ECHO Project

PentaSphere Array

Anthony Caruso & Kellogg Boynton

Principal & Senior Music Engineers, Sony PlayStation Studios

Introduction

This document will cover our approach to designing this array for the ECHO Project, our thoughts when evaluating the results and how they influenced the mixes, and finally aspects that we believe worked and others that could be improved upon.

The ECHO Project has been an honor the be a part of, and the influence of the other focus group members are already being seen in current projects we have been recording and mixing. We hope you have as much fun reading about it and exploring the recordings as we had making them.

A Bit of Backstory

When we recorded the score for Spider Man 2 at AIR Studios with Nick Wollage in 2022-2023, we knew that this game would be the first release that took advantage of the PS5's upcoming 7.1.4 output via Atmos bitstream. We asked Nick if he had any ideas for an immersive array he'd like to try, and he came up with a 5.0.4 setup for the string & brass sessions. Dr. Katia Sochaczewska was there as well, decoding the array to binaural while we recorded. We kept in touch and shared feedback about our experiments in mixing, editing and implementing the score. It was a great experience that set us down the path of incorporating new immersive approaches to that score, and eventually led to our participation in the ECHO Project.

Game Score Considerations

We approached the ECHO Project as if it were a recording for one of our PlayStation games, with the added opportunity to try some new things. There are some common factors that drive how we typically record and mix for the game scores. While we didn't necessarily adhere to these for the project, we wanted to try an array that would be compatible with these ideas and keep them in mind while working on mixes.

- Every sound in a game is deliberate and an essential method of guiding the player and conveying important information (look at this object, there's an attack from behind, walk in this direction), so the line between diagetic

music/sound and underscore that exists outside of the game environment is important to maintain. The imaging and placement of music in the soundfield or environment of the game shouldn't be distracting or send information to a player that is in conflict with the game audio functionality.

- A game score is usually part of a produced entertainment experience, and does not need to be completely realistic or a documentary of the time & space of recording. The use of spot mics and DI's, samples, and aggressive processing to make orchestral and other musical elements larger than life are typical.
- Center channel is for dialogue, and LFE is for SFX, so we do not mix into those channels. Our array would be able to function with a phantom center, and feel full enough without use of an LFE channel.
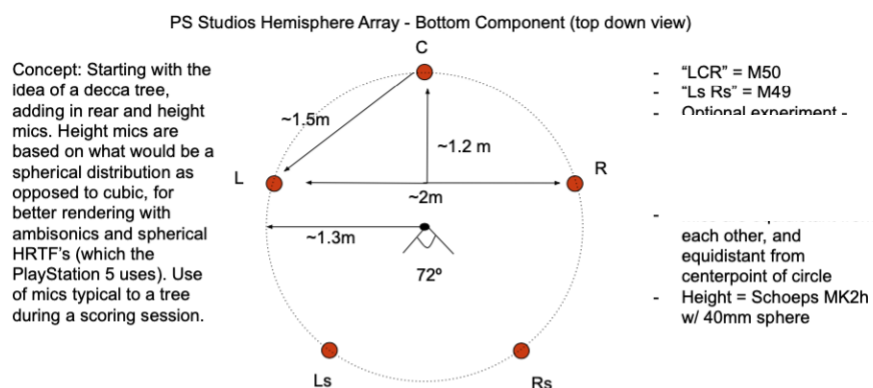
Concepts Behind the PentaSphere

We find that the use of a typical Decca Tree comprised of Neumann M50's just sounds like a score. For many of our instrumental recordings, including orchestra, we anchor the sound on this setup, so we wanted to continue to base the PentaSphere around the M50's. We have experimented on many sessions with arrays using small diaphragm condensers like DPA and Schoeps, but still find the M50's, particularly in a room like AIR's Hall, will bring something special to the sound.

We recorded the ECHO ensemble in both traditional and circular seating layouts, and we aimed to use a single mic array that worked for both. The traditional setup was straightforward—M50's as LCR would provide reliable results. The circular layout, however, posed a challenge. As mentioned above, during gameplay accurate sound direction and imaging are key for player feedback, and music shouldn't conflict with that. Additionally, we need granular control of elements within a composition to create interactive systems. Because of this, we rarely record full orchestras together; instead, we capture isolated elements and parts—strings, brass, choir, etc—that can be reused and recombined. This creates situations where, for example, we might use only the strings in an edit. But in the circular layout, they would be positioned behind the player, which may not work well for gameplay or a cinematic, and might better be panned to the front.
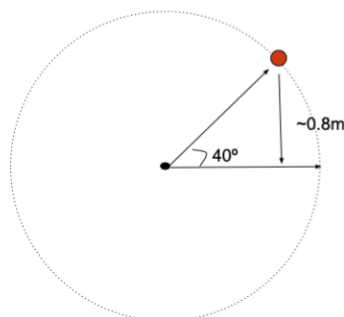
The result was an idea to place five evenly-spaced mics in a ring for the main layer of the array. This circle of mics could capture a 5-channel surround image, and also be rotated so that any orientation could become the front LCR. This meant bringing the L & R of the typical Decca Tree in and forward a little bit, and angled slightly differently, in order to create the symmetrical pentagon shape.

In choosing the rear mics for this array, we went with M49's for two reasons. While quite a different mic, it is usually impractical to get five M50's. We wanted to see if the use of Neumann tube mics would work as rear channels, and also match enough as we rotated the array. The second reason was we wanted to change the polar pattern for each seating layout. In the traditional layout, we would use cardioid to decorrelate the rears from the LCR, and in the circular layout we would use omni to try and match the response to the M50's as much as possible. The M49's polar pattern controls on the power supply made this easy to do.
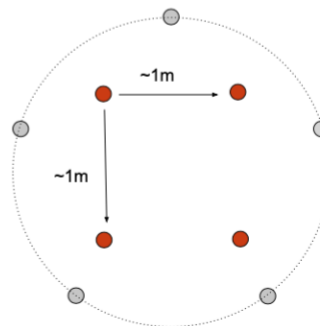
For the height component, we went with Schoeps MK2H, but with a placement that more closely matches the surface of a sphere rather than a cubical setup. The spacing of the height mics follow the curve of a sphere if the equator was the bottom part of the array. When the PS5's 3D Audio engine is rendering to binaural, the HRTF's are based on a spherical capture and render. While we do not often render the underscore to binaural (again to keep the music outside of the game environment unless appropriate), we had experimented with this placement of height mics when rendering to binaural with some success in the past, so we decided to try it in this context.

PS Studios Hemisphere Array - Bottom Component (top down view)

Concept: Starting with the idea of a decca tree, adding in rear and height mics. Height mics are based on what would be a spherical distribution as opposed to cubic, for better rendering with ambisonics and spherical HRTF's (which the PlayStation 5 uses). Use of mics typical to a tree during a scoring session.

- "LCR" = M50
- "Ls Rs" = M49
- Optional experiment -

- each other, and equidistant from centerpoint of circle
- Height = Schoeps MK2h w/ 40mm sphere

Height Component (side view)

Height Component (top view)

Array-Only Mixes

The Array-Only mixes consist of only our array, and no spot mics. We started by taking a good listen to the recordings and getting a balance together. Using Pro Tools, we clip gained all of the PentaSphere mics by +10.4 dB, which got us closer to a level that seemed good at reference in our mixing pods, which are under 1500 cubic feet so calibrated to 76dB SPL per ATSC A85. This brought our static array at unity loud enough to feel good but didn't require any limiting or other peak controls. It measured in the neighborhood of -17 LUFS at that point, an arbitrary number but maybe of interest.

In evaluating the image of the recording, particularly in the circular arrangement, we found that the rears could stand a boost, +1.5 dB. The top mics could stand to be attenuated -7.5 dB for the main pass of orchestra, and -12 dB for the prepared piano reamp and percussion overdubs. We also reduced the center channel by -1.5 dB in order to bring a feeling of width to the front. These changes made for an image that felt good on speakers, and when being monitored binaurally using APL Virtuoso.
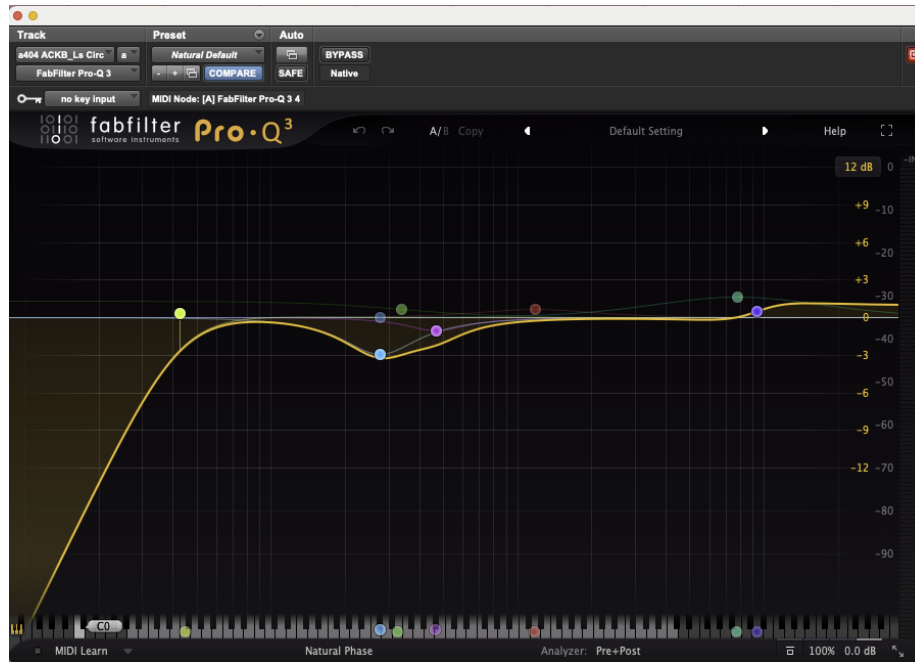
Pass D, the prepared piano reamp, was down -3.5 dB relative to Pass A, and passes B and C, the percussion overdubs for the circular layout, were down -1.5 dB relative to Pass A.

We used some EQ to reduce mud in the raw recording, and open the top end just a little bit. We used FabFilter Pro Q3, as this is our go-to corrective and filtering EQ.

LCR

Ls Rs

Height

Presentation Mixes - Setup

For the presentation mixes, we took an approach similar to our usual sound, which tends to bring a close front plane to our mixes and some work on the tonal curve that brings things a little closer to a pop mix than an orchestral one. We used additional reverbs to enhance the already great sounding Hall at AIR and strengthen the immersive feel. Lots of automation to bring the interesting bits to attention.

We began with the EQ's and balances from the array-only mixes, and added in some auxes and bussing so that we could process the 7.1.2 Bed and Height objects before they went to the Atmos Renderer built into Pro Tools. We tend to push with "color" EQ's like the Manley Massive Passive and MAAG EQ4 to enhance top and bottom, and focus on midrange boosts that bring out the parts that make sense for the piece at hand.

## Bed Overall EQ

Height Overall EQ

We add in bussing and VCA's to easily process and control parts of each pass of the recording. For these mixes, VCA's to help balance spots vs. room/height mics, plus Auxes for processing Room, Height and Spot mics. Each pass – A, B, C and D – had its own set of these controls (with less processing on the B, C & D passes). Pass A Bus processing had some EQ and Black Box, leaning toward even-order triode harmonics to add smooth enhancement but without adding too much gritty distortion, mix set to 51%.

Pass A VCA's & Bussing

Room Bus
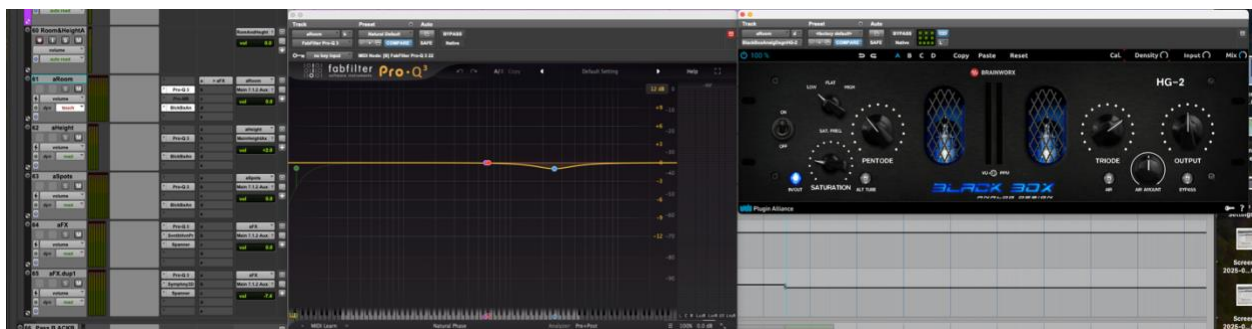
Height Bus

Spot Bus

We added several reverbs to Pass A. The main one on Pass A was a 7.1.4 Seventh Heaven set to Mechanics Hall, favoring tail over reflections. Crossfeed was reduced to separate channels more. An additional Symphony 3D was added with no early reflections, a long wide tail and was brought down by -4dB. The Spanners after the verbs reduced the center channel by -1.5 dB and -3 dB respectively, to enhance the feeling of width. Some low end was filtered.

Pass A also had some low end enhancement moves. One, a send from the Bass spot mic, went to a Pro Subharmonic and ProQ 3 filter. One, from the right Woodwind mic (which had most of the low winds), also with a Pro Subharmonic and Pro Q3 filter. These were panned center. The recorded LFE track had processing to level and add weight. Finally, the low mics actually came in quite handy not necessarily as a low end signal, but a thick, weighty quad image enhancer, and was Decapitated for good measure!

Bass & Woodwind Subharmonic (same settings for each, but on their own Auxes)

LFE Track

Low Mics

Mixing – Automation & Specific Sounds

Once we had some of these basic sounds set up, it was time to automate and work on some sounds within the spot and solo mics. Volker's pieces have so many good moments and trade-offs between the instruments as the compositions progress, and our array did an OK job with picking up these balances naturally, but needed some work for balance. Our style will push some of these elements and lines to make sure they're the center of attention, in the case of the circular setup even if those pieces were behind the listener.

We relied quite heavily on the string solo mics to push out the lines that needed it in Train Journey 1 & 3. For specific moments in those cues, each mic had an exciter, Decapitator and EQ to make them pop, and a Symphony 3D with a fairly short room set to 56% wet helped to keep them in the space while spotlighted. These solo mics were heavily edited and automated to switch between the unprocessed versions and the pushed versions.

Solo Mics, Split to Heavily Processed and Regular Versions
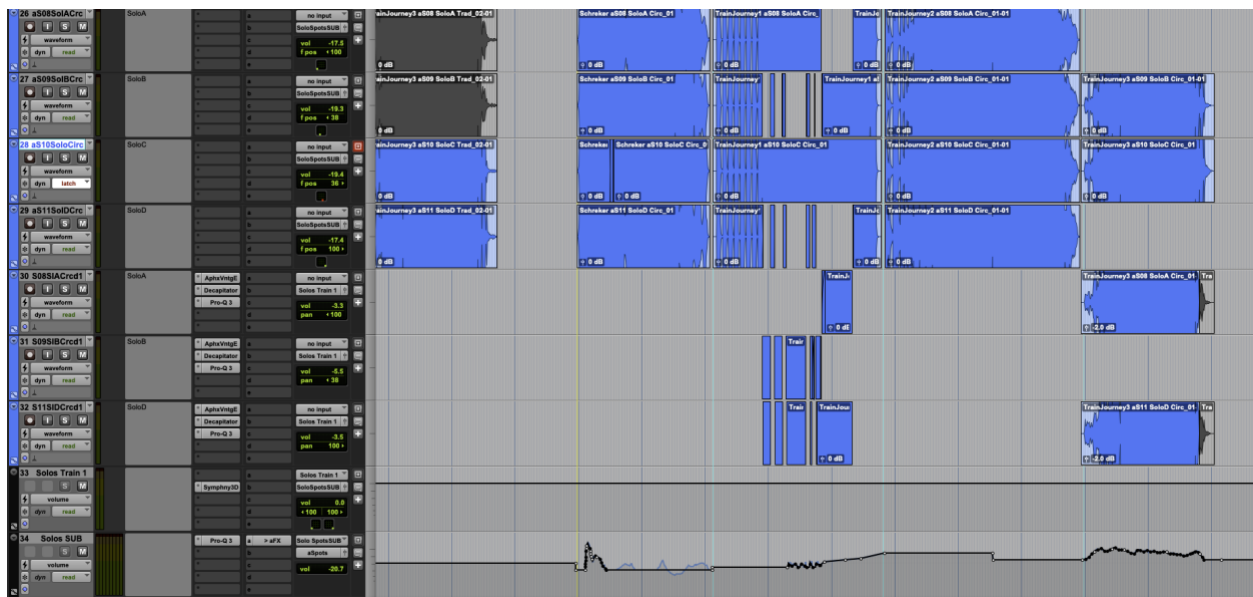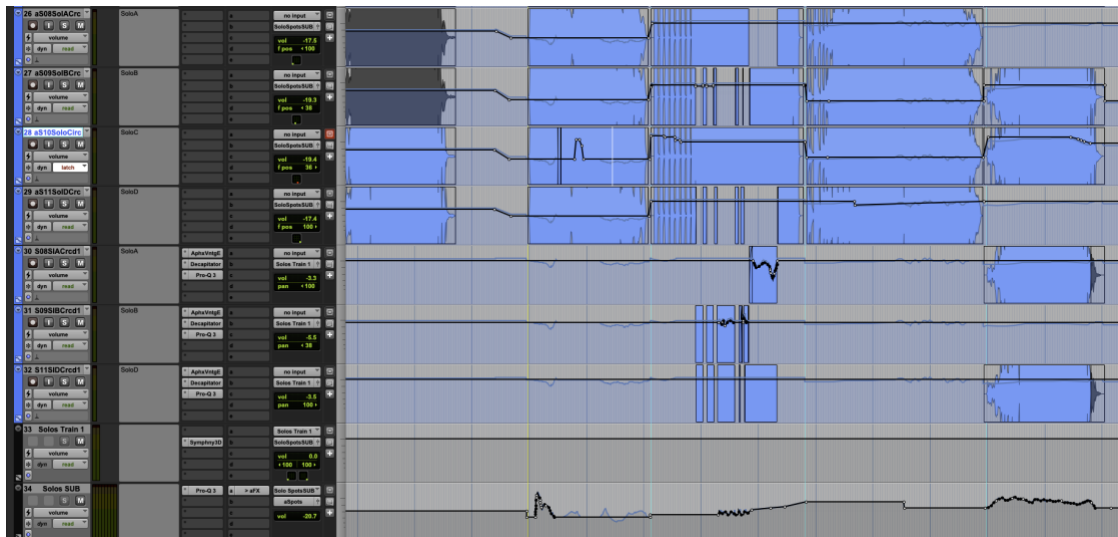

Solo Mics Enhancement (Slightly different for each one)
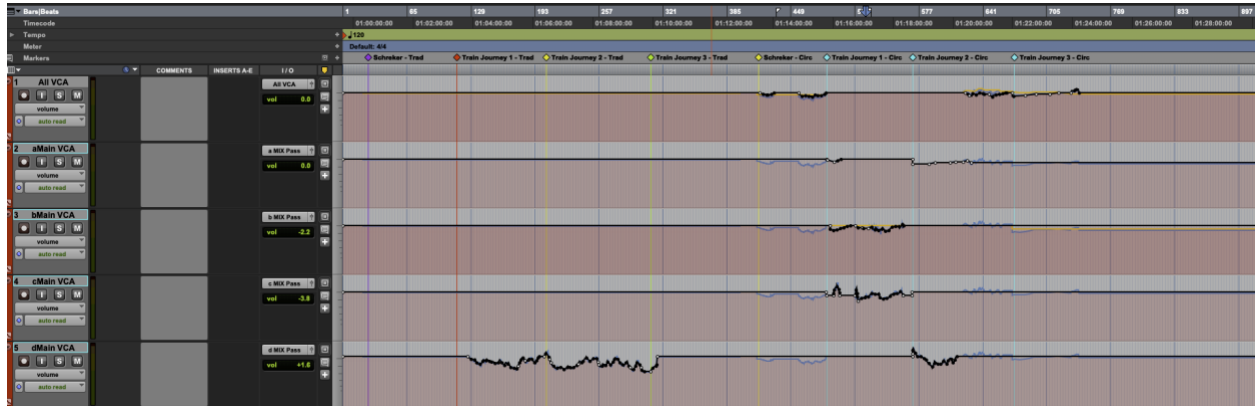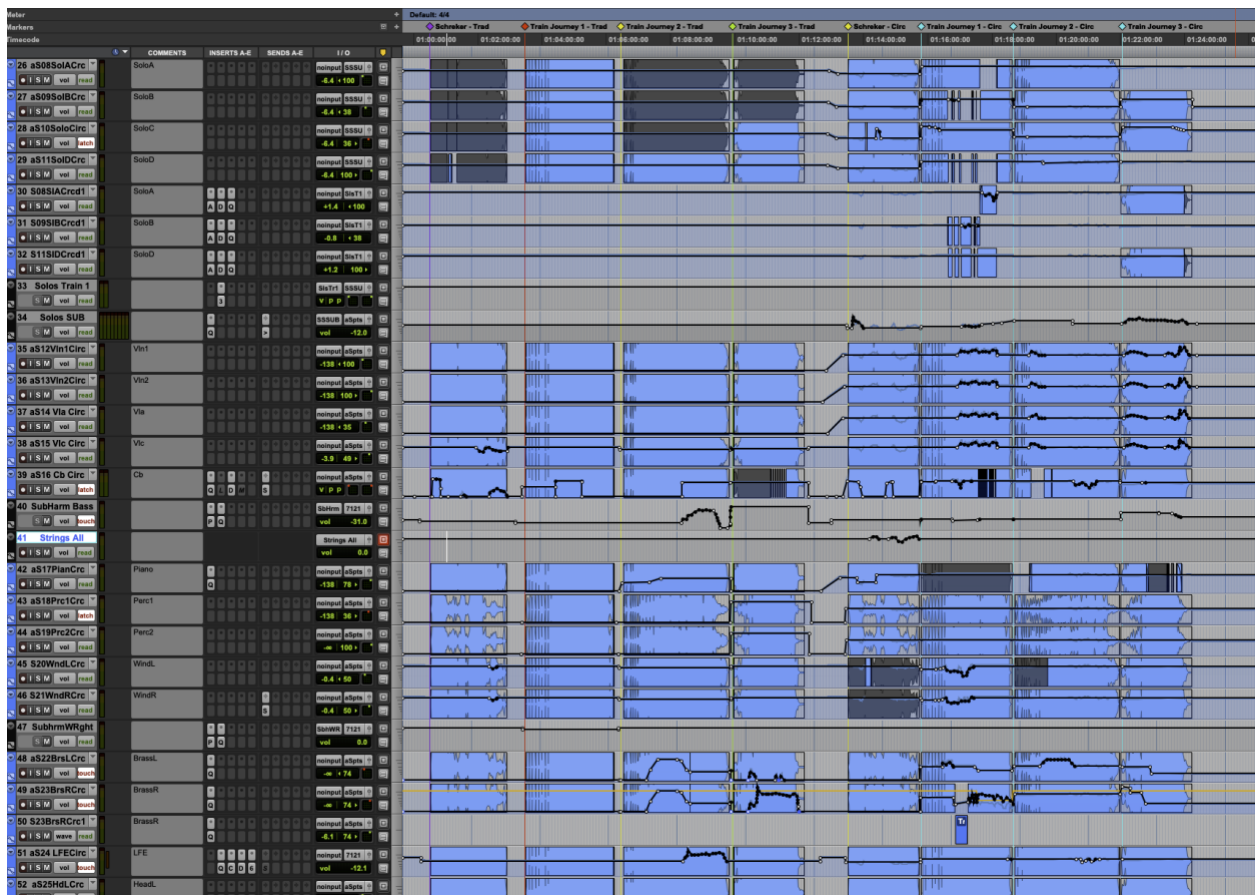
Solo Mics Verb

Solo Mics, Automation

The mix really comes to life with automation. Spot mics in particular are automated, as well as overall master level automation to enhance dynamics.
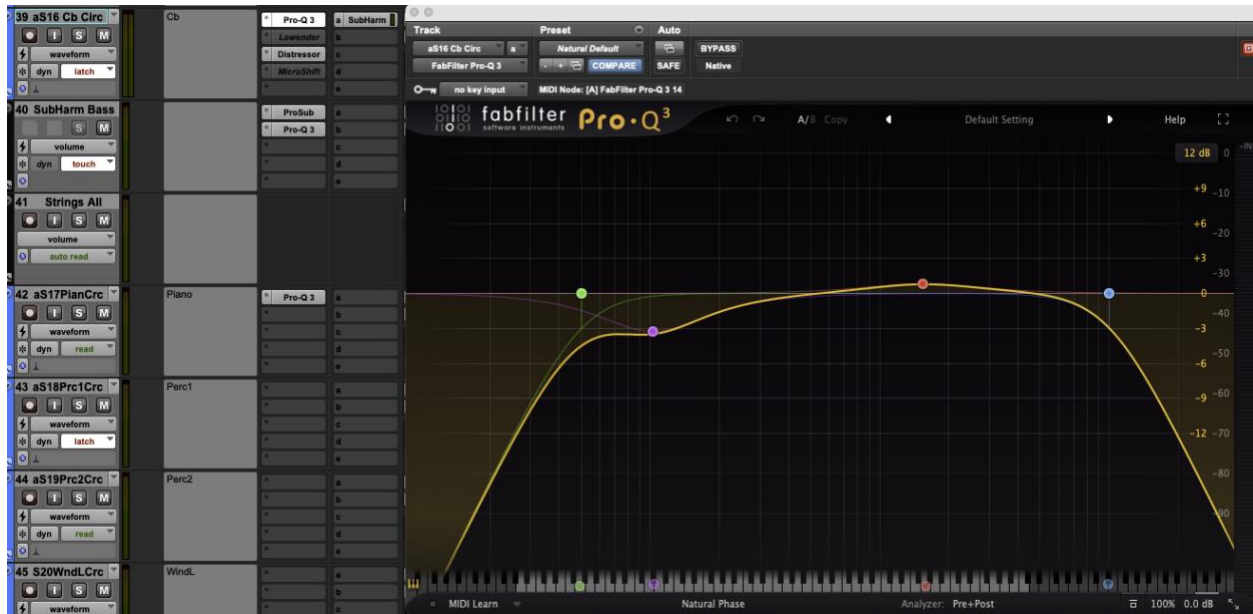
Overall VCA Automations

Other Automations

The Bass spot mic had some specific processing on it, which had a really cool focused place in the center of the circular mixes and brought out the sounds of the bow and slaps. It needed a bit of aggressive filtering to tone down the boom and get rid of as much trumpet as possible on the top.

Bass Spot EQ

Bass Spot Compression (parallel mix)

The piano mic had a bit of filtering to reduce unwanted bleed and clean up some midrange.

The brass spots had some filtering as well, to focus in on the main sounds of the brass.

Passes, B & C – Percussion Overdubs

For Pass B & C (percussion overdubs), we went with simpler processing as it didn't feel like these passes needed much to get them to speak in the mixes. Pass B is gran casa, Pass C is sticks. We moved the stick performance from Pass B on Train 2 to live on Pass C with the other stick parts, then reversed all of the panning on Pass C to balance out the percussion in the imaging (sticks on the left, casa on the right). In both passes, the spots are all muted except for the Bass spot, which for whatever reason sounded like a nice capture. This mic was panned to right & left respectively in Passes B & C. On pass C, the Bass spot also had

a Transient Designer adding about +1 dB on the Attack. The only other mics used in the percussion overdubs were the LFE and Bottom mics for Pass B gran casa only. The LFE had some simple low pass filtering, and the Bottom mics had no processing.

For Reverbs, we used a Fab Filter Pro R2 set to Mechanics Hall on Pass B, and a Seventh Heaven with some EQ after it on Pass C.

Pass B Gran Casa LFE

Pass B Reverb

Pass C Transient Designer

Pass C Reverb & EQ

Pass D – Prepared Piano Reamp & Overdub

Volker provided a complex layered prepared & effected piano layer for the Train Journey 1 & 2 movements. These added a lot of textural interest and sounds that would pop out here and there in the spaces between the orchestra. A mix of these tracks were reamped via a quad setup of speakers into the room on Pass D. We also used some of the tracks provided by Volker in places to add some more presence and panning opportunities. We tried some more extreme processing and movement, but they seemed to work well as they were and drew too much attention to themselves when they started to move around or have more processing added.

The main part of the sound for this pass is the PentaSphere. In addition to that, one of Volker's original effected tracks is panned up to the top in a .2 configuration, panned between the front and rear top object pairs, which added some height and interest up there.

A TC Electronic 2016 Room reverb at 100% wet was inserted directly on it to make it less present. Another of his effected tracks was panned to the Lss and Rss to add in some width to the image. Lastly, the Solo A-D mics had a nice direct sound of the speakers in the room, so these were snuck in at -8.4 dB to add some focus to the reaamp layers and were used to send to the Pass D effect return. Rather than a reverb, which there was plenty of on this pass, we used a Mk1 Rhodes Chorus setting on Cinematic Rooms, which added some width and interest to the image without making it feel wetter.

The Room, Height and Spot subs for this pass has some simple EQ. The solo mics (via Spots sub) also had a Decapitator to add some weight.

This pass was volume automated have it sit in the mix where we wanted it. Also in Train Journey 2, the spot mics were mute for the first half, then faded in as the piece reached it's conclusion.

Pass D Room Sub EQ

Pass D Height Sub EQ
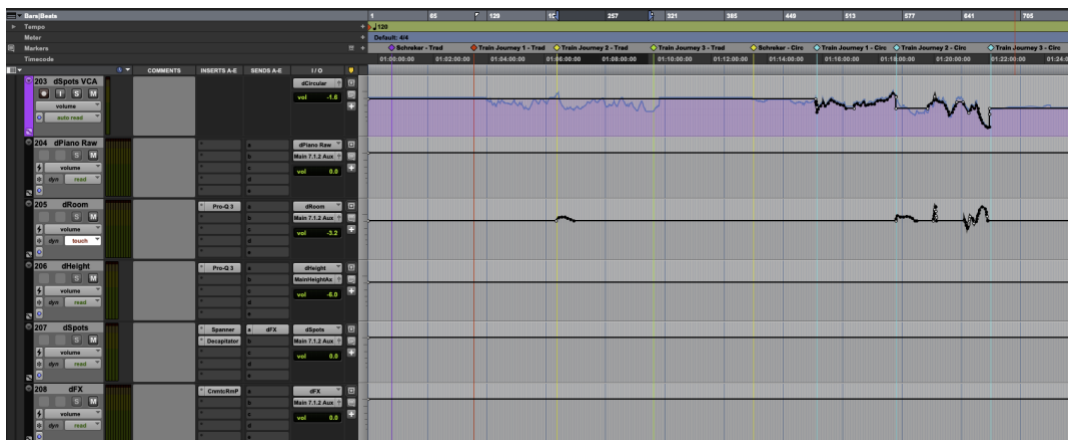

Pass D Height Reverb Insert

Pass D Spots Decapitator

Pass D Chorus Reverb

Pass D Automation

Does It Rotate?!

One of our ideas for this array was the rotation ability, so that in the circular layout we could try panning other points of the circle to the front. We used a Spanner on the main Array and Height Auxes to be able to quickly try out the rotation. While it did change the imaging and sounded interesting, it was difficult to really evaluate if it was successful because our use case would need an isolated stripe of just the strings playing. It did seem like having unmatched mics in the rear would probably not give us an image that was as strong as our main M50 LCR, and some mix decisions were made that probably wouldn't work in another orientation. We'd probably have to make a bespoke mix tweak for rotated versions. Also, the top mics having 4 channels did not give us totally symmetrical height options when the array was rotated.

If in the future we were going to try something like this, we'd probably place the players in the room a bit differently, such that any mic could truly become the center of an LCR and have the imaging make the most sense. In conclusion, the rotation was a good experiment but did not add much to this recording.

Closing Thoughts

In mixing the PentaShpere, and exploring the approaches and sound of our fellow focus group members, we found things that worked well and others that we would change in the future.

- The use of M50's as the main part of the array was great, no surprise there.
- Adjusting the positioning of the L & R mics didn't seem to have a detrimental effect.
- While the M49's worked OK as rears, they lacked some of the presence of the M50's and it's likely there were some other mic choices that could have provided a better front/rear coherency.
- We went with a 5-channel main part of the array because we trade channel count in favor of smaller data footprint and more interactivity layering bandwidth during runtime in a game. However, when comparing to the other arrays we really missed the space filled in by the side mics, and how they connected the front and rear. This has led to us recording side mics in our orchestral arrays since participating in ECHO. We have found that we still get more mileage from them by panning sides to a phantom location between front and rear channels. This also makes more sense for us in the folddowns that happen in the games, so we still retain side information in 5.1, as opposed

to discrete side channels which would be folded into the rears for 5.1, retaining some side information in both 7.1 and 5.1.

- The height mics worked, but may work better with a tighter polar pattern. After hearing back the coherent position height mic sound of the PMCA array, we have tried that and really love the sound. And we're finding that a .2 is enough for our live capture, placing the supercardiod height mics next to the side mics.

- We would normally use other room mics to build our main image – wide/outriggers, mid room mics, etc. We could have placed some of these for our array. When experimenting with combining some wide mics from other arrays, it gave us a bit of the enhancement that felt like it was missing.