VIRTUAL PRODUCTION & BEYOND

SLAYING THE MYTH TO UNCOVER THE TRUTH

CASE STUDY: SHORT FILM

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FAT HEAD

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This section has already been released and published.
It is available to read online at http://www.tinyurl.com/fathead-wp-cloud.

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This article discusses the challenges of recording clean dialogue on LED volumetric stages and in-camera visual effects (ICVFX) during production due to acoustical reflection, noise, and the image-centric bias of production. The author proposes various solutions such as considering sound reflection and noise mitigation during previs/techvis, minimizing personnel inside the volume during shooting, employing KVM switches to remotely connect keyboards, monitors, and mice to eliminate equipment noise, and using acoustical mitigation screens to shield reflective surfaces. The article emphasizes the need for cooperation and understanding between departments to avoid sound problems during production.

Author: Eric Rigney

[**Keywords:** final sample, LED volumetric stages, acoustical reflection, acoustical noise, virtual production, de-reverb, ambient sounds, production sound, sound reflection, noise mitigation, previs/techvis, equipment noise, KVM switches, acoustical screen, DIY solutions, commercial solutions, ZR Screen, AirHush, acoustical mitigation screens, camera framing, production design, sound department, equipment manufacturers, and post-production processing.]

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HOW IT ALL BEGAN

Brandyn Johnson graduated from the USC School of Cinematic Arts (SCA) with a Master of Fine Arts in Film and TV Production in 2021 and has since worked professionally as a production sound mixer, boom, and utility in sound departments.

Johnson met director c. Craig Patterson even before their education at USC had started. He said, "We found out that we were both awarded the George Lucas Scholarship, which covered tuition for three years, over at SCA." Before starting at USC, Johnson had already done his research by meeting students and faculty to figure out what he'd want to do once he got accepted, whom he would like to study under, and which classes he should focus on.

He started working on some student projects and recognized that no one wanted to do sound.
"People were focusing on the visuals, thinking about casting, and rehearsing," said Johnson. "Those are all great things, but no one wanted to deal with sound." The PAs were asked to do the sound, but they'd rather run and get coffee.

Johnson had some background in sound from his undergrad. "I would always take that up," he said. "It wasn't sophisticated tech. Just H4Ns and a boom." He didn't get to use any lavaliers for those early projects.
Johnson was the only person manning the mic and figuring out the settings to ensure good levels. Before being accepted into the program, he had already worked on three or four different shorts as a sound mixer or boom op. Fortuitously, a couple of those projects made it to Tribeca, and one got to Cannes.

"Once I got into the school, I was known as a person that did sound," said Johnson. "The ball kept rolling in that way, and I got some dope opportunities." In 2020, he received the Cinema Audio Society Student Recognition Award. He is currently an adjunct assistant professor at his alma mater, teaching what he loves to do (circa August 2022).

SOUND RESPONSIBILITIES ON *FATHEAD*

On *Fathead*, Johnson donned several hats, starting as one of the co-producers, then taking on the responsibilities of the production sound mixer and the supervising sound editor. He was on the project from day one.

Reminiscing about when he'd pitched *Fathead* to ETC along with Director c. Craig Patterson and Co-Producer Alexa Villarreal in early 2021, Johnson gasped, "It's been a long, wild ride." Once the production wrapped close to a year later, he admitted, "This film feels special for me."

"It's gone through a lot of changes to the story for several different reasons," which Johnson attributed to the "many variables at play." *Fathead* had numerous vendors and professionals who volunteered, and aligning schedules with them within the timeframe and resources at hand was a major challenge.

Once the team had decided where the film would be shot, Johnson started thinking about production sound and post, figuring out how that world would come alive. From the location scouting excursions to the LED volume stage, Johnson found that "it sounded terrible" and concluded that on *Fathead*, his challenge was to "figure out the acoustics." How to make everything sound its best.

Johnson reached out to other mixers who had previously dealt with these types of environments and asked them, "What things did you run into that you had to account for and solve for this super reflective volume?"

The reflected sound at the LED volume took about two and a half to three seconds to die out. "It's wicked. You're in an echo chamber," he explained. If this reflectivity were not mitigated, the team would have had to rely on automated dialogue replacement (ADR) for the whole film. "For any mixer, that's non-negotiable."

SOUND IS HALF THE FILM

Conveying what he observed as a student at the USC School of Cinematic Arts, Johnson noted, "If we look at all of the different departments, the sound department is the one with the most accolades." The sound faculty have earned several Academy Awards. "USC understands, on a higher level, that sound is half the film, and sometimes, even more of the experience."

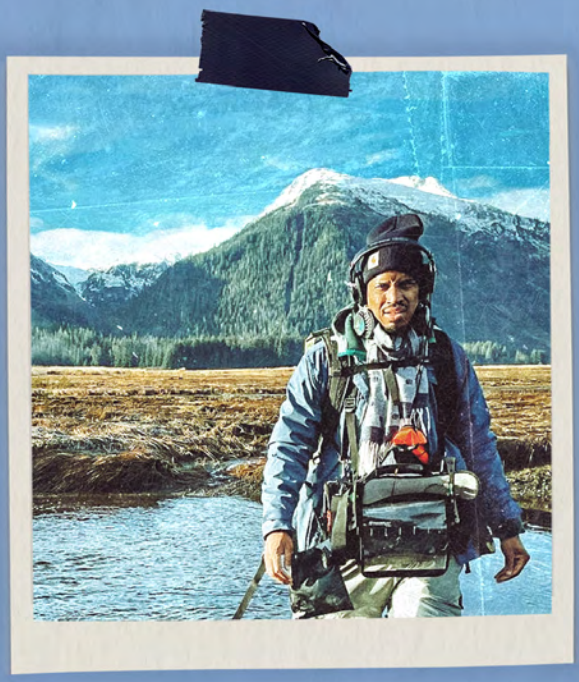
Johnson felt it was mostly the students who thought that sound was less important. They see production sound as a specialization and think of the sound person as a technician, not a creative storyteller. "USC is a place that teaches us how to be great storytellers. It makes sense that people don't want to do that technical thing. They want to be a creative storyteller."

WHERE SOUND MAGIC HAPPENS

Sound editing and sound design are where a sound person gets a chance to be creative and play, lending their brains and ideas to the story in a way that production sound does not get to participate. "This is where we get into the more creative elements of sound — how it plays into the storytelling," said Johnson.

During production, it's mostly about getting clean tracks for what gets sent to post. "Everything is done in preparation for post because that's where the job is done — everything comes together, and you provide that final delivery."

For Johnson, post is where the fun happens. He thinks that is why USC focuses on post-sound: mixing, sound editing, sound design, and dialogue editing. "Post is the main focus in terms of how sound helps tell a great story."



CONCERNING REFLECTIONS

Once the challenges of working in the LED volume became evident, Johnson reached out to Shawn Holden, the production sound mixer on *The Mandalorian*. He had read an **interview published in Production Sound & Video** — the official publication of the sound union magazine IATSE Local 695.

"I reached out to her on Facebook. It's a good thing there aren't many of us, and we're a pretty tight-knit community."

In the article, Holden mentioned a product from Delta H Design that helped mitigate the sound at the *Mando* stage. These devices are called ZR Screens. "What Holden provided me was quick and brief, but it was definitely mentorship and thinking about the space. Thinking about the types of things to focus on."

Holden put Johnson in touch with quantum acoustician Hanson Hsu, founder of Delta H Design, which led to getting some of those devices delivered to the set to test them on *Fathead*.

Holden also shared some tips on acoustics: "Once things start to fill the space, that will cut down the reflections." The reflections are bound to go everywhere in an empty room, as there's nothing to stop it. "Once actors and the crew step onto the stage, those bodies and the props, the softer things that can redirect or absorb sound, would start to mitigate and cut some of that reflection."

Johnson also started a dialogue with the production design department and costume designer. He shared his concerns with those teams and offered suggestions on what they could integrate into their creations to help with sound mitigation.

The sound mixer can educate the producers and department heads on implementations that may help acquire better sound during production. But many other pressures, including budget limitations, may force others to vote against these recommendations. "I'm not the production designer, and I don't get to make that call."

SOUND QUALITY OF EACH LOCATION

From his education and practice in the field, Johnson observed that every place has a particular sound quality. "There are ways to get those places to sound as close to what you want, depending on the story."

For *Fathead*, one of the scenes takes place in a cave, an environment naturally prone to reflections. In that particular situation, the LED stage reflections worked for the story.

The objective on location is to get the sound to be as clean and dry as possible "so you can do whatever you need to do in post," he said. Different worlds are constructed on the sound stages and have to sound like those environments do in the real world. "When you build a courthouse or an apartment on a stage, you want that dialog recording to match what we think that room would sound like."

On *Fathead*, there was no opportunity to have non-reflective, clean sound — "because the whole space was reflective." Johnson had to think about how to mitigate that reflection to attain the cleanest sound possible for post that matched the story and environment. "How can this room lend itself to something in our story, like the cave?"

Since Johnson took charge of almost every sound department role from pre-production to final delivery, he said, "The great

thing about wearing many hats on this project was that I could think ahead about the things needed to get the sound right."

As a co-producer, Johnson gained early insights into the production's demands, the director's vision, and what he'd have access to as a production sound mixer to deliver those goals. And being the supervising sound editor, he already knew what was needed to make things happen and what something needed to sound like.

Johnson stayed in constant communication with Patterson and did not want to lose the creative charge by getting wrapped up in the issues brought on by the reflections. He attributes most of the research around the different types of technology for visualizing the sound and the reflections to Eric Rigney. "I got busy, and Eric carried on with the research," he said. "Rightly so, he's credited as the sole author on the findings."

Small decisions saved huge hassles during production. Johnson made a judgment call on not moving those ZR Screens on some shots to save a few minutes, knowing that the scene was taking place in a cave and it would be possible to match that reverb in post. This helped accelerate his workflow by keeping the focus on what was essential.

HOMEGROWN SOLUTIONS

The production did not receive the ZR Screens during the first week of production. When these screens would arrive was not certain, so Johnson started concocting solutions on a budget using available resources. Sound blankets are a go-to tool for productions of every size. "We can stuff them in places and hang them too." he noted. "It can kill sounds from a generator or a fridge, from any direction." They work well at absorbing some frequencies and keeping those from polluting the recording.

Some scenes with Tika Sumpter, who plays Mother, captured during that first week required the full extent of iZotope de-reverbing solutions for clean-up in post. Johnson had anticipated these issues, so he had a backup plan. Usually, it would require some playing around and massaging it in post, or it would have to be re-recorded. "Luckily, we recorded some wild lines for her on a separate soundstage," he explained.

In a volume stage, loud sounds get amplified. The reflections worsened when the children screamed at the top of

> **"We had some BIG screams coming from little people!**

their lungs. It made Johnson's job that much harder. "I hope it lends itself to the story so that we don't have to do as much work in post," he thought. "We're in a junkyard. Everything is metal. Technically, things would be a little reflective and tinny."

Even with the best solutions applied to the file, Johnson shared that it may clean up the tail just when a person has stopped speaking, but everything said before will still have some of that reflection inside it. "You can hear it at the end of it. It just stops. But the reflection is still happening in the middle of what I'm saying because there's no way to take that out. It still exists in that middle frequency."

Johnson set out to make the film the best way possible. If it required ADR, despite his reservations. "If it's more than what I hoped to do, my production mixer hat comes off at that point. I will have to start thinking like a co-producer and a sound editor."

Given the limited funds, Johnson used every means within reach to acquire as many sound blankets as possible to guard against relying on ADR. The production design team was also strapped and couldn't carpet the ground. The dirt-covered ground was created over linoleum, so Johnson knew, "I would have to treat the floor."

Any part of the set that did not have ground covering got carpeted with mats and sound blankets. Everything on the ground was made safe for the performers.

"We're dealing with 12 to 15 nine- and ten-year-old kids screaming at the top of their lungs. That's what the story calls for." Johnson thought that even if he had all the ZR Screens in the world and the whole stage covered in blankets, it probably would still have some unwanted reverb or reflection.

Johnson used a de-reverb from iZotope and other

professional software to kill and mitigate the reflections of the screams during post-production. "We had some big screams coming from little people!"

Wherever the plug-ins and software aren't enough to kill reflections, ADR was seen as the last resort. "Until we come up with a better system to soften these reflections, anybody shooting on these stages knows it's something we have to plan for as a backup," he said. "Working on volume stages is going to require some level of ADR."

The close-ups and the quieter moments were where Johnson generally identified how well these tools performed. Given the nature of *Fathead*, it was hard to tell what was working and how much something had helped with getting cleaner sound during production.

"The space is big, so we need to get big too." Johnson took some 12' x 12' frames and covered them with sound blankets. Ideally, he'd have liked four of them, but that would have cut light for the camera department. "We'd put black on one side so the camera team could use it to cut the light," he explained. "On the other side, we covered it in blankets."

As the camera team got to use these sound barriers as flags to create negative fill, the sound department benefited from getting them closer to the sound source, which helped kill some of the reflections. "It became a collaborative thing."

Johnson also used an experimental MacGyvered sound barrier that Rigney engineered by adding a light diffusion honeycomb grid to a 6' x 6' frame covered with a sound blanket. Johnson observed, "The honeycomb grid was capturing the sound, and the sound blankets were there for anything hitting the wall and coming back. That ended up being a good barrier for us."

The results surprised Johnson so much that he said, "If we did it in the future, I would get a 12' x 12' honeycomb grid onto a 12' x 12' frame and get two of those."

The ZR Screens have a smaller profile but work similarly to the honeycomb grid contraption. "We were able to get them a little closer." They're 8' x 4.5'. It was easier to fit them into places where a six-by or a 12-by wouldn't fit, and they also worked for the lighting crew as they didn't cut as much light.

SOUND TEAM SIZE RECOMMENDATIONS FOR A VOLUME STAGE

The sound team struggled a bit with the ZR Screens as they are not light. Though the difference was heard in the recording, having to constantly move nine of those screens scattered around the stage took a toll on their stamina. Johnson shared, "They get heavier on the C-stands with these bars holding them up. After every setup, we moved nine screens and put them in the right position. It was a harder job than normal."

Utility is an all-hands-on-deck position. Traditionally, a utility person handles cabling, wiring the actors, and ensuring that the mixer is good and the boom op is on-set. They're the liaison and the eyes on set. The sound mixer is stationed at the cart, and the utility is the bridge. When an antenna needs to be run to the set, they are the ones to do that. Actors come on set and need to be wired; the utility handles that. Mats and carpets must be thrown down; they'll get it done. Sometimes the boom op will help.

Johnson had his sound cart stationed up close to the mouth of the LED volume. He did this to get the wireless system antennas as close as possible to mitigate possible distortions, as there's too much metal on set with ample room for distortion as the waves bounce off everything. "You never know what's going to happen inside an LED volume because it's got metal trusses all over the place," Johnson pointed out. "I wanted to be close enough to have a clear line of sight to my transmitters."

On a large sound stage, especially an LED volume, "it's damn near impossible to get great sound without a 4-person sound team." The sound department will benefit from having an extra utility person on the team. Johnson added, "You're going to be cutting into time, and other people are going to be frustrated." A five-person sound team with a trainee added to the mix might be the optimal team size most equipped for quick movement between setups.

One of the downsides of less-experienced sets, Johnson observed, is that "many people tend to forget that the grip department doesn't work for camera. They work for the set."

On a volume stage, Johnson imagined, "the key grip would know better, as these stages are expensive and attract high-

end productions with teams with at least 20 years in the business." With more support from the grip, the sound department might be able to manage without the need for additional utility.

LEVEL UP THE COLLABORATION

Fellow USC graduates filled several key roles, and that SCA connection helped the team get incredibly efficient with the workflow on *Fathead*.

"It's always helpful to be in a room and to lend a voice," said Johnson. But time spent attending meetings may not be compensated. "I want to be a voice, but I don't want to sit in a two-hour meeting and speak for five minutes."

Pre-lighting is an intentional space for the gaffer and the mixer to communicate. "Where are you going to put the flags? Can we put our ZR Screens here?" Knowing what the shot is and what the setups are ahead of time allows the sound team to decide how to treat the floor.

Citing an example of the inter-departmental collaborative efforts during production, Johnson shared how the ZR Screens, as they're large and black, doubled up as flags for the camera department to help shape light. Effective communication results from long-term working experience and associations.

Flags are a staple for any production, and Johnson suggested that "it'd be nice for grip departments to make their flags sound absorbent."

ZERO ADR

Johnson prefers not to ADR anything because that impacts performance. Especially with children; he pointed out that they generally don't do well in ADR. "Performance is delicate — it's a moment in time. We're not doing our job if we can't get that moment. We're not creating real magic."

Johnson values the role of actors in creating genuine moments on the set. "No one wants to come back and try to recreate the feeling. It doesn't lend itself to what film is capable of."

"So many of the great directors talk about sound as being so damn important. It's because they understand how sound separates a good project from a great project," stated Johnson. "We must start thinking collaboratively about how we include sound in the process because we're trying to create excellence here."

Production sound has always been about recording clean performance. Blankets are put around the actor's feet to get a clean dialogue recording. Keys and other dangling things are treated or taken away to make it sound quieter, so it doesn't impact the vocals.

Once clean dialogue is placed in post, everything gets recreated to depict what's happening in the scene. When shooting at a location where it might be difficult to recreate the sound later, or it's something beautiful and rare, the production sound mixer will make an extra effort to capture those sounds on location — a special creek or a local bird that might be hard to find. It makes the sound editor's job easier.

In post, the dialogue tracks are edited first, and the iZotope De-reverb plug-in or something equivalent may be used to kill those reflections. The dialogue is made as clean as possible. Then a world of background sounds is built underneath it. Some of these sounds are recorded, and most are sourced from different sound libraries.

Pitch may be altered, filters may get used to make things sound weird, and there's enough playing around to create a sense of the world. On top of that, there may be a foley session to generate sounds that connect the audience to the events in the film. Those are the action sounds that are avoided to get a clean dialogue recording on location. But those are the sounds that connect us to that reality.

"Imagine when we're watching a movie," said Johnson, "and they're walking, but you don't hear the footsteps. The audience will surely notice that. In post, those footsteps get put back into the world."

For Johnson, these are the parts where the creative piece comes in. His voice perked up, sharing how his mind works when he wears the supervising sound editor hat, "I want this part of the movie to feel suspended so I can pull out the background or lower it substantially to focus on one sound. You're complementing the story."

THE WORLD OF FATHEAD

"*Fathead* is a highly inventive world. I love *Fathead*," said Johnson. "It's beautiful to see a story told like this with so many people of color involved. It's not something that you see on screen that often."

What excited Johnson the most about the process was getting to witness "how we were able to shoot it with that same diversity and energy reflected on set." He's excited that folks everywhere will get to see *Fathead* and possibly have that same special feeling that he had when he first read the project.

Johnson feels the color contributes to making it a cool world. "This feels like a calling card," he suggested. He wants *Fathead* to live in people's homes for years to come. "It has that type of effect — the larger world of it. I'm excited for that part of it to become a reality."

After the shooting wrapped, Johnson already felt prepared to work on the feature to tell the whole story of *Fathead* and show the full world of Junkyard Paradise. ▪

Former Post-Production Executive,

Sony Pictures Entertainment

ERIC RIGNEY

Eric Rigney, a former post-production executive at Sony Pictures Entertainment, joined *Fathead* to perform a sound mitigation study. He'd been with Sony for 21 years and climbed up the ranks to vice president. He said of his experience, "When I was there, I considered myself an innovator. I was always listening and learning by going to all kinds of different talks." That's how he'd first heard of ETC and met Erik Weaver back in the day. "Probably, at least ten years ago," he said.

Rigney got a patent in camera direct dailies before it became popular. He left Sony to fulfill a personal dream and sailed around the world with his wife and two sons for four and a half years. When he returned, he said, "I had a choice of either catching up with what I had done, or I could intersect with tomorrow. Which is normally where I go to get in front of it."

Colleagues in the business pointed him to virtual production. That got Rigney back in touch with Weaver, which led to his involvement in the second R&D virtual production short film at ETC. "I got involved before they made the script selection," said Rigney.

MAIDEN VOYAGE TO A VOLUME STAGE

The first time Rigney got on an LED volume stage, he clapped — probably out of excitement. Right away, he said, "how do you guys deal with this?" He was talking about the blaring echo. It was the elephant in the room that no one had addressed. Weaver asked him, "Do you want to research it?" That's how he got engaged on the mission: Figuring out how to mitigate sound reflection and noise in a volume stage.

These LED stages are built with large glass walls wrapped in a semicircle, a J-shape, or a complete circle. The ceiling may also have LED panels. The floors are either polished concrete or have a wooden platform. It winds up being an echo chamber.

Rigney said, "Ironically, many of these LED volumes are built inside a sound stage." The sound stage is meant to be quiet. Once the LED volume is introduced, it gets echoey.

Most people looking into this technology are focused on the image. Rigney decided, "My focus is sound." The picture people aim to attain *final pixel* — to capture a finished image in-camera that will carry all the way through to the audience screen with minimal post-production work.

"I'm focused on *final sample*," said Rigney. He coined the term to define a similar goal for the sound department — to capture clean dialogue in a highly reflective, noisy environment and bring that from the performance to mastering, eventually serving it to the audience.

The challenge was that "the focus has always been on the image," noted Rigney. The other problem, in this scenario, is a bit more obvious: "the environment is all glass."

It is the opposite of a soundstage.

Rigney wants shows using virtual production to feel just as emphatically about sound as they do about the picture. He wants them to aim for *final sample* for sound with just as much enthusiasm as everyone chases *final pixel*. A pixel is the smallest region of a display screen that gets illuminated. He coined the term *final sample* to serve as a reminder of a similar principle for sound, as sound is measured in samples per second.

SUPPORTIVE COMMUNITY AROUND ETC

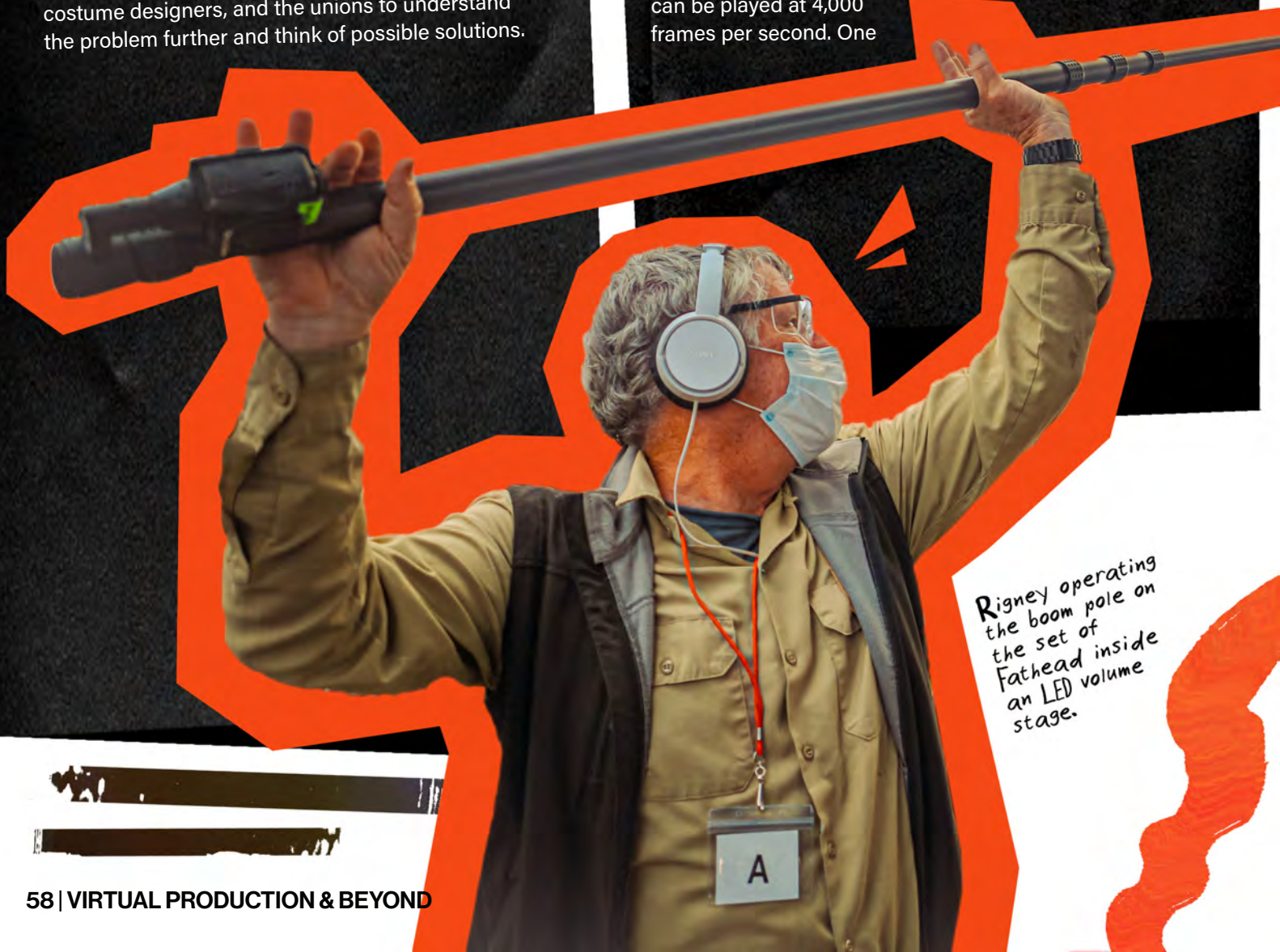
Rigney dove into the deep end and swam upstream. Fortunately, he didn't have to do that alone on *Fathead*. "Thanks to Erik Weaver and his group," he said, "it gave me the ability to access smart people. Calling people as a part of ETC to conduct the study opens doors." He got to work with set designers, costume designers, and the unions to understand the problem further and think of possible solutions.

Fathead allowed Rigney to do two things. "I was able to get on a volume stage and use an acoustical 3D camera." He also participated with the sound crew as a sound utility person. "My chief role was to move the mitigation material. We learned about different ways to mitigate sound."

Rigney reached outside the M&E space in the automotive industry and aerospace to locate a 3D acoustical camera made by VisiSonics Corporation.

The spherical device looks like a disco ball fitted with 64 microphones and five 3D cameras. The software maps out the reflections, letting you view the sound on the stage, and you even get to choose your frequencies and decibels to get a clear picture of what's happening.

Equipped with a new toy, Rigney landed on an LED volume stage, popped balloons, clapped his hands, and spoke lines of dialogue. Describing what he observed using the 3D acoustical camera, he said, "Once you set it up with user-defined parameters, you could visually see the sound reflections bouncing off the walls, the ceiling, and the floor." It does not shoot live, but it can record it. The recording can be played at 4,000 frames per second. One



Rigney operating the boom pole on the set of Fathead inside an LED volume stage.

second gets spread out to 10 minutes. "Once you see what is happening with the reflections or noise, you can address it," Rigney explained. "You can set it up to see different noise factors at varying decibel levels."

The tool even works with 3D glasses. You can put on an Oculus virtual reality headset and look around the space to see and hear the sound as you turn your head. "It's amazing," said Rigney, "you can play with it inside this space."

Rigney located a noise source that came up days before production began. There was an electronics setup that had a noise-generating source. "I let the vendor know," he said. They spotted the troublesome device and turned it off. It wasn't required for their operation. It was one of the loading carts for dailies. "That was an easy fix."

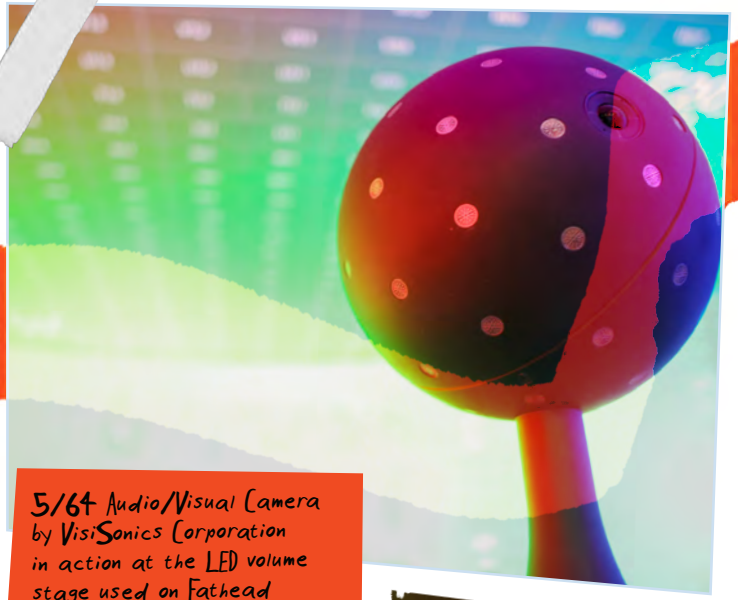
SOUND MITIGATION SOLUTIONS

Typically, furniture blankets, also called furni pads, are used for sound mitigation. Floor mats with rubber on the bottom and a carpet on the top may also get used.

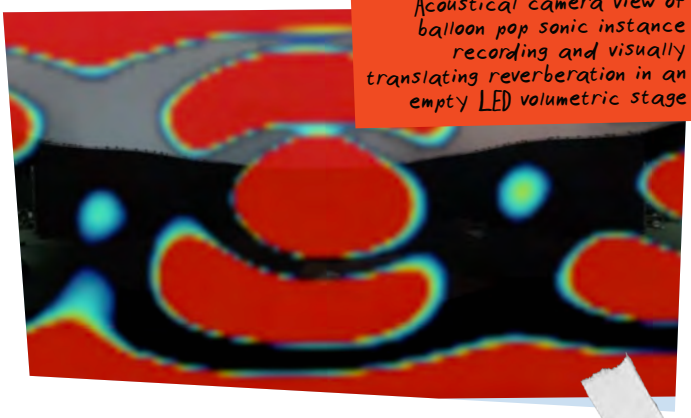
There is also the ZR Screen, which stands for 'zero reflection screen' — a product sold and rented by a company called Delta H Designs, Inc. — the brainchild of quantum acoustician **Hanson Hsu**. Hsu's website suggests that these ZR Screens create the proper environment to control the behavior of air molecules by forcing them to change from waves to particles — the sound energy then has no medium to ride upon and ceases to exist.

Rigney said, "Hsu describes it as waves of an ocean that come to a breakwater. When they hit the breakwater, it breaks up into whitewater." A surfer can surf on the wave, but they cannot surf on the whitewater because the energy and the surface tension aren't there anymore.

Hsu shared that as an analogy of what these panels do. They are 8 feet tall by 4.5 feet wide



5/64 Audio/Visual Camera by VisiSonics Corporation in action at the LED volume stage used on Fathead



Acoustical camera view of balloon pop sonic instance recording and visually translating reverberation in an empty LED volumetric stage

Rigney uses a high-powered laptop with GPU processing to monitor the sound reflections captured by the VisiSonics 5/64 Audio/Visual Camera

and an inch-and-a-half thick. "We put them on C-stands," said Rigney, "and moved them as close as we could to the actors, with minimal impact to lighting and camera."

When the ZR Screens were unavailable for the first week of the shoot, Rigney experimented with some available tools and engineered a makeshift solution. "You hang a honeycomb grid filter used for lighting on a square panel," he said. "We had a six-by-six." He then draped a duvetyn over that, and then, over that, he draped a furniture blanket and wrapped it around the frame.

"I'm calling it an echo shade," said Rigney, "because it shields us from the echo." The results surprised everyone.

Rigney also found the LED volume's shape particularly interesting from a sound perspective. "It is a big bell, which makes it act like a parabolic microphone." Sounds originating outside the volume get picked up by the recording.

Based on this observation, Rigney suggested: "Don't place the director's chairs inside the volume because they creak so much. When someone bends down to pick up something, scratches their leg, or drops a water bottle, that will get recorded."

The brain bar (volume control) has several workstations and carts. Rigney recommended that these machines be hooked up with keyboard, video, and **mouse (KVM) switches**. "You want to have your equipment KVM'd for the most part," he said.

Additionally, he suggested using duvetyn around them as soundproofing. "If they're typing away or talking, or whatever they're doing, moving their chair back. You're not picking it up."

COLLABORATIVE EFFORT TO GET BETTER SOUND

A buy-in from camera and producers is important because it takes extra effort and may impede their workflow to some degree and add a little bit of time. "On average, it adds 2-3 minutes when they're working with you," said Rigney. Without that teamwork, it may take up to 8-10 minutes to set up, and that too, only "if they'll allow that."

The camera setup takes a bulk of the time, and when it gets to sound, there isn't as much flexibility. "It's important that both picture and sound work hand in hand in this effort," he explained. Unless a production makes that a priority, "it's going to be difficult for sound to do it."

Rigney described an experience from the set when camera "held us off to the last minute." When it was finally time to put the sound mitigation in place, "they started rolling camera, so it was too late."

As the camera team dictates what happens around setting up a shot, they may not allow sound to move in and position the mitigation tools. The sound team may have to push its way in to make it happen. "Because ultimately, sound is our responsibility — just like picture is theirs," said Rigney.

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"They will choose to work hand in hand," hopes Rigney, "but if they don't, it could be a little bit of a tug of war." Sound often gets neglected. "300 people are working on how the picture works, and only three are working on how it sounds."

Further reinstating his point, Rigney said, "We need to share some space on the stage to get good sound. Talkies have been around since 1925. Let's keep it going."

The challenge with not being allowed to set the mitigation tools in place for every shot, said Rigney, is that "the reflection is so great that you're almost forcing us to rely on Automated Dialogue Replacement (ADR)."

WHY AVOID ADR?

"ADR should be a second net underneath the trapeze artists, not the first," said Rigney. "You want to avoid ADR."

Elaborating on his concept of *final sample*, Rigney said, "I also call it ZADR or Zero ADR because that's the goal." To do ADR, actors are brought into a sterile booth with a microphone and a mixer to re-record their dialogue tracks over their picture.

Rigney added, "You can never get the full performance back — performances are like snowflakes." As one-offs that happen on stage during production, they will melt away if it is not captured.

Rigney warns that ADR won't ever reproduce that original performance. "It's important that a production prioritizes it if they want to capture the vocal performance." He emphasized the need to maintain that intention and take the time to achieve it. "Otherwise, you're risking ADR."

Fathead has many kids. Generally, kids perform poorly with ADR. The script demanded screaming kids and environmental conditions that magnified the challenge more than usual. "It's not fair to imply that we only produce zero ADR data, but that's the goal," said Rigney.

SOUND UTILITY TASKS

Rigney volunteered to be a sound utility person during production to learn more about the practical side of things. One of his duties was to manage the movement of the nine ZR Screens, 15 furniture blankets, and five floor mats in between scenes, which happened frequently.

"We have to be the first ones to get our stuff out, and we're the last to get it back in," said Rigney. "There's always a big rush."

The team has to place blankets everywhere carefully so they do not mess up the props and production design elements. They also have to be aware of hazards so people don't trip on any of the blankets, carpets, or cables.

Another responsibility is to ensure that the microphones are well-positioned for each actor. The utility also prepares the slate and syncs it.

After experiencing the nitty-gritty activities on set that goes into capturing clean sound during production, Rigney concluded, "If you're going to make an effort with sound on a virtual production stage, it will require an additional person."

Whether that's a sound utility person or an apprentice, a fourth person is required to help with the mitigation movement, setup, and teardown. "Otherwise, you're just going to exhaust your crew and frustrate them, and they'll be less likely to put forward the effort to do what's necessary to achieve the goal of *final sample*."

GO PREPARED TO WIN

For virtual production, it is vital to implement

"You can never get the full performance back—performances are like snowflakes."

previs and techvis and simulate the shooting conditions and results for iterative exploration and improvements. Productions that invest in this approach will "have a greater chance of reaping the benefits," said Rigney.

He suggests bringing in a sound person into some of the previs and techvis meetings to communicate the goal and closely work with camera, lighting, costume, and production design to help mitigate the sound issues that get identified. This predictive approach may lead to replacing materials or changing an angle or a shape that improves the sound quality.

On *Fathead*, Rigney got in touch with the costume and set designers to communicate how to think acoustically. As a result, costume completely changed their helmets. Originally, the designs would have the "kids wearing a metal trash can lid used as the hat, like a samurai." That would have caused the worst-case scenario for sound.

Other designs included pots and pans on the actors' feet. The sets were going to be made of corrugated iron. Due to Rigney's early intervention, "they didn't go that route."

"It's a holistic approach," Rigney noted. "There's no silver bullet that's going to solve it." The whole team has to feel equally responsible about sound as they feel for the picture. "Sound is often not brought on until two weeks before, which is too late."

Rigney warns that ignoring the needs of the sound team may lead to an expensive loss of performance. "You'll have a lot of ADR, which costs more money and is a missed opportunity."

The wide shots are what Rigney found were the toughest to handle because "you can't put up all the mitigation." The advantage of shooting in a volume is being able to capture the scenery and all its ambient light, which is produced by expensive LED panels. "You don't want to cover it up with all these sound mitigation panels."

Most mitigation panels are black, which works well for negative fill. They can be used instead of flags. Rigney recommended that if negative fill is not needed, "it would be great if they had some medium grey and white ones" for neutral effect or bounce light.

NEW TOOLS AROUND THE BEND

"We didn't get to play with them on *Fathead*, but these are coming up in the future," said Rigney of some new technologies and methodologies he has investigated in the process.

Some games have acoustical coefficients placed on environmental surfaces. Based on these coefficients and the geometry, it determines how the sound will reflect, diffuse, and deflect. It's somewhat similar to how ray tracing works for lighting. Rigney said, "They are using that so gamers know what it would sound like in the environment."

By turning on these coefficients, Rigney deliberated that it would be possible to identify the offenders polluting the production dialogue recording. The coefficient would change by playing with the angle of things or changing the material. He said, "We can test an environment and modify it to fit the circumstances."

Productions can evaluate these risks to assess where losing the vocal performance and going into ADR are too high. "Theoretically, the other thing you could do would be to have someone listen to it and analyze it for every scene," Rigney said. "Almost like dailies. Say, The sound was no good. You need to do it again.'"

The technique can be used to determine a microphone's physical properties. Clean and dry takes from a table read can be used for the virtual actors, which can be recorded in the 3D game environment when these lines are delivered. "You record on a virtual boom mic based on the distance to see if the boom's coming in the shot," said Rigney.

Getting the boom out of the shot may require adjustments to where the operator is located, which can be determined this way. Rigney asserted, "It's about awareness and a new paradigm, where you're trying to get people to be aware of sound in a way they've never done it."

Rigney calls for a holistic solution and the kind of education supporting it. "Even though they might not fully appreciate it the first time they hear it, once people are aware of it, they can ask, 'Do we have a sound problem? Maybe we should think about this.'"

Another solution Rigney accessed is an array microphone called Konos from Dotterel Technologies in New Zealand. Their website describes it as "a compact 80-element high-fidelity microphone array with adjustable directivity, rear channel, and real-time noise filtering to capture clear sound in challenging sonic conditions."

Rigney explained, "It has 80 acoustical sensors placed along the sides of a square shotgun microphone." Instead of an audio cord, it uses a Cat 6 Ethernet cable. The microphone can focus the beam in many ways. It can pick up what you focus on while still hearing what's happening around it, which it can eliminate from the focused beam. It separately records the ambient sound.

"You can get your ambient sound recorded at the same time you're recording your actor," explained Rigney. "On a third channel, you can dial in the noise cancellation. It's like pre-canceling out to the point where you are eliminating most of the noise for post-production." It speeds up the process.

"It is a new technology that hasn't been done before." Rigney projected, "In the future, artificial intelligence combined with array microphones will be a way to address these types of things while still using the screens for mitigation."

Rigney wants productions to consider hiring an acoustician. He said, "If I owned one of these LED stages, I'd have an acoustician look at the previs before it goes too far — it's a lot easier to make changes before they cut wood."

"They should measure stages in decibels" is another suggestion Rigney made. "What is the decibel reading in the center of the stage?" There may be a way to arrive at a standard for such measurements — how things sound 10 feet from the center, 20 feet from the center, etc. "You can get people to spec it out and turn around and say, 'This one's noisy, or this other one's quieter. Which one do you want to go to?'" ▪

"They should measure stages in decibels" is another suggestion Rigney made.

"What is the decibel reading in the center of the stage?"

Contributors:

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Final Sample:

Mitigating Reverberation & Noise on a Volume Stage, Guarding Original Dialogue Performance

By: Eric Rigney

INTRODUCTION: FINAL SAMPLE DEFINED

In the context of LED volumetric stages and in-camera visual effects (ICVFX), the goal is often about attaining final pixel at source — for the image captured in-camera to be good enough to require minimal correction or augmentation in post-production.

By the same token, 'final sample' is a term coined by Eric Rigney to underscore a similar goal for capturing dialogue during production on an LED volumetric stage that is clean enough to carry to and through final sound mastering with limited post-production processing beyond de-reverb and ambient sounds.

ACOUSTIC CHALLENGES ON A VIRTUAL PRODUCTION VOLUME

Acoustical Reflection: LED volumetric stages are built with the intent of capturing real-time visual environments in-camera with the actors' performances during production. These tall LED walls are hard, smooth, and highly reflective surfaces sandwiched between concrete ceilings and floors that together create, in effect, an acoustical echo chamber.

Acoustical Noise:

A) A vertical LED wall curved into a semi-circular shape and capped with a flat vertical ceiling behaves like a parabolic microphone. Undesirable sounds, generated outside the stage, get picked up through the stage opening(s), are amplified,

and subsequently, pollute audio recordings.

B) Virtual production equipment, such as computers, uninterrupted power supplies, air conditioners, and keyboards that support the volume control personnel (aka 'brain bar'), are often placed right in front of a stage opening, unwittingly generating equipment noise that gets picked up by the audio recording captured inside the volumetric stage.

Image-centric Bias: Production sound is usually not afforded the same level of support or consideration as the camera and lighting departments. The quality of dialogue recordings is often compromised as a result of the current on-set image-centric bias.

SOLUTIONS: TOOLS AND PRACTICES

Sound reflection and unwanted noise can be effectively mitigated from a virtual production volume stage, but it will require the cumulative efforts of various departments and equipment manufacturers, starting with the panel technology, stage design, and construction that significantly contributes to the problem.

Previs/Techvis: Sound reflection and noise mitigation should be considered before production commences. The previs/techvis process that is presently focused primarily to aid the visual departments may also be used to identify and mitigate sources of sound reflection by creating an awareness of these challenges among other departments.

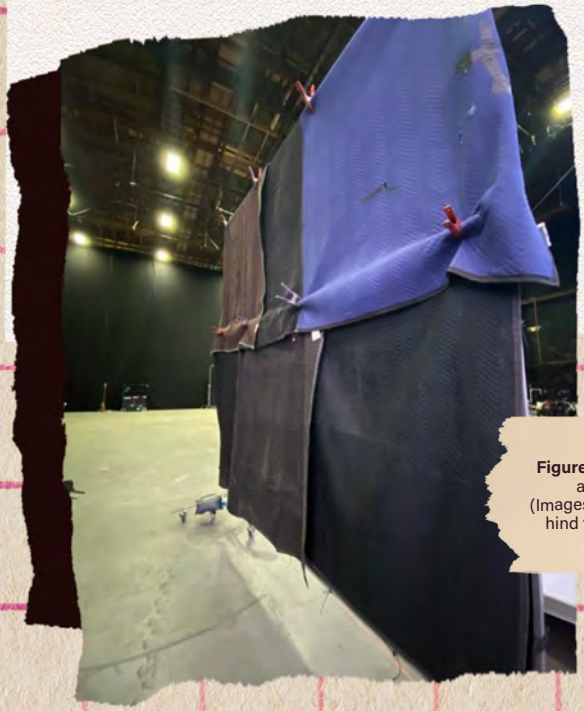
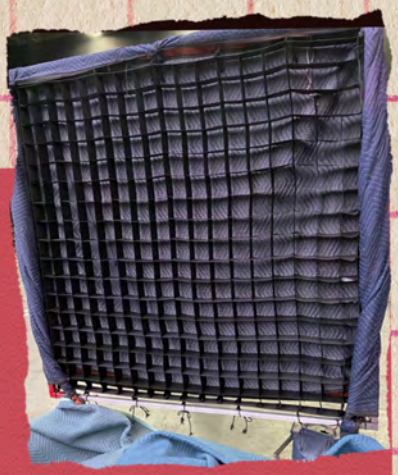


Figure 1 – DIY: Simple, 12'x12' (left), and Echo Shade, 6'x 6' (right), (Images courtesy of Eric Rigney, behind the scenes of ETC's *Fathead*)



On-set Best Practices:
Personnel: Minimize how many personnel are present inside the volume during shooting.

Stage opening: Clear off or shield personnel and noisy equipment from stage openings.

Equipment room & KVM[1]: Employ KVM switches to remotely connect keyboards, monitors, and mice allowing production to limit or eliminate equipment noise around the stage area.

MITIGATION TOOLS AND PRACTICES

Traditional Gear: Common materials used to mitigate sound reflection – such as furniture blankets, carpeted rubber floor mats, foam insulation, etc. should be used extensively to cover as much of the stage floor and areas behind large objects or constructions on the set such that they remain hidden from the camera.

Additional Gear: There are other solutions to help solve the sound issue – some are expensive and a few others are a bit more affordable. At present (circa December 2022), there are four acoustical screen solutions available for this purpose:

1. *Do-it-Yourself (DIY) Solutions*
   a. *Simplest*: Duvetyn and/or furniture pads hanging from C-stands.
   b. *Echo Shade*: A more effective solution is an echo shade. It is similar to the previous DIY example and additionally uses a panel frame with a polyester light diffuser honeycomb grid positioned in front of it.

[1] KVM switch, abbreviation for "keyboard, video and mouse" is a hardware device that allows a user to control multiple computers from one or more sets of keyboards, video monitors, and mice.

2. *Commercial Solutions, available for purchase or rent.*
   a. *ZR Screen, opaque, from Delta H Design, Inc.*
   b. *AirHush, transparent, from CircleHook, LLC.*

Placement: Acoustical mitigation screens should be placed as close to a speaking actor as the camera framing will allow. The screens should be placed facing toward the actor's mouth when they are speaking, and/or toward reflective surfaces.

Quantity: The results are improved with the addition of more acoustical mitigation screens. At least three acoustical mitigation screens should be utilized as a minimum. On a test project, nine screens were used, which proved to be more than sufficient for that particular use case.

Cooperation: Sound mitigation requires collaboration with the first assistant director (1st AD), camera and lighting department, and production design. These discussions are best addressed in pre-production and during rehearsals. The need for cooperation and understanding between the departments cannot be over-stated, as it can help avoid these problems from occurring by identifying these sources, proposing remedies, and eliminating them well before production.

Figure 2 – Commercial: ZR Screen

ADDITIONAL SOUND PERSONNEL

The sound department is more than fully occupied with their responsibilities. The efforts to position and reposition the above mitigation elements without holding the crew or production up usually will require additional support – a dedicated set production assistant (PA), grip, or additional sound utility personnel.

Figure 3 - Screen, Mat, and Pad Placement for Close-Up (Image courtesy of Eric Rigney, behind the scenes of ETC's *Fathead*)

SUMMARY

Sound is an integral part of production. The quality of sound determines how audiences perceive VFX and virtual production outcomes. The steps required to successfully mitigate sound reflection and unwanted noise on an LED volumetric stage is production's responsibility. Through preparation, collaboration, detailed previs/techvis, additional equipment and personnel, and supportive relationships among all the on-set creative professionals, these productions can succeed in capturing original performance dialogue that can carry over to the final sound mix. ▪