

UNIVERSITY OF TARTU VILJANDI CULTURE ACADEMY

Faculty Of Arts and Humanities

Sound and Visual Technology

Taras Shkoliarenko

ORCHESTRA RECORDING AND MIXING IN DOLBY ATMOS

Master's Project (30ECTS)

Supervisor(s): Christoph Schulz, MA

Viljandi 2024

Orchestra Recording and Mixing in Dolby Atmos

Abstract:

Dolby Atmos claims to be the new game-changing surround system, both being accessible and providing a completely new listening experience. This research aims to research and prove the uniqueness of the Dolby Atmos experience using the example of classical music. The research includes an analysis of the recording and Atmos mixing of a trio and a symphonic orchestra, as well as the audience's listening experience, in a comparison between stereo and spatial audio mixes. The research presented in this project can be used as a learning material, as a starting point for deepening into Dolby Atmos mixing.

Keywords: Classical music, spatial audio, Dolby Atmos.

Table of Contents

Introduction.....	4
1. Theory	5
1.1. History of Orchestra Recordings	5
1.2. History of surround sound systems.....	6
1.3. Investigation into the possibilities and challenges of recording and mixing orchestras in Dolby Atmos.....	7
1.4. Analyzing the impact of Dolby Atmos on the listener’s experience in orchestral music	8
2. Atmos mixing for the small ensemble	9
2.1 Production	9
2.1.1. Piano	9
2.1.2. Cello.....	10
2.1.3 Violin	11
2.1.4. Deca-tree	11
2.2. Post-production	12
3. Atmos mixing for symphonic orchestra.....	15
3.1. Production	15
3.2. Post-production	17
4. Comparison of the mixes	19
4.1. Personal opinion.....	19
4.2. Survey	19
Conclusion	22
Reference list	25
Appendix.....	28
I. Referenced Audio Material.....	28
II. License	28

Introduction

Orchestra recordings have undergone a drastic transformation throughout history. One of the modern fundamental changes is the invention of Dolby Atmos. This project explores the possibilities and challenges of recording and mixing orchestras in Dolby Atmos.

The theoretical part of this study relates to two key dimensions: the history of orchestra recordings and the evolution of surround sound systems. By exploring the origins of recording orchestral performances and the modern transition to immersive audio experiences, it becomes clearer what the starting point is in the practical part of the research. This background is essential for wise usage of Dolby Atmos possibilities, a technology that aims to revolutionize how we experience music.

This study deepens into the technical and artistic sides of using Dolby Atmos for recording and mixing orchestras. The recording process requires careful decisions about the proper hardware. The critical elements in this process are the choice of microphones and recording microphone technique, which plays a crucial role in capturing the details and dynamics of orchestral music and turning them into the immersive Dolby Atmos format.

Regarding post-production, there are two fundamental processes to consider: editing and mixing. Editing involves careful examination of every element of orchestral recordings to ensure they meet the most stringent quality standards for Dolby Atmos. The mixing phase entails crafting soundscapes considering the complexities of traditional stereo and the groundbreaking three-dimensional Dolby Atmos format. The ultimate goal is to create a genuinely immersive auditory journey.

A significant aspect of this project involves a comparative analysis between stereo and Dolby Atmos mixes. By comparing these formats, the main aim is to understand how Dolby Atmos transforms orchestral recordings, answering how spatial audio can make the listener feel more connected to the emotional richness of orchestral compositions.

In conclusion, this master's project answers the question: Is Dolby Atmos worth switching to globally? Are there any new sound systems ready to replace the good old stereo, and what are their advantages and disadvantages?

1. Theory

1.1. History of Orchestra Recordings

Although audiences have enjoyed classical music for centuries, recording and preserving these performances is a relatively new technology. The first known recording of classical music was made on a wax cylinder, capturing a performance of Handel's *Israel in Egypt*. In 1888, Emile Berliner developed the flat disc record, quickly replacing the wax cylinder as the standard recording format (Pike, 2023).

The early 20th century marked a significant period in recording large-scale orchestral works and classical music. The phonograph gained popularity in the 1910s and 1920s as a medium for popular and classical music recordings.

The recording of serious music became a growing phenomenon as the phonograph matured; the electrical recording process, from 1925 on, further improved the quality of recordings (Markus, 2023).

The evolution of orchestra recording techniques has also been a subject of interest. For example, the Decca Tree, a legendary recording technique, revolutionized orchestra recording with its warmth and spaciousness in stereo recordings.

The Decca Tree is an array of between three and five microphones that provides a well-balanced and mono-compatible stereo recording. It was devised and assembled for the first time in 1954 by Decca Recording Company's engineers Roy Wallace and Arthur Haddy. The first version of the Tree consisted of a suspended T-shaped steel array, bolting 3 Neumann M49 microphones to each end above the conductor's podium. Hence the phrase coined by Arthur when they place the array in position. (Hannah, 2021)

Technological advancements and recording equipment have changed the typical full orchestra recording setup over the past 60 years.

Furthermore, the significance of historical classical music recordings made before the stereo era of vinyl disc recording is evident in the reissuing of important historical recordings by major record labels and arts organizations ("Historical classical music recordings," 2022).

The 20th century saw continuous innovation in recording technology, leading to the diverse forms of media through which recorded orchestral music is experienced today, including audiophile digital formats, film, and video-game soundtracks (Paris, 2020).

In summary, the history of orchestra recordings in the classical music genre is a story of technological advancement, evolving recording techniques, and the preservation of significant historical performances, all of which have contributed to the rich tapestry of classical music recordings available today.

1.2. History of surround sound systems

Surround sound technology has a long history that dates back to the 1940s when Walt Disney's *Fantasia* utilized a prototype of surround sound called 'Fantasound.' The first documented use of surround sound was in 1940 for the Disney studio's animated film *Fantasia*. The initial multichannel audio application was called 'Fantasound,' comprising three audio channels and speakers. The sound was diffused throughout the cinema, controlled by an engineer using 54 loudspeakers (Tibbs, 2023)

The first genuinely successful surround sound format appeared in 1982 when Dolby Laboratories introduced Dolby Surround for home use. Dolby Surround could recreate the cinematic soundtracks of Dolby Stereo. The 5.1 surround sound version originated in 1987 at the famous French Cabaret Moulin Rouge. A French engineer, Dominique Bertrand, used a mixing board designed in cooperation with Solid State Logic, based on the 5000 series, including six channels (Surround Sound, 2024). Respectively: A left, B right, C center, D left rear, E right rear, F bass. The same engineer achieved a 3.1 system in 1974 for the International Summit of Francophone States in Dakar, Senegal.

Several surround formats are commonly used today, including 5.1, 7.1, and Dolby Atmos, the dominant immersive audio format in use.

Dolby Atmos technology enables the distribution of up to 128 audio tracks and relevant spatial audio description metadata, such as location or pan automation data, detailing the sound's movement, type, intensity, speed, and volume. This content is sent to theaters for playback through loudspeakers based on the specific capabilities of each venue. Each audio track can be assigned to a conventional audio channel or an audio "object." In theater settings, Dolby Atmos typically employs a 9.1 (commonly referred to as 7.1.2) channel-based configuration, reserving channels for ambiance stems or center dialogue and leaving 118 tracks for objects.

For home use in film, TV, and music, Dolby Atmos employs a technique known as "spatial coding" to condense the audio to a maximum of 16 concurrent "elements" or audio location clusters, adapting dynamically to the content. In Atmos games, the Intermediate Spatial Format (ISF) supports 32 active objects, with 20 additional dynamic objects possible for a 7.1.4 bed

configuration. Each object specifies its apparent source location in the theater using three-dimensional rectangular coordinates relative to the defined audio channel locations and theater boundaries.

Dolby Atmos home theaters can be constructed based on conventional 5.1 and 7.1 layouts. The nomenclature for Dolby Atmos setups includes an additional number at the end, indicating the number of overhead or Dolby Atmos-enabled speakers. For example, a 7.1.4 Dolby Atmos system follows a conventional 7.1 layout but includes four overhead or Dolby Atmos-enabled speakers. To experience the most authentic Atmos sound, you'll need a minimum 5.1.2 speaker setup (Jones, 2022), while the most professional configuration can reach up to 24.1.10.

1.3. Investigation into the possibilities and challenges of recording and mixing orchestras in Dolby Atmos

Recording an orchestra for a Dolby Atmos mix presents several challenges compared to a traditional stereo mix. First, Dolby Atmos mixes usually require a more significant number of audio channels than stereo mixes. That meant capturing and managing more microphones for individual instruments and orchestra sections. In Dolby Atmos, precise microphone positioning becomes even more critical to create a realistic three-dimensional audio experience. Engineers must carefully position microphones to capture the most information about each instrument and section, considering the sound field's height, width, and depth.

While stereo mixes rely mainly on panning and volume adjustments to create a sense of space, Dolby Atmos allows for more sophisticated spatialization techniques. Sound technicians can place individual tracks anywhere within a three-dimensional space, including above and below the listener. The mix requires careful attention to detail and may involve additional processing and mixing steps.

The spacing and acoustics are essential for both stereo and Dolby Atmos recording. However, with Dolby Atmos, the room characteristics are more important, as the mix has more space for spatial information of the recording environment, which can seriously influence the perception of depth and immersion in the final mix.

Dolby Atmos production requires a more complex workflow than stereo mixing. This includes additional processing and routing of audio channels and mastering techniques explicitly tailored for immersive audio. Finally, stereo mixes are widely compatible with various playback systems, but Dolby Atmos mixes require specialized playback equipment capable of playing immersive audio.

1.4. Analyzing the impact of Dolby Atmos on the listener's experience in orchestral music

Dolby Atmos significantly impacts the listener's experience of orchestral music, especially regarding sound quality, spatial awareness, instrument separation, and immersion.

First, Dolby Atmos Music creates a three-dimensional soundscape, expanding the soundscape to the sides and above the listener, making music more realistic. It allows artists and producers to create 3D soundscapes in an object-based mixing environment, giving songs space, clarity, and depth like never before (Dolby, 2019).

Moreover, it expands the traditional soundscape of a surround sound system by adding height channels, allowing the listener to visualize sound in a three-dimensional world. It will enable sounds to be placed in three-dimensional space, providing a more immersive and realistic listening experience (Alessi, 2023).

Listeners may appreciate the strong separation and ability to hear the distance between instruments, which is especially useful for orchestral music. Dolby Atmos allows instruments to be placed in three-dimensional space, improving the perception of distance and separation.

Dolby Atmos Music delivers an immersive experience that transports the listener into the concert hall. This provides an immersive experience for viewers, especially when combined with video, making the listener feel like they are in the center of the orchestra or the conductor's position with the orchestra around them (Lyngdorf, 2023).

To summarize, Dolby Atmos significantly improves the listener's experience of orchestral music by improving sound quality, spatial awareness, instrument separation, and immersion. It provides a more realistic and immersive listening experience, especially suitable for classical and orchestral music.

2. Atmos mixing for the small ensemble

2.1 Production

To get into the topic of Dolby Atmos mixing, it is logical to take classical music representatives with fewer instruments involved; this would make it easier for the tracks to define their location in space. As such a representative, I took a recording of Piano Trio no.2 in B minor, op.76 by Joaquin Turina, performed by Jāzeps Vītols Latvian Academy of Music students in Riga.

Dolby Atmos is quite demanding regarding the amount of audio information needed to record different microphone setups, which can be split into four groups.

2.1.1. Piano

Two stereo techniques were used for the piano recording: AB and MS (Figure 1).

The Spaced Pair (also known as AB) technique consists of two individual microphones, typically using cardioid or omnidirectional polar patterns, spaced apart to capture a wide stereo image of an instrument or ensemble. This technique is susceptible to phase issues due to the time differences of the audio arriving at each mic (Rode, 2018). Apart from that, it is the easiest technique to set up, and the balanced frequency response from an omnidirectional microphone will capture high-quality, balanced sound from bass to treble.

The only disadvantage is limited mono-compatibility, which isn't a big problem in the case of a small ensemble.

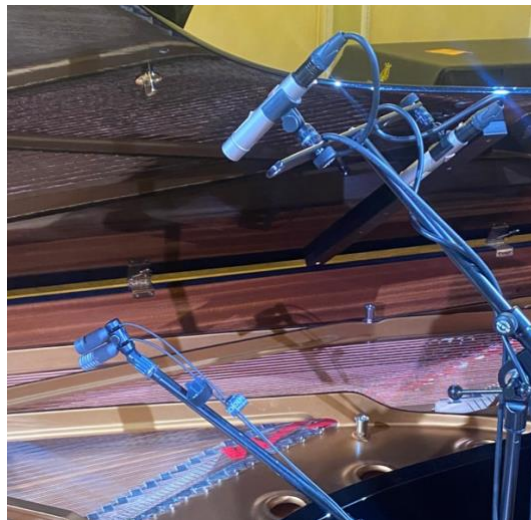


Figure 1. *AB and MS stereo techniques used for recording piano.*

Another stereo technique used is the Mid-Side (also known as MS). To achieve this technique, you will need a cardioid or omnidirectional microphone and a bi-directional (figure eight) microphone. The choice between cardioid and omnidirectional microphones for the mid-

channel is a decision made by the sound engineer according to their aims and microphone characteristics. The cardioid will pick up just the sound in front of it, while the omni includes more of the ambient sound. Apart from that, omnis represent the sound without any proximity effect.

The (in this setup used) cardioid microphone (Mid) faces the sound source on-axis, while the figure eight microphone (Side) faces the left and right and picks up off-axis sound. After the recording, the tracks need to be decoded; in Logic Pro X, the direction mixer in-built plugin can help. The main advantage of the MS in this recording is the reduced room ambient pickup. That means that the mid-microphone will capture mainly the direct sound from the piano, and the side (space) part can be adjusted according to the sound engineer's taste. As for the room, we have separate recording technology; it would be beneficial to use MS as a primary stereo technique.

2.1.2. Cello

For the cello recording, two microphones were used: one small diaphragm cardioid microphone 15 cm from the tailpiece and another large diaphragm cardioid microphone around 20 cm from the fingerboard (figure 2). The cello's body resonates most prominently in the tailpiece area, so the first placing enhances the full richness and depth of the sound and almost excludes the bowing sound. Conversely, the fingerboard area produces less resonance than the cello's body. Placing the microphone there can provide a cleaner and more focused audio capture. As the effect may seem almost the opposite, it'll be easy to get the desired sound in post-production by simply mixing the two recordings.



Figure 2 Microphones' placement used in cello recording

2.1.3 Violin

Two microphones were used for the violin recording.

First is a small diaphragm cardioid microphone placed in front of the violin player above the music sheet stand. This is a classical placing used in orchestral instrument recording.

Second is the M160 ribbon microphone placed above the head of the violin player (Figure 3).

The M 160 is the only double-ribbon microphone with a hypercardioid polar pattern on the market. “This polar pattern prioritizes sound coming from the front, while most signals from the sides and some from the back are reduced. A precise bass response, warm mids, and silkily elegant trebles merge to form a unique sound” (Beyerdynamic, n.d.).



Figure 3. *Microphones' placement used in cello recording*

Such a placing is, in a way, an experiment to imitate the violin and place it in Dolby Atmos mix in a way the violinist would have heard its playing, and such a microphone would add a bit of warmth to the violin sound, which can be added in post-production.

2.1.4. Deca-tree



Figure 4. *Decca tree array used in the trio recording*

As Dolby Atmos offers a 7.1.4 surround system, the recording room must be appropriately recorded to be recreated in the mixing process. For that purpose, the Decca tree microphone technique would work. In the current recording, Schoeps MK5 microphones in omni-position are used for left, right, and mid-Decca tree tracks, placed in a way that there is a 25cm distance from left to middle, middle to right, and 50cm from left to right microphone. Apart from 3 main microphones, two outriggers are added to the array. To recreate the width of the hall, two extension mics were set up as wide as possible (figure 4).

Table 1. *Trio recording input list*

Input	Instrument	Microphone
1	Decca Tree Left	Schoeps MK5 (omni)
2	Decca Tree Middle	
3	Decca Tree Right	
4	Outrigger Left	Sennheiser MKH 8040
5	Outrigger Right	
6	Extension Left	Neumann KM184
7	Extension Right	
8	Violin	Beyerdynamic M160
9		Sennheiser MKH 8040
10	Cello	Neumann TLM103
11		Sennheiser MKH 8040
12	Piano AB	Neumann KK131
13		
14	Piano MS	Schoeps MK5 (cardioid)
15		Schoeps MK8

2.2. Post-production

Before going to surround mixing, diving into the stereo version of trio mixing is essential. First, we need to pan right all the left and right channels, including the Decca tree (excluding the middle channel), outriggers, extensions, and AB stereo piano recording. The MS recording needs to be decoded by the direction mixer plugin placed in the MS summing track and switched into MS mode.

The primary tool and difficulty in classical music mixing is precise panning, which will recreate the positioning of the instruments in the final result. Combining each microphone track into an instrument track stack and placing stacks according to the players' placement during the recording is more convenient. The stacks must be in stereo pan mode, allowing for modifying both the stack and the channels inside it. For perfect panning, the Decca tree would come in handy, recreating the stereo image of the recording.

Apart from panning, it is essential to deep into the track's dynamics. The main rule while mixing classical music is keeping the balance between the instruments, giving more space to soloing ones. The outstanding option would be if the sound engineer also follows the music piece's scores.

The outriggers and extension microphones allow the recording venue to be recreated and the original reverberation to be reconstructed. But still beneficial could be an option to have a bit of hall reverb on separate channel sends to modify the spacing to achieve the best result.

As for the Dolby Atmos mix, first of all, if using Logic Pro X, it needs to be set up as a spatial audio project (File > Project Settings > Audio > Spatial Audio: Dolby Atmos).

Before deepening into the Atmos mixing section, it is essential to clarify its two main terms. In Atmos, we have two main ways to organize the tracks: as beds and as objects (Audient, n.d.). Both of them have different advantages and disadvantages. Beds are beneficial for summing tracks for instrument groups; they can trigger the LFE channel and are less resource-consuming. The bed is generally used for those parts of the mix that don't need to move around too much and don't require precise granular positioning within the surrounding field. However, like in stereo mixes, separate tracks that are part of a bed group use basic panning. Objects can be better placed in space, as they all are spaced separately; they enable a degree of left/right, front/back, and top/bottom separation between mix elements that stereo and channel-based surround formats can't match, making it possible to put your band or electronic arrangements in a compelling 3D space around the listener. However, it cannot trigger the LFE channel and doesn't work in groups, which requires exact placing in space and consumes a lot of computer resources.

For the trio instruments panning, I decided to use violin tracks, recorded by both Beyerdynamic and Sennheiser microphones, as separate objects, as there is no information below 120 Hz to trigger the LFE potentially. It is crucial to keep in mind the distance between the sound source and the microphones to exclude the possible phase issues. Still, with the recording of a non-stable instrument, such as a violin, it is pretty challenging to control that, as while moving, the violinist can subconsciously change the distance between the sound sources and the mics,

causing temporary phase issues. However, the experience showed that in Atmos, the amount of headroom that can be filled with sound is enough to exclude the potential phase problems, allowing the use of both mics in the mix. The tracks are placed in a way that imitates the position of microphones during the recording. The cello's frequency range is between 65,4 and 659.3 Hz, making implementing LFE into the mix essential (HyperPhysics, n.d.). Cello tracks are placed in a surrounding bed and right, according to where they were placed during the recording. However, the cello is lower in frequency, so its directionality will be less detectable. It is worthwhile to set it even more right to emphasize its placement and balance it with the left-placed violin.

Taking into account the fundamental frequencies for the piano from 27,5 Hz to 4186 Hz, it goes without saying that the piano stereo channel will benefit most from being presented as a bed, placed in the center front of the mix.

As for the Decca tree, extensions and outriggers are also placed as 3D objects. Each track should be placed close to the output of the 7.1 surround system: Decca tree left, center, and right to left front. Center and right front left and right extensions to left and right surround outputs, and left and right outriggers to left and right back surround outputs, respectively. As the Decca tree was elevated while recording, it is crucial to elevate the sound sources, too.

After placing the instruments in space, the dynamic levels must be adjusted according to the sound engineer's interpretation.

3. Atmos mixing for symphonic orchestra

3.1. Production

The extract from Anton Bruckner's Symphony No. 2, performed by the Münster Symphony orchestra, is taken for the symphonic orchestra example.

Anton Bruckner's Symphony No. 2 in C minor, also known as the "Symphony of Pauses," was completed in 1872. It was the fourth symphony composed by Bruckner, after the Symphony in F minor (1863), the Symphony No. 1 in C minor (1866), and the Symphony in D minor (1869) (Symphony No. 2, 2024).

A Decca tree array was used for the recording, elevating three microphones. The extension and the outrigger pairs are added to the recording process to give some wideness.

The orchestra is placed uniquely, and it is called The Furtwängler seating arrangement. Wilhelm Furtwängler was a German conductor and composer widely regarded as one of the greatest symphonic and operatic conductors of the 20th century (Wilhelm Furtwängler, 2024).

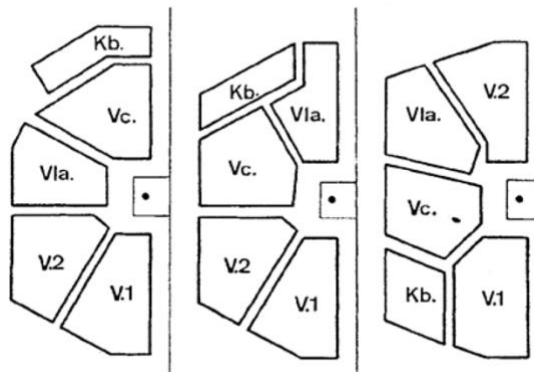


Figure 5. *Alternative orchestra arrangements. From left to right: American, Furtwängler's, German. V.1 = First violin, V.2 = Second violin, Vla. = Viola, Vc. = Cello, Kb. = Bass*

He used a variation of the "German" layout with violas in front of the second violins and cellos in the middle. The benefits of Furtwängler's arrangement of seats in the orchestra include improving the sound quality and balance of the orchestra. This arrangement, used by Wilhelm Furtwängler, involves placing the violas in front of the second violins and the cellos behind the violas (figure 5). In this way, the instruments are positioned to make a more apparent distinction in timbres among violin groups, with the 1st and 2nd violins facing each other. The arrangement aims to provide a more defined and balanced sound, especially in challenging compositions, where the distinct sounds of violin sections are crucial in interpretation.

Orchestra consisted of:

- Strings: 14 1st violins, 12 2nd violins, 10 altos, 8 cellos, 6 basses

- Woodwinds: 2 clarinets, 2 flutes, 2 bassoons, 2 oboes
- Brass: 5 French Horns, 3 trumpets, 3 trombones, 1 bass trombone
- Percussion: Tympany

For the spot miking, condenser microphones are mostly used in front of the players, near the music sheet stand (figure 6).

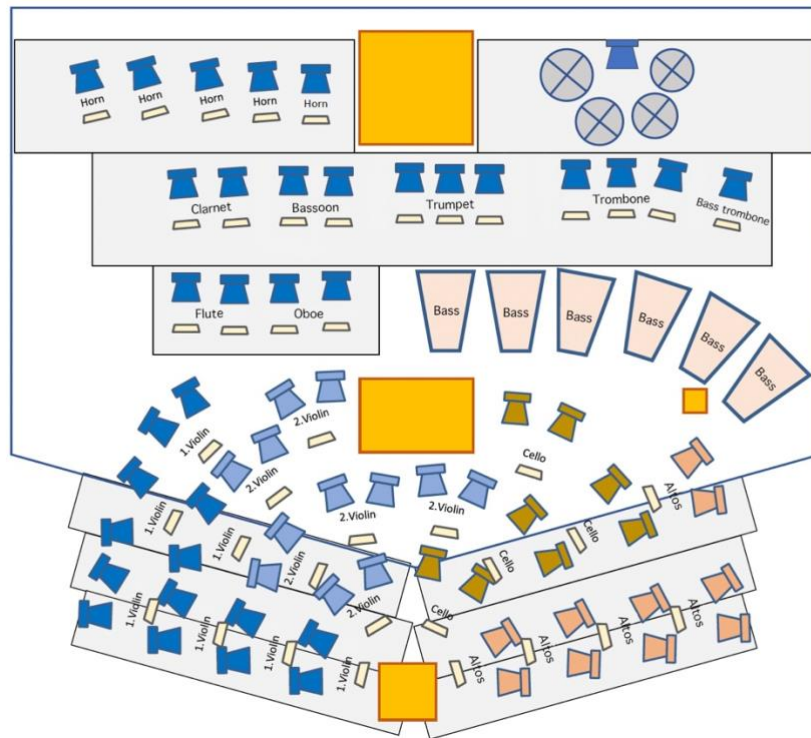


Figure 6. Instruments placement for the symphony recording

Table 2. Input list and microphone selection for the orchestra recording.

Input	Instrument	Microphone
1	Decca Tree Left	Neumann KM 183
2	Decca Tree Middle	
3	Decca Tree Right	
4	Outrigger Left	DPA 4041
5	Outrigger Right	
6	Extension Left	Neumann KM184
7	Extension Right	
8	Hall recording	Schoeps MK2S
9		

Input	Instrument	Microphone
10	1 st Violins	Neumann KM184
11	2 nd Violins	Neumann KM184
12	Altos	Neumann KM184
13	Cellos	Sennheiser MKH800
14	Bass	Schoeps MK2S
15	Clarnet	Neumann KM184
16	Flute	Neumann KM184
17	Bassoon	Sennheiser MKH40 P48
18	Oboe	Neumann KM184
19	Trombone	Neumann TLM 103
20	Bass Trombone	U87
21	Trumpet	TLM 103
22	French Horn 1	AKG C414
23	French Horn 2	AKG C414
24	Tympany	AKG C1000S

3.2. Post-production

Firstly, let us dive into the mixing process in stereo.

First, we pan maximum left and correct all the left and right channels, respectively, including the Decca tree (excluding the middle channel) and outriggers.

I usually put instrument sections in a track stack to mix the orchestra, so I get a stack for strings, woodwinds, brass, and percussion. For panning, I primarily switch stacks' panner into stereo pan mode and place it according to section placement during the recording. After that, the separate instrument tracks are adjusted within the stack to match their original recording placement. When the panning is set up, arranging the individual track's dynamics is essential, as mentioned in section 3.2. For the space design, the primary recreation of the recording venue is made by the room stereo pair placed in the back of the recording hall. But if the mix still lacks reverberation, the separate tracks sent to Logic's space designer plugin are also an option. For the Atmos mix, the project is first switched to spatial audio.

For the Decca tree, every track is switched into a 3D object. The left, middle, and right channels are put into the left front, center, and right front; left and right outriggers go to left and right surround outputs, respectively, and for the left and right rear sound, the room stereo track is

used. As all of the Decca tree microphones were elevated during the recording, their elevation is also recreated in object panning.

Each section has instruments that might trigger the LFE channel, so because of them, the beds are chosen for the instrument. For that, the stack input mode needs to be switched to surround. After that, the panning mode in instrument channels changes, which allows for precise panning and connecting the LFE for the channels, whose frequency response might go under 120 Hz.

While panning the instruments, it is essential to recreate the instrument positioning according to where they were placed during the recording. The orchestra was in the Furtwängler arrangement, so the instrument was placed according to that scheme.

After placing the instruments in space, the dynamic levels must be adjusted according to the sound engineer's interpretation.

One of the most crucial topics is correct exporting and sharing the Dolby Atmos mixes. To save the mix correctly, it needs to be exported as an ADM BWF file (File > Export > Project as ADM BWF...) (Apple, n.d.). The Audio Definition Model Broadcast Wave Format master file is required when you submit a Dolby Atmos mix to a mastering engineer or streaming services. ADM BWF files are also compatible with industry tools used to edit and master Dolby Atmos mixes for further distribution. An ADM BWF is a multichannel interleaved WAV file that you could play back like a standard wave file; however, you would only hear the first two tracks of the bed tracks. If you want to share the mix without a streaming platform, the Dolby Atmos Renderer application is needed. In Dolby Atmos Renderer, the ADM BWF file can be exported as IMF IAB (interoperable immersive audio format on which the broadcasting industry has agreed and standardized) or as an mp4 file (File > Export Audio > MP4...).

4. Comparison of the mixes

4.1. Personal opinion

One of the main project's objectives was to compare the stereo and Dolby Atmos mixes to understand if the new generation of surround sound gives the immersive feeling the engineers are discussing. For that, the stereo and two Atmos mixes (in fixed and head tracking spatial audio modes) for each track were listened to.

Here are the main points of personal listening experience:

- The sound in both Atmos modes feels more spacious. The sound sources feel less layered; the audio flow creates a feeling that there is a separate place for every single track. But the contrast should be considered. General impressions can be compared with visits to basic 2D and 3D cinemas, where the objects sense more volumetric, but the overall experience is not changed drastically.
- There is no significant difference between stereo and Atmos in a fixed mode. Even though the sound has some differences regarding the feeling of spaciousness, the contrast will likely be detected if the sound is switched back and forth on purpose.
- Head tracking mode is a very powerful tool that makes music more interactive. The experience creates the feeling that the listener is in a concert hall and the orchestra is performing live for them.
- While using the Apple AirPods Max headphones in head tracking mode, it was discovered that while walking after turning left or right, the system recalibrates after around 30 seconds according to your new direction. Most probably, the headphones analyze the position of the shoulders and set up the direction relative to them. This feature might spoil the immersiveness, especially if the listener tries to concentrate on the rear channels for some time.

4.2. Survey

To make the conclusions after the listening experience less personal and subjective, a survey was conducted among the students of Viljandi Culture Academy and Tallinn residents. It consisted of three main parts. Before deepening into listening comparison, firstly, it is good to know if there is any dependence on the availability of musical education and awareness of the Dolby Atmos system. In the second part, the respondent is offered to listen to three versions of the trio mixing: stereo mix, Atmos static mix, and Atmos mix with head tracking. After that,

the respondent is asked to fill in their impressions about the differences in mixes, whether there are any, and what kind of differences are.

The third part is similar to the second, but instead of a trio, it's proposed to listen and analyze the excerpt from the symphony mix.

The results show that most people are aware of Dolby Atmos if not completely, and at least have a clear understanding of what to expect from this sound format (figure 7).

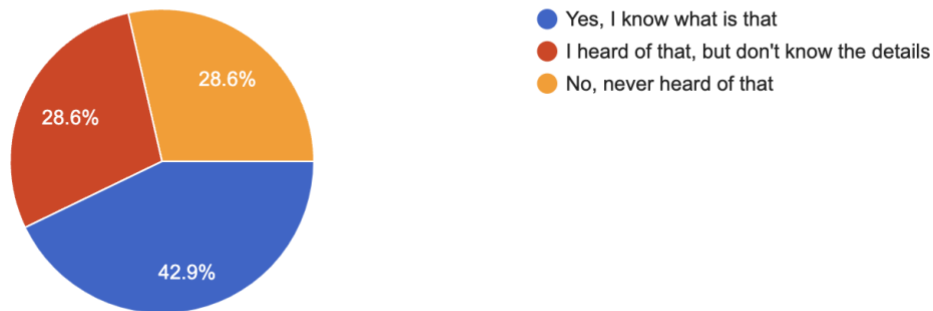


Figure 7 "Have you heard of Dolby Atmos before?"

Respondents are unanimous in that there is an improvement in their listening experience in Dolby Atmos for both the trio and symphony mixes. People admit that the difference began with the audible since the switch from stereo to Atmos mix was in fixed mode. Most of the respondents say that the sound turned "more spacious," "more clear," or admit that "there is more depth in music." However, most answers show that this improvement is not too significant (figure 8).

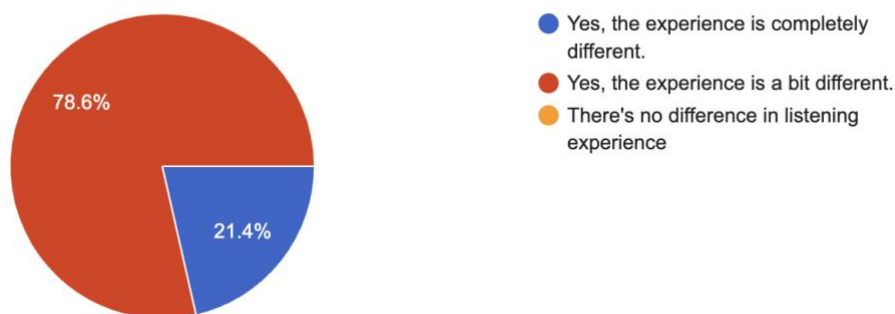


Figure 8 "Is there any difference between the mixes?"

Interesting results came with head tracking mode. For the orchestra recording, respondents confess that orchestra in head tracking brought them a completely new listening experience (figure 9); most people felt right "in the opera house or theatre," and it "got easier to detect

separate instruments.” However, most respondents say that all the artificial non-musical sounds (e.g., creaking chairs, pressing buttons) became much more detectable, making it vital for sound engineers to spend more time cleaning the recordings.

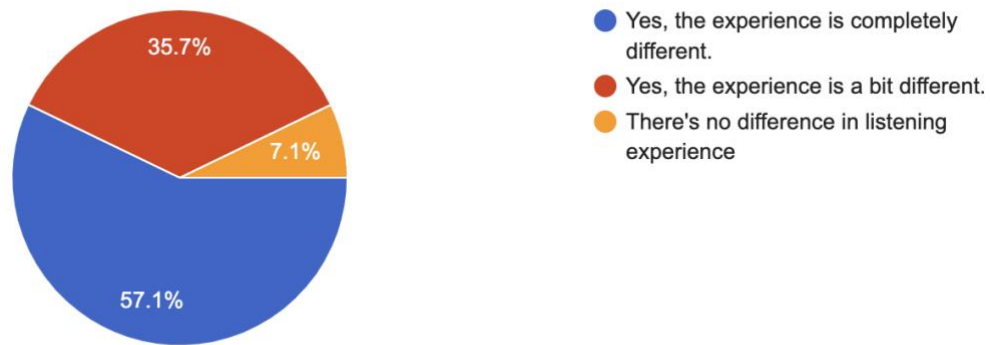


Figure 9 *"Is there any difference in sound between fixed Atmos mix and one with head tracking?"*

Conclusion

Dolby Atmos is an innovation that is a way to achieve the future of the music experience. By now, there are quite a lot of learning materials, and it is becoming prestigious and better paid. For instance, in Apple Music, music available in Spatial Audio — which supports Dolby Atmos — will receive a royalty rate up to 10% higher than content not available in the format, which showed to be an effective move. The number of songs available in the format has increased by nearly 5,000% since launch and has more than doubled over the last year alone (Eggertsen, 2024). However, as the study shows, the story behind the spatial audio might be overrated.

Here is the list of advantages and disadvantages.

Advantages:

1. A better listening experience. The survey and my experience show some improvements in recording sound, especially in head tracking mode. Interacting with different sound sources (instruments, voices, tracks) gives more space to use the system in cross-media art, giving artists, musicians, and sound engineers a new tool.
2. Quick and stable system development. Dolby Atmos is a music trend today. It is supported by such prominent companies as Apple to encourage sound engineers, technicians, manufacturers, and musicians to create, use, and develop the system, fixing problems, creating new formats and compatible gear, and introducing them to more music enjoyers.
3. System's accessibility for sound engineers. The post-production experience shows Dolby Atmos spatial audio is exceptionally user-friendly and intuitive. While working with that, mixing felt less technical and more like making art, imagining not the stereo output of the average listener's headphones but the actual musicians and how they could have interacted with the listener while assessing music.

Disadvantages:

1. User's accessibility. Spatial audio isn't a standard for all music streaming platforms. As of March 2024, the options are Apple Music, Tidal, and Amazon Music. Moreover, there aren't many listening gears to experience the Dolby Atmos. Usually, these are the home theatre audio systems, sound enthusiasts' improvised setups, and headphones.

Talking about the headphones, they aren't that much affordable, so every user gets to know spatial audio. Apart from that, some Atmos-compatible headphones get negative reviews regarding the "spatialness" of the music they hear. With that, I have to say that the Dolby Atmos sound experience is more of a privilege than an everyday thing impermissible for the system, which claims to become a new sound standard.

2. Rawness of the Dolby Atmos. Regardless of being hi-tech and trendy, the system has some shortcomings that must be solved. First, no unified Dolby Atmos format is available for everyone to listen to the best quality music. Even though streaming platforms require an ADM BWF master file, exporting as ADM BWF is inconvenient and won't be stereo-compatible. This format can be rendered into mp4 format, but it isn't lossless, and listening to video format feels more like a temporary solution than a severe approach. Although most Atmos-compatible headphones are Bluetooth-connected, playing lossless music via Bluetooth is impossible, so the unified export format issue needs to be solved as soon as possible.
3. Deficiencies of the modern spatial audio devices. Head tracking mode turned out to be a valuable tool with much potential in art installations and virtual reality. However, head tracking has technical limitations. I believe that obligatory automatic recalibration might be a temporary restriction for modern audio-tracking devices. Still, I think that it needs to be switchable in two modes: one with recalibrating, which will be helpful for average outside walking, where the direction shouldn't spoil the overall listening experience, and another, where the front of the listening room is fixed and unchanged, allowing the listener explore the space he is in, discovering all the fronts and the backs of the interactive venue. This mode would be helpful for art installations using spatial audio solutions.
4. The price of the music production process. Recording a classical trio for a stereo mix would require a maximum of 8 audio inputs. To get enough sound information for mixing in Dolby Atmos, up to 16 audio inputs are needed. With that, it becomes logical that the recording price, the required hardware, and weight would increase significantly (2 or 3 times). Even if for a full-size symphonic orchestra, there will be less of a problem to have it mixed into Atmos (as while recording symphonic orchestras, Decca tree technology is often used, as well as room recording channels), the appropriate monitoring system, which has to be certified by Dolby is still a big financial challenge even for famous professional sound engineers. All these points make many people ask

themselves if a slight improvement in using spatial audio is worth the price spent on production.

To conclude, Dolby Atmos is a sophisticated surround system that aims for spatial audio to become not a luxury but a common everyday thing, being introduced in cinema, personal music listening, and even in modern cars. The abovementioned work showed that classical orchestral music can. However, the rawness of the system and its price still cannot spread the system widely.

However, in any case, it has potential and needs time and effort to become an innovative instrument.

Reference list

- Alessi, M. S. (2023, September 6). Science, History, and Future of Spatiality in Music: Can It Sound More Immersive? Soundoflife.com.
<https://www.soundoflife.com/blogs/experiences/spatial-perception-music>
- Apple (n.d.). Export ADM BWF files in Logic Pro for Mac. Logic Pro User Guide for Mac. <https://support.apple.com/ru-ru/guide/logicpro/lgcp258ed132/mac#:~:text=The%20ADM%20BWF%20master%20file,Atmos%20mixes%20for%20further%20distribution.http://hyperphysics.phy-astr.gsu.edu/hbase/Music/orchins.html>
- Audient (n.d.). Objects and Beds Explained. Audient. Retrieved May 11, 2024, from <https://audient.com/tutorial/objects-and-beds-explained/#:~:text=With%20beds%20handling%20the%20more,on%20which%20they're%20reproduced.>
- Beyerdynamic (n.d.). Beyerdynamic M 160. Beyerdynamic.com.
<https://global.beyerdynamic.com/m-160>
- Dammerud, J. J. (2006). Stage acoustics. [Literature review, University of Bath].
https://www.researchgate.net/publication/267554113_Stage_acoustics_-_Literature_review
- Dolby (2019, May 23). Dolby Atmos Music – Experience Music Like Never Before. News.Dolby.com. <https://news.dolby.com/en-WW/173266-dolby-atmos-music-experience-music-like-never-before>
- Eggertsen, C. (2024, January 22). Apple Music to Pay Higher Royalties for Spatial Audio Tracks. Billboard.com. <https://www.billboard.com/business/streaming/apple-music-higher-royalties-spatial-audio-streams-1235586800/>
<https://www.digitaltrends.com/home-theater/what-is-dolby-atmos-music-and-how-to-get-it/#:~:text=Atmos%20Music%20sources,%2C%20Tidal%2C%20and%20Amazon%20Music.>
- Hannah (2021, August 9). The Decca Tree | The Secrets Behind the Legendary Recording Technique. Abbeyroadinstitute.co.uk.

<https://abbeyroadinstitute.co.uk/blog/the-decca-tree-the-secrets-behind-the-legendary-recording-technique/>

Historical classical music recordings. (2022, November 21). Wikipedia.

https://en.wikipedia.org/wiki/Historical_classical_music_recordings

HyperPhysics (n.d.). Playing Ranges of Instruments. <http://hyperphysics.phy-astr.gsu.edu/hbase/Music/orchins.html>

Jones, S. (2022, November 10). The Ultimate Guide to Dolby Atmos, Part 2: What Kind of System is Right for Me?. <https://www.polkaudio.com/>.

<https://www.polkaudio.com/en-us/polkllore/how-to/the-ultimate-guide-to-dolby-atmos-part-2.html>

Lyngdorf (2023, July 25). An introduction to Dolby Atmos Music.

[Lyngdorf.Steinwaylyngdorf.com](https://lyngdorf.steinwaylyngdorf.com).

<https://lyngdorf.steinwaylyngdorf.com/beginners-guide-what-is-dolby-atmos-music/>

Marcus, L. M. (2023). Birth of a mass medium. Britannica.com.

<https://www.britannica.com/topic/music-recording/Birth-of-a-mass-medium>

Paris, O. (2020, May). *Recording The Orchestra*. www.soundonsound.com.

<https://www.soundonsound.com/techniques/recording-orchestra>

Pike, L. (2023, April 28). *The first known recording of classical music made on wax cylinder - Handel's "Israel in Egypt."* 2MBS Fine Music Sydney.

<https://www.2mbsfinemusicsydney.com/the-first-known-recording-of-classical-music-made-on-wax-cylinder-handels-israel-in-egypt/#:~:text=The%20first%20known%20recording%20of%20classical%20music%20was%20made%20on,as%20the%20standard%20recording%20format.>

Rode (2018, March 27). Stereo Microphone Techniques. Rode.com.

[https://rode.com/en/about/news-info/stereo-microphone-techniques#:~:text=The%20Spaced%20Pair%20\(also%20known,of%20an%20instrument%20or%20ensemble.](https://rode.com/en/about/news-info/stereo-microphone-techniques#:~:text=The%20Spaced%20Pair%20(also%20known,of%20an%20instrument%20or%20ensemble.)

Surround Sound. (2024, April 29). In Wikipedia.

https://en.wikipedia.org/wiki/Surround_sound

Symphony No. 2 (Bruckner). (2024, May 9). In Wikipedia.

[https://en.wikipedia.org/wiki/Symphony_No._2_\(Bruckner\)](https://en.wikipedia.org/wiki/Symphony_No._2_(Bruckner))

Tibbs, R. (2023, January 9). 'Fantasia': the first film to use surround-sound.

Faroutmagazine.co.uk. <https://faroutmagazine.co.uk/fantasia-the-first-film-to-use-surround-sound/>

Wilhelm Furtwängler. (2024, April 5). In Wikipedia.

https://en.wikipedia.org/wiki/Wilhelm_Furtw%C3%A4ngler

Appendix

I. Referenced Audio Material

Trio and symphonic orchestra mixes (stereo and Dolby Atmos):

<https://drive.google.com/drive/folders/1CcRdre4U1w2fS8dHFqmG5bsdF1ko6cAP?usp=sharing>

II. License

Non-exclusive license to reproduce thesis and make thesis public

I, Taras Shkoliarenko,

1. herewith grant the University of Tartu a free permit (non-exclusive license) to reproduce, for the purpose of preservation, including for adding to the DSpace digital archives until the expiry of the term of copyright,

Orchestra recording and mixing in Dolby Atmos,
supervised by Christoph Schulz.

2. I grant the University of Tartu a permit to make the work specified in p. 1 available to the public via the web environment of the University of Tartu, including via the DSpace digital archives, under the Creative Commons license CC BY NC ND 3.0, which allows, by giving appropriate credit to the author, to reproduce, distribute the work and communicate it to the public, and prohibits the creation of derivative works and any commercial use of the work until the expiry of the term of copyright.

3. I am aware of the fact that the author retains the rights specified in p. 1 and 2.

4. I certify that granting the non-exclusive license does not infringe on other persons' intellectual property rights or rights arising from the personal data protection legislation.

Taras Shkoliarenko

15/05/2024