



Raising the Roof at Red Rocks

By: Dan Daley

The iconic amphitheatre gets a new sound system and a new topper as live music returns

As Frank Sinatra once quipped, “Cock your hat—angles are attitudes.” And Old Blue Eyes knew a thing or two about how to wear a chapeau. Red Rocks Amphitheatre, carved out by the New Deal’s Civilian Conservation Corps just before WWII and named in a *Rolling Stone* magazine poll as the “coolest outdoor amphitheatre in the nation,” turns 80 this year and it has gotten a makeover with the most noticeable element being its own new topper: a brand-new roof, one with its own very smart angle.

It’s not unusual for AV technology articles to reference a venue’s roof. That’s the part of a space from which the rigging descends that supports all those lights and sound and

video elements. But Red Rocks’ roof is no ordinary crown; rather, it’s the pinnacle of man’s complement to, rather than competition with, the red sandstone that makes up much of Red Rocks Park. It’s also often the first thing visitors to the amphitheatre will see once they first set foot in the park. The renovation of the stage roof is perhaps the most visible part of the Elevate Denver 10-year, \$937-million bond program, its mission being to enhance the City and County of Denver through critical improvements to the city’s infrastructure. How’s that for pressure when you’re designing an AV system?

“It’s a really cool project and a unique experience—I can see why artists want to play there,” says Andy Burkart, of BCER Engineering, the design consultancy that put together on paper the new d&b audiotechnik sound system and replacement infrastructure for the venue’s video screen and other technical aspects. “The roof was the keystone for the project, which was 90% structural in nature. They wanted to increase the rigging capacity of the roof, but it had to be done within the aesthetic and budgetary parameters.” But, he adds, it was also a challenge having to make those sys-

tems design fit into the new roof design in ways that served both the practical and the aesthetic. For instance, unlike a typical indoor performance space that relies on artificial light, Red Rocks is music's equivalent of Shakespeare's Globe, as ready to rock a daytime show as an evening one, and in the warmer months those later shows still have plenty of natural light. Thus, a lot of infrastructure that is easily hidden in a conventional theatre needs to work extra hard to be invisible here.

This required extra wiring. The new PA system, for instance, demanded additional cabling—West Penn HA210 10/2 speaker cable, to be exact—in part because a catwalk between a tower and the stage, previously used as a conduit for the wiring for the three PA amplifiers, was removed as part of the new architectural plan. This caused Burkart to work with the project's general contractor, GH Phipps Construction, and Brown Note Productions, the systems integrator that installed the PA system and cabling, to develop alternate and much longer runs underneath the stage for connecting amps and speakers. That cabling would also serve the QSC Q-SYS Core 510i added as the AV systems' new control system, accessed via QSC's 11.6" TSC-116w-



The seating consists of long benches topped by ipe, also known as Brazilian walnut, considered to be the most durable matured wood.

G2 touch screens. (An existing 8mm, 14.5'-high by 20.5'-wide LED video wall installed by Daktronics in 2017, was relocated within the stage area.)

"For the same reasons, everything had to be arranged to match the aesthetic," Burkart says. "We had to choose products based on things like paintability, as well as how they served their intended purpose." These extended to things like the antennas for the Shure ULXD digital wireless microphone system, for which a Winegard FlatWave digital terrestrial-television antenna—able to be painted to match

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The roof under construction.

the roof structure—was chosen, instead of the arrow-shaped flat antenna that's usually used with the system. (The switch-out was okayed by Shure engineers.) Microphone, Cat-6, and 12G SDI cabling was run in conduit ensconced inside newly constructed left and right vertical support columns, keeping it hidden from view, terminating in a customer patch bay, enclosed in FSR Model 500 outdoor wall boxes at the bottom that act as a quick-connect matrix between stage and rigging levels, and that also links to the venue's MDF closet for network connectivity.

The roof's potential impact on the venue sound was also considered by Short Elliott Hendrickson (SEH), the architects on the project, which included the new roof design. "It's an outdoor venue and a naturally occurring venue, so we were cognizant of how a new roof design could impact its acoustics," says Alex Jauch, SEH's design architect and project manager on the project. "The main goal was to not distort the natural acoustics to the

extent possible." This was accomplished via impulse measurements of the existing roof and software modeling of the new design prior to installation. These results subtly influenced the roof's final physical design, for instance with slight flaring at the sides to minimize SPL buildup on stage, and the inclusion of Douglas fir beams on the underside, which absorb rather than reflect sound.

The stage also hosts six new cameras: four Panasonic AW-UE150 PTZ units along the roof itself and a pair of all-weather-rated AW-HR140 PTZs on the north and south spot towers. (The non-rated cameras are fitted inside weather-protection enclosures. Burkart says choosing the newer, unrated AW-UE150 cameras gave them 4K video at a better cost.) The cameras are used for POV images routed to the existing video display and to a hard disk recorder that like the video switcher (both legacy items from before the renovation) are located in the small recording studio adjacent to the front-of-house mix position

Rock solid sound

The PA system is the single biggest new AV system in the renovation. It comprises four d&b enclosures in each of the three LCR arrays: ALi160 boxes in the left and right arrays and ALi90 boxes in the center. These are installed between the new roof and its rigging and attached to the main roof truss. "It's not a custom mount but it probably still wasn't too much fun to put in," Burkart quips.

Ryan Knutson, Brown Note Productions' president, understands the joke but says it wasn't quite that challenging. "We had to do some creative rigging but luckily we had steel beams available, so it wasn't as difficult as it looked," he says. "We didn't attach the system to the rigging, but we had lifts on-site, so the boxes went up and clamped onto the steel pretty easily."

More nuanced was how Knutson angled to have the sound system meet a broader set of needs than the previous installed PA. Like most performing arts venues, touring shows visiting Red Rocks will most likely bring a PA with them; thus, the installed sound system there is used mainly for things other than those shows, including regular events like Yoga on the Rocks as well as occasional corporate events that use the PA for prerecorded music and speech. Those purposes seemed to be served by the generic long-throw horns that comprised the venue's existing sound system. "But it was really what you'd call a public-address system, not really a musical one," says Knutson. "The new sound system was designed by the consultant, and we were there to install what they specified, but we also saw our role as making some recommendations. We wanted them to consider systems we thought would also provide the kind of vertical coverage they wanted but were also more musical-sounding. The d&b system was a great solution for that. It's compact—it fit in below the roof but above the new rigging— but has the power to cover most of the seating area." He adds that the AL Series speakers have a low profile, which helped with their

location, though they are in clusters of four boxes each, which limits SPL but not enough to shortchange coverage for the types of applications they'd be asked to handle. "They're light but they're loud," he says, adding that the Q-SYS control system Brown Note also integrated allows those same everyday events the venue hosts to access the PA system without having to have a professional engineer on-site.

However, Red Rocks also has its own inherent ideas about sound, fashioned by its environment. Sound checks done when the amphitheatre is empty are legendary for their reverberation, and upper-level seats are subject to sometimes radical frequency and SPL variations because of wind, temperature, humidity, and altitude (the venue is situated 6,450' above sea level). "If you were to do an impulse-response test in there when it's empty, it might be pretty shocking," says Knutson. "You'd be firing into a naturally, highly reverberant environment." That was an excellent environment for Red Rocks' original mission, which was a venue for orchestral and other acoustic music performances, but it can work against amplified sound. The main challenge, says Knutson, is attenuating gain before feedback. That, he says, was addressed for the installed PA with a combination of d&b's ArrayCalc simu-



The d&b PA is installed between the new roof and its rigging and attached to the main roof truss.

lation software and its R1 remote control software, which reads a file created by ArrayCalc to generate a project-specific user interface graphically, channel by channel, loudspeaker by loudspeaker, group by group, with

parameter control for equalization, delay, levels, switchable filter functions, mute, and power. The software was loaded on the three d&b D30 amplifiers used to power and control the PA system over the R1 network.

Photo: Courtesy of Brown Note Productions

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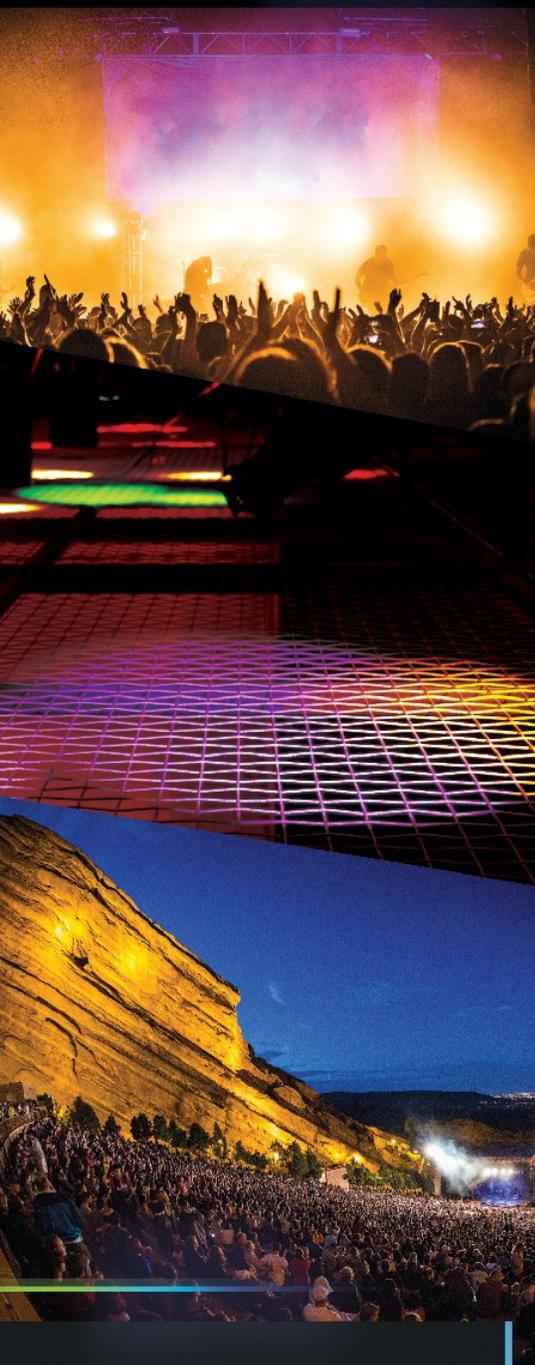
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“We weren’t putting together a concert PA system in this case,” Knutson says. “But, in some ways, it was more of a challenge because this system has to do so many different things and do them well in an interesting environment. And it does.”

Up on the roof

Red Rocks’ roof is an inescapable visual element of the amphitheatre. The venue is bounded on the left and right by rock-clad towers and other architectural elements that blend it in with the surrounding sandstone landscape, as does its seating: long benches topped by ipe, also known as Brazilian walnut, considered to be the most durable matured wood. These replaced the original old-growth clear-heart redwood benches that were installed when the amphitheatre was built in the late 1930s and lasted more than half a century. But the roof always looked man-made, a precisely rectilinear lid on an otherwise organic-seeming tableau that might have been serendipitously left behind by some antediluvian flood. Not surprisingly, it was high on Denver’s list for an upgrade, especially since the old one also had longstanding water-drainage issues of its own. The city and county selected lead architect SEH to conduct a feasibility study, using drone filming and 3D point cloud technology, and generate accurate digital renderings of the space.

The new 8,500-sq.-ft. roof is, if not organically camouflaged, at least as high-tech as the rest of the renovation. Installed by locally based vendor Superior Roofing, it’s a copper-clad topper fabricated on-site from rolls of Nordic Brown copper shipped from Germany. Its gently sloping plane incorporates a faceted edge that, from the audience’s point of view, appears curved like the rocks around it. The dark brown pre-patinaed copper standing-seam metal roofing, supported on four newly planted steel columns, faces the sky, while the underside of the roof features engi-



Andy Burkart, of BCER Engineering.

neered straight-grain tongue-in-groove Douglas fir, all elements designed to help it both stand out from and fit in with its surroundings.

But what’s under that roof is also pretty special. SkyDeck, by InterAmerica Stage, the Sanford, Florida firm specializing in overhead rigging, stage machinery, and structural design and engineering, is a cat-walk-rated, tension-wire grid with a live-load capacity of 40lb per square foot. It’s intended to provide a highly safe environment for riggers to operate in. In terms of its design, three bridging trusses, running upstage to downstage and distributed on 10’ centers from centerline, complete a larger truss system that holds up the SkyDeck, the rigging steel, and the roof itself. The original structure could support roughly 36,000lb of show rigging and snow; the new structure can now handle more than 150,000lb.

Situated inside the truss system at a little over 40’ above the stage floor is a network of evenly spaced steel I-beams, which are attached to the bottom chords of the three main trusses and the two larger bridging trusses. These I-beams, arranged in a grid pattern, hold the 88 modular SkyDeck panels in place. The latter are attached to the I-beams via proprietary InterAmerica Stage saddle brackets. Each SkyDeck panel is strung with stainless-steel cables, seven in one

Audio in the Rafters

There was one additional audio element to Red Rocks' roof renovation. Venue director Tad Bowman says the amphitheatre had done a preliminary test with Mixhalo, a wireless hearing-assist and audio-enhancement solution, in October 2019 during a Vampire Weekend show. "We intended to work with them to integrate their technology at Red Rocks when the pandemic hit," he recalls. "As we started ramping up again this year, we connected with them to get them set up in the new roof."

Mixhalo, a proprietary network-based data delivery platform, delivers high-bandwidth, real-time audio directly to attendees' own phones and wireless headphones. The wireless solution is deployed through scalable Mixhalo data-transmission antennas, capable, at least theoreti-

cally, of an unlimited number of connected clients on the receiving end. The audio is data-compressed and packetized using a proprietary protocol, similar to RTP, and designed for resilient field operation that preserves audio fidelity.

Corey Laplante, Mixhalo's COO, says the platform was installed by the company's own technicians, who placed antennas and WAPs in the new roof system after the other vendors had finished with the new architecture and PA system.

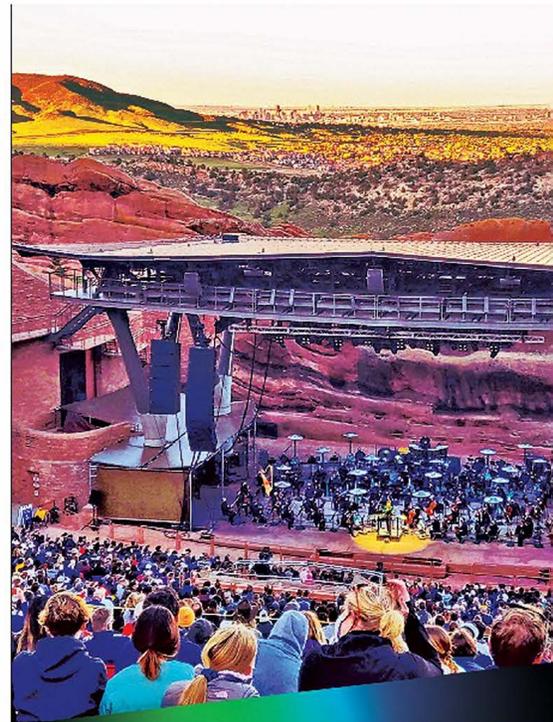
"Even the best PA system has its limits, be it venue acoustics or a noisy person next to you, and we bypass that using your own phone and headphones," he explains, further noting the signal is encrypted to prevent recordings, and can be scaled to any sized space. — DD

direction and 19 more that form a cross section, woven on 2" centers to form a sturdy mesh surface. A set of gas piston-assisted hinged panels is also located upstage right. They open at center, like double doors, allowing riggers to bring equipment up through the roughly 5' x 8' opening in the grid with a chain motor.

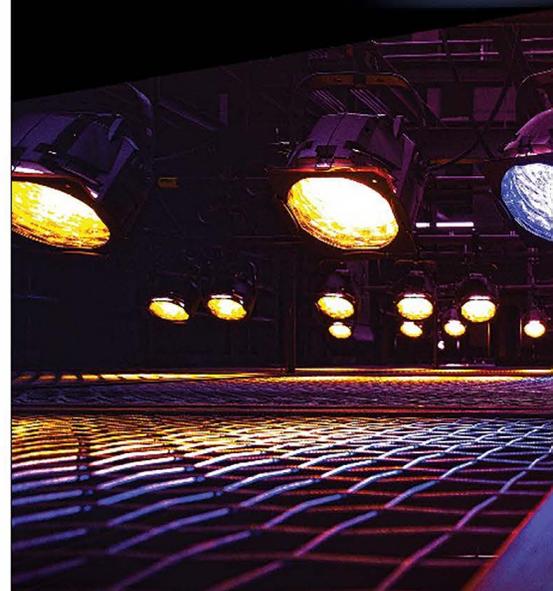
The venue's rigging steel, which is composed of structural channel, is located 2' above SkyDeck's woven-wire walking surface. Easy and safe access to the rigging is the intent of the SkyDeck, says Greg Fecher, InterAmerica Stage's lead designer and project manager for the Red Rocks project. "It's a safe and effective way for touring companies to rig their systems," he says, noting that the entire rigging level is surrounded by a guardrail, allowing riggers to move about freely without lifelines. "They no longer have to walk the steel or rent boom lifts, reducing the amount of time needed to rig a show, so it's about safety and efficiency."

Tad Bowman, Red Rocks' venue director, who once stated plainly that the previous 32-year-old stage roof had "outlived its life expectancy," is more than satisfied with how the renovation has turned out. "Fantastic," he says of the new roof, which he agrees is emblematic of the venue. "It has a more organic shape and more curves to it, and it contributes to the venue's sound. We had the Colorado Symphony in here last week and [properties master] Dante Dunlap says it makes the entire orchestra sound better onstage. The new PA system is a definite improvement over what was there before. It's a much better place to perform and hear music now."

Red Rocks was scheduled to open in time to celebrate its 80th anniversary during the 2021 season, with a capacity of 2,500 for socially distanced performances that will include Chicago, Bill Burr, the Black Crowes, and others. Those shows will arrive expecting to raise the roof, only to find that it's already been done. 📶



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