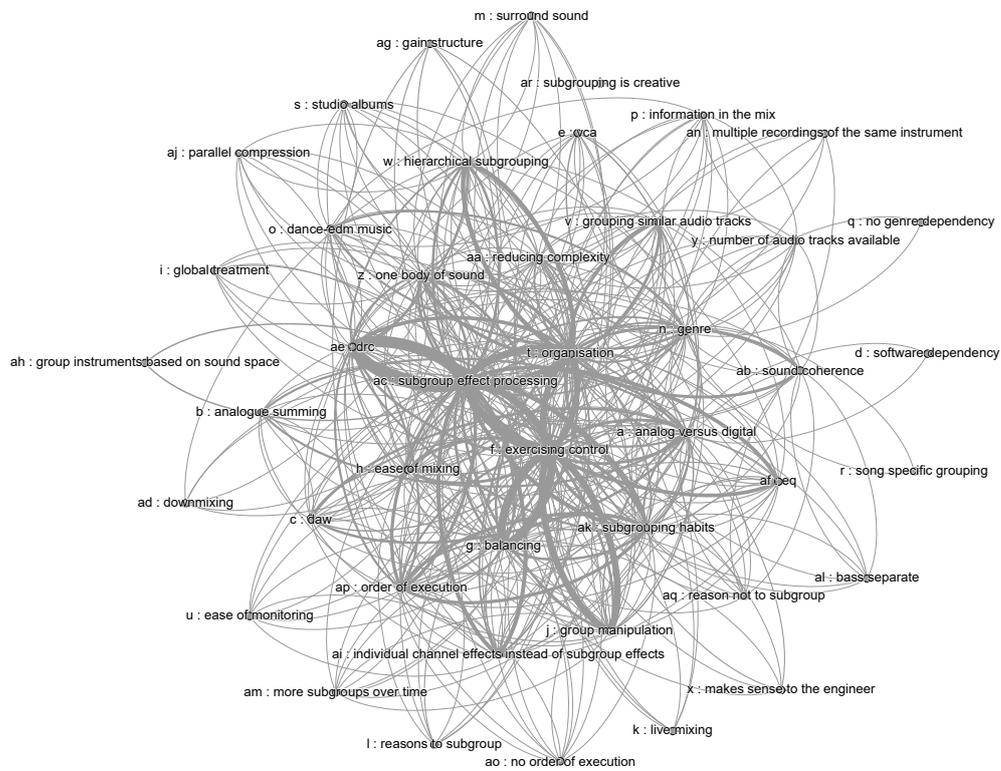


Fig. 2: Codes clustered by word extract similarity.

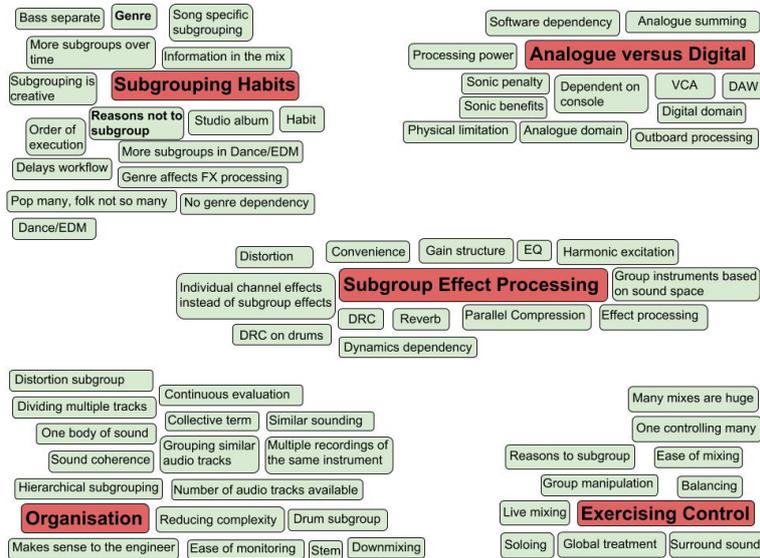


Fig. 3: The thematic map. Themes are shown in red and codes are shown in green.

Table 2: Rank order of execution in the mix process

Rank	Mix Process
1	Panning
2	Subgrouping/EQ/DRC
3	Loudness/Level
4	Effects(temporal)

“Equalizing is first because I’m recording live instruments and it’s important to clarify the spectral space of the recording and remove non-critical or distracting frequencies. Compression and effects further distinguish the recording. Then grouping, panning, and levelling are creative decisions most important in the final mix down, which must be made in the context of a full mix.”

“I set level, panning, and compression/EQ on the individual tracks. Then submit usually by instrument. I apply FX to both the individual channels and the sub mixes.”

“I progress from an organisational approach then to gain structure as primary focuses. Following that would be dynamics. Effects are ‘sugar on top’. Loudness would be the last thing I would be thinking of, when the final balance is achieved. . . gain structure is probably the most important aspect to mixing in my opinion especially when mixing on an analog console . . . The level out of the mix buss has a distinctive effect on how the overall mix will sound. With digital you are more concerned with just simply not clipping.”

One respondent implies that subgrouping is creative while another suggests it is part of the organisational aspect and important for gain structure and another mentions that they subgroup by instrument type. In contrast, one respondent said there is no order of execution and that mixing is an organic process.

Respondents were asked to estimate how often various subgrouping related decisions were made over the last 100 mixes, see Table 3. “Subgrouping to maintain good gain structure” received 100% median percentage rating, which relates to Subgroup Effect Processing and will be discussed later. “Subgroup some or all of the audio tracks” indicated that there may be cases where subgrouping is not valid. However, the median percentage was 100, so this implies subgroups are used much more often than not. The median percentage for “Changed your subgroups partway through mixing” was 23. Two respondents said they would rarely change

Table 3: Subgroup decisions made in the last 100 mixes

Mix Decision	Min %	Median %	Max %
Subgroup to maintain good gain structure	0	100	100
Subgroup some or all of the audio tracks	60	100	100
Split drums into different subgroups	0	35	100
Change your subgroups partway through mixing	0	23	80
Subgroup to eliminate auditory masking	0	5	100
Subgroup to pan a group of instruments	0	5	50

subgroups, but would further split them to create new subgroups, e.g.;

“Goodness knows why I might change routing, but I change things all the time, it’s often a refining process to achieve a better sound. I add subgroups more than change them but I might disband some that aren’t working or I need more control into two separate subgroups, backing vocals being split up for example.”

The last two questions had a median of 5%. We assumed mix engineers might subgroup instruments together to reduce masking, since instruments in a subgroup often occupy the same spectral space and it would be useful to EQ all of the instruments together. However, we were surprised to see such a low score. In fact half of the participants gave a score of 0% and only one gave 100%.

Respondents were asked yes/no questions to decisions the mix engineer might make when mixing, summarised in Table 4. These types of questions were mainly related to instrument choices, especially drums and guitars. The two most polarising questions are related to auditory masking and to acoustic and lead guitar placement. The results to the auditory masking question tend to agree with the result in Table 3. Each

of these questions was followed by ‘can you please tell us why,’ so that they could provide qualitative feedback.

Table 4: Answers to simple yes/no questions from on-line survey questionnaire

Mix Decision	Yes	No
Do you create subgroups with subgroups (Hierarchical)	6	4
Subgroup kick drum separately	4	6
Subgroup snare drum separately	3	7
Subgroup bass guitar played percussively with percussion/drums	3	7
Put rhythm guitar and lead guitar in the same subgroup	6	4
Put bass guitar and lead guitar in the same subgroup	2	8
Place acoustic guitar and lead guitar in the same subgroup	8	2
Subgroup to achieve a uniform tone	6	4
Subgroup to reduce auditory masking	2	8

There was only one genre related question, but other questions generated genre related answers. Respondents noted genre-dependency in subgrouping, for instance;

“I might submit ‘strings’ for a rock track, but for an orchestra I’ll break this down into ‘violins’ and ‘cellos’.”

One respondent mentions that some subgroups receive different effect processing based on genre, in particular DRC. Also, certain styles require effect processing using subgroup processing, while others benefit from a global treatment. A respondent noted that a guitar subgroup for reggae would be treated differently than in rock music. Other statements include;

“The more compression required, the more subgroups necessary.”

“Many genres of music need subgroups, it’s not the genre, but the amount of information in the mix.”

The need for more subgroups when more compression is required indicates that there could be more need for gain staging, so as to correctly process the varying

amounts of dynamic range. This suggests that a reason for creating subgroups is to reduce complexity.

Dance and EDM music was mentioned separately by two different respondents. One statement being

“Dance or EDM as a particular genre uses a vastly greater number of effect ‘tricks’ hence sub grouping with this genre is generally more focused on this as opposed to most other genres in which I am just concentrating on organisation and dynamics.”

An example relating the quantity of subgroups to genre is illustrated in the following ambiguous statement,

“Pop=lots, folk=not so many.”

The respondent mentions that there are many subgroups when mixing ‘Pop’ music, but this could mean that there are more instruments to subgroup or that ‘Pop’ needs more subgroup processing.

Genre appears to be a significant deciding factor on how subgrouping is applied. However, at least two respondents claim that genre has no impact on their subgrouping decision. One respondent stated that genre does not have much influence on his subgrouping decisions and is always song specific or depends on the information in the mix.

3.4.2 Subgroup Effect Processing

Subgroup effect processing is where at all of the tracks in the group benefit from similar processing. This theme was formulated because the topic of effect processing was mentioned the most in responses (130 code references associated with this theme). It was also a major theme when we visualised the relationship between the coded references seen in Figure 2. The types of subgroup effect processing that respondents used is summarised in Figure 5. All respondents would apply DRC.

Other types of audio processing that were mentioned were enhanced stereo imaging, doubling, harmonic excitation, distortion and parallel compression. A statement from one respondent illustrating subgroup effect processing referred to the ‘body of sound’, which could be interpreted as a group of similar instrumentation;

“Subgrouping drums, vocals, guitars etc. enables you to apply overall compression and FX so the body of sound can be treated as one, FX could be anything from

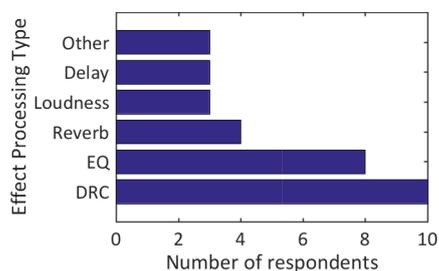


Fig. 5: Summary of subgroup FX processing applied.

as simple as reverb or more complicated like adding parallel compression.

We asked respondents how likely they were to apply DRC to certain instrument subgroups, see Figure 6. Statements related to this question include

“Elements such as drums, percussion and bass, need the most dynamic range compression because they create the groove. Legato instruments such as brass, pads or vocals are not as closely tied to the groove so they should be more free.”

“I pretty much always use some form of compression on drums, lead vocals and bass, source, get rout and parallel compression.”

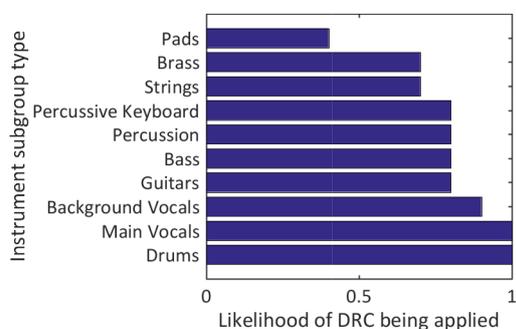


Fig. 6: The subgroup types that are most likely to have DRC applied.

In [2], the most subgrouped and hierarchically subgrouped instrument types were drums and vocals. Many comments supported the view that drums, vocals and bass get more DRC because they have the greatest dynamic range and are the foundational part of a mix [8]. An interesting comment was

“Drums and Vocals. . . always get a touch of compression in my mixes, even if it’s one or two dB, this helps the

master bus compressor focus on the overall mix and not be triggered by a subgroup.”

The rationale that some instruments may need to be removed from a subgroup because they adversely affect group compression leads to “Do you subgroup kick drum separately?” from Table 4. One stated that they would do so in order to compress it. Another related statement was that since it is such a powerful instrument it would affect compression on the other drums in the subgroup and need to be processed separately.

We asked “Do you subgroup instruments to achieve a uniform tone through EQ?” One respondent stated they would use subgroup EQ processing all the time, but not for uniform tone. Two responses mentioned that they do it since it is easier on CPU, but this slightly contradicts earlier points about trying to treat a particular instrument type. Others noted convenience in achieving uniform tone, and the ability to make instruments sound like they are in the same room, which was the only response that discussed reverb in respect to subgroup effect was processing;

“Primarily for convenience. I’m fascinated with gluing sounds together whether that’s by creating a virtual soundstage or something more abstract.”

“It can be handy to group the bass and drums when using ambience or reverb effects to make all instruments seem like they are in the same space/room.”

In Table 3 the “Do you subgroup to maintain good gain structure?” question had a median percentage score of 100;

“... I have to note that gain structure is probably the most important aspect to mixing in my opinion especially when mixing on an analog console such as an SSL or Neve . . .”

“Affects how subgroups get treated - some genres benefit from subgroup dynamic compression. Others just from the gain structure advantages.”

The second statement was in relation to genre and the respondent highlighted advantages of subgrouping to achieve good gain structure since it allows gain processing to be applied in a step by step instrument group process.

All respondents put strong emphasis on subgroup effect processing, but some referred to effect processing on

individual tracks instead of subgroup effect processing. This mostly related to EQ, where a respondent might sculpt the sound of each instrument individually to reduce masking. In most cases this was in reference to guitars as in [2], where they were treated individually because they served different roles in the song e.g. distorted guitar, lead guitar.

3.4.3 Organisation

Organisation directly relates to Exercising Control and Subgroup Effect Processing, since they cannot happen without first organising tracks in to sensible subgroups. It also relates to Decision, since the mix engineer has to decide how to organise their subgroups. Relevant statements include;

“Putting audio tracks with some commonality into a group.”

“Routing instruments or groups of instruments into individual busses that then feed to the mix buss. This is done for purpose of processing, balancing or simply for organisation and ease of monitoring particular groups (soloing).”

“It is a combination of discrete audio tracks mixed together under a collective term, but not the final stereo mix.”

The word organisation was only mentioned once above, but other words and phrases like ‘commonality’ and ‘collective term’ are organisational.

In Table 3, when we asked how often respondents split drums into different drum subgroups i.e. hierarchically subgroup, the median percentage was 35%. We previously found that when hierarchical subgrouping did occur, 12% of drum subgroups created were hierarchical [2]. When asked “did you modify the subgroups you had already created?” two respondents said they would rarely change subgroups, but would further split them to create new subgroups, an example of hierarchical subgrouping.

Two questions related to how many subgroups respondents used based on how many tracks were in a multi-track, and how many tracks were needed before they considered subgrouping. The minimum, average and maximum amount of subgroups the respondents would normally create in relation to the number of audio tracks can be seen in Figure 7.

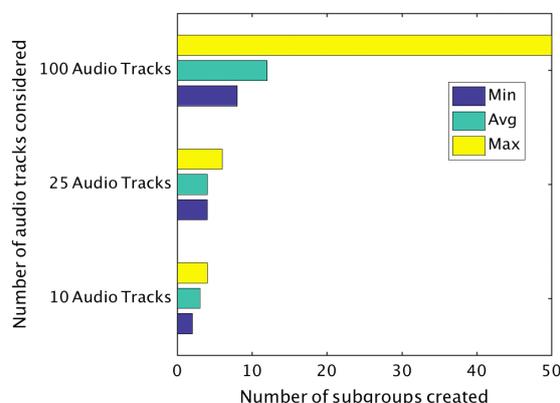


Fig. 7: The minimum (blue), average (green) and maximum (yellow) number of subgroups respondents create based on a given amount of audio tracks.

Factors dictating how many subgroups are used and how they are organised include whether digital or analogue gear was used, genre, how complicated the mix was and how much processing was needed. Respondents said they would need two to four audio tracks before considering subgrouping, except for one respondent who said twenty four tracks were needed since less than twenty four tracks was easy to manage. Other reasons were that subgrouping can make sounds fit together cohesively, and multiple recordings of the same instrument should be subgrouped. An example would be if there were a number of different microphone recordings of a bass guitar as well as the DI track [16, 17], for which subgrouping was observed in [2]. For another respondent, organisation was mix specific;

“First if the subgrouping makes sense internally, and second if the group works in the context of a mix.”

One respondent would subgroup all guitars together simply for organisational purposes.

“Due to the physical limitations of an analog console. . . subgroup all the guitars anyway simply for organisational purposes. Any processing would be done individually.”

3.4.4 Exercising Control

Exercising control and the simplification of the mixing task was an important theme in the data. By exercis-

ing control we mean that by subgrouping many audio tracks, the tracks can be collectively manipulated in terms of level and effect processing using a single fader or dial without losing control. Two definitions given by respondents on subgrouping are as follows,

“... dividing multiple tracks of audio into separate groups, this makes large complicated mixes easier to manage, essential for live mixing, ... incredibly beneficial for mixing in the studio.”

“Whenever one controller is used to control more than one. Most commonly, it is fader grouping, and these take two forms: 1. Control groups (one fader controls other faders) and 2. Processing Groups (signals are combined into an ensemble/stem/group ...)”

One respondent mentions it being essential for live mixing, which is understandable considering that it simplifies continually adjusting gain levels. Another respondent refers to the subgroup as a control group and implies that subgrouping is used for control. Overall, only 50% of the respondents said they use subgrouping to simplify the process, but on further analysis, the terms control and simplification were mentioned throughout the responses. One statement summarising this was;

“More complexity, more subgroups”

Other statements say that the more tracks there are, the more subgroups needed to keep the mixing task as simple as possible while maintaining a good degree of control,

“It makes it much easier to monitor groups of instruments or instruments that contain multiple sources (such as drums). One could describe this also as ‘soloing’.”

“When a mix gets beyond 24 tracks... it makes it easier to fine tune the overall mix if a group of instruments needs to be adjusted. Many mixes are 96 faders of information or more.”

“Large track counts, e.g. 100+, subgrouping will be essential to retain control.”

“If they’re all too bright, it’s easier and more DSP friendly to do them all at once.”

Exercising control was also mentioned in a surround sound context where the respondent states

“Surround might need control over the centre channel, you may have many kick drums you want to compress as a whole etc. you may want to remove the kick drum from the main drum compression so it stops affecting the other drums via the compressor.”

3.4.5 Analogue versus Digital

The modern Digital Audio Workstation (DAW) has revolutionised how mix engineers approach mixing, since they now rarely worry about physical limitations. The Analogue versus Digital theme became clear once we attempted to understand if subgrouping practice has changed over the last five years. Some respondents said that because of the modern DAW they now use more subgroups since they no longer have the physical limitation of an analogue desk and the amount of available subgroups is almost limitless.

“A big change... during the transition from all analog mixing to mixing in the box. Generally these were physical limitations due to the console... virtually unlimited sub-grouping in DAWs.”

“Subgrouping approach has only changed via computing power has grown, as I mix mostly within a DAW, the more power I have the more I can expand my mixer...”

“If I were using an analogue desk with only 8 groups, then maybe, but these days I don’t need to constrain myself in that way.”

There were two statements made that illustrate why a mix engineer might not have used as many subgroups before they had access to a DAW.

“In the analogue domain, I may not do this because the subgrouping requires an additional pass through a summing amp, which – depending on the console – might pay a sonic penalty.”

“20 string mics are still one instrument and it is useful to be able to treat it as such. Pre DAW, these items would all have been bounced to stereo as part of the recording process.”

Finally, there was a statement that summarises what is meant by the theme of Analogue versus Digital in a subgrouping context.

“Subgroup processing is part of the current sonic environment.”

4 Discussion and Assumptions

(A1) - eight out of the ten respondents agreed with this statement and subgroup effect processing was a major theme in this report. Also, statements were given that subgroup effect processing, especially DRC and EQ, is essential and is heavily used. DRC was referenced 31 times throughout the survey responses and EQ was referenced ten times. We therefore consider this assumption to be true.

(A2) - eight out of ten respondents agreed with this statement. This assumption was touched on under the themes of Organisation and Exercising Control where respondents mentioned putting similar instruments into the same subgroup in order to mix them as one. An example of this is when the mix engineer attempts to mix drums or is making a stem track. Based on the fact it is an obvious reason to create subgroups and so many respondents agreed, we would consider this assumption to be true.

(A3) - six out of ten respondents said that genre has an effect on how they create subgroups. There were many examples given by the respondents on when this would occur, particularly for EDM/Dance music. However, some respondents said it does not affect their subgroup choices and one respondent said it depends on the information in the mix. Based on the many examples given by the respondents on when genre affects subgroup choices and the overall majority of respondents agreeing with this assumption, we consider this assumption to be true.

(A4) - five out ten respondents said they create subgroups to reduce complexity. However, if we examine Figure 7 we see a trend where the more audio tracks there are, the more subgroups there are. This suggests that mix engineers create subgroups to reduce the amount of faders and effects they have to manage. Therefore, reducing complexity. There were many statements provided that fell under the themes of Organisation and Exercising Control that suggested that subgroups are created to make the mix engineers life easier. Despite that only half respondents agree with this statement, the volume of qualitative data suggests otherwise. Therefore, we would consider this assumption to be true.

(A5) - six out of ten respondents said they hierarchically subgroup. The median percentage for respondents who split the drum subgroup up into smaller subgroups

in their last 100 mixes was 35%. We also found this occurred in previous work mainly with respect to drums and vocals [2]. In relation to Table 3, two respondents both similarly said they would rarely change subgroups, but they would further split them and create new subgroups which is the same as hierarchical subgrouping. Based on these results we would consider this assumption to be true.

(A6) - All respondents agreed with this assumption. It was also found to be true in previous work [2]. The idea of subgrouping based on instrument family also came up under the themes of Decisions and Organisation. It could be argued that this was an obvious assumption. However, we have never seen it explicitly stated anywhere in the literature as a rule [8, 1, 9]. Consequently, we consider this assumption to be true.

(A7) - The median percentage for respondents who answered the question “in the last 100 mixes did you subgroup to maintain good gain structure” was 100%. One respondent mentioned this to be one of the most important aspects of mixing. They said that they would initially use subgrouping for organisational purposes and then for maintaining good gain structure. We consider this assumption to be true.

(A8) - The median percentage of respondents who answered the related question in Table 3 was 5%. Furthermore, when respondents answered in a simple yes or no context, only two out of ten respondents said yes. This is not a result we expected as we know that masking reduction is important to mix engineers and by treating instruments that share a similar spectral space together this would make masking reduction easier to achieve. Based on the results found, we consider this assumption to be false.

(A9) - All of the respondents said they would apply DRC to their subgroups. Furthermore, we also asked what instrument groups each respondent is most likely to apply DRC to and found this to be drums and vocals. These results agree with the findings in [3], where the authors tested the assumption “Gentle bus/mix compression helps blend things better” and it was found to be correct. We believe this assumption to be true.

5 Conclusion

From the analysis and discussion presented here, it is clear that subgrouping is not as simple as subgrouping all instruments that are similar to each other. There

is more of a thought process behind subgrouping and a number of different factors come into play when subgrouping decisions need to be made. For instance, genre has an impact on the type of subgrouping strategy used. It determines if and how subgroups should be broken down, what type of effects processing is to be used, what instrumentation subgroups contain, and how many tracks there will be in a subgroup.

The data gathered through the survey validates the majority of the assumptions that were made previously with regard to subgroup processing and organisation. It also uncovered underlying information that would otherwise be passed on from practitioner to practitioner, or learned through trial and error, but that would remain undocumented.

Many of the findings in this survey are of no surprise, such as subgrouping by instrument type, subgrouping for effects processing and subgrouping to make the mixing processing less complicated. However, these are often just stated in the literature as a reason to subgroup without discussion as to why [8, 1, 9]. Furthermore, results from the survey tend to agree with the results uncovered in [2]. However, it is worth mentioning that the participants in the previous study were students and not professional level mix/mastering engineers.

Considering these results in an intelligent audio production tool context, they indicate that subgrouping should be considered in developing these types of systems [10, 11, 4, 12]. If professionals perform subgrouping when mixing, then systems trying to mimic similar results may also benefit from this. We thus make the following seven recommendations for any intelligent mixing system that were to consider using subgrouping;

1. Subgrouping should be applied when there is more than one of any instrument type and should be applied to instruments that are similar to each other i.e. subgroup drums or guitars.
2. Subgrouping should be applied to maintain a good gain structure.
3. Based on the rankings in Table 2 we suggest that subgrouping be applied after panning and before DRC or EQ is applied. The reason for it being applied before DRC or EQ is because DRC or EQ will then be applied to each subgroup as well as individual channels.

4. Subgroups should be created based on the genre of the music being mixed. Genre should inform the types of effect processing applied to subgroups.
5. If hierarchical subgrouping is to be used, this should be applied to drums, vocals and guitars.
6. DRC subgroup processing should always be applied to drum and vocal subgroups and to a lesser extent EQ should be applied to all subgroups.
7. The number of subgroups should be created in proportion to the amount of audio tracks available as well as the genre of music being mixed in order to reduce complexity.

These recommendations are based on the analysis of 72 student mixes in [2] and the detailed survey of ten award-winning professional mix and mastering engineers herein. They are by no means exhaustive, but it is hoped that they will be utilised and validated further in an automatic mixing system.

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References

- [1] Izhaki, R., *Mixing audio: concepts, practices and tools*, Taylor & Francis, 2013.
- [2] Ronan, D., De Man, B., Gunes, H., and Reiss, J. D., "The impact of subgrouping practices on the perception of multitrack mixes," in *Audio Engineering Society Convention 139*, Audio Engineering Society, 2015.
- [3] Pestana, P. and Reiss, J., "Intelligent audio production strategies informed by best practices," in *Audio Engineering Society Conference: 53rd International Conference: Semantic Audio*, Audio Engineering Society, 2014.
- [4] Scott, J. J. and Kim, Y. E., "Instrument Identification Informed Multi-Track Mixing." in *14th International Society for Music Information Retrieval Conference (ISMIR 2013)*, pp. 305–310, 2013.

- [5] De Man, B. and Reiss, J. D., “A knowledge-engineered autonomous mixing system,” in *Audio Engineering Society Convention 135*, Audio Engineering Society, 2013.
- [6] De Man, B., Boerum, M., Leonard, B., King, R., Massenburg, G., and Reiss, J. D., “Perceptual evaluation of music mixing practices,” in *Audio Engineering Society Convention 138*, Audio Engineering Society, 2015.
- [7] Ronan, D., Moffat, D., Gunes, H., and Reiss, J. D., “Automatic subgrouping of multitrack audio,” in *Proc. 18th International Conference on Digital Audio Effects (DAFx-15)*, DAFx-15, 2015.
- [8] Case, A. U., *Mix smart*, Focal Press, 2011.
- [9] Owsinski, B., *The mixing engineer’s handbook*, Nelson Education, 2013.
- [10] Hafezi, S. and Reiss, J. D., “Autonomous multitrack equalization based on masking reduction,” *Journal of the Audio Engineering Society*, 63(5), pp. 312–323, 2015.
- [11] Reiss, J. D., “Intelligent systems for mixing multichannel audio,” in *17th International Conference on Digital Signal Processing (DSP)*, pp. 1–6, IEEE, 2011.
- [12] Scott, J., Prockup, M., Schmidt, E. M., and Kim, Y. E., “Automatic multi-track mixing using linear dynamical systems,” in *Proceedings of the 8th Sound and Music Computing Conference, Padova, Italy*, 2011.
- [13] Pestana, P. D. L. G., *Automatic mixing systems using adaptive digital audio effects*, Ph.D. thesis, Universidade Católica Portuguesa, 2013.
- [14] Braun, V. and Clarke, V., “Using thematic analysis in psychology,” *Qualitative research in psychology*, 3(2), pp. 77–101, 2006.
- [15] Boyatzis, R. E., *Transforming qualitative information: Thematic analysis and code development*, Sage, 1998.
- [16] Clifford, A. and Reiss, J., “Reducing comb filtering on different musical instruments using time delay estimation,” *Journal on the Art of Record Production*, 5, 2011.
- [17] Clifford, A. and Reiss, J. D., “Using Delay Estimation to Reduce Comb Filtering of Arbitrary Musical Sources,” *Journal of the Audio Engineering Society*, 61(11), pp. 917–927, 2013.