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Stereo Microphone Techniques in Drum Recording

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Stereo Microphone Techniques in Drum Recording

Preferred stereo techniques for use in overhead applications in the musical genres of Funk, Pop/Rock & Jazz

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Abstract

The decision on what microphone technique to use in recording situations is commonly based on technical characteristics of the technique and there is often little time to experiment. This is a problem for many engineers since the quality of the recorded source material has become the biggest factor of sound quality and the microphone technique used has a big influence on the attributes of the reproduced sound. In this study the most commonly used stereo microphone techniques used in the industry were compared. A group of trained engineers rated sonic attributes rather than what they know about the stereo techniques, with the aim of predicting the most suited technique for use in drum overhead applications in the musical genres of Funk, Pop/Rock and Jazz. The stimuli used for the test was simultaneous recordings of X/Y, Blumlein, ORTF and A/B microphone setups in the three genres, both upbeat and downbeat. Analysis of the results provides a guide in making the decision on what stereo technique to use for drum overhead recordings in different musical genres.
The results show that A/B is the most popular stereo technique overall and also seems to be the most all-round techniques. In some cases however, it is beneficial to use one of the other stereo techniques. X/Y seems to be the least suited stereo technique for use in this type of recording. The results show that not only the musical genre must be taken in to account when choosing stereo technique, tempo is also a factor to consider.

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1. Introduction

1.1 Background

When choosing a stereo technique for recording there often is little time for experimenting to see which one is better suited for the recording setting. The decision on what microphone technique to use is commonly based on technical characteristics of the technique such as mono summing compatibility and space consumption. It can also be based on the nature of the sound source, recording environment and even plain aesthetics, especially in the case of live broadcasting. These are assumptions made on theoretical characteristics, and not a decision made by listening to the technique in the recording environment. This is a problem for many engineers since the quality of the recorded source material has become the biggest factor of sound quality and the microphone technique used has a big influence on the attributes of the reproduced sound. In other words, to achieve the kind of sound you want, it is essential to get it right from the beginning. If you record a stereo soundstage with too much width, a hole in the middle and poor sense of direction will occur and it will stay that way throughout the production, there is no fixing it in the mix.

1.2 Scope

In this paper the most commonly used stereo microphone techniques used in commercial recordings were compared with the aim of predicting the most suited technique for use in drum overhead applications in the musical genres of Funk, Pop/Rock and Jazz. The focus was solely on studio recording applications and only techniques using two microphones were presented. A more vast investigation would not have been possible to perform within the time limits of this study.

In order to find the best suited stereo technique for the different genres, the characteristics of the different techniques must be examined. This paper will focus on the most commonly used techniques in commercial recording, but of course there are several other techniques available and even variations of the ones presented that could also be investigated. However it is not possible to do so in this paper.

The stereo techniques used today can be divided in to two groups.

- Time Based Stereo
- Coincidental Stereo

1.3 Coincidental Stereo

Coincident stereo uses two microphones set at the same horizontal point, stacked vertically and set at an angle to each other in the vertical plane, aimed at the sound source. The purpose of the vertical stacking is to get the membranes to record the sound at the same point in time, to minimize phase differences between the membranes. This technique relies solely on inter channel intensity differences to achieve the sense of stereo. Because of this, microphone setups using this technique are also known as *intensity stereo*. Most commonly cardioids are used set at an included angle to each other of about 90 degrees. When using coincident microphone techniques, it is important to use microphones that have a polar pattern that is consistent with frequency. Many condenser microphones become increasingly directional with higher frequencies and this can cause the centre to lose focus. Because of its minimal inter channel phase difference, coincident stereo techniques have excellent mono summing compatibility, but the lack of time and phase difference can also be perceived as a lack of room reverberation. As long as the microphones of a coincident stereo technique remain in the near field of the sound source the angular accuracy remains unaffected.
Even though coincident stereo techniques contain no inter channel phase differences, the intensity differences in the low frequency region, that is below 800Hz, translates into phase differences which in many ways resemble the inter aural time delays that humans use to perceive direction of sound. Even in the high frequency region the inter channel intensity differences result in head masking and ear diffraction which also resembles our natural way of hearing in stereo. Thanks to these characteristics coincident stereo techniques provide a good stereo image with clarity and a clear sense of direction. When using coincident stereo techniques, it is important to take consideration of the acoustic centre of the microphone since this is not fixed, but varies with frequency and incidence of sound. Because of the variation in acoustic centre, it is very difficult to form a real coincidental pair of microphones. The best solution seems to be to treat the membranes as the acoustic centre, placing them as close to each other as possible. This is due to the acoustic centre seeming to get closer to the membrane with increasing frequency. Since we can’t tell direction in low frequencies it is better to focus on the higher ones.

The coincidental stereo techniques tested in this paper are:

1.3.1 X/Y

X/Y - Microphones are stacked with their membranes as close to the same physical point as possible to minimize phase differences between the microphones. Typical included angle between the microphones is 90-120 degrees. The angle between the microphones, the source width and the polarity of the microphones affects the width of the stereo image. In X/Y, cardioid microphones are typically used, but one can also use hyper cardioids which has a back lobe that will capture some of the room reverb and thus gives a more reverberant sound than the dry sound that regular cardioids microphones offers. However, when using hyper cardioids, a smaller included angle should be used to ensure a stable centre image.

1.3.2 Blumlein

This technique uses the same setup as X/Y but with bidirectional microphones, typically angled at 90 degrees. The back lobe of the bidirectional microphones captures room reverberation and offers a sense of depth that the X/Y setup can´t provide while at the same time offering a clear sense of direction and a stable centre image, due to inter channel intensity differences. As with all coincidental techniques, mono compatibility is excellent but the lack of phase differences might cause the sound to be perceived as lacking “airiness”.
Stanley P Lipshitz praises the characteristics of coincidental techniques and especially Blumlein, which he considers to be the most natural sounding and detailed stereo technique of all.

1.4 Time Based Stereo

Time based stereo most commonly uses two microphones on a lateral line perpendicular from the direction of the sound source spaced apart up to one meter. The stereo information is retrieved from both time and intensity differences, however the intensity differences will be much smaller than in intensity stereo techniques. The further away from the sound source the setup is positioned, the smaller the intensity differences get, which means less directional information.
Because of the phase differences causing comb filter effects, microphone setups using this technique will have less clarity and worse tonal balance on sounds coming from the far left and right than coincident techniques. The mono summing compatibility will also be inferior to that of the coincident techniques. The time differences are however, by many perceived as room reverberation, giving time based stereo techniques an "openness" that coincident stereo techniques lack.
To achieve a full stereo image a inter channel time difference of 3 ms is needed. Sound travels about one meter in 3 ms, consequently the microphones need to be spaced apart no more than 1 m to achieve full coverage of sounds coming from the far left and right. A danger of using bigger distances between the microphones is that the sound might be perceived as coming from just one of the speakers. Herein lies a dilemma, the closer the microphones are spaced, the less low frequency phase shift occurs, but at the same time stereo width suffers. A problem with time based stereo is the so called "hole in the middle". Since only a quarter of the delay to create 100% stereo width is needed to fill 50% of the stereo panorama, when one uses full stereo width there will occur a widening of the centre image causing a "hole" in the stereo image in between the speakers.
The conclusion made is that spacing and distance to the sound source is essential to achieve a good stereo image when using time based stereo techniques. The time-based stereo technique tested in this paper is:

1.4.1 A/B

A/B, or "Spaced Cardioid Microphones" uses two microphones with spacing typically between 0, 6-3m. Spacing varies with the size of the sound source and the distance to it. One general rule is that the microphones be spaced 1/3 the distance from the centreline to the outer line of the sound source. The sense of space is mostly a result of phasing between the microphones, and not true room reverberation. When using spaced cardioid microphones, a greater distance to the sound source is needed than with omni microphones to get the feeling of space. All reflections will suffer from off axis coloration.

1.5 Near Coincidental Stereo

There is also a hybrid of the two major groups commonly called Near Coincidental Stereo. In this technique the microphones are spaced far enough apart (typically 15-30cm) for us to perceive the time differences but close enough so that comb filtering effects aren´t as severe as in fully time based stereo. Consequently, the stereo information is retrieved from both time and intensity differences. As with techniques based solely on time differences, mono summation compatibility suffers from the microphone spacing, but the inter microphone distance also provides a wider stereo image than that of the coincident techniques. Since the microphone spacing is kept rather small only high frequencies suffer from phasing, the bigger the inter microphone distance, the earlier phasing and comb filter occurs. In short, the spacing of the microphones contributes to a somewhat wider image than with the corresponding coincidental techniques, however reducing the sense of direction. The near coincidental stereo technique tested in this paper is:

1.5.1 ORTF

The ORTF stereo technique uses two cardioid microphones with an included angle of 110 degrees, with capsules spaced 17cm apart. The spacing is meant to mimic the human ears natural distance from each other. Phasing only occurs at high frequencies. This technique offers more “airiness” than fully coincident techniques because of the time differences but it suffers from a less stable centre image and less clarity.

In order to investigate which technique is best suited for the different genres, drum overhead recordings of downbeat and upbeat grooves in the genres was made and listening tests conducted with a group of 22 audio engineering students with at least 2 years of experience.

2. Method

2.1 Parameters

In order to predict what stereo technique is most suited for the task, one must first define the parameters on which engineers make the decision on what stereo technique to use. An informal survey was performed through a group discussion with ten students in the area of music and audio engineering where the participants were asked to point out the characteristics they deemed important in drum recording. All of the participants considered the characteristics in table 1 as vital in stereo recording and reproduction.

Table 1

Depth	Is it possible to place instruments on a perpendicular line stretching from in between the speakers and further back?
Width	Does the stereo image use the entire space between the speakers? Does the arc of sound spread beyond the width of the speakers?
Space / Room reverberation	Can one get a clear sense of the room in which the recording takes place?
Sense of direction	Is it possible to determine where in the microphone coverage region the different instruments are placed?
Tonal balance	Does the reproduced sound correspond to the original?
Intensity	Is the energy content of the instrument sufficient?
Air / Openness	Does the sound feel open or closed/trapped?

2.2 Recording

In order to perform the listening tests, the test stimuli were recorded in Studio 1, at the department of Music and Media, Luleå University of Technology. In total, 28 audio files were recorded consisting of drum grooves typical of the different genres, both upbeat and downbeat. The drum grooves were chosen by the drummer, based on his experience in the different genres.
Also, a neutral drum groove was recorded. The four different stereo techniques where recorded simultaneously for each musical style to avoid variations in the drummers performance. The signal chain consisted of AKG C414 BULS microphones, Millenia HV3 Preamp and a Digidesign 192 I/O Audio Interface. Audio was recorded using Protools 8. Microphone gain was set so that all stereo techniques had a peak level of -12dBFS (±3dB). The recording session was monitored through Genelec 1038 studio monitors. The drummer who performed the drum grooves was 22 years old, with more than 10 years of experience and studies in drumming at municipal, high school and at university level. The drum set used for the recording was a Yamaha Maple Custom of the following sizes:

Kick drum: 20”
Tom: 10”
Floor tom: 15”
Snare: Ludwig Supraphonic 14”
Hi hat: Zildjian New Beat 14”
Crash: Zildjian A Custom 16”
Ride: Zildjian A Custom 20”

(Ride cymbal used for the Jazz grooves was Zildjian K Custom Dry Complex Ride 22”)

The stimuli that was recorded for the test was 4 simultaneously recorded audio files, one for each stereo technique in each of the following musical styles:

Pop/Rock Downbeat.
Pop/Rock Upbeat
Funk Downbeat
Funk Upbeat
Jazz Downbeat
Jazz Upbeat
Neutral Drum groove

Audio files are available for download at:
http://dl.dropbox.com/u/5887682/Stimuli%20used%20for%20C-essay%20by%20Patrik%20Blomqvist.rar

(Audio files uploaded 2010-04-06)

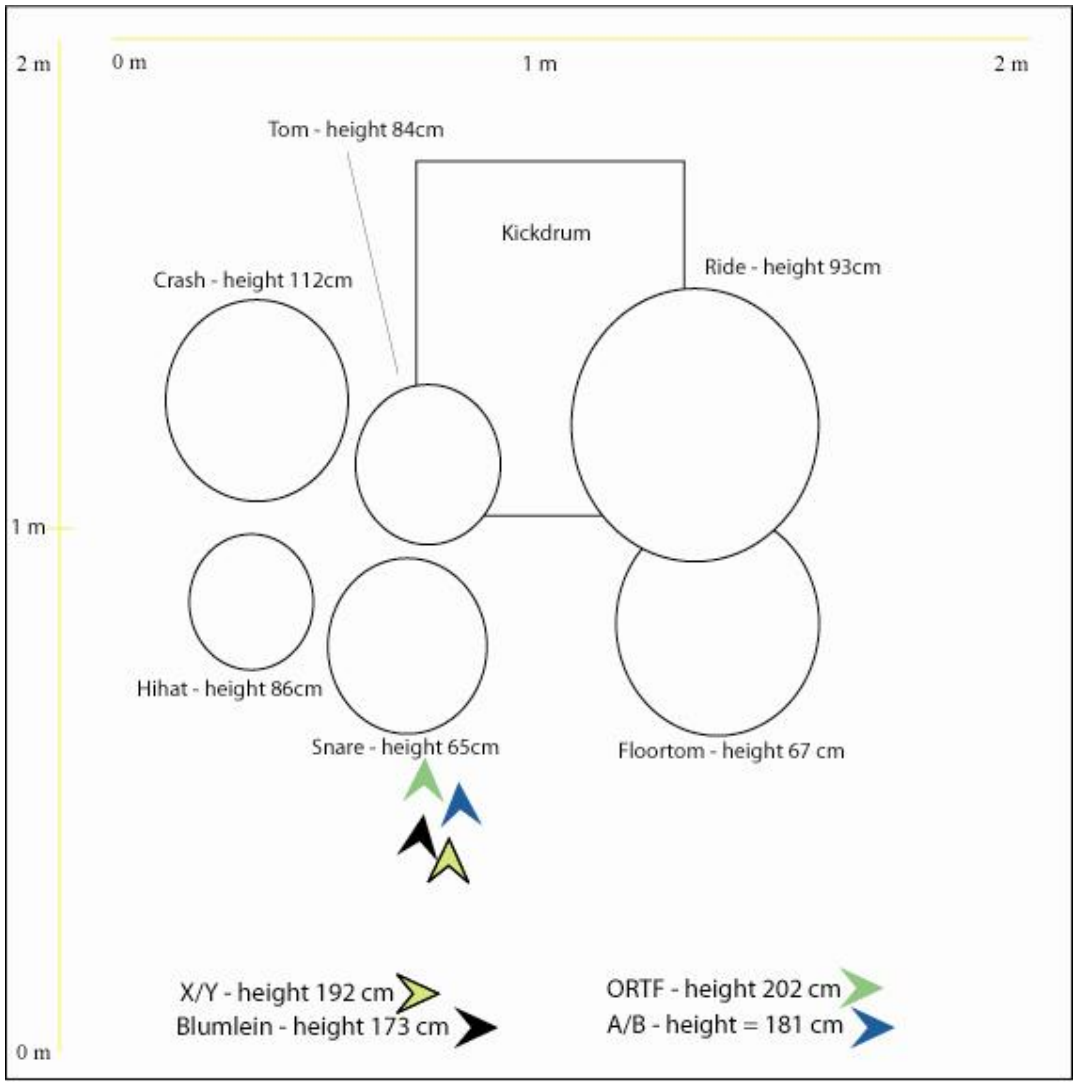
Drums were placed in the room as shown in figure 1 and 2.

Figure 1.

Figure 2.

The decision on where to place the microphone setups was made by letting a group of 5 audio engineering students perform a sound check for each of the stereo techniques. All decisions were made through discussions in between the participants. The starting point for every technique was 6 dm directly above the drummers head. The students were instructed to alter the microphone setups height and lateral position so that the snare and kick drum was reproduced in the centre of the image and so that full stereo width was achieved without the sound leaning in any direction. One stereo technique at a time was positioned and the students were able to come to a consensus on the optimal placement for each of the stereo techniques. The A/B microphones were spaced apart 43 cm, which is one third of the width of the drum set. Microphones were placed as shown:

Figure 3.



2.3 Listening test

The listening test was made using Protools 8 LE, a Digidesign 002 Rack Audio Interface and a printed questionnaire. The printed questionnaire is available as Appendix number one. AKG K171 Studio Headphones were used for listening. All audio samples were played with a peak level of -12dBFS (±2dB). 22 subjects were tested, of which all were in the age of 20-30 and had at least two years of experience in audio engineering. The tests were supervised to ensure answers were marked at the appropriate part of the questionnaire. Subjects were allowed to adjust the listening level prior to answering the questions, but once the test had started the listening level remained constant. In the initial part of the questionnaire, subjects were asked to state their age, experience in audio engineering in number of years, and what genre they've most frequently worked with.
In the initial part, subjects were asked to without listening, estimate which of the four stereo techniques they think is best suited for the three different genres, both downbeat and upbeat. This was done to determine which of the stereo techniques engineers would have used for a recording in each genre.
In part 1 of the listening test, subjects listened to the simultaneously recorded stereo techniques for every musical style, one by one, and chose the stereo technique they deemed best suited for that specific musical style. Subjects were allowed to switch back and forth between the stereo techniques freely. Subjects were also asked to identify 2 characteristics that motivated their choice. For example, one subject might select stereo technique number 2 because of good width and room reverberation. The 7 characteristics mentioned earlier (width, intensity, sense of direction, air/openness, depth, reverberation and tonal balance), were used as a reference, but subjects had the possibility to use their own characteristics as well. This was done to see what stereo technique the engineers perceive as best suited for each genre, and why. The identity of the stereo techniques were hidden from the subjects and the order in which they appear in the Protools session was randomized by using 5 different Protools sessions, all with different layouts.

The order in which the stereo techniques appear could look like in Figure 4, but the order would be different in any of the other 4 Protools sessions used. Since the subjects weren't allowed to know the identity of the stereo techniques, they were only allowed to see what is shown in figure 5. The picture illustrates a subject listening to the Pop / Rock Downbeat drum groove, switching in between the stereo techniques using the solo latch function. Subjects would after making his/her decision, mark the answer at the printed questionnaire and move on to the next musical style.

Figure 4.

Figure 5.

In the second part of the listening test, subjects listened to the neutral drum groove, one stereo technique at a time. They were asked to select the musical genre that they felt the different stereo techniques would be best suited for. For example, a subject would listen to the X/Y recording of the neutral drum groove, and select Pop / Rock as the musical genre that it would be best suited for. This was done to see if any of the stereo techniques contain sonic attributes that makes them especially suited for any specific genre. The subject would then motivate his/her answer using 2 of the same characteristics that were used in Part 1. Test subjects weren't allowed to switch in between the stereo techniques, but had to listen to stereo technique 1, mark their answer and then proceed to listen to stereo technique 2, mark their answer, move on to number 3 etc. The order of the stereo techniques was randomized in the same way as in Part 1. Finally, in part three of the test subjects were asked to briefly describe their opinion on the ideal drum sound for each musical genre in their own words.

3. Results

3.1 Initial questions

The results of the initial questions are shown in figure number 6-11. The results show that a majority of subjects guess that A/B would be best suited for all the four genres, especially in Pop/Rock.

Figure 6.

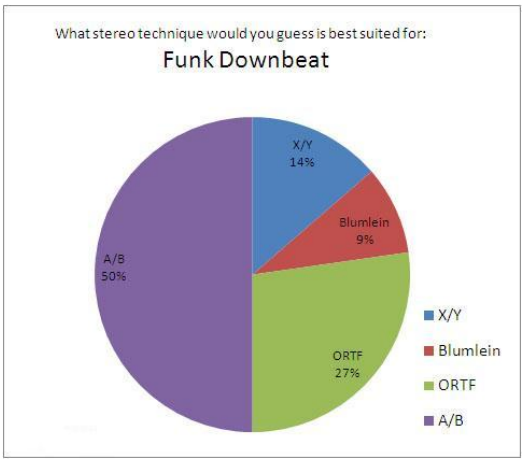


Figure 7.

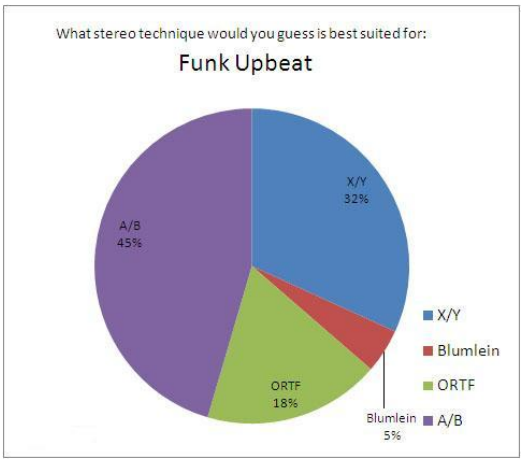


Figure 8.

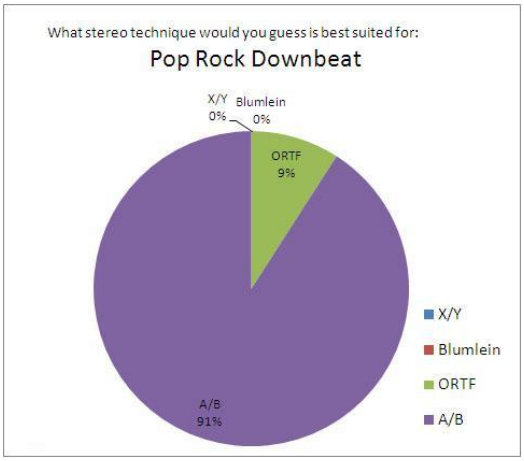


Figure 9.

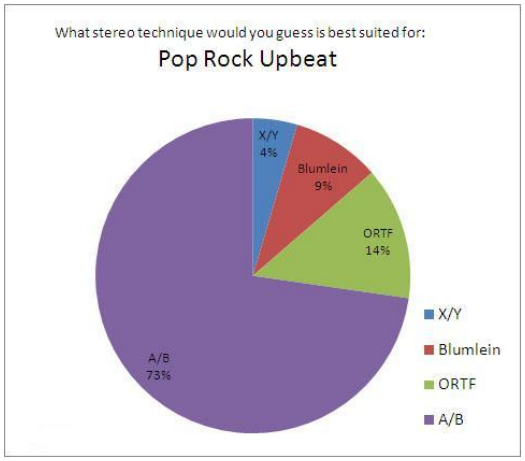


Figure 10.

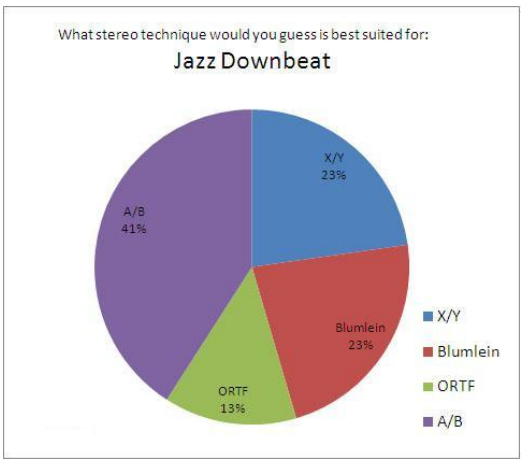
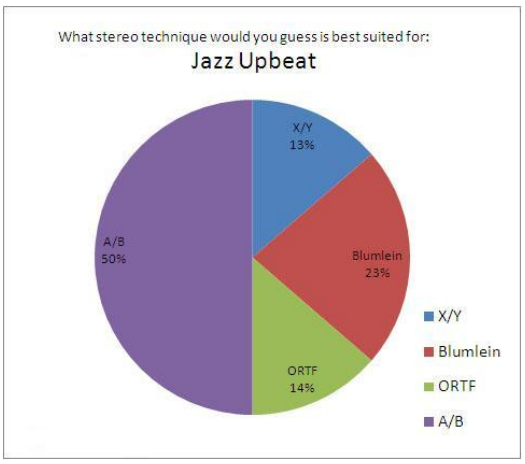


Figure 11.



3.2 Part one

The results of part one is shown in Figure number 12-17.

Figure 12.

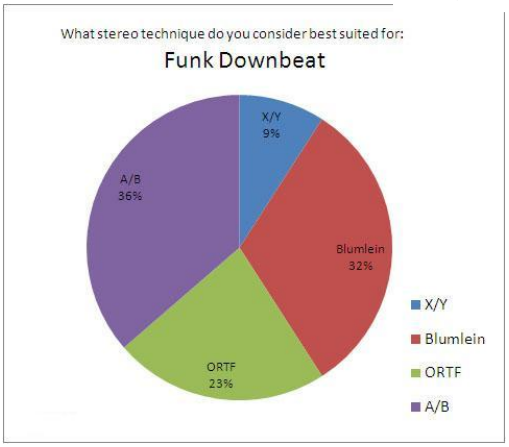
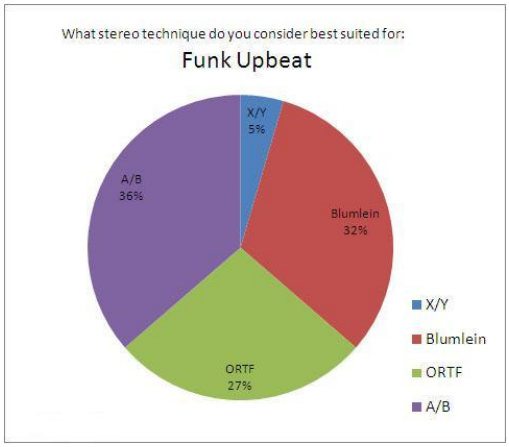


Figure 13.



In the Funk part of the test, A/B, Blumlein and ORTF are almost equally popular.

Figure 14.

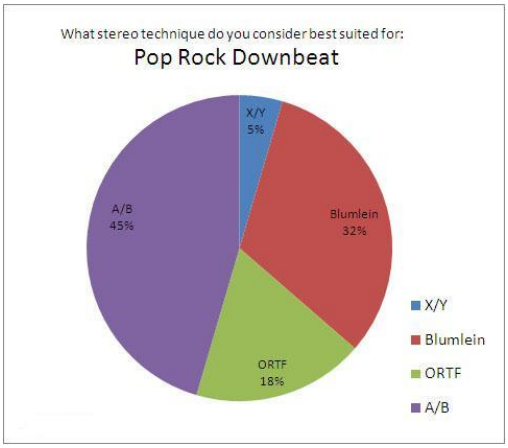
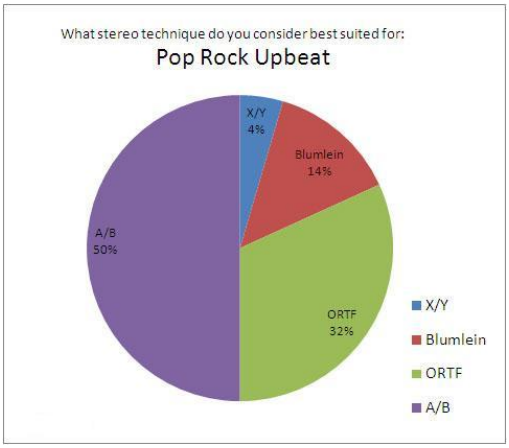


Figure 15.



For Pop/Rock, A/B seems to be preferred, however with Blumlein making ground in downbeat Pop/rock and ORTF doing so in upbeat Pop/Rock.

Figure 16.

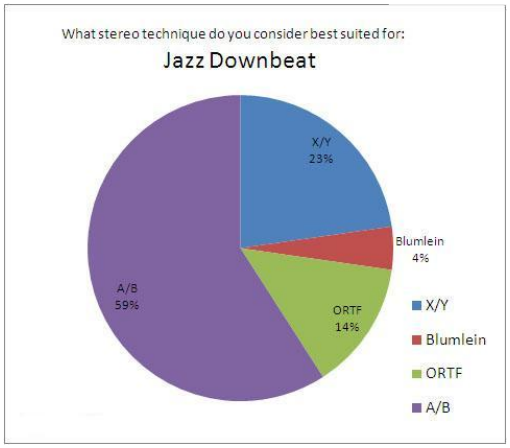
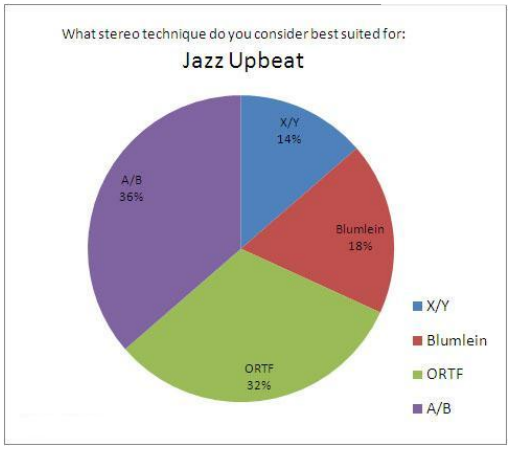


Figure 17.



In the Jazz section, A/B has a clear majority in downbeat Jazz. In upbeat Jazz, A/B and ORTF seems to be equally preferred by subjects. X/Y gets 1/4 of the subject's votes in downbeat Jazz.

3.3 Ideal sound image

The results of part three indicate that the ideal drum sound for funk would be a detailed sound with a clear sense of direction. Figure number 18 illustrates the characteristics that were considered as important for the ideal sound of Funk drums by subjects in part 3 of the test. The results of part three shows that intensity is by far the most important characteristic of the ideal drum sound for Pop/Rock. 50% of subjects consider intensity to be an important characteristic of the drum sound in Pop/Rock. Figure number 19 illustrates the characteristics that were considered as important for the ideal sound of Pop/Rock drums by subjects in part 3 of the test.

Figure 18.

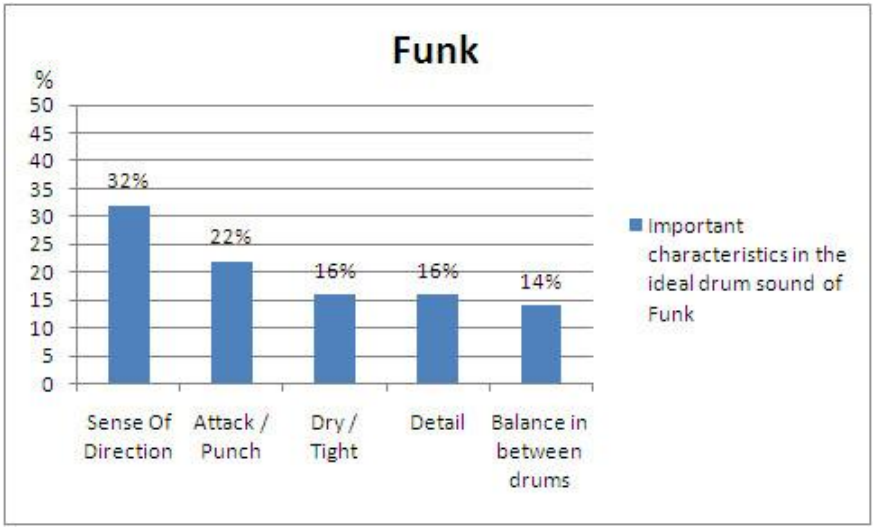
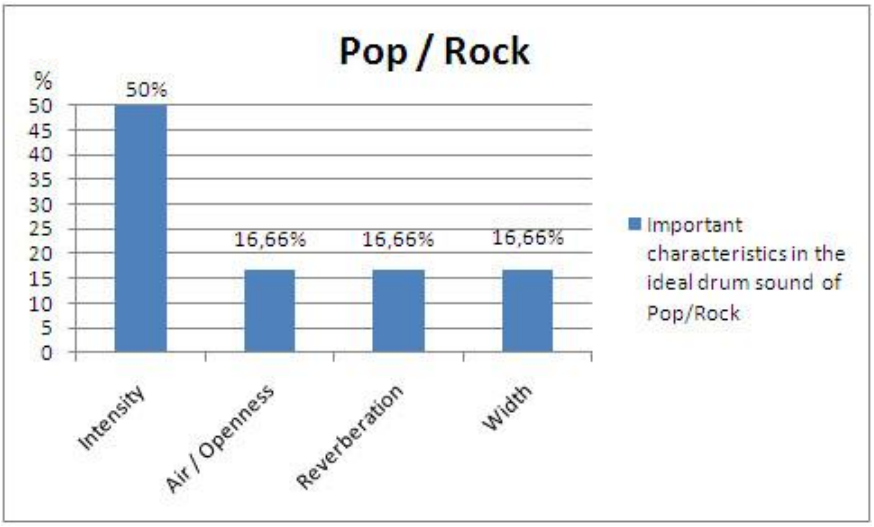
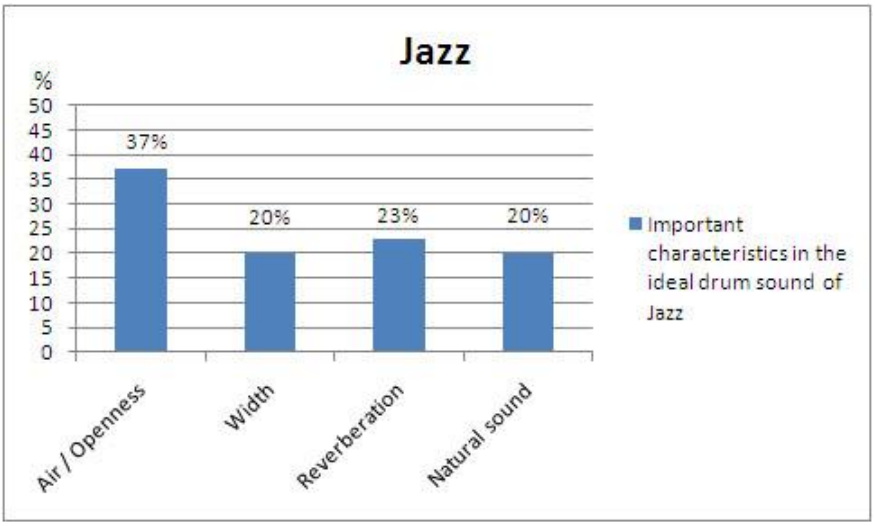


Figure 19.



The results of part three indicate that an open, natural sound with sufficient room reverberation would be the ideal drum sound for jazz. Figure number 20 illustrates the characteristics that were considered as important for the ideal sound of Jazz drums by subjects in part 3 of the test.

Figure 20.



3.4 Motivating characteristics

Tonal balance and intensity seems to be the foremost characteristics of X/Y. Figure number 21 illustrates the results of the test subjects motivating characteristics for choosing X/Y in part one and two of the test.
Tonal Balance, Air/Openness and a clear sense of direction seems to be the foremost characteristics of Blumlein. Surprisingly, Blumlein receives few points for reverberation.
Figure number 22 illustrates the results of the test subjects motivating characteristics for choosing Blumlein in part one and two of the test.

Figure 21.

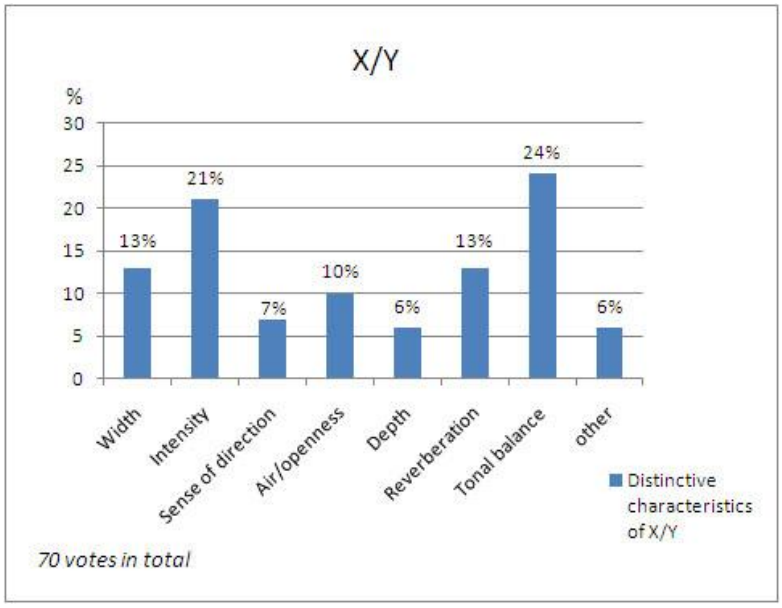
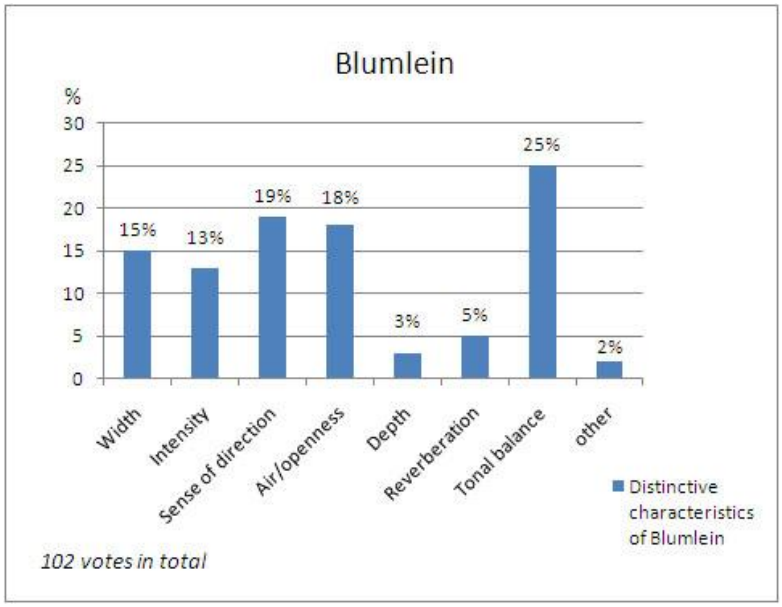


Figure 22.



Tonal balance and stereo width seems to be the foremost characteristics of ORTF. Figure number 23 illustrates the results of the test subjects motivating characteristics for selecting ORTF in part one and two of the test. A/B seems to be the most all round of the stereo techniques, providing most of the sought after characteristics. Figure number 24 illustrates the results of the test subjects motivating characteristics for choosing A/B in part one and two of the test.

Figure 23.

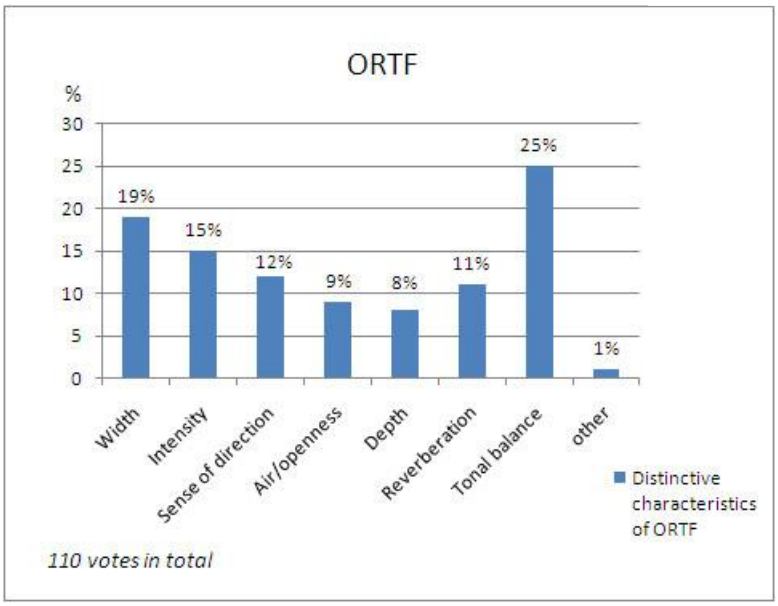
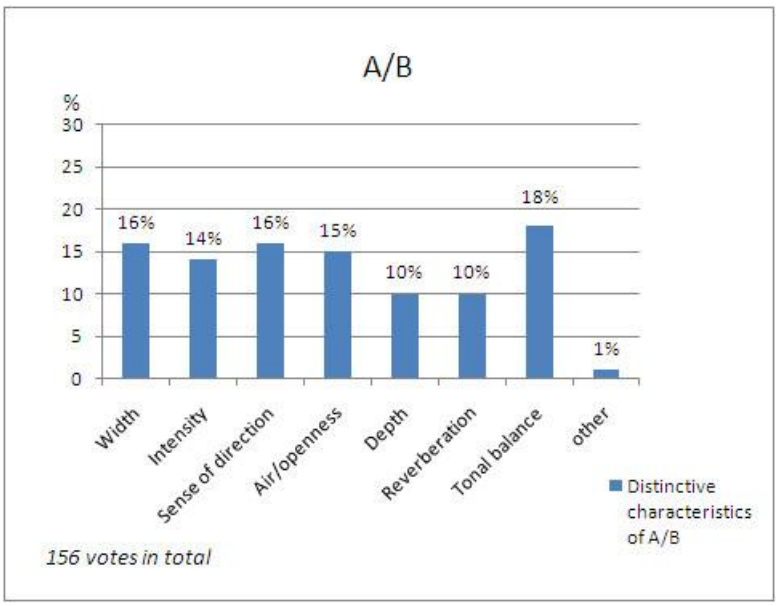


Figure 24.



Afro/Pop/Rock engineers deem Stereo Width, Sense of Direction and Tonal balance as important factors in the drum sound. Depth seems to be of little significance.
The following table show the motivating attributes (and number of times used) of 10 subjects that stated that they´ve mainly worked in Afro, or Pop/Rock. The presented characteristics are extracted from both part one and two of the test. Red and underlined text indicates characteristics that the subject used to motivate the answer for at least five of the ten musical styles.

Table 2.

Subject	**Width**	**Intensity**	**Sense of direction**	**Air / Openness**	**Depth**	**Room Reverb**	**Tonal Balance**	**Other**
1.	2	3	1	4	2	3	4	1
2.		3	1	1		4	**7**	4
3.	4	3	**5**	1			**7**	
4.	1	1	**9**	2		1	2	4
5.	**5**	1	1	2	3	2	**6**	
6.	4	3	**5**		4		4	
7.	2	2	**7**	4	2	2	1	
8.	**8**	2	1	3	2	1	2	1
9.	**6**	2	3	2		4	3	
10.	1	2	3	4	1	2	**7**	

Classical engineers deem Stereo Width, Intensity, Air/Openness and Tonal Balance as important factors in the drum sound. Depth and Sense of Direction seems to be of little significance. The following table show the motivating attributes (and number of times used) of the two subjects that stated that they´ve mainly worked in classical music. The presented characteristics are extracted from both part one and two of the test. Red and underlined text indicates characteristics that the subject used to motivate at least 50% of given answers.

Table 3.

Subject	**Width**	**Intensity**	**Sense of direction**	**Air / Openness**	**Depth**	**Room Reverb**	**Tonal Balance**	**Other**
1.	2	**6**		**5**		1	**6**	
2.	**6**	3		3	2	1	**5**	

3.5 Statistical Analysis

Based on the nature of the data, a Chi2 test was considered as best suited for determining the significance of the results. The Null hypothesis was that all results were a product of chance, with an even distribution of answers. The significance level was set to p = 0,05.

3.5.1 Chi2 Test of Initial Question

Funk Downbeat	*p = 0,0320*
Funk Upbeat	*p = 0.0490*
Pop/Rock Downbeat	*p = <0,0001*
Pop/Rock Upbeat	*p = <0,0001*
Jazz Downbeat	*p = 0,3168*
Jazz Upbeat	*p = 0,0502*

The null hypothesis can be discarded for Funk and Pop/Rock, but not for Jazz.

3.5.2 Chi2 Test of Part One

Funk Downbeat	*p = 0,2942*
Funk Upbeat	*p = 0,1713*
Pop/Rock Downbeat	*p = 0,0490*
Pop/Rock Upbeat	*p = 0,0128*
Jazz Downbeat	*p = 0,0016*
Jazz Upbeat	*p = 0,4052*

The null hypothesis can be discarded for Funk and upbeat Jazz.

3.5.3 Chi2 Test of Motivating Characteristics

X/Y	*p = 0,0109*
Blumlein	*p = < 0.0001*
ORTF	*p = <0,0001*
A/B	*p = 0,0005*

The null hypothesis can be discarded for all of the stereo techniques.

4. Analysis

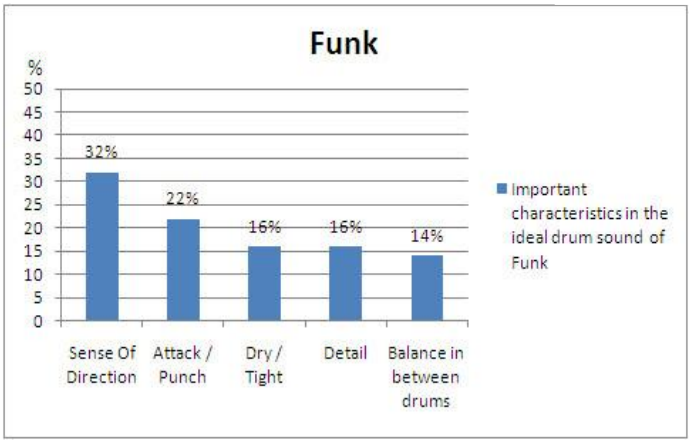
When looking at the results of the initial question where subjects are asked to guess what stereo technique would be best suited for the different musical styles, it becomes quite obvious that there is a clear preference for the A/B stereo technique when making drum overhead recordings. This is no surprise, since A/B is by far the most commonly used stereo technique by engineers making this sort of recording. However, it does become clear when comparing the results of the initial part with the results of part one (especially Pop/Rock) that what audio engineers predict would be best suited is not always the same as what is perceived as being so, when given the chance to compare the different stereo techniques. Remember only 5 % of subjects guessed Blumlein would be suited for upbeat funk, but 32% perceived it as being so. This indicates that even though A/B seems to provide us with most of the major qualities that we look for in a stereo technique, surely there is something to be gained by learning more about the characteristics of other stereo techniques.
When looking at the motivating characteristics given by the subjects, a pattern emerges where most subjects seem to motivate most of their answers with one or two characteristics, using the same characteristic for as much as 90% of answers. This shows that some subject´s answers are based on a personal preference, rather than specifically for each genre. For example, an engineer might be listening for the stereo technique with the widest stereo image and selecting this for all the different genres, when in fact it would be better to look for a stereo technique with a clear sense of direction for that specific genre. Another strong indication that personal preference might be an issue is the fact that the two engineers that stated they work mainly with classical music choose different motivating characteristics for their answers then the Pop/Rock engineers. Of course with just two subjects it is hard to make a strong case but the tendency is there.

In order to dig deeper we must look closer on the ideal drum sound of each genre and compare these to the characteristics of each stereo technique, as presented in pages 20-23.

4.1 Funk

The results of part three indicate that the ideal drum sound for funk would be a detailed, dry sound with a clear sense of direction. In order for the sound to be detailed and dry, the stereo technique used should not contain much room reverberation and provide good tonal balance. X/Y can be discarded immediately since it does not seem to be perceived as providing a clear sense of direction, which is the key attribute of the ideal drum sound. The time-based stereo techniques (A/B and ORTF), does provide a sense of direction, but it is marginally less than that of Blumlein.
If you add the fact that the time-based stereo techniques contain more room reverberation, which is not desirable, it would seem that Blumlein is a better choice for use in the musical genre of Funk. Another important attribute of the ideal drum sound for funk is attack/punch. This is something that a coincidental technique should be better at providing, since it does not have the problem of comb filtering effects that blur the higher frequencies in time-based stereo techniques.When looking at the results of part one, Blumlein is preferred by 32% of subjects, both in downbeat and upbeat. A/B receives 32%. Since Blumlein does not have the advantage of personal preference that A/B has, this again is a strong indicator that Blumlein would be a good choice for use in overhead drum recordings in the musical genre of Funk.

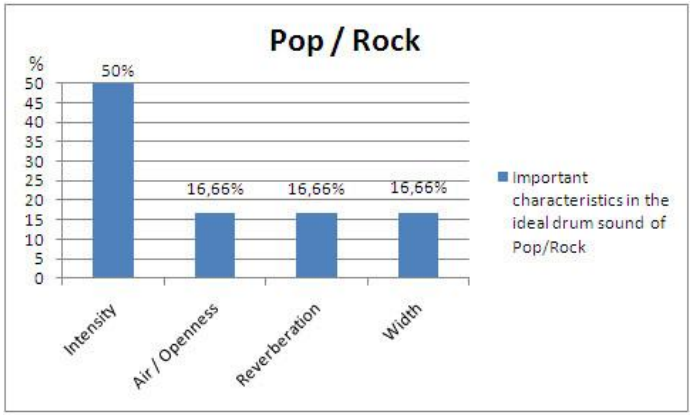
Figure 18.



4.2 Pop/Rock

The results of part three indicate that intensity is by far the most important characteristic of the ideal drum sound for Pop/Rock. Other attributes that are mentioned by more than 25% of subjects are air/openness, room reverberation and stereo width. The stereo technique that receives most points for the attribute of intensity is X/Y. However, since only 4% of subjects choose X/Y as best suited for pop/rock upbeat, and only 5% for downbeat, it would not seem to be suited for use in this genre. The significant lack of votes for X/Y in this genre indicates that there is something other involved than personal preference. In part one, Blumlein receives 32% of votes for downbeat pop/rock, but only 14% for upbeat, in benefit of ORTF. It might be that the detailed sound that coincidental techniques provide is appreciated in downbeat, but when recording upbeat pop/rock grooves, the "distortion" that comb filtering effects of time-based stereo techniques result in is desirable. It would seem that for downbeat pop/rock, A/B or Blumlein might be the best choice. For upbeat pop/rock, A/B or ORTF is probably best suited.
A/B seems to have more air/openness than ORTF, but worse tonal balance, so when selecting in between the two one has to have those two characteristics in mind. Since tonal balance is not one of the most important characteristics of the ideal drum sound, it is probably better to discard ORTF in favour of A/B and its air/openness when recording upbeat pop/rock.

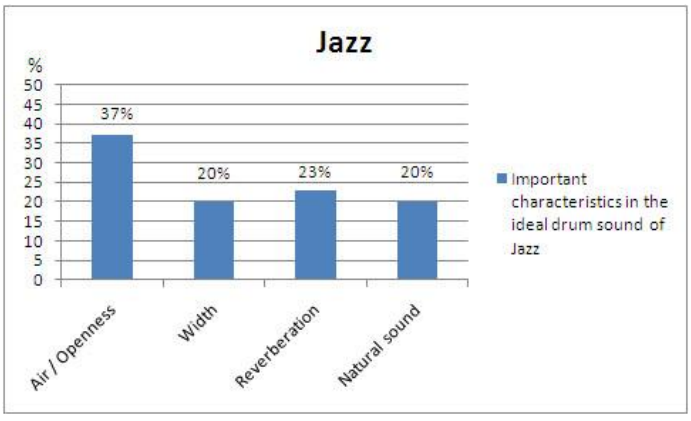
Figure 19.



4.3 Jazz

According to the results of part three, the key features in the ideal drum sound of jazz is an open, wide, natural sound image with good room reverberation. The characteristic deemed important by most subjects is air/openness. Surprisingly, X/Y receives 23% of votes for downbeat jazz, and 14% for upbeat. The most prominent characteristics of X/Y are tonal balance and intensity. It might be that tonal balance translates into the natural sound that is desirable, which is why some subjects consider it as suited for use in jazz. However, since X/Y receives fewer points for air/openness and stereo width than other stereo techniques it is not the best suited technique for this genre. When looking at the characteristics of the stereo techniques, it would seem that A/B or Blumlein is best suited for use in the musical genre of jazz. Both provide good tonal balance, stereo width and air/openness. ORTF also does well, but it contains less air/openness than the other two. In the results of part one, A/B is preferred by 59% of subjects for jazz downbeat, which in combination with the previously mentioned characteristics indicate that it would be the best suited stereo technique. In upbeat jazz however, only 36% prefer A/B, and 32% prefer ORTF. This might be because of the fact that A/B suffers from worse comb filtering effects than ORTF. In downbeat jazz, this might be accepted since drums are not struck as frequently as in upbeat. As the tempo increases, the detail of the sound image becomes more important and it is therefore better to use ORTF which does not contain as much comb filtering. Blumlein does not receive many points for room reverberation and is only preferred by 4 % of subjects in downbeat and by 18% in upbeat. It would seem that A/B is best suited for use in downbeat jazz and ORTF is best suited for use in upbeat jazz.

Figure 20.



5. Discussion

5.1 Conclusion

In this paper the most commonly used stereo microphone techniques used in commercial recordings were compared with the aim of predicting the most suited technique for use in drum overhead applications in the musical genres of Funk, Pop/Rock and Jazz. The study was made through a listening test with 22 participating audio engineering students. The stimuli used for the test was simultaneous recordings of X/Y, Blumlein, ORTF and A/B microphone setups in the three genres, both upbeat and downbeat. Even though there is no clear preference for any specific stereo technique in the different genres, the results does show that to achieve the overhead drum sound that we are aiming for, it is beneficial to know and understand the attributes of the different stereo techniques. Surely, one will not be able to use Blumlein for every Funk recording and expect a perfect result every time, but with a greater understanding for the pros and cons of the stereo techniques an engineer is provided with a powerful tool to push the sound in the right direction. As the results of this paper show, it is not only the genre that affects what stereo technique is best suited. Tempo must also be taken in to account. As an engineer, one must be able to set aside personal preferences, and look for the characteristics that are typical for the drum sound of the different genres.

When comparing the results of the initial questions with the results of part one, it becomes clear that the preference most engineers have for the A/B microphone setup is not always motivated, even though A/B seems to be the most all-round of the techniques, covering most of the sought after characteristics. Blumlein seems to be a good choice if a highly detailed sound with a clear sense of direction is desirable. It does however, not contain the intensity that the time-based stereo techniques gain from the comb-filtering effects. X/Y does not seem to be suited for use in drum overhead recording, since it does not fit the ideal sound of any of the genres investigated in this paper. Interesting though, is the fact that X/Y receives more points for room reverberation, than Blumlein, which theoretically should not be the case.

Of course, there is the question if the choice of stereo technique matters at all, since it is common practice to use closely positioned microphones for each drum when making drum recordings. The author's opinion is that even if the choice of stereo technique does not make all the difference, it probably does not even make half, but it IS a tool in pushing the sound in the direction you want.

5.2 Improvements

The way this research was made might not have been the most appropriate way of investigating the relation between stereo techniques and different musical genres. By asking the subjects prior to listening to the test stimuli to guess what stereo technique is best suited for the different genres, subjects are informed about what is being investigated. The result might be that when taking the test, subjects try to identify the stereo technique they guessed would be best suited, rather than the one that actually would be best for the genre. A more efficient way of doing the research could have been asking the subjects to listen to the audio samples and to rate the different characteristics of each stereo technique, resulting in a template of the attributes of each stereo technique. This template can then be used when selecting a stereo technique for the desired drum sound. The sound can be further adapted for the genre by changing the inter microphone distance, angle and distance to the sound source. Another clear indication that it would be better to focus on the characteristics of the stereo techniques is that the results of the statistical analysis show a far greater validity for the motivating characteristics than for the result of part one and two. All results of the motivating characteristics can discard the null hypothesis with a probability of over 98%, which is statistically very significant. In part one and two, the significance is not nearly as strong, and in many cases it is not possible to discard the null hypothesis at all.

5.3 Further Research

A good way of pursuing this research might be to further map the perceived characteristics of the different stereo techniques. By letting subjects listen to audio samples of over head recordings of drums and rate the characteristics, a template can be created, containing a visual guide to the sonic attributes of each stereo technique. This template can be used to select the best suited stereo technique for the type of drum sound that is desired.

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7. Appendix

Appendix #1

INITIAL QUESTIONS:

Age?	Number of years:	
Experience in audio engineering	Number of years:	
What genre have you worked with the most?		

Which of the stereo techniques X/Y, Blumlein, ORTF & A/B do you guess would be best suited for::

	Circle your answer:			
Jazz/Rock downbeat	X/Y	Blumlein	ORTF	A/B
Jazz Rock upbeat	X/Y	Blumlein	ORTF	A/B
Funk downbeat	X/Y	Blumlein	ORTF	A/B
Funk upbeat	X/Y	Blumlein	ORTF	A/B
Jazz downbeat	X/Y	Blumlein	ORTF	A/B
Jazz upbeat	X/Y	Blumlein	ORTF	A/B

.....

LISTENING TEST PART ONE:

Listen to the examples for each musical genre and choose the example you consider best suited for the ideal sound of the genre.

Clarify your answer by selecting two well reproduced characteristics that motivates your answer.

.....

1. Stereo Width 2. Intensity 3. Sense of Direction 4. Air/Openness

5. Depth 6. Reverberation 7. Tonal Balance 8. Other

.....

	Example nr:	Two vital and well reproduced characteristics:
Jazz/Rock downbeat		
Jazz Rock upbeat		
Funk downbeat		
Funk upbeat		
Jazz downbeat		
Jazz upbeat		

.....

LISTENING TEST PART TWO:

Listen to stereo technique 1 - 4 and choose which of the musical genres Funk, Pop/Rock & Jazz you think each example is best suited for.
Clarify your answer by selecting two well reproduced characteristics that motivates your answer.

1. Stereo Width 2. Intensity 3. Sense of Direction 4. Air/Openness

5. Depth 6. Reverberation 7. Tonal balance 8. Other

	Circle your answer:			Two vital and well reproduced characteristics:
Stereo technique 1:	Funk	Pop/Rock	Jazz	
Stereo technique 2:	Funk	Pop/Rock	Jazz	
Stereo technique 3:	Funk	Pop/Rock	Jazz	
Stereo technique 4:	Funk	Pop/Rock	Jazz	

.....

LISTENING TEST PART 3:

Describe in your own words what sonic attributes you associate with the different genres
Example: "It´s important that the cymbals don´t sound too harsh, and the snare needs to have some punch to it"

Funk:

Pop/Rock

Jazz: