

INSTALLATION PROFILE

Back to the Drawing Board

How integrators took advantage of structural changes to the Salt Lake Tabernacle for an aggressive AV overhaul.



**BY JACK
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When work started on major structural changes on the Salt Lake Tabernacle to bring it in line with modern seismic standards, the tabernacle took the opportunity to integrate staging, AV, and communications systems at a core infrastructure level—from robotic and dolly-mounted HD cameras to steerable-array loudspeakers and digital video projectors.



When a structure as architecturally unique and historically important as the home of the Mormon Tabernacle Choir undergoes a major renovation, there's a lot at stake.

It was determined a few years ago that the 140-year-old Salt Lake Tabernacle in Temple Square needed a major structural update to bring it in line with modern seismic standards, and that required the building to be closed to the public for more than two years while the upgrade was implemented. With state-of-the-art broadcast and postproduction facilities already in place at the church's nearby conference center, the project provided an ideal opportunity to aggressively incorporate staging, AV, and communications systems at a core infrastructure level.

FFKR Architects engaged two consulting firms to assist in system design on the project. Auerbach Pollock Friedlander was chosen to handle video and communications systems along with lighting and staging, while Kirkegaard Associates was picked to design audio systems for both speech and music reinforcement and a new 5.1 mixing room. Charged with integrating this massive installation was Diversified Systems, led by project engineer Andy Prager and project manager Patrick Caley.

"The church is very particular about the way they want things, and they are always looking for the latest and greatest equipment," Caley says. "Fortunately, they have an outstanding engineering staff that we worked very closely with. It's rare to find a client with so much technical expertise."

The project's goals were to add a modern broadcast facility infrastructure and reinforcement system while preserving the

historic nature of the building. Coordinating the entire AV side of the project on behalf of the church was Sean McFarland, chief engineer of the facility's AV department.

"We had very specific direction from the church leaders," McFarland says. "Our direction was to not make it a new building, but to strengthen and maintain the old building. That was our challenge."

STAGING AND VIDEO

Within the tabernacle, four distinct modes of operation require different staging for different event types. Two modes, General Authority and Stake Conference, are essentially rostrum-seating configurations for meetings with church leaders. Performances are handled via two Orchestra modes for full and reduced versions of the choir. To accommodate these needs, a staging system based on movable "wagon" modules was designed.

"The wagons are pretty substantial pieces of furniture," says Dan Mei, Auerbach's project manager. "When a change is needed, the pieces are brought up from storage in the basement on lifts and castered into place."

Audio, video, LAN, and power are built into the system as well, allowing connectivity from custom Wireworks MSCF481 48-channel microphone splitter and MB6 6-channel microphone stage boxes and FSR FL-640P and FL-540P floor boxes. Video

monitoring on the rostrum is provided by 46 Sony KLV-S19A10 LCD flatpanels mounted into the side of the railing panels, invisible to the audience.

Another new addition to the tabernacle was integrated video projection with a pair of Roadster HD12K high-definition DLP projectors with native 1080i resolution from Christie Digital. But designing a non-intrusive system was a challenge.

"Our two main problems were noise from the projectors themselves, and keeping the screens from blocking the view of the organ," Mei says.

The solution for the latter was to use motorized vertical rise screens from Vutec. Two Retractable-Vu Pro screens are housed in custom millwork behind the last row of choir seats, flanking the organ. With a 16:9 format available at a size of up to 275in. diagonal, the screens are clearly visible throughout the tabernacle, yet totally hidden when not in use.

To eliminate noise, the team moved the projectors outside the room. They are now housed in an attic space behind the domed ceiling so they are invisible to the audience.

"I was a little surprised we were allowed to cut into the dome, but the church understood the situation," Mei says. "In the attic, we could provide the cooling, fire protection, and acoustical damping the projectors needed, and the port windows for the projectors really don't intrude visually."

Architectural and structural constraints required that the two projectors shoot in crossfire fashion to opposing screens. Imaging issues arising from this configuration were handled using Christie Digital's Twist image-warping and blending modules.

With weekly live broadcasts in high definition, the video capture system was another critical element, and the church's vision was both challenging and precise. There are three fully robotic camera locations in the facility. Seventeen SMPTE 311 fiber drops offer additional camera positions when needed.

The three robotic positions use Sony HDC1500L cameras outfitted with Fujinon HA42X9.7BERD HD ENG-style zoom lenses and image stabilization. These are operated from the camera-control room in the conference center, one block away. The primary robotic camera is stationary, mounted inconspicuously on the facing of the east balcony so it directly faces the stage area but is out of sight for the congregation. Robotics are provided by



Top: The attic space beneath the tabernacle's spectacular dome now houses two Christie Digital Roadster HD12K HD DLP projectors.

Right: For video capture, three Sony HDC1500L cameras are outfitted with Fujinon HA42X9.7BERD HD zoom lenses, using robotic control via Ravensclaw Talon remote camera heads for precise pan/tilt control.



Ravensclaw, which recently developed a pan/tilt controller, the Talon, for these types of applications. Designed specifically for use with HD cameras, this remote camera head provides fine-grain remote control with silent precision.

The other two robotic cameras, also using the Talon, are located left and right on the main floor of the tabernacle, just inside the balcony support columns. Although they are in plain sight, few attendees ever notice the cameras. These are mounted atop a pair of retractable steel columns that extend about 11 1/2ft. above the floor. Painted to match the marble look of the balcony support columns, the columns and cameras are fully retracted into the basement when not in use.

Two more camera positions were designed specifically to perform smooth dolly moves without intrusive hardware or loss of floor space. To meet this request, a vertical trolley-rail system was designed, running perpendicular to the stage area and mounted on the reinforced outside railings of the north and south balconies.

"Any noise from the trolley system was objectionable, and there were concerns about vibrations affecting the picture, as well," Caley says. "There was really no standard system available to meet those specs. In the end, our fabricator designed a system from scratch."

A human operator guides the camera along the trolley, allowing professional tracking shots along its 50ft. length.

LIVE AUDIO

The audio side of the tabernacle project was no less challenging. Renowned for its highly reverberant sound, the Salt Lake Tabernacle's primary requirement was improving intelligibility of the spoken word, but the speakers needed to be as unobtrusive as possible. The solution involved using steerable arrays.

The steerable array concept uses a vertical speaker arrangement with an onboard, dedicated DSP for each driver. As a result, a specific vertical dispersion pattern can be programmed in the DSP to avoid unwanted reflections against walls and ceilings, while allowing inconspicuous



Top: For smooth dolly moves with Sony HDC900 cameras outfitted with Fujinon H222X7.2BESM long-zoom lenses without intrusive hardware or loss of floorspace, the team designed a vertical trolley-rail system running on the outside railings of the balconies. **Bottom:** The event control room uses AMX NI-3000 NetLinX integrated controllers and NXF-Mini NetLinX mini-card frames and a Peavey MediaMatrix system for more than 500 annually scheduled events.

deployment—ideal for a historical retrofit such as this one.

For the tabernacle, two AXYS Intellivox systems from Duran Audio were employed—one for the main floor and the other for balcony coverage. The Dutch firm has developed a unique approach to steerable arrays called Digital Directivity Synthesis (DDS). Using this technique, the required cross-section of vertical coverage is mapped back to the array, optimizing each channel's output filtering to achieve the desired result.

Richard Laidman, senior consultant for Kirkegaard, designed the system. "As part

of the aesthetic constraints on design, we mounted the main floor speakers onto the support columns under the balcony," Laidman says. "That's why we went with a delay system. A single pair of steerable arrays near the front of the room could easily cover it all, but the required model would be too tall to be inconspicuous."

Thus, the main floor is covered by two Intellivox systems, mounted left and right on the columns that support the balcony. Two Intellivox-DS280 units cover most of the main floor, while a smaller pair of Intellivox-DS180 arrays assist with coverage toward the rear and under the balcony.

As a final touch, a row of Electro-Voice 405-8H ceiling loudspeakers is secreted in the front of the stage and used as lip fill, providing high-frequency reinforcement for those seated in the center front area and furthest off-axis from the Intellivox columns.

For the balcony, a pair of Intellivox-DS500 arrays are discreetly mounted flanking the organ. Despite the extreme throw distance, these 16ft.-tall arrays create precise coverage of all balcony seating without putting excess sound energy on the dome or the balcony facing.

"This is where the DDS wave shaping really helped," Laidman says. "We were able to create excellent delineation between the coverage for the main floor and the balcony. The speech intelligibility on both levels is very good."

To handle contemporary music events, a JBL VerTec system is flown. The system consists of two arrays of 10 VT4888 loudspeakers to cover the main floor and facing balcony, with a smaller array of three VT4887A loudspeakers rigged behind them to cover the side balcony seats. The entire system is controlled via a Dolby Lake Processor and powered by Crown I-T4000 and I-T8000 amplifiers. Used only for amplified contemporary music events, the system is kept in storage for most events.

For additional music reinforcement coverage in the shadowed area under the balcony, another minimally visible application was developed. Rather than using downfacing enclosures or surface-mount cabinets, compact Renkus-Heinz TRX61 near-field loudspeakers were built into 10 24in. square cavities that were cut into the underside of the balcony seating structure. This allowed the loudspeakers to be aimed at an angle, enhancing directional realism while avoiding unnecessary floor-to-ceiling energy under the balcony.

While live music from the choir and orchestra are acoustic in nature, that glorious noise must still be captured for broadcast. This is accomplished through numerous microphone drops throughout the hall.

"Every instrument is miked," says senior audio engineer Trent Walker. "We use a lot of DPA microphones because they give us so much flexibility."

Up in the attic, the audio is run through mic preamps, converted to digital, and transported via multichannel audio digital interface (MADI) to the 5.1 mixing room. For speech, the primary podium micro-



A 32-fader Euphonix System 5-BP mixing console with full redundancy for both power and DSP core is the centerpiece of the multifunctional 5.1 mixing room. It uses the EuCon Hybrid DAW control protocol to enable the surface to control Digidesign Pro Tools HD 7.2, Steinberg Nuendo, and individual DSP channels for editing and post work. A Euphonix R-1 recorder is used as a backup to the Pro Tools mastering system.

phone is an Audio-Technica U857QL cardioid gooseneck with shock mount, while wireless vocal mics are all Shure UHF-R wireless systems with both Beta 87A and KSM9 capsules.

"The Shure systems are a good example of the flexibility needed for this project," McFarland says. "The original specification was for the Shure UHF, but by the time the project was completed, the new version was shipping. And we knew we wanted the upgrade."

All visible production elements in the main hall of the tabernacle are custom-painted to blend in with the historical look and feel of the room. The Duran Audio Intellivox columns are painted to match the spaces where they hang, while the motorized lighting truss and JBL VerTec line arrays are painted white to match the dome. Even the FOH mix position on the main floor, which houses a Yamaha PM5D-RH mixing console and associated effects, is designed to be as inconspicuous as possible.

AUDIO PRODUCTION CONTROL

The 5.1 mixing room is truly multifunctional in nature. Live mixing is done in

5.1 surround sound and relayed directly to the neighboring conference center control room for inclusion in the live broadcast. In addition, postproduction activities take place there throughout the week.

"This whole room is a difficult task," says Trent Walker, senior audio engineer for the church. "We knew what we wanted, but there were a lot of issues to overcome."

The room itself was literally carved out of the available space in the basement and built from the ground up. It's a floating room, designed by Kirkegaard to match two similar facilities located in the conference center. The centerpiece is a 32-fader Euphonix System 5-BP mixing console with full redundancy for both power and DSP core.

In addition to live audio mix duties, the System 5-BP uses the EuCon Hybrid DAW control protocol to enable the surface to control Digidesign Pro Tools HD 7.2, Steinberg Nuendo, and individual DSP channels for editing and post work. A Euphonix R-1 recorder is used as a backup to the Pro Tools master system.

All mixes are done in 5.1 surround sound, with both Dolby Digital and Dolby E encoding and decoding equipment on

hand. Wilson Audio loudspeakers provide surround monitoring. Left, center, and right locations are covered by the Watt/Puppy model, while the rear surround channels are handled by a pair of Duettes. Bass is provided by a pair of Genelec 7070A subwoofers.

For postproduction, a Panasonic PT-D7700U-K video projection system was installed, targeting an 82in. custom Luxus Screenwall from Stewart Filmscreen.

"Originally, the spec called for a 50in. plasma," Prager says, "but that big, reflective surface was a problem. A fixed-screen wall material is just more forgiving acoustically."

To overcome the noise from the projector's cooling fan, a custom AcoustiLock enclosure from Noren Products was commissioned.

A similar projection system was installed in the choir rehearsal room, but with a 150in. screen. Full surround decoding is provided by a Lexicon MC-4 processor, with an Extron Electronics DVS 304 AD scaler allowing inputs from DVD or S-VHS sources. Full 5.1 audio in the room comes from L-Acoustics 112P loudspeakers.

MISCELLANEOUS OPERATIONS

With more than 500 annual events scheduled in the tabernacle facility, an AMX control system consisting of NI-3000 NetLinx integrated controllers and NXF-Mini NetLinx mini-card frames was programmed to reduce the amount of staff time required for relatively simple tasks. AMX Modero touchpanel controllers are located in the event control room, audio production room, the FOH mixing console area, and the choir rehearsal room. This allows Microsoft PowerPoint presentations and DVD and tape playback using the tabernacle projections system without requiring dedicated AV staffing.

For PowerPoint transport, Extron TP T 460 twisted-pair transceivers are used to traverse the 300ft. of space from various stage locations to the projectors without quality loss. In addition, the AMX system interfaces with the building's Peavey MediaMatrix system to enable other basic actions, such as activating the single microphone used during daily organ recitals.

"For presentation situations, the building needs to be self-sufficient," McFarland says, "and that's where AMX comes in. It automates some of the daily tasks so we can do more without having full staff at each event."

Audio control in the tabernacle is provided by the MediaMatrix system, which is programmed with a number of presets to simplify audio routing. Control zones include upper- and lower-balcony speech reinforcement, the Renkus-Heinz speakers in the underside of the balcony, stage fold-back, and choir fills. Presets handle vari-

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ous staging configurations for both speech and performance modes, plus organ recital, choir rehearsal, and separate handling for wireless microphone sources.

In addition, MediaMatrix controls an entire 70V audio system that feeds support facilities in the building, including the back-of-house hallways, offices, dressing rooms, event control, observation room, general authority lounge, green room, and security room. This system consists of

175 Atlas Sound FA116T72 ceiling loudspeakers spread throughout the facility, all powered by Crown CTs 8200 amplifiers.

With the building essentially acting as an insert point for the main broadcast facility located in the conference center about 1,500ft. away, connectivity between the facilities was a major priority.

"It's really all tielines, but it's very complicated," Prager says. "There are SMPTE 311 camera tielines. Then there are fiber transmitters and receivers at both ends for SDI, AES, and HD, as well as Ethernet for the routing switcher frame control, plus PC GUI control. It's all running over fiber."

Intercom is provided by a Clear-Com Matrix Plus 3 digital system, hosted in the conference center. The routers are from Nvision, while fiber distribution is by Evertz.

In terms of interconnects between rooms, infrastructure for the tabernacle, and connectivity to the conference center, the equipment list fills more than 1,000 lines of a spreadsheet, and the wiring diagrams are mind-boggling. Suffice it to say the integrators at Diversified Systems invested a lot of time translating everything into workable shop drawings. Flexibility is provided through 55 patch panels for audio, video, and data. Housing all the ancillary gear required 24 equipment racks, sourced from GKM Broadcast Racks and Middle Atlantic.

"I think this was a spectacular project," McFarland says. "The challenge of putting all this equipment into a historic structure took a real collaborative effort. All parties—architects, consultants, contractors, integrators, and installers—did a great job of recognizing the requirements of the other trades and pulling together. Everyone at the church is very pleased, and the entire team deserves a hand." ■

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