Audio Engineering Society

Conference Paper

International Audio Education Conference
July 22 - 24, 2021

Signal Flow Training with Virtual Simulations as a Co-Curricular Tool

Samuel Z Fisher,

[1] *AudioFusion LLC, NY, USA*

szfpro@gmail.com

ABSTRACT

Traditional pedagogical approaches to signal flow training were forced to be rethought amidst the Covid-19 pandemic. This unprecedented event forced educators to reevaluate curriculum and tools for distance learning in a rapid timeframe. In an effort to adapt courses to online formats, educational programs revealed the growing consensus of virtual simulations being effective for console and signal flow training. The objective of this paper is to document the impact of virtual simulations in audio education amid social restrictions and highlight its relativity for post-pandemic conditions. Observing the progress of educators and students who used virtual simulations in their studio or live sound courses combined with survey and user engagement data collected over the semester to support the results.

1 Introduction

Classic audio education has always relied heavily on the "hands-on" approach to training. Traditional learning requires many hours of being physically present in front of hardware mixers, patchbays and microphones with a mentor serving as a guide. For an institution to provide a variety of hardware and allocate time for student access, even during the best of times, is a difficult administrative task. With increasing social restrictions applied, this scenario was no longer feasible. Majority of programs worldwide were forced online where the "hands-on" element does not exist. Educators evaluated and implemented virtual simulations to make up for this lack of "hands-on" interaction. This presented ideal testing conditions and a unique opportunity to document this research.

From personal experience as a student wanting to advance in my audio engineering studies, I designed a virtual training simulation, "SoundcheckPro", consisting of mixing consoles, patchbays and external audio devices which proved useful as a tool to practice when away from campus hardware labs. The original prototype was a winning project in the Student Design Competition at the AES 137th Convention in 2014. Since then, I have been advocating for virtual training in pro audio education through standalone and virtual reality simulations. The pain point which founded this project resonated with many educators and students who were restricted in accessing campus suites due to lockdowns.

This isn't a pandemic issue. Simulations serve a purpose. This is about the passion of education. To be able to reach students during the pandemic and beyond. The results are so good it enlightened the community to the benefits of virtual simulations as a co-curricular tool.

Figure 1. SoundcheckPro, Virtual Signal Flow Trainer Session Mode Interface

2 Not A Traditional DAW

The requirements of a simulation will appear similar to components found in conventional DAWs. The 'modern DAW' is an innovative tool that allows any user with a computer to achieve the best sound from infinite editing possibilities. These benefits do not translate to the analog hardware domain. A simulation will reflect a pre-existing physical environment with the intention of challenging the user with a variety of devices and routing configurations. If the environment offers a mixer with 16 channels, 4 subgroups and 3 external compressors then, that's all there is. There is no right click to make additional channels or subgroups or inserts fx. An engineer needs to understand the flexibility of the devices and work to maximize those limitations. This only comes through experience.

Example: A mixer with stereo returns inputs, could technically be used as extra channel signals

Notably, all current DAWs on the market offer a single mixing interface within a single application. Comparing mixers is, and should always be, an integrated part of the experience in order to achieve full learning potentials. SoundcheckPro offers 7 mixing console simulations internally. The variety promotes the confidence to troubleshoot different workflows and observe different naming conventions describing similar functions.

3 Immersion in Virtual Reality

Further realism of a simulation is possible within Virtual Reality. In this scenario, the hardware devices are presented and operated in 3D space. The surrounding visual environment would ideally be a studio control room, live or creative space. A distinguishing difference separating Augmented Reality (AR) from Virtual Reality (VR) is that any existing elements in the real-world are still present in AR and would be a distraction. In VR, the headset completely engulfs the user and blocks out anything exterior to the virtual world. Additionally, more assets relating to music studios can enhance a realistic emotional response similar to that of being physically present in such spaces. Items such as track sheets, iconic posters, or interior decor allow the user to become even more immersed in the experience.

Imagine leaving inexperienced students in a major studio environment on their own without supervision. That scenario is unlikely in the real-world, however, very possible in VR. Students with lesser knowledge or even younger age groups can have their first exposure with hardware leaving them more prepared with each following encounter. During a demo at a gaming conference in Orlando, a child as young as 8 years old made his first attempts to use the patchbay after observing other users. His initial efforts were incorrect as he tried to plug a cable from the patchbay and drag the cable to the far side of the desk hoping to patch into a compressor directly. With a little instruction, this 8 year old would learn to plug both ends of the cable on the patchbay in order to send the desired device. The revelation of what an 8 year old would do if left to a studio unsupervised is only possible in virtual simulation.

Figure 2. An 8 year old's first attempt using the patchbay in the VR Recording Studio.

Despite the strong advantages of Virtual Reality, there are some major drawbacks. Obstacles such as motion sickness and fatigue are likely to occur as users need to constantly look around 3D space. These symptoms greatly reduce a student's ability to absorb content and will obstruct their greater learning potentials. Therefore, it is recommended to use Virtual Reality for shorter durations as users become acquainted with the technology. A simulation with a conventional 2D interface would be more appropriate for the early stages of learning.

The 3D/VR simulation is best suited for those who have "graduated" to the experience equipped with the confidence to explore and troubleshoot. When displaying the VR studio simulation at an AES Convention in 2017, engineers who demoed the technology, even without ever trying our software or virtual reality prior, would immediately know how to locate all components necessary to operate the environment. Students who tried the demo might have needed minor assistance but, once it was clear to them, they were operating the entire space independently. This result is the precise goal of any audio engineering education program; for students to be most prepared to operate any environment at full capacity.

4 Components of a Simulator

All of the following must be distinguished and accessible in the simulation (the same as you expect a gain parameter on any mixer)

- **Sources** - audio files and mic inputs.
- **Destinations** - All outputs in that could be used as monitored mixes (main out, auxs, bus groups, cues etc)
- **Console** - Simulation of the mixer(s) with independent zooming
- **Routing Matrix** - Digital I/O or analog patchbay of all inputs & outputs.
- **Transport and Zooming**- Essential to highlight channels that might only have audio played at various sections of a track.
- **Settings** - offering more flexibility or routing than might be displayed on front panels
- ***Virtual Reality** - the common standards of room-scale design*

Without the above mentioned, the learning potentials are diminished.

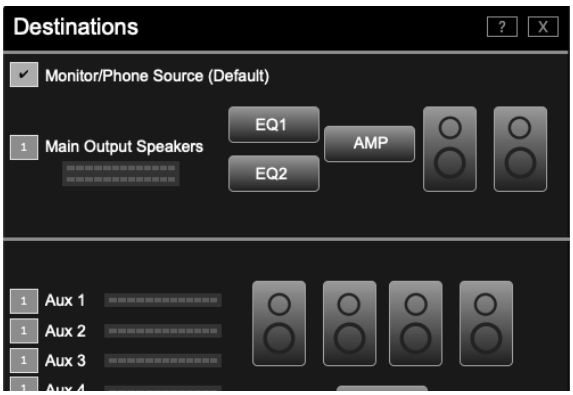

Figure 3. Screenshot of the Destinations Tab.

5 A Series of Evaluations

From the onset of the pandemic, I consulted with hundreds of educators over hundreds of hours from around the world who inquired about virtual simulations as an option for their courses. Each educator expressed different struggles and needs. Mainly, educators were seeking a way to interactively demonstrate signal flow through a console, patchbay routing and offer the ability to troubleshoot problems in an environment. Everything a virtual simulation should be for pro-audio.

Demonstrating a virtual signal flow exercise over a video call was the best real-world example of how these educators hoped their course content would translate into the online format. The flexibility of a simulation offered educators the confidence to adequately train students in a variety of subjects in a remote setting. Noted below are some of the reactions from both students & educators during the early beginnings of the pandemic.

Educators:
“Just what the doctor ordered for pandemic teaching of signal flow”

“Very excited by the prospect of having such a tool for my students to practice Signal Flow”

Students:
“I'm a student for musical production, and i wanna try your virtual software, because due to quarantine we can't go to the physical studio in the itm university, thanks you for the trial”

“I´m studying music production, this software will be useful for me to practice in how to use a mixer, because of nowadays situation I can not attend campus classes”

6 New Pedagogical Approaches

An important aspect of working with hardware is getting through first impressions and gaining ‘confidence’. The patchbay is a hardware component that many struggle to understand and find intimidating. Merely saying that “it is the central routing matrix of an analog environment” is not adequate enough for most first year students to understand. Educators express that students only understand patchbays once they’ve interacted with it’s routing capabilities “hands-on”. This would normally be a slower controlled process as students

need to wait for relevant courses to learn the basics with supervision. With a simulation, students are given instant access to virtual patchbays with the ability to work from home at any convenient time. All inputs and outputs in the environment are represented on the patchbay. Students can experiment with connections and visualize the signal changes on meters across devices. An alert will popup should a user induct a feedback loop.

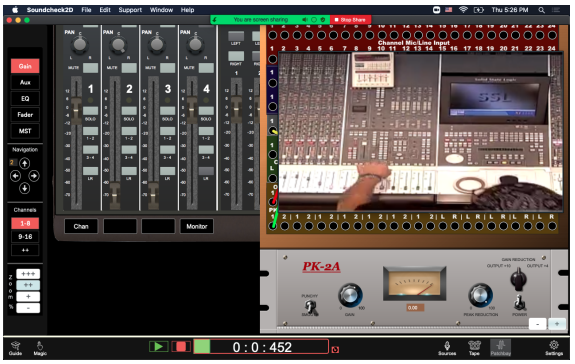

Figure 4. An educator demonstrates the similarities between a physical and virtual console over ZOOM

Signal flow is the path which audio takes from source to output. It can be a simple signal chain or a more complex routing scheme. Signal Flow derives its character from the engineer that is operating a given environment. Two engineers might use the same hardware radically differently depending on their preference of workflow. So too, educators yield different approaches to curriculum & pedagogy. The new accessibility of a component, such as the virtual patchbay, posed the question of how to best implement virtual simulations in a curriculum especially given the short time to prepare.

Two types of implementation have been identified:

Hardline Implementation - Treat the simulation as a new lab suite built on campus. Throw students into the simulations as early as possible to experiment with the outcomes unsupervised. Improve the curriculum based on results similar to that of demonstrating techniques with real hardware.

Parallel Implementation - Using the simulation within an existing curriculum where applicable. For instance, demonstrating how to insert a compressor in a DAW also presents an opportunity to demonstrate how to insert a compressor in the analog domain. Identifying other possible areas of parallel implementation could also enable programs to keep signal flow reflexes relative in students' minds as they are prone to forget material during gaps between hardware classes.

To inspire more practical use, lesson plans and exercises were supplied in the form of "Signal Flow Drills". These modular exercises could be redesigned to offer more variety of challenges to students. It has been very popular for onboarding educators who needed ideas on how to segment the topics.

Popular Drills:

- Mixer Signal Input, Speaker Output
- Patchbay Routing (Inserts, FX Sends)
- Subgrouping
- Pre vs Post Fader

A Detailed Signal Flow Drill

Setting up a studio or live session is a time sensitive operation. Microphones need to be placed, wired to the environment and the signals need to play out to all desired destinations. Failing to do so in a timely manner or exposure to feedback loops will likely be detrimental to an engineer's career.

Being a simulation, a live performer is not required. An audio file and microphone could be assigned in the sources tab (representing a performer).

The workflow to achieve playback differentiates between mixing hardware. However, the idea always remains the same; signals need to reach the mixer and then play out to the main speakers or headphone mixes. With a variety of virtual consoles offered in a simulation, it is possible to demonstrate all of the workflows in roughly *3-10 Steps*.

The following are the most common:

1. Raise the input gain
2. Raise the channel fader
3. Assign channel to main mix bus
4. Raise master fader
5. Assign monitor output
6. Raise monitor volume

In a virtual conference setting like ZOOM, educators would use the virtual simulation for interactive demonstrations and offer assignments to reinforce the intricacies of signal flow. Some had the option of streaming lessons from campus studios or live stages. They were able to draw comparisons of the hardware offered on campus simultaneously with the virtual environment. This kind of accessibility to hardware workflow is a drastic disruption as to how these subjects are generally taught. Typically, students need to wait a considerable amount of time before educators feel comfortable allowing them access to hardware out of fear of liability or limited time available. With a virtual simulation students were practicing the workflow being taught in real time following along with their instructor from home. No student was in the back of the class waiting for their turn to operate the gear and they were better prepared when they arrived at labs. At this pace students can truly graduate to the 3D product similar to how they translate a 2D simulation to a physical room.

Figure 5. An educator demonstrates the similarities between a physical and virtual patchbay over ZOOM

7 Opportunity For Change

Education has mostly taken a backseat in the pro-audio product market. There are no tools previously dedicated to audio education or administration. Virtualized console & signal flow simulations are first of their kind. Audio Education has remained unchanged for many decades. An opportunity presented itself in which we must deviate from the norm and experiment with new ideas. Virtual simulations offer the highly flexible control of signal flow allowing educators to sustain their course subjects in remote settings and become familiar with new approaches to delivery.

It is a special gift to have access to these machines. Simulations offer what has always been special about these machines and more instead of having just fifteen minutes with them. Not every school has a multi-million dollar studio. Not every school can make time to throw students in a multi-million dollar studio to mess around. Every school could have 10 or more of these virtual boards at a fraction of the cost and optionally scale to reach the student demand. 30 students can be sitting on a multi-million dollar setup at the same time in a classroom or at home. WIth the addition of Virtual Reality, that “feeling” that is authentic to these environments is highlighted and brings them into the excitement.

The educators who had the most success implementing virtual training into their courses came from their ability to “be resourceful” when restricted. To those who felt comfortable “running with it”, a virtual simulation like SoundcheckPro felt natural and served an effective purpose.

Below is response to virtual simulations in the early weeks of the semesters.

Educators:
“We just did our first day ‘hands-on’ with SoundcheckPro and it worked really well. The students were really happy to get their hands on the console and start routing and leveling. This tool is going to be very useful even outside of pandemic conditions.” - Canada

Students:
"I go to a great program! Really believe that this tool will make it even better." - San Francisco

"I am enrolled in an audio engineering program in Pasadena, Tx. Due to COVID and construction to our new studio, learning the ins and outs of using a console in person has not been an option. Using this software really helps bridge the gap during these times. Thanks" - Texas

8 Failure to Innovate

The only thing that was disappointing, is that some schools just didn't 'get it' and didn't bother to try it. The programs who were embracing the technology were rewarded tenfold. For so many schools to tell me this is beneficial tells me the other schools were not really interested enough to evaluate or attempt to implement new tech for the benefit of students. The institutions know the large consoles are important enough to put it on display. It should be important enough to get that type of experience into student hands to practice independently. It's not for the teacher to say it won't work especially during remote and uncertain times. The students are the ones that understand new technologies. For this reason, I put strong emphasis on educators to get the technology in front of students as part of their evaluations.

Many programs were simply not aware of the development of such virtual tools. Due to lack of knowledge of efficient alternatives, many schools merely gave up teaching studio courses or signal flow. This, I believe, falls on the societal organizations that did not respond with "actionable" efforts in desperate times to spread awareness and strengthen community. It is nothing but a shame and the ones who suffered are students.

9 Data-Driven Audio Education

'SoundcheckPro Stats' are derived from user actions in the software. Each parameter, cable connection or general interaction will trigger an action to be collected in user accounts for them to monitor their own progress. Between June 2020 and January 2021, there were over 1 million actions made. These are data collections of signal flow, console and patchbay functions that were all made by students and educators from around the world. The actions that populate SoundcheckPro Stats have all been made during lockdown when most were restricted from accessing campus suites. The programs that managed to sustain lab sessions on campus noted how students were better prepared for their first encounters due to the knowledge learned in the virtual experience. A positive indicator that audio education did not halt for the semester using virtual simulations despite crippling restrictions.

Several schools averaged thousands of patchbay and console actions each week. These are data points that have never truly been monitored even outside pandemic conditions. This has ushered in what I call, "Data-Driven Audio Education", when student progress could be monitored even when remote and enabling educators to strategize according to data.

Monthly Soundcheck Stats September 2020:
Over 10,000 Patchbay connections
Over 15,000 Console interactions
Over 90 actions average per session

Lifetime SoundcheckStats January 2021:
Console Interactions ~ 400,000
Patchbay Interactions ~ 150,000
Session Interactions ~ 400,000
Average Session Duration ~ 30 minutes

Soundcheck Stats

Data Point	Value
App Launches	12
Session Launches	13
Last Mixer	AWX
Patchbay Actions	100
Maggie Uses	10
SZF Uses	3
AWX Used	6
Feedback Loops	0

Figure 6. The first iteration of SoundcheckPro stats available to user accounts

10 Final Evaluation

Combining the datasets provided in SoundcheckPro Stats with the evaluation survey filled by educational users to draw conclusive results:

- 89% happy with the experience
- 93% say effective for Signal Flow Training
- 96% say effective for console training
- 96% say effective for patchbay training
- 82% say generated student interest
- 81% say effective amid social restrictions, 18% say neutral
- 89% say it will be effective in post covid conditions
- 89% say helps students better understand material
- 63% say students were better prepared for labs, %33 say neutral *(keeping in mind not many programs had access to labs)*

Educator Review:
"SoundcheckPro has been a useful tool in a time where most students are remote and unable to gain the hands-on training they would in the classroom. This application has allowed me to continue teaching proper techniques when students are not in front of a console." - Barbara Adams, Rowan University

"My students come to the studio with greater confidence, ready to work" - Jon Clark, Salt Lake Community College

"I don't believe I could have made it through an entirely online semester without SoundcheckPro. It kept my students interested, got them familiarized with multiple consoles so they could draw comparisons and make learning new consoles much easier." - Angela Beyer, San Jacinto College

11 Conclusion

Virtual trainers provide an infinite ability to continue reinforcing the knowledge and reflexes that students need to thrive in physical environments. Simulations are safe, cost effective and accessible. In a virtual trainer, no one is in the back of the class or too distant to learn. Not even in the midst of a global pandemic. The most rewarding statistic is that students feel confidence when they get their opportunity to use what is considered by many "music's most intimidating pieces of gear". While other students might be overwhelmed, students taught in virtual simulations feel right at home. Educators feel they retained their ability to teach consoles, patchbays and signal flow with the element of "hands-on" that was previously missing in distance learning.

Remote learning was always there. Now there are numbers supporting that remote learning does work in audio education. If a student could get their hands on this equipment more, they will become more experienced. The reason I have been able to develop a tool that relates to so many is because of the countless hours invested into understanding the nuances of simulating different environments.

The methods adopted by audio programs to teach signal flow virtually combined with actionable statistics and survey feedback, demonstrate the growing general acceptance of virtual training simulations as an effective co-curricular tool in audio education for campus, online or hybrid models. Further research will relate different approaches to using virtual simulations to increase efficiency for traditional and distance learning.