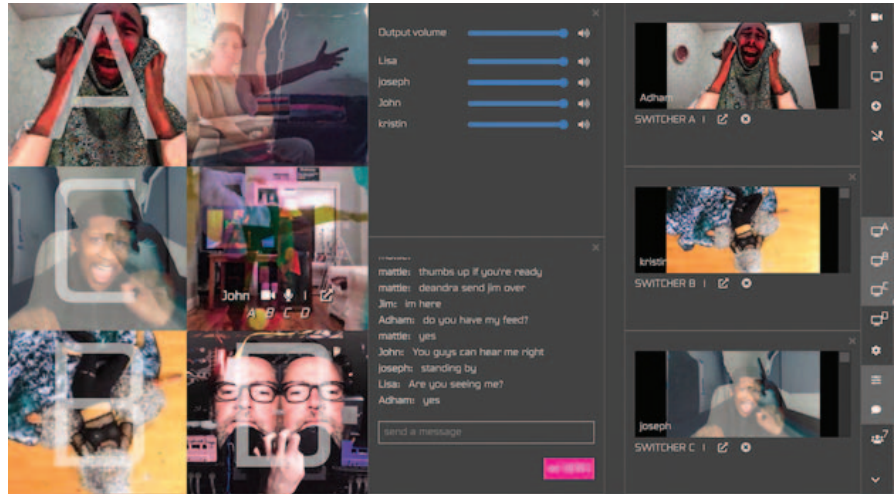


Latency and learning from Zoom

BY ANGRETTE MCCLOSKEY



A screenshot of the interface for LiveLab, a low-latency browser-based video collaboration platform designed specifically for remote virtual performance.

PANDEMIC-DRIVEN QUARANTINES and stay-at-home orders have forced us out of shared physical spaces, and into a globally dispersed online space. How we engage with each other is determined by our online platforms. This is especially true for performance whether online or at a venue. Event and performance professionals who build stages every day are aware of

the physical attributes of a space affects performance. Whatever a venue tech-packet may want you to believe, there is no venue that is truly turn-key or one-size-fits-all. We build, modify, light, and network our stages according to their use. The same logic we apply to physical stages we can also apply to online platforms, such as Zoom, in determining how a platform takes

performance. The use of Zoom beginning last March for everything—including performances, rehearsals, design processes, and classes—has created a sea change in how we make, think about, teach, and see performance.

Not only did the shutdown halt the production processes for many theatres and theatre departments, but it radically

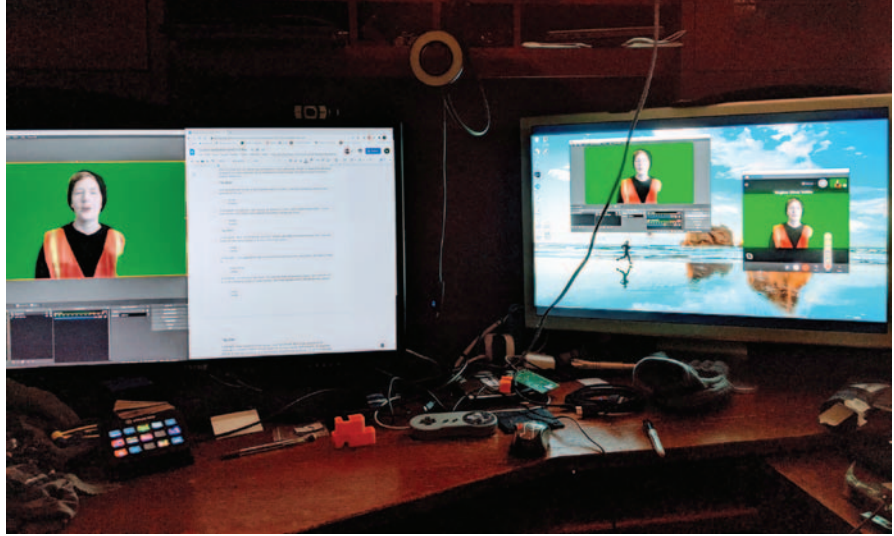


Angrette McCloskey (in Brooklyn) during a discussion with Ray Oppenheimer (in Oakland) conducted over OBS.ninja. Latency and connection details to the left.

limited the access of theatre students to the in-person, hands-on experiences so central to their proficiency in a competitive work environment. As performances moved to Zoom rectangles, attrition from theatre programs, especially design programs, spiked. Even so, with *spatial* distance as a mandate, artists and educators have been immensely resourceful for overcoming social distance. While coders and software engineers may be the current architects of our social spaces, collaborators from all fields have worked to find new modes of engaged, live interaction.

Numerous producing companies, backed by the likes of giants such as Amazon and American Express, have taken considerable cost and risk to produce media events during the pandemic. In contrast, for community theatres and university and college departments, funding for equipment, labor, and materials has either dried up or is about to. Accessible tools—affordable and usable—are essential to artists, educators, and students. Free and open source alternatives to Zoom, namely OBS.ninja¹ and LiveLab², when integrated into a workflow, allow for highly flexible, low-latency audio and video communication *at very low cost*. These are being used by artists and technicians to collaboratively develop and perform remote virtual performances.

Live performance as an industry— theatre, dance, performance, opera, concerts, festivals, conferences, events, fashion shows, awards shows, and more— working to maintain itself financially and in the eyes of the public, has been forced to shift out of in-person events. Since the 1910s live radio has acquainted us with “live” as signaling a synchronous event broadcast to us from a remote location. “Broadcasting live from . . .” works as a marketing slogan for radio and TV; the slogan is less appealing for community theatre in 2020-21. These theatres are supported by loyal audiences for whom being “there” is truly to be in the lap of the performer. Thus, theatre and other live performances which generally occur *in*



Intermedia artist Meghan Moe Beitiks (in Florida) on Ray Oppenheimer’s streaming setup (Oakland), during rehearsals for a bicoastal performance of *Points of Light* (2021).

Tools for understanding and working with latency are vital as we adapt to our globally dispersed virtual space.

the same place as their audiences, have had a harder time retaining what “live” means, not only for their audiences, but also as artists and technicians. While many theatre companies have successfully mounted live-remote performances, *live performance* (at least, before COVID) relies not only on occurring at the same *time* as it is received by its audience, but also in the same *place* as the audience.³ We have lost the functionality of the places we used to congregate in. Adaptation takes time, money, and labor.

When we look at how small theatre departments, and community theatres have shifted, the slick, xR driven performances of the MTV Video Music Awards or beautifully filmed theatre productions, such as the West End production of *Lazarus*, are replaced with clunky, glitchy, Zoom performances, or theatre-turned-(bad)TV. Where production companies fall within this spectrum is primarily budget-dependent. Performing arts companies who had the resources to create strong archival materials, now stream footage of previous productions. Other companies have had the ability (including COVID-testing budgets) to use their theatres. Bringing back a core group of actors and essential crew, they record

performances for a remote audience who receive a livestream in their homes. In the meantime, those in the most restricted circumstances have switched to a fully remote model.

Many producing companies shifting to a live entertainment industry with a remote audience, have left behind vast swathes of their labor force and support structures. An example is the rapidly pivoting, highly symbolic institution that is the Metropolitan Opera. The world’s first public broadcast was transmitted from the Met on January 13, 1910. “*Carmen* heard from a mile off,” read the *New York Times* advertisement. Starting with live “telecasts” (1977-88), and later “simulcasts” (2006), the Met Opera has capitalized on broadcasting its performances worldwide. Since the pandemic, it has turned to streaming operas for paid subscribers and teamed with major media services. They are exemplary in their ability to expand their audiences, but their recent move to re-negotiate union contracts in light of lost revenue is a betrayal. As the largest performing arts employer in the United States, employing nearly 3,000 people pre-pandemic, the Met Opera depends on staff, artists, and technicians

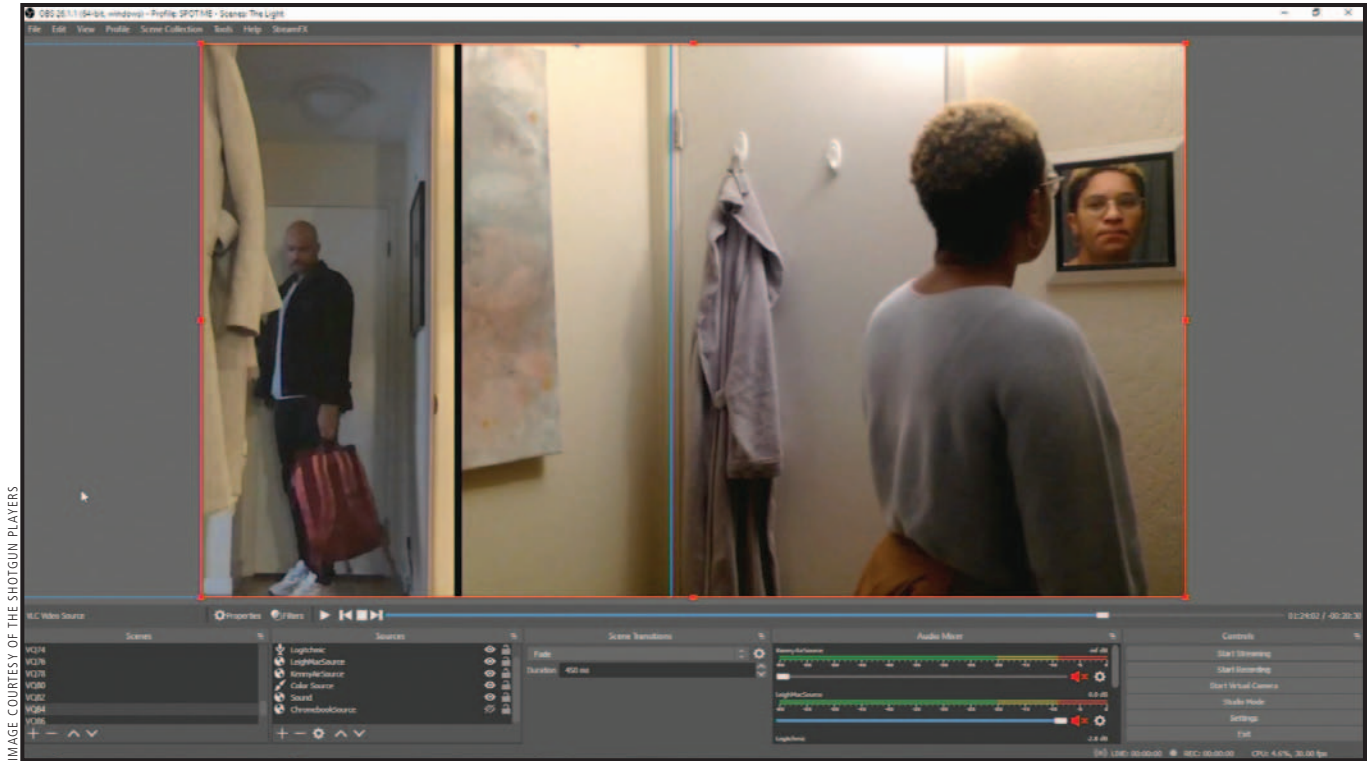


IMAGE COURTESY OF THE SHOTGUN PLAYERS

OBS allows multiple sources to be assembled to create a coherent visual story. Above: Shotgun Players' world premiere of *The Light*, written by Loy A. Webb, directed by Nailah Harper-Malveaux.

who support opera for *in-house* audiences of thousands. Now, emptied of everything that made those productions possible it streams its archival footage.

Be it the Metropolitan Opera, or a local community theatre, the common challenge is that performance is no longer an in-house event experienced by eyes and ears *in situ*. One of the many magics of performance is how it manipulates space and time in front of our eyes. Now, to reach our eyes, it must be distributed, delivered, and processed.

All data transfer entails some degree of latency. Latency in the Internet and gaming world is defined as: a time interval between the input to a simulation and the visual or auditory response. In performance, latency is how long it takes one actor to hear another actor, and how long it takes the audience to hear both. Unlike the Internet, theatres are ultra-low latency environments. So is a rehearsal space. So is my living room. A shared spatial envelope, for the most part, negates latency as an obstacle. We may deal

with things like sightlines or poor acoustics, but ultimately you are already *at the source* of the sight and sound. What you do and what I see happens “in no time” or all at the same time, because we *share a space*.

A 2006 study titled “The effect of network latency upon remote interactive musical performances” is relevant to remote actors experiencing delays within a scene. Music and performance are time-based arts and depend on rhythm and duration. It is because of this that high and/or unpredictably variable latency have such debilitating effects. Latency challenges the identity and performance of the medium itself. Bartelette, et.al.’s study observes that, while duets developed strategies of handling delays, “coordination, pacing, and regularity” was not consistently maintained; at latency at or above 100 ms “*the musicians rated the performances as neither musical nor interactive.*”⁴ In regard to image processing, studies show that a human can interpret visual cues seen for as little as 13 ms (at 75 fps). By comparison, Zoom

recommends a latency of 150 ms, and only supports 30 fps.

While most computers have hardware that supports complex video processing, processing and decoding audio is CPU-intensive and the hardware supporting it varies greatly across users. The way Zoom handles this is by pulling everyone’s disparate video and audio signals to their central servers, and from there packaging it up to send a unified signal to each person. When it combines the multiple audio feeds as one, it determines who is the loudest, and prioritizes that speaker and mutes everyone else. This allows Zoom to handle large groups for meetings. The side effect in Zoom is equivalent to a performance where only one actor holds the microphone at a time. This situation improves when all participants are able to turn off Zoom’s “echo cancellation” and select “use original audio.” For this to be possible, participants need to be using headphones (preferably wired).

Zoom's failures set in stark relief what we miss from in-person performance. Ray Oppenheimer, a lighting designer and lecturer at San Francisco State University, is teaching a new course titled *Creating, Designing, and Streaming Virtual Performances*. Disappointed by the insufficiencies of Zoom, Oppenheimer integrates multiple platforms, namely Open Broadcaster Software (OBS) and OBS.ninja (a Web-RTC based software), into a low-cost media workflow system for remote, low-latency rehearsals, design collaborations, and performance distribution. He teaches students how to use the OBS.ninja and OBS workflow to create collaborative performances native to the online environment. By sometimes pairing it with more traditional theatrical programs such as Isadora, CueLab, and Touchdesigner, it allows him to continue the hands-on education of his design students. He explains that a virtual performance is a type of site-specific performance. As with the first time one enters a stage or venue, you assess what resources it has and what it does not, what the room can support, and what it cannot.

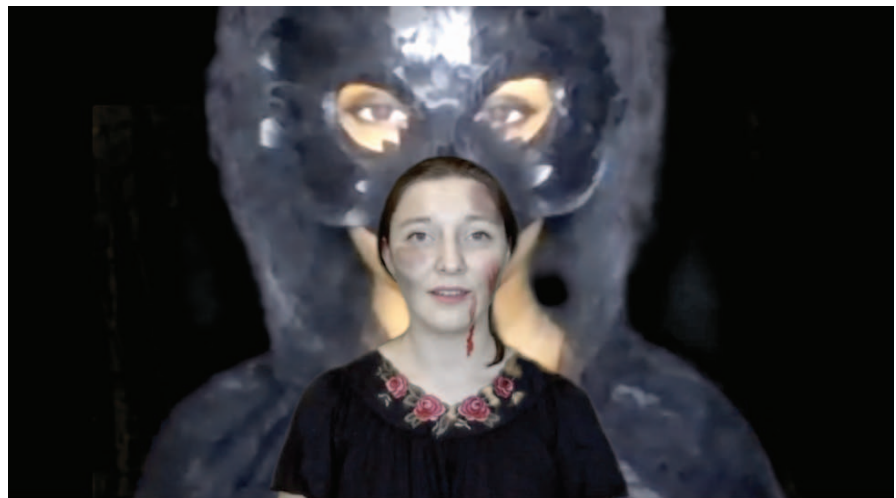
Many tools being used to bridge live and remote performances, other than Zoom, were initially developed for online gaming applications. Massively Multiplayer Online Games (MMOGs) integrate latency concerns within everything from their network infrastructure to their content creation. The optimal environment for online gamers allows for synchronization between their action and the action registering on screen. The goal is an unhindered stimulus-response loop, such that the mechanism of the technology fades away. Consistent with studies on remote music performances, Riot Games notes that gamer enjoyment levels decrease significantly with delays at 100 ms, and attrition of participants increases. Devoted online gamers and the companies serving them commit energy, equipment, and expertise to address latency delays.

For most theatre, latency is a brand

new problem, one which they deal with in the midst of extreme financial insecurity. The budget of community theatres and universities Oppenheimer works with range from \$0, where the production relies on existing equipment and free online software, to \$500, where very limited additional equipment and paid software is provided. When dealing with student productions, educators cannot assume their students have a dedicated computer, and students' Internet service is often shared amongst several members of a household. As a result, financially accessible media workflows requiring limited equipment and technical expertise are central to continuing performance education, not only in the pandemic, but as we explore the globally dispersed online space we are in.

latency communication within a geographic region. LiveLab, developed by CultureHub, a global online arts and community founded by La MaMa and SeoulArts, is also free, open source software for creating peer-to-peer video and audio connections. In these platforms, one user streams their AV directly to everyone else in the room, and they receive the AV signal from everyone else in the room directly. Audio feeds are unmitigated, as though everyone were in the same room talking at the same time. This allows for sound-bed, over-talk, and lower delays, providing for greater responsiveness between performers.

Oppenheimer warns me that this process can be very processor-hungry, so these tools are best used with smaller casts. Oppenheimer's self-made PC can



Fairfield University's recent production of *Woman and Scarecrow* had the creative team working in Connecticut, Florida, and Washington. The director and videographer Park Lytle recorded individual performances through Zoom, then edited them together with OBS.

Unlike Zoom, OBS.ninja creates peer-to-peer video and audio connection offered as a free browser driven service, as well as deployable open source codebase to establish low-latency connections. Instead of sending signals off to a server, they create a path that goes directly from me to you. While we still depend on the processing speeds of our computers and Internet connection, it removes the trip to Zoom's servers. This allows for lower

stably support a cast of eight. Because of the relationship between cast/audience capacity, and number of feeds, these are systems for streaming *out* to an audience, but not for streaming an audience *in*.⁵ These particular developments leave untouched the interaction between audience and performer. They may function as a stage, but they are not a whole theatre, house included.

LiveLab does not require integration with

OBS, as does OBS.ninja. Like OBS.ninja, it's a quick set-up for non-technical users. However, without the integration with OBS, LiveLab does not offer the same flexibility as the OBS.ninja/OBS workflow. One cannot, for example, create a cue stack of scenes, import images or videos from a file, or stack, scale, or add masks to an image or video source. In LiveLab the output volume of each participant is adjustable, but it does not have the advanced audio controls of OBS, nor can an audio file be sourced directly. With OBS.ninja/OBS workflow, a sound designer working remotely to the computer running OBS, feeds sound triggered and manipulated live via OBS.ninja. A video designer or set designer can do the same. While allowing for a great deal of flexibility, the OBS.ninja/OBS workflow used by Oppenheimer erases the need for in-person technical support, or additional equipment at the site of the performers. Basic requirements for performers don't become any more complicated than Zoom, but the engagement between performers and options for design are enormously enhanced.

The most direct solution to high latency problems is getting vaccinated and safely back into shared spaces. Regardless of how quickly this happens, learning from these hardships is what we owe our future selves. Our ability to telecommunicate improves daily, but will never achieve anything better than an asymptotic approach towards co-presence. Tools for understanding and working with latency are vital as we adapt to our globally dispersed virtual space. What we do know: Time works differently here. ■



Angrette McCloskey, PhD is a set designer, production manager, and educator for hire. She has worked over 20 seasons of New York Fashion week, designed over 100 plays/musicals, and received her PhD in Theatre and Performance Studies at Stanford in 2017. She teaches *Period & Styles of Architecture and Decor* at San Francisco State University and is considering a new project composing an updated textbook on the subject. Angrette can be reached at angrette@gmail.com or visit <https://angrette.com/>.

Endnotes:

- 1 OBS.ninja developer: Steve Seguin
- 2 LiveLab lead software developer: Olivia Jack; contributors: Tong Wu, Jesse Ricke
- 3 Telematics, the integration of telecommunications and information technology has been explored and studied by performance artists and musicians since the early 1980s. See also "Telematic performance and the challenge of latency," 2017 by Rofe and Reuben from the *Journal of Music, Technology, & Education*.
- 4 Bartlette, Christopher, et al. "Effect of Network Latency on Interactive Musical Performance." *Music Perception: An Interdisciplinary Journal*, vol. 24, no. 1, 2006, pp. 49–62. JSTOR, www.jstor.org/stable/10.1525/mp.2006.24.1.49. Accessed 24 Mar. 2021.
- 5 Chat feeds from remote audiences may offer a sign of "live" from the audience, but unless they are purposefully integrated into the structure of the performance, what they produce is a delayed record of reactions that populates in friction with the time of the performance. A physically dynamic actor performing for the camera cannot watch for the audience's nuanced reactions in Zoom boxes, much less follow a text chat.