



How to Make a String Quartet Sound Bigger by Using Different Recording Techniques

Laitila Teppo

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ABSTRACT

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences
Degree Programme in Media and Arts
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How to Make a String Quartet Sound Bigger by Using Different Recording Techniques

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The goal of this Bachelor's thesis was to give an insight on the different recording techniques used by the industry professionals when recording a string quartet. In the core of the work there are two interviews from respected industry professionals and a recording session implementing the techniques that were discussed. The author was working as a recording engineer, assistant producer and mixing engineer during the recording session.

There is only a limited amount of research done on this specific topic. The purpose of this Bachelor's thesis was to give the knowledge and tools to anyone who is aiming to make their string quartet recording sound bigger and fuller.

The thesis begins with an introduction to the concept of the string quartet and its instruments. Then there are the insights from the industry professionals and the string quartet recording session. Rest of the thesis consist post-production techniques and discussion. The string quartet tracks from the session and other audio examples were included. The results indicated that it was possible to make a string quartet sound bigger. The main techniques that were used to achieve the bigger sound were overdubbing, layering and subtle post-production.

Key words: string quartet, recording techniques, mixing

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ABBREVIATIONS AND TERMS

| | |
|-------------|--|
| EQ | Equalizer, a tool for audio that is used to alter the volume of individual frequencies or frequency bands. |
| Overdubbing | Recording technique where a new separate recording is added in to a previously recorded session or track. |
| Layering | Recording technique where you combine multiple individual sounds or tracks to achieve bigger sound. |
| Sordino | A mute that dampens or alters the sound of an instrument. |
| Plugin | A add on or software extension that is used to enhance or alter audio in a digital work station. |
| CPU | Central processing unit. |
| Unison | Coincidence in pitch of sounds or notes. |
| Blumlein | Stereo recording technique developed by Alan Blumlein. |
| Omni | Omnidirectional microphone pickup pattern. |
| PZM | Pressure zone microphones that utilize boundary effect to produce sound. |

1 INTRODUCTION

This Bachelor's thesis will present different recording and post-production techniques that will make a string quartet sound bigger or fuller. These techniques are mainly aimed for non-classical situations but anyone recording string instruments can benefit from the information. The core of this thesis is two interviews from respected industry professionals Risto Hemmi and Timo "Tipi" Tuovinen. The techniques that these interviews brought out were then implemented in a string quartet recording session at Hollywood House Studios in March 2022. During the session string arrangements for three different songs were recorded.

The need to achieve a bigger sound from a small string section like a string quartet comes from the fact that it is really expensive to have a full string orchestra booked for a studio session. The modern-day budgets are limited and the pace of working is really fast. With the techniques presented in this thesis it is possible to achieve professional results with limited recourses.

This thesis is aimed for people who have some basic knowledge about audio recording and mixing. All of the audio recordings, the implementations done during the recording session and the mixing techniques should be treated as examples and not as absolute truths.

2 STRING QUARTET

The term “string quartet” can mean two different things. First of all, it is a group of four musicians consisting two violinists, one violist and one cellist. The term also refers to compositions that are made to this specific ensemble. The first well known compositions for this ensemble are from 1750’s and onward. The works of Joseph Haydn helped to establish the sound of the string quartet that was then adapted by all the major Classical era composers including Wolfgang Amadeus Mozart, Franz Schubert and Ludwig van Beethoven. (Stowell 2016.)

Many times, in non-classical music when strings are added to the arrangement a bigger sound is desired. Many recordings that have strings on them are actually recorded with string section or even a string orchestra consisting even up to 60 musicians. Especially in score music for movies composers like Hans Zimmer still uses large string orchestras to achieve this big “Hollywood sound” (Rojas 2021). This thesis tries to give answers to engineers who are after a bigger sound but only have a limited budget and don’t have access to a big string orchestra.

When doing a recording of a classical piece the stereo image should be as precise as possible. You should use techniques and microphones that give you a precise localisation of the individual players. When considering a non-classical situation there are no strict rules. (Carnes 2021.)

2.1 Violin

The violin's range is from G3 to A7, that equals to 196hz to 3520hz. The overtones and upper harmonics can even reach the limits of human hearing of 20khz. It is very important to keep these facts in mind when picking out a microphone while recording a violin. A bright condenser microphone with hyped frequency response can yield to a situation where the harmonics are over pronounced and the recording will sound too shrill and cold. Selecting a smooth sounding large diaphragm condenser microphone or a ribbon microphone can lead to a more pleasing and natural sounding representation of the violin. Keep in mind that you always have to think of the context that the violin will be in. (Robjohns 2006.) See Picture 1. for typical dispersion characteristics of string instruments.



PICTURE 1. Typical dispersion characteristics of string instruments. (Robjohns SOS 2006)

2.2 Viola

The viola's range is from C3 to E6, that equals to 130hz to 1318hz. It is tuned a fifth lower than the violin. Just like the violin the overtones and upper harmonics live in the high end of the human hearing range. The viola has a deeper sound than the violin and it has a somewhat nasal character. It fills out the frequency

range between the cello and the violins beautifully. The same principles mentioned above apply when choosing a microphone for viola. (Robjohns 2006.)

2.3 Cello

The cello's range is from C2 to C6, that equals to 65hz to 1046hz. The cello is usually in charge of the low end in these situations where there is no double bass. The character of the instrument is much deeper and fuller than a violin or a viola. Due to the lowest fundamentals resonating at 65hz the instrument can benefit from a microphone that has a good low-frequency response. (Robjohns 2006.) When setting the distance of the microphone from the cello, it is important to listen out for unwanted boominess and resonances from the body (Hemmi 2022). See Picture 2. for the musicians involved in the recording session.



PICTURE 2. The string quartet for the recording session. Helena Dummell, Susanna Syrjäläinen, Lotta Ahlbeck and Aino Rautakorpi. (Laitila 2022)

3 INTERVIEWS

The goal for these interviews was to get information about different recording techniques used by the industry professionals. The author was able to get two really respected and experienced professionals on these two interviews. The questions asked were narrowed down to help the author with the upcoming recording sessions and the persons interviewed were provided with some information about the studio and the music that the author was going to work with. See the full interviews in Appendix 1. Hemmi, R. Interview 2022 and Appendix 2. Tuovinen, T. Interview 2022.

Risto Hemmi (Picture 3) is a Finnish recording, mixing and mastering engineer. Hemmi has also worked as a producer and sound designer on multiple occasions. Hemmi has worked on over 500 albums and over 30 movies and has been one of the main forces behind Finnvox Studios since 1979. (Tiihonen 2016.) The author was really fortunate to be able to interview Hemmi at Finnvox Studios in March 2022.



PICTURE 3. Risto Hemmi at Finnvox Studios. (Mankkinen YLE 2015)

Timo "Tipi" Tuovinen (Picture 4) is a Finnish recording, mixing and mastering engineer. Tuovinen has worked professionally in the music industry since mid 70's.

Tuovinen has worked on multiple movies as score producer and recording engineer. (Tuovinen 2016.) The author interviewed Tuovinen in March 2022 at Tuovinen's personal studio in Vantaa.



PICTURE 4. Timo "Tipi" Tuovinen. (Salmi 2014)

3.1 Microphones and microphone techniques used for recording a string quartet in the context of non-classical music

The author asked both Hemmi and Tuovinen to describe the recording techniques that they have used and what type of microphones they prefer when recording a string quartet. Hemmi prefers to use a technique consisting 8 microphones placed accordingly: main pair in front of the players, close microphones for each instrument and a room pair (Hemmi 2022). Tuovinen uses a slightly different approach and prefers to use a main pair, blumlein pair, PZM pair on the floor and then a wide omni pair (Tuovinen 2022).

Microphones that Hemmi mentions are DPA 4006 omnidirectional microphones for the main pair and Neumann U87 and U89 as the close microphones (Hemmi

2022). Tuovinen doesn't specify any specific microphones except for the blumlein pair he prefers the Sandhill ribbon microphones (Tuovinen 2022).

3.2 Positioning the musicians

Both Hemmi and Tuovinen emphasize that the musicians should be placed in a half circle where the seating order is from left to right: first violin, second violin, viola and cello (Hemmi 2022; Tuovinen 2022). This enables the players to have a good eye contact and they are accustomed to perform in this arrangement. Hemmi also suggests that you should find the spot in the room where the quartet sounds the best. (Hemmi 2022.)

3.3 Room acoustics for the string quartet recording sessions

On this subject, the two interviewees had slightly different views. Hemmi emphasizes that the room should be lively enough that the instruments "come alive" and that it is easier for the musicians to perform in a not completely dead room (Hemmi 2022). Tuovinen suggests that the room should be controlled and the early reflections should be avoided as much as possible (Tuovinen 2022).

3.4 Using overdubbing and layering when recording strings

Both Hemmi and Tuovinen emphasize that when a bigger or fuller sound is desired from a small string section, overdubbing and layering is essential (Hemmi 2022; Tuovinen 2022). Both also agree that it is really important to alter the sound of the string quartet on each pass. The techniques used to alter the sound are applying sordinos and moving the musicians in to a mirrored position. (Hemmi 2022; Tuovinen 2022.) With multiple passes, you should also alter the balance of the microphones to create a different sound for each pass to avoid unwanted effects from layering (Tuovinen 2022).

3.5 Creating width and depth to string recording

Both Hemmi and Tuovinen suggest that you can use widening plugins to artificially widen the stereo image if the context allows it (Hemmi 2022; Tuovinen 2022). Hemmi also blends in the room microphones by just a tiny bit to introduce depth to the recording (Hemmi 2022). Tuovinen's microphone technique where he has a widely spaced omni pair also helps to make the stereo image wide (Tuovinen 2022).

3.6 Mixing the string recordings

Hemmi prefers not to use any EQ or compression if possible. Although some corrections can be done with EQ if there are problems in the recording. If the levels need to be controlled he will use faders to automate the levels to avoid adding compression. (Hemmi 2022.)

Tuovinen uses more processing but it can also be considered subtle. Tuovinen uses EQ to cut from 1.5khz with wide bell to control the upper middle range. This frequency range gives the listener hints about the size of the room and the amount of the players so it needs to be reduced. Compression is also added to bring out the sub harmonics for a fuller sound. Only gentle compression with 2:1 ratio and 2db to 4db of gain reduction should be used. He also emphasizes the use of saturation when mixing. (Tuovinen 2022.)

Both use reverberation technique where they work with two different reverbs. First reverb is a shorter and brighter and the second one longer and darker. Usually hall-type algorithms are preferred. (Hemmi 2022; Tuovinen 2022.)

3.7 Headphone mix for string players

Both Hemmi and Tuovinen point out that string players usually monitor with headphones only on one ear. This technique allows the other ear to hear the direct acoustic sound and it helps with intonation. Tuovinen suggest that the backing

tracks and the click track should be sent as a mono signal to further reduce the leakage from headphones. When working with Pro Tools, MPC click tone should be used because it is designed to be the least prone to leak to microphones. To minimise the risk of click track bleeding in to the microphones you can automate the level of the click track. (Hemmi 2022; Tuovinen 2022.)

3.8 String arrangements

Both agree that a good arrangement is essential in achieving a bigger and fuller sound. Tuovinen specifies that the arrangement should be made so that the instruments support each other rhythmically and harmonically. Unison and unison played in octaves sounds big and is effective in pop music as Tuovinen points out. (Hemmi 2022; Tuovinen 2022.)

3.9 What to consider when scheduling the recording day

Hemmi and Tuovinen both emphasize that having multiple breaks during the day is really important. The breaks especially help with intonation. Hemmi mentions the importance of the preparations: everything should be set up and tested before the musicians arrive. A good start for the day will yield in better results so it is important to make sure that the preparations are done with great care. (Hemmi 2022; Tuovinen 2022.)

4 THE STRING QUARTET RECORDING SESSION

The goal for the recording session was to try to implement the techniques that Tuovinen and Hemmi brought up and to learn from them. It was important to have a recording session that would benefit real artists and not to just have made up exercises for thesis work.

The recording session took place in March 2022. The preparations for the session started much earlier with conversations with the artists and producer. The author decided to use professional musicians for the string quartet to achieve highest quality possible. Lotta Ahlbeck who also played the violin in the session helped the author to assemble the musicians for the quartet. The quartet was Aino Rautakorpi on the first violin, Lotta Ahlbeck on the second violin, Helena Dummell on the viola and Susanna Syrjäläinen on the cello (Picture 2).

The preparations for the session day included assembling and testing the whole set up. The author also made sure that everything was ready for the musicians like the chairs, music stands and that the headphones worked. This was all done to get a good start for the day as Hemmi emphasized in the interview. A Pro Tools template was also made during the preparations including headphone mixes and backing tracks etc.

The session day started out with coffee and musicians warming up for the day. The atmosphere was relaxed and the day started out nicely all thanks to the preparations. We had a sound check where the gain of the preamplifiers was fine-tuned and the final adjustments for the microphone placements were done. The day went along well and we had time to take a lunch break and some shorter breaks. The day was intense but the time management and the schedule was successful.

4.1 Songs and Arrangements

For the songs and the arrangements, the author wanted to have music that would somehow benefit from not just having a string quartet but having a bigger sound from the strings. The first song is composed by Maiju Lehti and the arrangement is by Lotta Ahlbeck. The two other songs are by artist Emmy June and producer Aapo Kauppinen. The string arrangements were done by musician, educator and arranger Lauri Marjakangas.

4.1.1 Maiju Lehti - Intro

This song is an intro to an upcoming album. The production was not finished during the writing of this thesis so in the examples there will only be tracks from the string recording session. The song started with a demo from the artist Maiju Lehti and then it was finalised in collaboration with Lotta Ahlbeck. The arrangement which was done by Lotta Ahlbeck is mainly a straight forward string quartet piece. The arrangement still benefits from overdubbing and layering. The techniques used help to make this piece sounding bigger than just a four-piece string section. During the mixing process, the artist and producer will discuss how full or layered they want it to sound but for the purpose of this thesis all of the layering and overdubbing is used.

4.1.2 Emmy June – In the Park

This song will be released on Emmy June's album in 2022. The string arrangement was made by Lauri Marjakangas in collaboration with the producer Aapo Kauppinen. This song fitted perfectly for this thesis because it had space for bigger string sound. The arrangement was made so that the players had few different stems each so we had to take them on separate takes. This also helped to achieve bigger sound as discussed with Tuovinen and Hemmi. The song wasn't released during the thesis writing process so only the string quartet recording is heard in the audio examples.

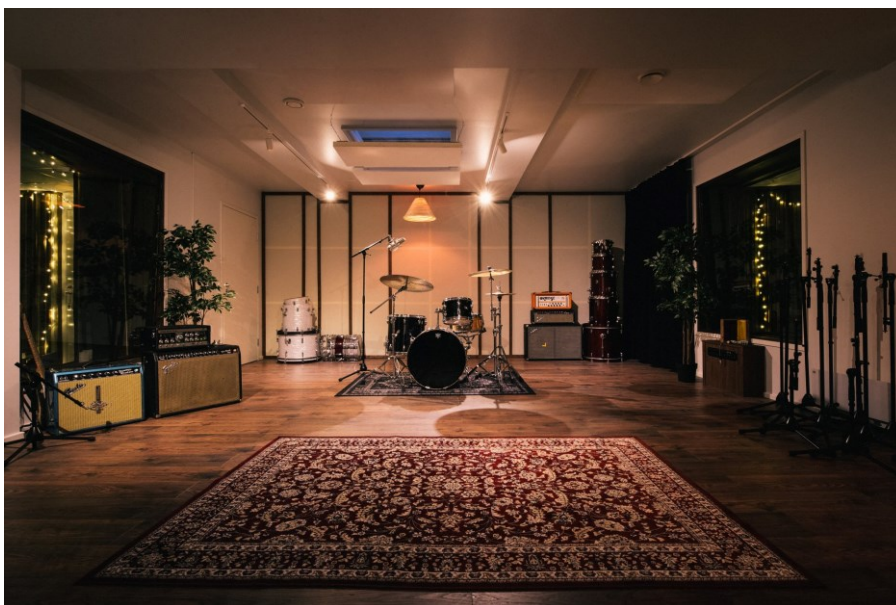
4.1.3 Emmy June – Every time I Want Back

This song will also be on the upcoming Emmy June album. The string arrangement was made by Lauri Marjakangas. The string arrangement has two main parts that were recorded on different passes. First there is the main string section part and then there is the rhythmic riff that copies the guitar part in the choruses. The song is a great example on how to benefit from these recording techniques in a band context. The song wasn't released during the thesis writing process so only the string quartet recording is heard in the audio examples.

4.2 Studio

The studio where the recording session took place is Hollywood House Studios located in Vallila, Helsinki. The studio is owned by producer, mixing and mastering engineer Matias Kiiveri. The main live room (Picture 5) is 60 square meters and it is rather lively sounding despite the low sealing. The acoustics were modified with curtains and applying two movable acoustic gobos on both sides of the quartet. The goal was to make the room have tight focused sound where the quartet was playing and have livelier sound behind the microphones as Tuovinen advised. Tuovinen specified that there should be as little of early reflections as possible. (Tuovinen 2022.)

The microphone preamplifiers used were Universal Audio Apollo for all of the microphones except the close microphones. The close microphones went in to a Soundcraft Series 1600 analog mixing console. The author chose to use Apollo preamps mainly because of the digitally controlled gain and low noise performance. In a situation like this where you have multiple stereo pairs it is just more convenient to have the gain matched digitally. The low noise performance is crucial when doing multiple passes. There was no equalization or compression applied when recording.



PICTURE 5. Hollywood House Studios live room. (Järvinen 2020)

4.3 Microphones and microphone techniques

The goal was to implement the microphone techniques that we discussed with Tuovinen and Hemmi. It was interesting to explore these two different approaches. Hemmi's technique is main pair, close microphones and room pair and Tuovinen's technique is main pair, blumlein pair, wide omni pair and floor pair (Hemmi 2022; Tuovinen 2022). In this section, there is information about the microphones and the placements used (Picture 6). The examples presented in this chapter are unprocessed so you can hear the effects of the placement and the microphone selections.



PICTURE 6. The microphone setup. (Laitila 2022)

4.3.1 Main pair

For the main pair the author used Schoeps MK2 small diaphragm condenser microphones. The microphone itself consist an amplifier frame CMC 6 and a MK 2 near-field omni capsule. Listen the Example 1 – Main Pair Schoeps Omni.

This main pair was placed in front of the musicians. The middle of the capsule was 133cm from the floor and they were angled at 45 degrees 18,5cm apart (capsule to capsule). The author started with these moved way wider but it didn't work and it didn't give good central image when paired with rest of the microphones. It

is notable that the 18,5cm that we ended up with is really close to ORTF technique where the capsules are 17cm apart. The height was set so that it was at head height of the players when they were in the seated position as advised by Tuovinen (Tuovinen 2022). The picture below (Picture 7) is from the setup phase so the microphones weren't perfectly aligned yet.



PICTURE 7. The main pair and the blumlein pair. (Laitila 2022)

4.3.2 Blumlein pair

As the blumlein pair (Picture 7) the author used RM BIV-1 ribbon microphones. These microphones aren't so common but they provide you with a familiar modern ribbon microphone characteristics similar to the Royer Labs r-121. This pair was placed in blumlein configuration behind the main pair at about third lower in height compared to the main pair as Tuovinen advised (Tuovinen 2022). Listen Example 2 - Blumlein Pair RM BIV-1.

4.3.3 Wide omni pair

This pair was Neumann U87 Ai large diaphragm condenser microphones set to omni pattern (Picture 8). These microphones were placed as a wide spaced pair. They were just over 260cm apart and at a height of 30cm from floor to the middle of the capsules. Listen Example 3 – Wide Omni Pari Neumann U87ai.



PICTURE 8. Shure SM57 on the floor and Neumann U87 Ai. (Laitila 2022)

4.3.4 Floor pair

The floor pair should have been a pair of AKG 414 microphones set to omni pattern but one of the microphones started to make unwanted noise during the set up and was sent to be serviced. We ended up using two Shure SM57 dynamic microphones with TritonAudio FetHeads. This pair was placed directly on the floor 106cm apart (Picture 8). Listen Example 4 – Floor Pair Shure SM57.

4.3.5 Close microphones

These microphones were four RM BIV-1 ribbon microphones. The author felt that the added separation gained from the figure 8 pattern and the warm ribbon characteristics would suit the desired sound the best. These were placed above the

violins and viola and in front of the cello at about 70cm from the top of the instruments as advised by Hemmi (Hemmi 2022). Listen Example 5 – Close Microphones RM BIV-1.

4.3.6 Room pair

The room pair was two Stam Audio SA-87 large diaphragm microphones set to omni pattern (Picture 9). The SA-87 is a clone of vintage Neumann U87 microphone so it gives you that classic condenser microphone sound. These microphones were placed 320cm apart at the height of 120cm. They were placed as far in the room as possible. Listen Example 6 – Room Pair Stam SA-87.



PICTURE 9. Stam Audio SA-87 at the opposite wall from the quartet. (Laitila 2022)

4.4 Overdubs and layering

Both Hemmi and Tuovinen suggested that overdubbing and layering the takes will lead to a bigger sound. It is important to alter the sound for every layer so that the final result will give you an impression of a bigger string section. (Hemmi 2022; Tuovinen 2022.) During the recording session, we ended up having three takes that were then layered. The takes were the main take, then a take where the musicians inserted sordinos and then a take where they would switch the seating arrangement to a mirrored position. Additional layers were added to highlight certain parts when needed. The examples presented in this chapter are unprocessed. These examples have the multiple microphone placements mixed in and balanced accordingly.

4.4.1 Main take

This is the most prominent layer in the mix. The mix of the microphones is heavily biased towards the main pair. The musicians are in their original seating order and no special techniques are applied. This is the most important layer and it should be musically (tuning, rhythm, expression etc.) be as good as possible. Listen Example 7 – Main Take.

4.4.2 Applying Sordinos

During this take the musicians apply sordinos to their instruments. The sordino alters the sound and dampens the upper harmonics. The author also found out that when layering this take with the main take it helps to favour the darker sounding microphones. Especially the blumlein pair helped to blend this take in to the mix. Listen Example – 8 Sordinos On and Sordinos Off.

4.4.3 Moving the players

The third layer was made so that the players switched positions in to a mirrored arrangement (Picture 10). From left to right: cello, viola, second violin and then the first violin. The individual close microphones were also moved to match these new positions. As Tuovinen advised the darker sounding microphones should be emphasised in these extra layers (Tuovinen 2022). Listen Example 9 – Mirrored Positions.



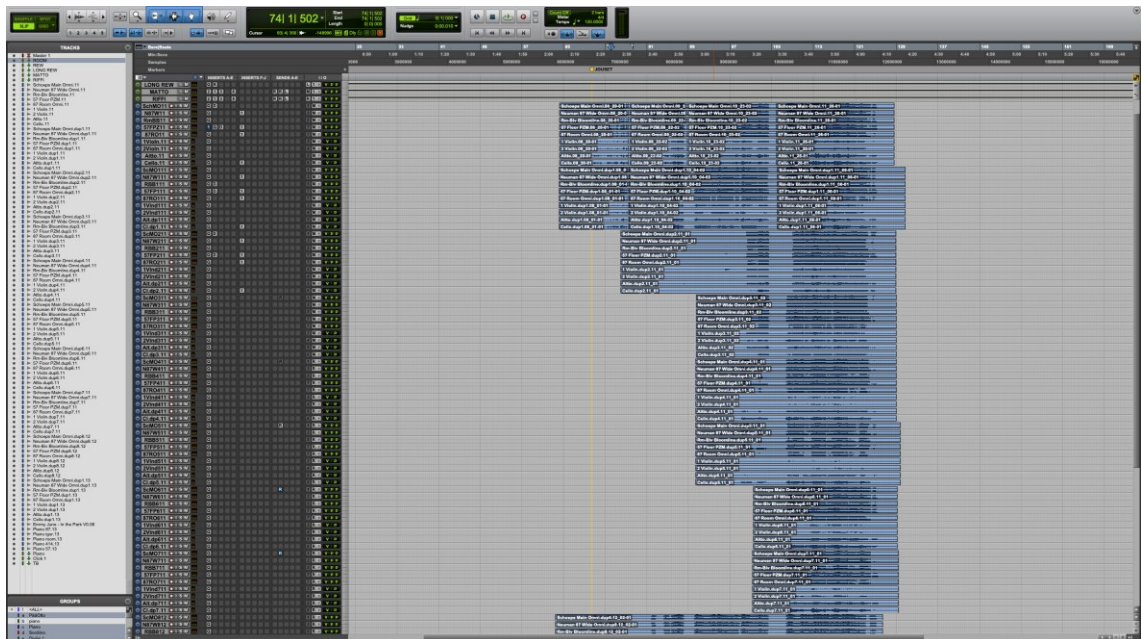
PICTURE 10. The quartet in a mirrored seating order. (Laitila 2022)

4.4.4 Additional layers

When we felt that some specific part from the arrangement would benefit from extra layering we would experiment with that after we had the three layers mentioned above. On some occasion, we doubled a melody line with the cello and on some parts, we recorded additional first violin parts to emphasize the melody. Only one or two musicians would play during these takes to avoid having too much of the full quartet sound. For these additional layers, you should be really careful that you don't have too much of the ambience from the room. Listening for the early reflections, as Tuovinen mentioned, is important when having this many layers. Adding too much layers will actually introduce unwanted artifacts and it doesn't make the end result any better after a certain point. (Hemmi 2022; Tuovinen 2022.) Listen Example 10 – Additional Layer.

5 POST-PRODUCTION

During the post-production phase the recording will be mixed in to its final form. There are various tools that you can use when working in the modern day digital audio workstation environment. It is important to not get too carried away with all of the different plug-ins and possibilities. As Hemmi mentioned, he usually prefers the sound of strings without any EQ. Tuovinen's mixing techniques can also be considered subtle and the sound mainly comes from balancing the different microphones used. Both professionals emphasised that when working with acoustic instruments it's important that the recording is done with great care. No amount of post-production will be able to save badly recorded material. (Hemmi 2022; Tuovinen 2022.)



PICTURE 11. Pro Tools session for In The Park string recording session with 105 tracks. (Laitila 2022)

5.1 Pro Tools sessions

It is important to have the audio tracks precisely named so that you can understand what you have recorded (Robjohns 2006). In this kind of a recording situation the number of audio tracks will be large due to the overdubbing and layering techniques (Picture 11). The author decided to record in 48khz/24bit format to keep the session file size manageable and to ensure that the CPU would handle high audio track counts with low latency.

It should be noted that the strings were recorded in a new separate Pro Tools sessions and not in the original sessions where the main tracks of the songs were recorded. The stems from the original sessions were used as backing tracks when recording. It proved out to be useful to have rhythmic parts (drums and percussion) and the harmony parts (piano, bass and guitars etc.) on separate stems when making the headphone mix for the musicians.

5.2 Mixing

In this chapter, there is an overview of the different techniques used to process the string recordings. These should be seen as examples of different possibilities and not as rules or absolute truths. The techniques used are mainly based on the methods that Hemmi and Tuovinen talked about during the interviews. Listen the demo versions of the string mixes Example 11, Example 12 and Example 13.

5.2.1 Balance

Hemmi emphasizes that it is important to spend time to get the balance right when starting out the mix (Hemmi 2022). When working on the balance, it is important to understand the goals of the arranger. The melody line should come out as the most prominent part. The second violin and the viola play a supportive role and the cello is the foundation of the sound. These all depend on the arrangement and when in doubt you should contact the arranger or the producer to make sure that you have a correct balance between the elements. Most of the sound in these mixes comes from the main pair microphones so the balance should be addressed while recording.

The balance between the main take and the additional layers is crucial. When we are after a bigger sound we need to introduce these in to the mix carefully. You should focus on listening for the early reflections and unwanted room sound when adding these in. (Tuovinen 2022.)

5.2.2 Saturation

Saturation is a subtle form of distortion. When applied carefully it makes the sound warmer and smooths out some of the transients. In the days of fully analog recording the saturation was always present due to the devices used when recording and mixing. Things like vacuum tube preamplifiers, mixing consoles and recording to tape all introduced this pleasant saturation. When working in digital audio workstation this saturation needs to be added in if a warmer saturated

sound is wanted. (Rogers 2021.) As Tuovinen suggested some saturation was added to these recordings during the mixing phase (Picture 12). The author used few different plugins that emulate these classic saturation characteristics. Tuovinen mentioned that it is better to have multiple plugins with subtle settings than to have just one doing all the saturation. (Tuovinen 2022.)



PICTURE 12. Saturation plugins that were used during the mixing phase. UAD Studer A800, Soundtoys Decapitator and Sonnox Oxford Inflater. (Laitila 2022)

5.2.3 Equalization

These audio tracks were only subtly equalized. The main thing was to get rid of the unnecessary low-end rumble with high-pass filters. Tuovinen's technique is to cut and control the upper middle range from 1.5kHz with wide bell (Picture 13). According to Tuovinen this helps to make the sound appear warmer and bigger. (Tuovinen 2022.) This technique sure helped to make the recording sound bigger when carefully implemented. On some tracks where there was too much of low midrange build up due to the size of the room or due to a microphone placement there was some subtle subtractive EQ to be done.

5.2.4 Compression

In its most basic form compression is used to reduce the dynamic range of an audio recording. It lowers the level of the loudest peaks and brings up the quiet parts (Senior 2009). In these songs, some subtle compression was applied. Tuovinen suggested to use a mastering or a buss style compressor with gentle settings (Tuovinen 2022). The author used few different compressors with subtle 2:1 ratio and only few dBs of gain reduction (Picture 13).



PICTURE 13. The EQ, compression and reverb plugins that were used. Fabfilter Pro-Q 3, Fabfilter Pro-R, UAD Manley Variable MU and Valhalla VintageVerb. (Laitila 2022)

5.2.5 Reverb

Both Hemmi and Tuovinen emphasised the importance of using correct reverberation techniques when bigger sound is wanted. Both suggested to use a hall type of algorithm as a starting point. The technique where you use two reverbs as discussed in the interviews works so that the first reverb is brighter and shorter and the second one is longer and darker. With this technique, the reverberation sounds somehow deeper and more natural. On these songs two reverbs were

used simultaneously with some of the 1.5kHz range reduced as Tuovinen advised (Picture 13). The pre-delay times were set with great care as Hemmi suggested. (Hemmi 2022; Tuovinen 2022.)

DISCUSSION

It was interesting to implement and test these techniques that were described during the interviews. It is difficult to say that which is preferred method, Hemmi's or Tuovinen's. When thinking about overdubbing and layering, Tuovinen's microphone techniques brought slightly better results because of the size of the studio that the recordings were done. If it would be possible to record in a larger room or at a studio like Finnvox and one wouldn't have to do so extensive overdubbing the Hemmi's microphone techniques could give fantastic results. All in all, both techniques are superb and excellent results can be achieved no matter which one is used. In the final results, techniques from both of the professionals were used.

This thesis should be seen as an exaggerated example on how to layer a string quartet. Maybe in a real-life situation, this many layers or extensive overdubbing in pop music context is not needed. If a bigger sound for like a movie or some other score is needed, these techniques will surely help when carefully applied. When a bigger sound is needed the best way is to have a bigger space to record in and to hire more musicians. The results were good, but the task is quite difficult as Tuovinen mentions in the interview. The most successful one was maybe In The Park which ended up sounding huge.

It was a real joy to record with such professional musicians, producers and arrangers. It is so inspiring when everyone is listening each other and new ideas or small changes can be applied right there on the spot. The author wants to thank everyone involved!

The authors personal goal for this thesis was to have a great learning experience about recording and mixing string instruments. That that goal was truly met. The author was really fortunate to be able to interview both Risto Hemmi and Timo "Tipi" Tuovinen and is sincerely thankful for their answers and insights on the topic.

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Tuovinen, T. Mixing, mastering and recording engineer. Interview 11.3.2022. Interviewer Laitila, T. Vantaa

APPENDICES

Appendix 1. Hemmi, R. Mixing, mastering and recording engineer. Interview 17.3.2022. Interviewer Laitila, T. Helsinki.

1. What microphones and microphone techniques do you use for recording string quartet in the context of non-classical music?

Well usually I use this technique where I have 8 microphones. I have main stereo pair which I place to the so called best spot. Usually I use omni pattern DPA 4006 microphones. Not too far apart from each other so that I can get a good centre image. I put them where I like they sound the best.

Everything starts with good placement of the players in the room. Let's think of the big studio B-room we have here (Finnvox Studio). There are many ways that you can place the quartet in that room. You have to find a spot where the players are comfortable and the sound is good in the room. I could say that the room is the most important thing if you want to achieve this magnificent big sound. You can't achieve this in a lousy room. The room doesn't have to be a concert hall but it has to have enough acoustic properties so that the instruments really ring out.

Well back to microphone techniques. I have the main pair which I already mentioned and then I have close mics. Most of the time I use Neumann microphones 87s and 89s. I have to say that in the final mix the balance between these is something like 75% main pair and 25% from these close mics. Addition to those I use a pair of mics that are placed far away. I use that pair to add just a touch of room to the sound.

So those are the microphones: the main pair in the sweet spot, close mics and room pair placed far away from the quartet. Sometimes when everything goes really well, the players play well and with great balance, you don't actually need the close microphones in the mix. But that goes totally case by case. Sometimes in the context of non-classical music and depending on the rest of the arrangement you may need the attack from the close mics.

With violin and viola, I position the close mics above the instrument. The height from the instrument should be something around 70cm to 80cm, not too close! I try to aim it from a slightly tilted position not straight from above. This is something that you have to listen carefully, if the placement is not sounding good you have to do something. With cello, I position the mic in front of the instrument. The distance should be again around 70cm to 80cm. If you go too close there are two things that emerge, first of all the sound will be too harsh and coarse and second thing is boominess and unwanted resonances from the body of the instrument. These things even out when the microphone is placed further away from the instrument and you will achieve beautiful sound.

2. How do you position the musicians?

I position them in a position where they are accustomed to play and perform. A string quartet is usually placed in a half circle where they have a good eye contact. Place them so that you have good balance and stereo image to main pair with some separation.

3. What to consider about the room or the studio?

The room should not be too dry, the players don't know how play in a dead room and the instruments don't come alive. The room itself should have a good sound, no boominess or uncontrolled resonances. Most of the small rooms have some unwanted resonances. In a big room, you should test where is the best spot for the quartet. When it sounds good in the room, it should sound good further down the line as well.

4. Do you use overdubs or layering when recording strings?

Well in non-classical and film score settings there are also situations where you specifically want a string quartet to sound like a string quartet. So that the recording only has four instruments and four musicians with no additional layers. But if you want the big Hollywood string sound you need to do lots of layering and overdubbing. There are some things to consider when overdubbing that will make

your recordings much better. Usually when you just do multiple passes of exactly the same thing it will not end up sounding good.

5. What to consider when overdubbing?

You should always alter something! If you want the big sound and you have only four players you need to alter something on each pass. Let's say that you have a really good take and you want to overdub that, put on the sordinos for the next pass. After that pass, you could make the players switch places, that will alter the stereo image. Maybe if possible you could put on varispeed, just so that it changes the pitch just a tiny amount. These things help because when layering with same exact instrument and player the resonances and timber of that specific instrument start to accumulate in an unpleasant way. If you don't change anything it will not sound bigger it will only start to sound phasy and clogged.

Think of a situation where you have 30 players playing together in a same room and it sounds amazing. Every player has their own specific instrument with their own natural resonances. No two instruments have exactly the same resonating frequencies. Every player has their own vibrato that is totally unique to every player. Players also have this thing that is called micro pitch, everyone is playing the same note but each player is just slightly playing the pitch differently. These are some of the things that make it sound big. You can achieve this with layering but it takes time and extra effort to get it right.

6. How to create width and depth to string recording?

Well depth usually comes from the room mics. When they are placed for example 6 meters away they are already "late" by 20ms. When you add those in to the mix you get this perspective you need.

It is also really important which reverb you use and how you use it. Most of the time we use plug-ins. It is really important to set the pre-delay correctly. When it is set correctly you first hear the dry signal and after that the reverb. Your brain needs to have some time to analyse the sound, we are talking about this window

of about 40ms. If the pre-delay is set too short it can make the depth of field scruffy and you lose the sense of depth.

With width, you need to think about the context. If it is only string quartet it should not be panned too wide, you still need to hear the directions clearly and have a realistic stereo image. If the strings are in let's say a band context you could use mid/side techniques to make them wider. If you want big sound and you have for example one main take and three overdubs you could use them like this: the main take is panned normally, first overdub you flip the panning, second overdub you pan it only to left and fourth only to right. That will sound really wide. You can use some of the overdubs as mono and pan those to the sides that way you don't have to process stereo image artificially with plugins. You must to constantly think about the context: are the strings alone in the mix or are they part of the band.

7. How do you mix strings?

The reverb is the most important thing! Usually I don't compress the strings, if you have to alter the dynamics I would follow with faders. Great players play with good dynamics so usually you don't have to compress.

The reverb should give you this mental image or transfer you to an imaginary space. Usually with strings I start with these concert hall type of reverbs and most of the time they work really well.

I prefer the sound of strings without EQ. For example, if the cello mic is placed too close you may have to cut out some of the boominess but that's all. Best sound is usually without EQ. Just spend time to get the overall balance right when starting out the mix.

8. What to consider when making headphone mix for the players?

One could say that there are differences between the generations of players. Older professional players usually don't like it when they hear the direct sound of strings from the headphones. They prefer to hear their instrument completely acoustic. Some of the younger players have gotten used to play with headphones

and they may want to hear the direct sound. With less experienced studio musicians it is common to start so that the one ear is exposed and the second one has the headphone.

You should make sure that they are feeling comfortable no matter which method they use.

9. What to consider when making string arrangement?

A good arrangement is made so that it fits well with the rest of the music. There could be a situation where one person makes the string arrangement and then another person makes the horn arrangement, this could lead to a catastrophe. When a professional writes the score, they can make everything work together. Let's say when the horns and strings play together, the chords are formed correctly. Good arrangement is essential!

10. What to consider when scheduling the recording day?

Well the start of the day is really important. Make sure that everything is prepared beforehand. Before the musicians arrive make sure your microphones are set up, music stands are ready to go and the headphones have good balance. You know, when they sit there, put the headphones on and play the first note they immediately feel like "Yeah, this sounds good!". If you have problems with the start like there is a microphone cutting out or one of the musicians doesn't hear the backing track that can really take the focus away. That bad start can echo through the day. Take the extra effort and make the morning start nicely, if the beginning goes easily usually the rest of the day will go well as well.

When you have recorded for some time make sure you stop and say, "Let's go grab some coffee!". That's because many people are having this thing where they think "let's play, let's play so we can get home early!" or something like that. Make sure you have those breaks during the day! That will help with focus and pitch. You should not have those extra-long days either. I can say with what I have seen it just doesn't get better when you have reached 10 hours. If you have a long day take a good longer break during the day.

Appendix 2. Tuovinen, T. Mixing, mastering and recording engineer. Interview 11.3.2022. Interviewer Laitila, T. Vantaa

1. What microphones and microphone techniques do you use for recording string quartet in the context of non-classical music?

It all really depends on the other stuff that is going on around the strings. If the song has a fast tempo and all this other rumble going on I would use cardioid microphones in basic ORTF as my main pair. If the song has space for strings I use this technique where I mix between Omni microphones and figure 8 ribbon microphones. I regularly use PZM microphones on string instruments. If you don't have PZM's put Omni figured microphones on the floor. Usually if the strings are sounding thin and weak your microphones are set too high in the room. Room acoustics are an equalizer! If you want a darker sound you must go near the floor. The higher you go in the room the more the upper middle frequencies are boosted. For example, if you put the mics up there like 2 to 3 meters it's like boosting 1khz by 6db and that could sound really unpleasant with strings. This also depends on the size is of the ensemble. When we are talking about string quartet I would not go above the heads of the musicians. In your situation, I would go with spaced omni pair placed in the front of the quartet. Place them as a spaced pair with the angle of 45degrees about 40cm apart. Behind this main pair put a ribbon pair in blumlein configuration. I regularly use Sandhill microphones for this but any figure 8 ribbon pair should do just fine. The blumlein setup needs to be lower than the main pair by about a third of the height. Then place PZM pair on the floor, this gives you more body to the sound. This should give you a good starting point. I would go with these microphones and blend them to taste when mixing.

Extra width can be achieved with extra omni pair that is placed really wide and close to the floor.

I wouldn't use close miking if you are after big sound. The separate close mics only give you more hints that there are only four players. I would only use them if there is a lead line that needs extra enhancement.

I must say that it is actually really difficult to make string quartet sound big. If you can pinpoint a single instrument from the mix it will make the recording sound small. Smallest line-up that you can really make sound huge is 3 first violins 3 second violins 2 violas 2 cellos and 1 double bass.

The most important thing when trying to make this small quartet sound big is the arrangement. The arrangement should not have many different rhythms split to separate instruments. When you hear a single instrument playing a different rhythm it pops out and makes the whole recording sound small. The movement in the arrangement should be rhythmically same with all the stems or there needs to be at least two instruments doubling the rhythm. This way the arrangement makes it sounds bigger.

2. How do you position the musicians?

When using over dubs I would place them in a classic configuration so that it's from left to right: first violin, second violin, viola then cello. After the first pass, I would flip the stereo image so that it's the mirror image of the first layer. When doing over dubs I would record the whole stereo image from left to right. If you record the left and right sides separately and then blend them it will start to sound small. I have found that it's best to have the first row as mentioned and then flip the second row, it will sound larger than having separate left and right over dubs.

3. What to consider about the room or the studio?

I would make the room quite controlled and dampened if possible. The thing is that you can make the recording sound big with plugin reverbs. If the reverb has too much of the first reflections from the room it will make the recording sound small. If we hear the first reflections our brains can detect that the room is small and the orchestra is small.

4. Do you use overdubs or layering when recording strings?

Yes! That is the only way how you can make small section sound bigger. If you have the microphone set up that we discussed earlier you can make the recording sound quite large.

The arrangement is really important. For example, it's better that the obligato lines are in octaves than that they are unison or thirds. The sound of single instrument playing a third or unison can give a way that there are only four musicians.

5. What to consider when overdubbing?

Usually I only do two passes. The third one should be with sample instruments. You could also add in a synth playing the alto and cello stems to make it bigger. If you want to record the third pass you should move the microphones really close and cut the 1.5k by a lot. You could try that out but I can't remember when I would have done the third pass. When you have too many layers they will only introduce more of the ugly early reflections of the room and they could even start to give you this phaser effect.

I have used this technique where I make the third row out of sampled instruments. It requires that the track is played with click track. These sample instruments need to be "bad" sounding: dark sound, no attacks. It needs to be mixed in so that you almost can't hear it, only when you take it off you notice that the orchestra gets smaller. Maybe have the viola and cello more prominent in the mix than the violins. This dark sounding third row is also a really good source for reverbs.

You can have different balances between the microphones with different passes. The first take I would go mainly with the main pair and small amount of the other mics but after that pass go darker with the mix. The ribbons and PZMs give you this darker sound.

Using sordinos when over dubbing is also a good trick. It will give you a darker sound and that blends in nicely with the rest of the passes.

You should tell the musicians to aim for a darker, more quieter sound when recording. Play near the finger board. Usually the players are used to play with a louder more piercing sound that cuts through. You want to achieve a smoother sound with less attacks. The problem is that when the volume rises it is actually the attacks that get louder not the root tone. The perfect situation would be that the root note rings out louder than the attacks, it will sound smoother and bigger.

6. How to create width and depth to string recording?

These microphone techniques will give you the depth and the width. If you need additional width you could introduce just a little bit of extra width with a widening plugin, but be careful with these.

7. How do you mix strings?

The first thing is to introduce some fine saturation. If the strings are sounding ice picky then you need more saturation. Use multiple subtle saturators rather than just one doing all the heavy lifting. After that you should check the range of 1.5k to 2k. That area makes it sound thin if there is too much of that. Compression is needed with strings because that's how you get the lower harmonics to ring out. The compressor should be subtle like something that you would use for mastering or for vocals. The ratio should only be around 2:1 and with gain reduction from 2 to 4 decibels. If you need more compression use two compressors. Place the first compressor before the eq and second one after the eq. The first one with slow attack and fast release and the second one with fast attack and slow release. Both should be having gain reduction of 2 to 3 decibels. This compression gives you the lower harmonics that you need to make the strings sound bigger. If the attacks are more prominent than the lower harmonics you can never make it sound big.

I would use two reverbs one shorter brighter hall reverb and one longer and darker. From the sends to these reverbs I would cut 1.5k by a lot. The upper middle reveals the size of the room or the orchestra.

8. What to consider when making headphone mix for the players?

When using click you need to use the MPC (Motion Picture Click) click from Pro Tools. Send this in mono to only one side of the headphones. When monitoring the headphones should be placed so that the left ear is open and hears the acoustic sound and the right ear gets the playback and the click. MPC click is developed so that it doesn't leak from the headphones when recording strings. It used to be this box that was made by UREI and it has then been sampled and used widely since then. You should automate the click track so that when there are quiet parts the click is quieter and when there is lot going on the click is louder. The click track should be muted on the first beat of the last bar. After that the musician who plays the leading role, usually the first violin, shows the ending.

If you use sampled instruments you should record them beforehand. The players can react to sampled instruments but the samples cannot react to real players. It is possible to play the samples afterwards but the editing will be a pain.

I prefer to use open headphones. In my experience if the players have both ears covered with headphones it leads them to play out of tune, usually flat.

The intonation between the players is really important, that is also a big part that makes a recording sound big. When the chords ring out in tune you get all the lovely upper harmonics.

I wouldn't give them their direct sound to the headphones, that can make it harder to keep good intonation. The tuning should be obtained from the acoustic sound from the instrument not from the headphones.

9. What to consider when making string arrangement?

You should have at least two instruments playing the same rhythm. When every player has a separate rhythm and a separate line it will make the arrangement sound smaller. Usually it is the higher parts that give away the size of the orchestra, like there is a single violin playing the melody part. When listening these big pop strings, you usually see that they are playing in unison. Unison played in octaves sounds really big. It is also a good measure to make separate stems to separate takes. When the players are playing a different stem than on the first

pass the first reflections and the room acoustics will not accumulate in the same spots of the spectrum.

It is important that the players have correct bowings. If the players are playing with different bowings it will make a single instrument stand out and then you lose the illusion of a bigger orchestra.

10. What to consider when scheduling the recording day?

It is really important to have breaks! The intonation will suffer after an hour, no matter if they are professionals. The only way to keep the intonation great is to have breaks. You know, take a shorter break every hour or so and then a longer lunch break. The players may fight you and just want to keep playing but you must make sure that you make them have breaks. Staying calm and keeping the mood relaxed always helps.

Appendix 3. Audio examples and the songs

Recordings from the string quartet recording session:

Example 1 - Main Pair Schoeps Omni

Example 2 - Blumlein Pair RM BIV-1

Example 3 - Wide Omni Pair Neumann U87ai

Example 4 - Floor Pair Shure SM57

Example 5 - Close Microphones RM BIV-1

Example 6 - Room Pair Stam SA-87

Example 7 - Main Take

Example 8 - Sordinos On and Sordinos Off

Example 9 - Mirrored Positions

Example 10 - Additional Layer

Example 11 - Maiju Lehti Intro Strings Demo

Example 12 - In The Park Strings Demo

Example 13 - Every Time I Want Back Strings Demo

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