An exterior view of the lobby at dusk.

Adding Music to the Campus

Inside Stanford University's Bing Concert Hall

By: Mel Lambert

Located between San Francisco and San Jose in the heart of Silicon Valley, Stanford University has earned an enviable reputation as one of the world's leading research and teaching institutions. But its cofounders, Leland and Jane Stanford, also saw a need for music, art, and other cultural events within a campus environment, electing to "promote the public welfare by exercising an influence on behalf of humanity and civilization." Since 1891, the university has fostered creativity and the arts, with access to several performance spaces. A jewel in the campus crown, however, is Bing Concert Hall, unveiled in January 2013 with a three-day opening celebration featuring performances by the San Francisco Symphony, mezzo-soprano Frederica von Stade, the St. Lawrence String Quartet, Stanford Symphony, and Stanford Chamber Chorale.

Designed by Ennead Architects, the new concert hall resulted from a close collaboration between the architectural team, led by Richard Olcott and management partner Timothy Hartung; Dr. Yasuhisa Toyota, of Nagata Acoustics; Robert Campbell and Joshua Dachs, of theatre planning and design consultants Fisher Dachs Associates; and donor Peter Bing, who, in addition to providing substantial financial support for the project, also provided creative input during the design process. Audio consultants on the project were Sonitus Consulting, with sound isolation/noise control by Robert F. Mahoney & Associates, video by Boyce Nemec Designs, architectural lighting design by Brandston Partnership, and curtain wall by R.A. Heintges & Associates. Pro Sound & Video handled system integration, with Musson Theatrical supplying lighting dimmers and controllers and Holzmueller Productions theatrical lighting gear. The total project cost was $110 million.

Left photo: Courtesy of Tim Boot/Sonitus Consulting; Top photo: Alsilnn Weidele/Ennead Architects

Low walls embracing each seating section are angled and articulated with beech wood, which has a specific density and textured surface strategically designed to reflect and disperse sound.

"Bing Concert Hall exemplifies the seamless integration of architecture, acoustics, and technology with the goal of transforming the practice, study, and experience of the performing arts," says Olcott, design partner with Ennead Architects, which also designed Zankel Hall at Carnegie Hall, Oklahoma City Civic Center Music Hall, and Holland Performing Arts Center in Omaha, Nebraska. "Home to Stanford Live [the university's performing arts presenter and producer] and the university's music department and providing a state-of-the-art venue for visiting performers and student artists, the building integrates performance and curriculum for students while engaging the greater Bay Area community. The program—the central element of which is an 842-seat, vineyard-style concert hall—includes a studio/rehearsal hall, artists' suites, a music library, instrument storage rooms designed to double as practice rooms, and an artists' lounge." Olcott has designed three other projects at Stanford University: Iris & B. Gerald Cantor Center for the Visual Arts (1998), Stanford Law School's William H. Neukom Building (2011), and the Anderson Collection at Stanford University, scheduled to open in the summer of 2014.

"That continuity of architecture was very important for us," says Matthew Rodriguez, the hall's director of operations and production. "Our goal was an intimate performance space that would serve the long-term interests of the campus. The hall needs to offer a perfect environment for classical music but with adjustable acoustics and a [removable] sound system for other musical and dramatic genres. The hall offers a reverb time of 2.6 seconds in its natural form and just over 2.2 seconds with the acoustic drapes deployed; it's a perfect space for our needs." Other key staff members include operations manager Janeen Giusti, production manager Kim Pross, and AV manager Nick Malgieri.

Located within a 12"-thick concrete enclosure, the concert hall occupies a 155'-by-130' oval drum designed for optimal acoustics from every seat in the house, encircled by an irregularly shaped lobby. To the west, a forecourt plaza leads through an entry portico into the lobby. To the south, a terrace is designed to accommodate event functions; to the north, a more intimate terrace for

Photo: Aislinn Weidele/Ennead Architects

performers overlooks a clearing preserved for large outdoor events. A studio/rehearsal hall on the north side is acoustically isolated from the concert hall for simultaneous use; variable acoustic curtains allow tuning, while a flexible pipe grid accommodates a variety of performance types.

"The concert hall's primary function is to accommodate unamplified musical performances," Olcott says. "To support Stanford Live, which brings a variety of artists to campus, as well as Stanford's Center for Computer Research in Music and Acoustics [CCRMA], state-of-the-art lighting, variable acoustics, sound reinforcement, video projection, and recording technologies are incorporated. Within the oval-shaped room, the furthest seat is only 75' from the conductor.

"Each seating section has an intimate feel, particularly the center-section seating, which begins at the same level as the stage. Low walls embracing each seating section are angled and articulated with beech wood, which has a specific density and textured surface strategically designed to reflect and disperse sound. The stage measures 73' by 54', with six moving platforms [to provide adjustable topologies]."

Contrasting with the hall's performance level are the sail walls and ceiling cloud, "whose lighter tones imbue the upper region of the hall with an uplifting quality," Olcott says. "The large, sculptural, convex-shaped sails surround the seating and define the hall's volume. These reflectors are carefully shaped and angled to provide optimal acoustic reflection or absorption." The sails also serve as screens for video projection.

Some 48' above the stage, a double-curved ceiling reflector houses most of the technical lighting, rigging, and sound-reinforcement equipment. "All wall and ceiling reflectors have been constructed to meet specific density requirements," Hartung explains, "and their surface articulation assists in reflecting sound. Between the sails, variable acoustic curtains allow for room tuning to better accommodate performances that include amplified sound."

Toyota says, "Our design goals were to achieve both rich and clear acoustics, with intimacy a key concept acoustically and architecturally since the auditorium was designed to work in an ideal way for classical music. Our design discussions were shared by all members of the design team, including the architect, the theatrical consultant, and the AV consultant; in order to integrate all the discussions into the architectural design for the project, these deliberations were led by the architect.

"It was an acoustical challenge to involve a full-size orchestra in the program of this mid-size, 842-seat concert hall, but the result was very successful. We plan to extend the acoustical design techniques we developed at Stanford to future installations." Nagata Acoustics' past projects include Walt Disney Concert Hall, in Los Angeles, and the New World Symphony SoundScape, in Miami.

Theatrical planning and design

Fisher Dachs Associates/FDA began by developing a "building program that defined the scale of the project and detailed the public and support spaces," says associate principal Robert Campbell, who worked closely on the project with FDA principal Joshua Dachs. "Once the choice was made to pursue a vineyard-style concert hall, we developed the concert hall's geometry to achieve an intimate setting for music with excellent sight lines for all seats but which still complied with the acoustical parameters and guidelines provided by Nagata Acoustics." In addition to designing seating layouts and sightlines, FDA worked to ensure that public and back-of-house spaces were effectively laid out so the facility would be easy and efficient to operate. FDA also designed technical equipment, including specialized rigging and lifts, and the theatrical lighting.

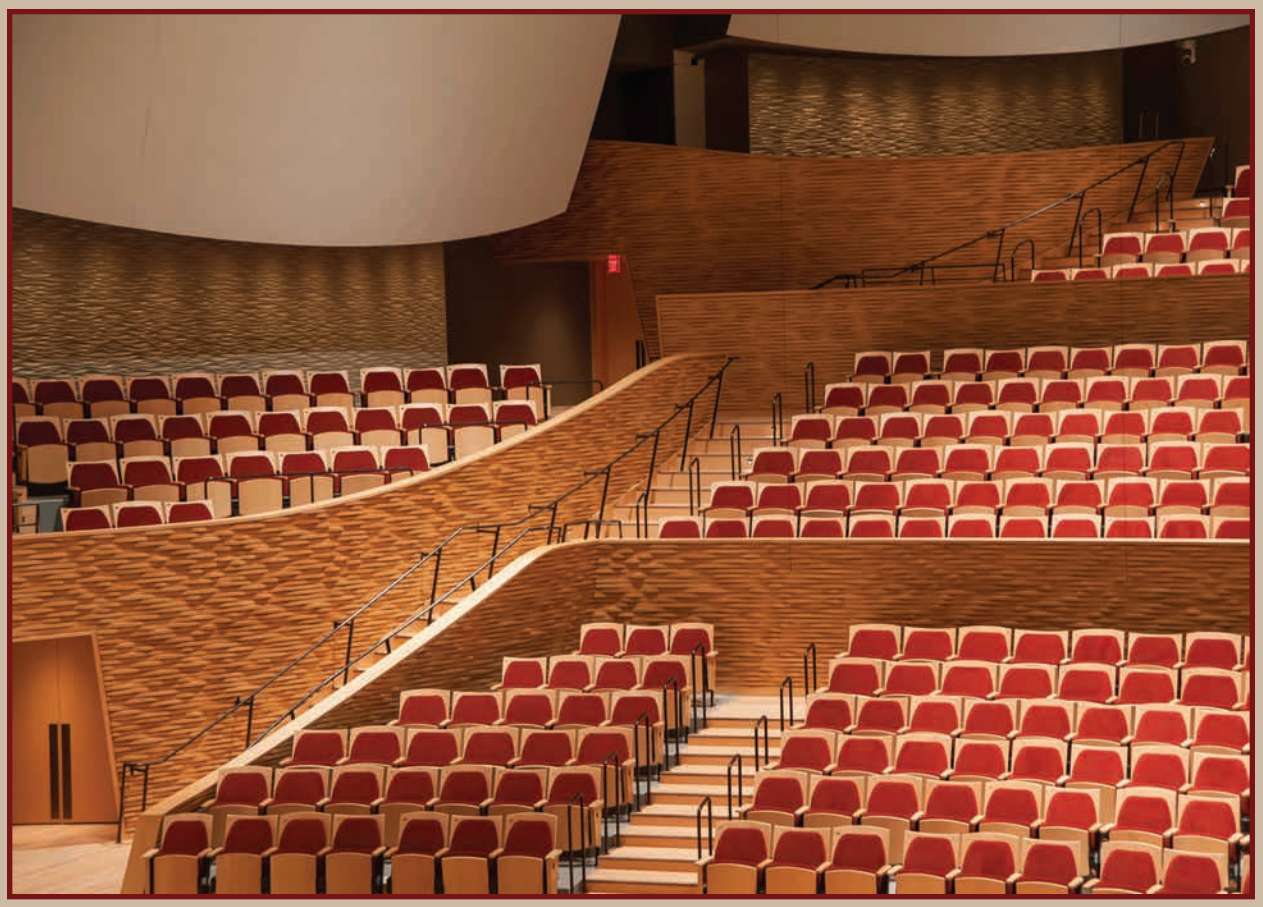
"The hall was designed to work for a range of programming," Campbell says, "including symphony concerts, amplified concerts, chorus, staged opera, simulcasts, etc. We worked with the design team to incorporate systems that would need very little effort to turn over the room for each type of event. The concert lighting and systems were provided by ETC and installed and commissioned by Musson Theatrical. Boyce Nemec Designs was our sub-consultant for the building's video systems, while Sonitus specified a custom-designed, left-center-right sound reinforcement system. J.R. Clancy provided custom rigging solutions."

Sonitus Consulting worked previously with Nagata Acoustics on both the Walt Disney Concert Hall and New World Symphony projects. "We enjoy a good relationship with Dr. Toyota," says Sonitus principal Fred Vogler, "and know how to develop creative solutions during the programming stages to ensure that sound is intelligible throughout the space. For sound reinforcement, we opted for a customized system using ATC components, just as we did for the Walt Disney Concert Hall."

"We needed to develop a more advanced design for Bing Hall because of the variable stage heights and added a center cluster," says Sonitus' Tim Boot. "We realized during early planning that because of the compact space and the small stage, the auditorium would need a suspended central array that could be lowered via bomb bay doors through the main ceiling-mounted sound reflector, which, because of load restraints, involved close liaison with the acousticians and structural engineers."

A variable acoustics system was designed to cover the hard wall surfaces with absorptive curtains mounted on motorized tracks. In addition, an innovative system of telescoping fabric panels located on-stage behind an acoustically transparent wall provides extra sound absorption behind the performers.

According to Ben Lilly, ATC Loudspeakers' trans-



The terraced seating sections.

ducer/R&D engineer, “The two primary sound-reinforcement loudspeakers are located on-stage as a stereo pair so that the reinforced source is as close as possible to the acoustic source. These large, three-way systems comprise several components powered by ATC P4 amplifiers: primary front-firing, upper and lower elements and a secondary side-firing element. The side-firing element is mounted on a tilt-and-swivel yoke, which, in turn, is mounted on an electrically actuated lift. In this way, the correct orientation can be set up regardless of the on-stage speaker position and the stage riser height.” Each loudspeaker is mounted on 5" castors.

To provide additional coverage for the central seats, a pair of front-fill loudspeakers was specified. “Typically, if the main stage loudspeakers are pushed wide,” Lilly continues, “both front fills will be used. A narrower arrangement of main stage loudspeakers, with less of a hole in the stereo field, may utilize only one front fill.” These loudspeakers house a pair of 9" Super Linear LF drivers, a single SuperDome mid, and a single 1" tweeter powered by a P4 amplifier. Two stand-mounted loudspeakers provide additional coverage for rear audience seats located closest to the stage; each speaker houses a single 9" Super Linear LF driver, a SuperDome mid, and a single 1" tweeter, powered by an on-board amplifier pack. Also provided were portable stage subwoofers for increased low-frequency reinforcement.

“The center cluster is the most interesting element,” Lilly says, “and also one of the most complex. It has been designed to deliver omnidirectional coverage from the single cluster, via front, left-side, right-side, and rear speakers. But interaction between the four elements presents two major problems: constructive summing of the low-frequency signals results in an overly bass-heavy balance that masks mid- and high-frequency detail, vital for intelligibility, and mid- and high-frequency comb filtering between the elements, which is especially apparent in the overlap regions between horizontal radiation patterns. We have a method of overcoming these problems based on a proprietary Path Length Control System with acoustic dividers that greatly reduces the reliance on electronic EQ.” Each element houses a single 15" Super Linear LF driver plus a 3" Soft Dome mid and a Soft Dome tweeter.

“The ATC system was designed to provide wide dispersion, a natural fidelity, and a wide dynamic range,” Vogler says. “Line arrays were not considered because we felt they are too directional for this type of acoustic; the

Photo: Aislinn Weidele/Ennead Architects

four-sided custom center cluster made more sense," in combination with the floor-mounted enclosures.

"We also specified Yamaha CL Series production consoles for the facility," Boot says. "There is a CL-1 in the control room for simple front-of-house mixing, a CL-3 for stage monitors, and a CL-5 in a dedicated FOH mix position for more complex productions." All three consoles are networked on an Audinate Dante network with shared I/O resources; Prism 16-channel D-to-A converters interface with ATC amplifiers that power the PA system via a Harman BSS Audio Soundweb London system. A separate recording control room at stage-left features a Yamaha DM-1000 digital console and ATC reference monitors.

J.R. Clancy provided custom rigging in the array of sail-like acoustical wall and ceiling panels, using an installation team from Western Theatrical led by project leader Brian Drake. "Between the gracefully curving panels, we provided a total of 22 motorized acoustical curtains, hanging from rigging on a three-tiered catwalk system, as well as a series of acoustical panels," says Brett Cooper, J.R. Clancy's on-site project manager. "Behind the slot walls surrounding the stage—as per the consultant's drawings—we designed and built pop-up acoustical panels that allow technicians to adjust sound reflectivity and reverberation, depending on the needs of a specific performance, whether it's a soloist, a rock band, or a full orchestra."

For the ATC cluster suspended in the center of the acoustical ceiling, J.R. Clancy provided a custom hoist with a load capacity of 2,000lb and a fixed speed of 20fpm with an over-speed brake assembly. Also supplied were four motor-control cabinets [MCC], three of which were located in the technical attic off the catwalk system. "The MCC on stage-right runs the acoustic curtain locally on house right, while the stage-left cabinet runs the house-left curtains," continues Cooper. "The house MCC runs all the overhead equipment: the projection screen, light pipes, speaker cluster, and bomb bay doors. The fourth cabinet runs the variable acoustic pop-up panels with a rigging control console located at the back of house. We also provided a SceneControl pendant receptacle off stage-right, with a 15m cable to allow the hall to run all the equipment from the stage."

A Shure UHF-R wireless microphone system was selected by Sonitus for the hall. "Product quality is critical in this type of venue, where the acoustic noise floor is very low and the performances can be very dynamic," Boot says. "After reviewing the specific needs, it was decided that UHF-R—designed for the high pressure and extreme conditions of large-scale installation environments—was the right choice. By incorporating this type of high-end wireless technology, the unique landmark venue is equipped to respond to any type of performance without interference or degradation."

Video projection systems

"The video systems were selected to meet the sometimes conflicting requirements of the various constituent groups and the realities of the project budget," says Andrew Smith, of Boyce Nemec Design, the project's production video consultant. "In general, we chose components that provide good functionality for reasonable cost. Two Panasonic AW-HE100 cameras with pan/tilt serve various production needs; one uses security surveillance-type hybrid analog and IP cameras for operation by production personnel, and the other uses triple-CCD HD-SDI cameras for IMAG, streaming, latecomer video, and recording." The HD-SDI infrastructure is from Kramer Electronics, while Crestron supplied the HD-BaseT backbone.

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The hall's 360° layout posed unique challenges for video projection. "The ends of the hall are not wide enough for projection screens ideally-sized for modern 2K projection," continues Smith. "The main Stewart Filmscreen projection screen, therefore, is located just downstage of the choir seats, meaning that events requiring the full-size screen are unable to utilize the full seating capacity. For those events, two smaller screens are positioned at each end of the hall for full audience viewing."

All three projectors were installed in a central projection booth by a team from Pro Sound & Video; closest to the booth is a rear-projection screen, while the other two are front-projection. "In order to provide contrast in a front-projected image in a space with light colored walls, the main projection screen is a gray material," Smith says. As well as the permanent video-projection systems, strategically located connection panels are provided to accommodate portable equipment used for ambient projection mapping on the architectural sail surfaces.

Fixed- and moving-light systems

There were several selection criteria for the concert hall's lighting systems. "First and foremost, the fixture and dimming systems had to be very quiet," Campbell says. "As with most of our concert halls, we specified networked ETC SineWave dimming technology, which virtually eliminates lamp-filament noise. Each fixture was selected to be very quiet, including the moving lights that were provided

The Yamaha CL-3 production console for stage-monitor mixing.

to accommodate different types of productions."

Lighting fixtures are suspended from five curved and motorized trusses set to the desired heights under computer control or in dedicated lighting slots in the ceiling. Trusses can be lowered to the floor for lighting maintenance and attachment of additional fixtures for special events. Power and data wiring is routed to the trusses via cable reels. The ceiling design also incorporates holes for the passage of chain hoist rigging lines for setting temporary lighting trusses.

"We installed $1 million worth of ETC lighting dimmers and controllers," says Musson Theatrical's Michael Howden, who served as project manager and programmer. "The ten ETC SineWave SW24 dimmer racks provide control for 480 fixed and moving instruments arrayed on a network and accessed from three lighting controllers: a 48-channel Eos SmartFade ML as main with an Eos RPU as backup and an Eos Ion as a client desk for visiting lighting designers." Musson also provided 90% of the architectural lighting control, arrayed across three networked ETC Paradigm control systems for the hall, lobby, and studio/rehearsal space.

"The fixtures include a large number of ETC Source Four ellipsoids," says Jim Schelstrate, sales director with Holzmueller Productions, "including twenty 10°, fifteen 14°, ten 19°, twenty 26°, thirty-five 36°, and ten 50° models with color frames plus forty 15° – 30° zooms and 30 PAR EAs with lenses." Also supplied were a total of 54 ETX Desire D40 Vivid LED luminaires with various lens configurations, eight Philips Vari*Lite VL1100TS ERS moving lights with framing shutters, ten Vari*Lite VL550 washes, and two Lycian Super Arc 400 follow spots.

"Five of the hoists we provide above the acoustical or 'cloud' ceiling are for lighting battens," Cooper adds. "The acoustical ceiling comes out like a U shape, and five pipes drop down for lighting. Two high-capacity hoists are ready to take on the variable loads created by adding and removing lighting instruments; we worked with the theatre designers to make these battens as accessible as possible for technicians working around the ceiling panels."

To maintain rigging stability in the hall without having to rely on the building structure, the team installed supplementary steel. "There were intricate patterns for how all the cables had to work," Cooper says. "To get signal and the electrical power down to the light pipes, for example, we used 19 cable reels. Large, specialized hoists were custom-built for this project to handle a great deal of weight, so we needed to install 80 sections of extra steel to get everything into the right place."

J.R. Clancy also installed primary and secondary hoist

Photo: Courtesy of Tim Boot/Sonitus Consulting

assemblies for the two projection screens. The primary screen has a 35'-by-18' viewing size and is lowered and stored under the stage; a smaller, secondary screen lives in a permanent installation upstage. "The two hoists, at 1,500lb and 500lb capacities respectively, allow technicians to bring in the screen automatically for projected scenery and other video elements and store it below the stage when not in use," Cooper says.

Audience and client reactions

"The client team members as well as us were so happy during the first rehearsal," Toyota says. "I was especially happy since Peter and Helen Bing, the main donors for the project, were very satisfied with the results."

"For theatre functionality and acoustics as well as intimacy, energy, and sightlines, reactions were overwhelmingly great," Campbell says. "The users are happy with the facility. Every day, they are fine-tuning the way they use the hall's systems. What made the project so successful was that we had the music department, Stanford Live operations, and Stanford project management—as well as many other stakeholders—contribute during our design meetings to the decisions that reached overall consensus."

"The first reactions to our installed sound system for a jazz concert were that it sounded totally transparent," says Vogler, who worked for five years on the project. "The acoustics sound phenomenal," Boot says, "and integrate well with live performances. It's a glorious space."

"We were immediately impressed by the clarity and crispness of the acoustics," Rodriguez says. "The intimate, vineyard design supports the emotional moments you would hope to have in such a space. It offers a wonderful palette for artists to connect with the audience and share their art with our patrons."

Mel Lambert has been intimately involved with production industries on both sides of the Atlantic for more years than he cares to remember. He is now principal of Media&Marketing, a Los Angeles-based consulting service for the professional audio industry, and can be reached at mel.lambert@mediaandmarketing.com or 818-558-3924.