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Delivering Dadvatar

By Richard Cadena

Technology takes the stage in *Co-Founders*, the musical

Esata's deceased father is brought to life as "Dadvatar" and appears onstage projected in real time.

Co-Founders, the musical, which ran at San Francisco's American Conservatory Theatre this spring, is set in the heart of Silicon Valley, apropos for an art piece in which technology is not only an important theme but is also a character. The heartwarming storyline is about a young coder in Oakland named Esata who hacks her way into the most competitive startup accelerator in San Francisco to save her mother's house from the threat of gentrification. The music was wonderfully infused with hip-hop, soul, gospel, funk, jazz, and R&B, and the visuals were spectacular, the highlight of which might be the real-time-rendered avatar of the protagonist Esata's deceased father. "Dadvatar" who appeared on stage projected in real time on a downstage holo scrim, serving as a confidant, emotional support, and technical project.

But it wasn't your standard-issue, pre-rendered animation or projection effect. Dadvatar was a live performer offstage, rendered in Unreal Engine using motion capture and delivered to the audience in real time with all the interaction and rhythm of a live performer. Unreal Engine, the real-time 3D game engine developed by Epic Games, is often used to build visuals for video games, films, television, virtual production, live events, and more. In this case, it was a highly effective tool that helped to tell the story uniquely while serving as a prime example of how immersive technology can work in live theatre.

After seeing the show, I spoke with three of the *Co-Founders* creative and technical team, including co-writer and producer Beau Lewis, visual content designer David Richardson, and projection system designer Frédéric O.

All photos: Kevin Berne

"I've been doing this for a long, long time," Boulay says. "And this is probably the most complicated show I've ever programmed. We had so many cues. so many transitions, so many things."

Boulay, to understand how technology was used to shape the show, including how Dadvatar was conceived, prototyped, and brought to life.

The genesis of Dadvatar

For Lewis, the journey began not with tech but with theme. "Our approach around technology for the show has always been that technology can't be a gimmick," he says. "This needs to be a story that works at its deepest levels around themes that people relate to, and those themes are around universal truths, around belonging, about outsiders, around loss, around grief, around change. And so, the idea for Dadvatar started with (the question], 'What is at the core of Esata's desire to create something new?' And, really, [hat comes from her loss of her father, finding a way to grieve and heal, and he being the person who got her interested in technology by coding PC games and hacking Atari consoles in the garage. You don't necessarily realize how powerful that impact can be until you measure it forward in decades. And so, with Esata losing her father, how would she grieve? How would she cope with that? And the idea that we had, which seemed novel five years ago, was, what if she built an AI of her dad?"

Esata's virtual father, Dadvatar, becomes her closest companion and emotional support, as well as a metaphor for the way we try to preserve connection through technology. "Once we had that idea," said Lewis, "we thought, how would we portray that on stage?"

Real-time presence and Unreal Engine

Achieving a live, emotionally realistic, digital character might only be achievable by embracing cutting-edge tools, the team believed. They built Dadvatar using a powerful tech stack that includes live facial motion capture, real-time rendering, and an avatar designed using photogrammetry, Unreal Engine, and the MetaHuman system. MetaHuman is a character creation tool for producing realistic, customizable digital humans that can be used in Unreal Engine. It includes facial animation rigging as well as body and hand rigging with motion capture. The facial capture was driven by a webcam feed into Unreal via Live Link, while body gestures were controlled via an Xbox controller operated

live by the actor, who performed offstage.

"The actor would be backstage, and he would be playing the Xbox controller," Lewis says. "'Y' might throw his hands up like this, or 'X' might salute, and the little joysticks would kind of waver him back and forth. So, he had to learn. Luckily, he played Xbox. We tried to make it as intuitive as possible, but we basically designed a video game for Dadvatar."

More accurately, Richardson's brother, Ryan, designed Dadvatar using Unreal Engine before he was called to work at the Sphere in Las Vegas. But this live pipeline created better opportunities for improvisation and authentic emotional reactions, and it also introduced challenges, the most notable of which was latency. Richardson says there was about a half-second delay.

"We were able to delay the audio during dialogue so that you don't feel that," he says. "But when it came time for Dadvatar to sing and perform in those songs, then half a second makes a big difference."

The team solved this by avoiding scenes where Dadvatar sings on the larger screen, where latency would be more visible, and instead limited those performances to smaller onstage monitors.

A human in the wings

The role of Dadvatar was performed by Tommy Soulati Shepherd, who was backstage and not visible to the audience, delivering a deeply nuanced performance.

"A lot of credit goes to Tommy for learning how to act with that apparatus," says Lewis, recognizing that he had to react in what seems like real time, but with a delay, while using an Xbox controller to manage his body movements and gestures. "That's a lot to ask of an actor who is backstage, looking at a webcam feed of the stage and the audience, to then play in real time with. He really took it on, and it got better through tech and through previews and continues to get better, to be honest, to the show. That's amazing."

The team refined the approach to mostly compensate for latency, acting quirks, and monitoring systems, to make the interaction more realistic and seamless. "Once you get in the story, [the latency] all just evaporates, and it just becomes a story."

Multi-layered space: projection as storytelling

The production used layered projections very effectively to create depth, set the mood, and shape the meaning of the scene. A translucent scrim in the foreground was a canvas for large downstage projections, upstage screens, and stage lighting, which all had to work in tandem.

"The hardest part of the show was not so much the visuals, but the lighting," Boulay says. "Lighting this is very difficult, because you don't have front lighting at all. Zero. You have to light them from the top or the side, and you've got to give the illusion that there is front lighting. When you saw the show, you probably didn't even really think about it because it was very well done. Xavier [Pierce, lighting designer] did a fantastic job."

Boulay designed the projection using two double-stacked Epson Pro L1505UNL laser projectors for the downstage and an Epson Pro EB-PU2216B laser projector for the

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Boulay specified two double-stacked Epson Pro L1505UNL laser projectors for the downstage and an Epson Pro EB-PU2216B laser projector for the upstage projections.

upstage projections. He brought in the screens from an Italian manufacturer to save money, and he said the quality was "great."

"The front screen, the Hologauze [made by Holotronica], was the most complicated," Boulay says. "You need a lot of brightness to make it look halfway decent because it's a nearly transparent gauze. The space was so tight that, to do these big images, we used snorkel lenses. The projector for the back screen and the projector for the front screen were literally separated by scenic elements. We had inches to spare to get the dimensions we wanted."

"It was really funny hearing the back and forth between Frédéric and lighting," Richardson says. "'Would you give me an inch and a half here? Do you have a half an inch there?' Everybody is fighting for every single fraction of an inch up there. If the theatre had been two feet shallower, it would have been complicated. It's almost like it was designed for this show. It worked out."

Boulay notes that working with double-stacked front projection, the snorkel lenses were "very, very demanding." He ended up with a 64-point mapping to make sure everything was aligned correctly.

"It's not like you put a projector on and you get this nice rectangle automatically and it stays that way," he says. "We go through the whole process, and we have no real issues. But then we start getting into the performances, and they start opening the door, the HVAC comes on, and the screen starts bulging out. But it ended up working out. We figured out what to do to keep the morphing of the screen to a minimum."

Millumin, media servers, and real-time creativity

A major piece of the technology puzzle was the media server. Millumin is a France-based media server platform that combines live show control (cue lists and a timeline) with video mapping, DMX control, effects, audio routing, MIDI, OSC, and more. Boulay, who has worked with it since its Alpha stages, says it's "really amazing, very flexible, and allowed us to program, modify, and adjust on the fly."

"It's sort of like a mini version of Adobe After Effects paired with a typical media server. David designed all the visuals, but being able to work with the media server was paramount to being able to put the show together because it was fast."

Richardson says, "I could go, 'Okay, we need to do this. Can you do that on Millumin, or do I need to open After Effects and Premiere?' There were a lot of things that sped up [the workflow] because Frédéric would say, 'I can cut that down, I can move this, I can reverse that and rebuild it in Millumin without having to go through the After Effects pipeline again'."

This live adaptability was crucial during tech rehearsals, which involved about 60 people. "Any time they're waiting on us," Boulay says, "everybody's sort of tapping their foot. 'All right, guys, this is great, but are we almost there?' So, having flexible tools that would let us experiment and see the outcomes and present to the director [was important]. I've been doing this for a long, long time. And this is probably the most complicated show I've ever programmed. We had so many cues. so many transitions, so many things."

Richardson says, "Because this is live theatre, the songs and music were always evolving. We would get new versions constantly, and the music was played live. The band might vamp for dialogue, or the music might change because of creative decisions. We were editing on the fly."

"There would be times where we would want to be on SMPTE," he says, "so I had to redesign the visuals and break them up. So, this first part is here, then we go into a loop for the dialogue, and then it's a new video trigger going back into the song. It was a fun learning experience."

Cues, protocols, and the network

Central to the video, audio, and lighting was a complex show control network, cueing systems using different protocols, most of which were triggered by an ETC Ion console.

"You don't want to have a stage manager that has to call hundreds of lighting, audio, and video cues to different operators," Boulay says. "We

tried to make everything come from the lightboard, but that became sort of complex. We used Open Sound Control (OSC), which I always describe as MIDI on steroids. I never work with MIDI because it's not granular enough. You don't have enough steps. OSC is endless; it's infinite. You can work with what's called float 32 [32 decimals]. The precision is enormous, but it's also a lot of data. So, when you do things that sweep, the refresh rate is such that you're able to have smooth things. For video, we mostly used it for triggering cues."

The band used a click track and some timecode, according to Boulay. The lighting console not only cued the lighting looks but also the majority of the video and some of the audio cues, if they had to be timed to an event. Other times, the cues would be triggered by the audio department, and it would fire lighting cues that would, in turn, trigger sounds and video.

"There were hundreds and hundreds of cues in the show," he says. "It's hard to know when you see the show because a good lighting designer makes it look like almost completely fluid. I think they had something like 600 or 700 light cues."

The team used NDI for real-time video feeds, including Dadvatar, and separated that signal into its own VLAN to avoid packet collisions with other data. They also built in redundant systems, including mirrored media servers, so no single point of failure could torpedo the show.

"At any moment," Boulay says, "you're controlling multiple things. Then you add a new node for each node. If you've got a lightboard, then you've got a secondary backup lightboard. If you've got a media server, you've got a secondary media server that can take over. We did some testing throughout the process, and we could just switch from one to the other in less than a second."

Still, Boulay says there were "gremlins." But they rebuilt the entire network and managed to make it stable in tech rehearsals.

"I went to see the show with my family on July 3 [near the end of the run] and there were no glitches. I was like, well, maybe I should be in the theatre at all times," he jokes.

Because of the front and rear projections, lighting designer Xavier Pierce was restricted to using side and top lighting and still managed to make it look natural.

Custom interactivity: building in the audience

One technical feats in *Co-Founders* is its nightly incorporation of live audience suggestions. Using QR codes, patrons submit business startup ideas, which are collected live in Google Sheets, parsed by a custom app, and integrated into the show. One submission is chosen as the winner, and toward the end, the cast sings a jingle pitching the business idea.

"Someone would write a riff on the business idea," Boulay says, "and the people onstage would sing it as if they'd been singing this every night. On the stage, there is this big neural network [projected on the scrim] where all the business ideas sort of float around and interconnect, like, this is really about the people and the interconnection of all these ideas."

Fast and furious

Reflecting on their time developing the show, Boulay says, "It was fast, it was constant, and there were always modifications. David and I survived three-and-a-half weeks of tech. When I got home after the show, I was completely spent. We spent 12, 14 hours every day, six days a week, for three-and-a-half weeks programming. David had to modify and change small details that maybe were not that obvious, but made a big difference at the end. So, the choice of media server was definitely important to this show."

"Our hope," Lewis says, "is that this show helps inspire people to create things that seem impossible, and that spirit of hustle and entrepreneurship and imagination is something that needs to be watered, and that we are here to celebrate and to include the voices of the outsiders as necessary participants to challenge systems and help improve them and change them."

In *Co-Founders*, code becomes memory, projection becomes presence, and a story of loss becomes a celebration of creativity. And if that's not the future of theatre, it's at least a powerful glimpse of possibilities.