



CASE STUDY

Zellerbach Hall
University of California
Berkeley, California





Constellation at Zellerbach Hall

Constellation electroacoustic architecture, part of Meyer Sound's line of digital audio products, marks a breakthrough in acoustical technology for performance venues. With its ability to instantly enhance an auditorium's acoustical characteristics at the push of a button, Constellation enables a venue to offer the optimal acoustical response for any type of event. This extraordinary flexibility, combined with natural sound quality and a lower cost compared with most physical or mechanical alternatives, expands the range of performances a multipurpose venue can host, while promoting greater audience satisfaction.



SUMMARY

A Second Level of Acoustical Excellence for Zellerbach Hall

Zellerbach Hall is a focal point for the performing arts on the University of California, Berkeley, campus. Completed in 1968, Zellerbach Hall (which houses the 500-seat Zellerbach Playhouse, in addition to the main auditorium) received the Award of Honor for Design Excellence from the American Institute of Architects. The 2,014-seat Zellerbach Auditorium is home to Cal Performances, the largest presenter of performing arts in Northern California.

Zellerbach Hall was built to be a permanent home for the performance series, which stages events in every conceivable musical style, from orchestral and chamber music (it is home to the Berkeley Symphony Orchestra) to jazz, opera and ethnic music from around the world, as well as dramatic and spoken-word presentations. The university also makes use of Zellerbach Hall for graduations and other ceremonial events.

This exceptionally diverse programming imposes extraordinary demands on the hall's acoustics. In the mid-1960s, however, there were few options for dealing with this. Variable acoustics methods involving physical or mechanical means were (and are) prohibitively expensive, and electronic enhancement was in its infancy: difficult to maintain and not natural-sounding. Zellerbach Hall architects Vernon DeMars and Donald Hardison judiciously opted for the only reliable solution available at the time: a "happy medium" wherein the acoustics were acceptable for most of the hall's programs, if optimum for only some. The resulting mid-band reverberation time ended up being 1.45 seconds.

This was an ideal length for chamber music, opera and recitals, but at the high end of acceptability for dramatic and spoken-word performances. Music benefiting from a longer and more complex reverberation characteristic, such as orchestral and choral performances, and some types of ethnic and electronic music, was, of necessity, more compromised.



A traditional orchestra shell was employed to project more sound into the hall and aid musicians in hearing each other, but erecting and striking it was laborious and time-consuming, making it difficult to schedule programming of different types even as close together as consecutive days. Accommodating events of mixed genres on the same program was even more problematic, because of both the differing acoustical requirements and the considerable restraints on space and movement imposed by the shell. And the shell did nothing to address the issue of reverberation characteristics.

“We had been grappling with this issue of maximizing the hall’s sound for a number of years,” says Cal Performances director Robert Cole. “We know the acoustics are quite good as they are; many wonderful artists have performed here with great success. There have been, however, some instances, such as when a period orchestra like Philharmonia Baroque Orchestra performed, when I have wished we could modify the architecture of Zellerbach to better replicate the space in which the music was originally meant to be performed.”

The challenge presented by Zellerbach Hall was to extend and enrich the venue’s excellent pure physical acoustics, gaining a second acoustical environment more akin to the great, classic concert halls of Europe, while not losing any of its existing positive attributes. Most critical was naturalness: whatever the acoustical signature in use, the sound must avoid any semblance of “artificial reverberation.”

Challenges

- Need to support an extremely wide variety of events with optimal acoustics
- Effect a complete “acoustical renovation” without interrupting a busy program schedule and in time for imminent gala performance
- Avoid costly and cumbersome approaches involving physical changes to room volume and surfaces

Requirements

- Provide acoustical ambience ideally suited to spoken word, theatrical, orchestral, choral and selected ethnic and electronic music
- Increase projection of sound and improve musicians’ ability to hear each other onstage
- Minimize any visual or aesthetic impact on the interior architecture
- Ensure simplicity and ease of use
- Maintain natural sound quality

Benefits

- Improved capability to support musical styles benefiting from longer, richer room reverberation
- Independent control of key acoustical characteristics: reverberation, intimacy, loudness, clarity, envelopment, warmth, etc.
- Quality and quantity of early reflections (essential for clarity) controllable separately from reverberation, with capability for the relationship between the two to differ in each preset
- Relieve the need for a physical orchestra shell without losing its benefits
- Ability to host touring orchestras and choral groups more effectively



“Meyer Sound’s Constellation solved a major problem for us as we planned our Centennial Celebration Performance and Gala comprised of dance, music and a large orchestra and chorus all in one evening. It was the only way we could pull it off.”

Robert Cole
Director, Cal Performances

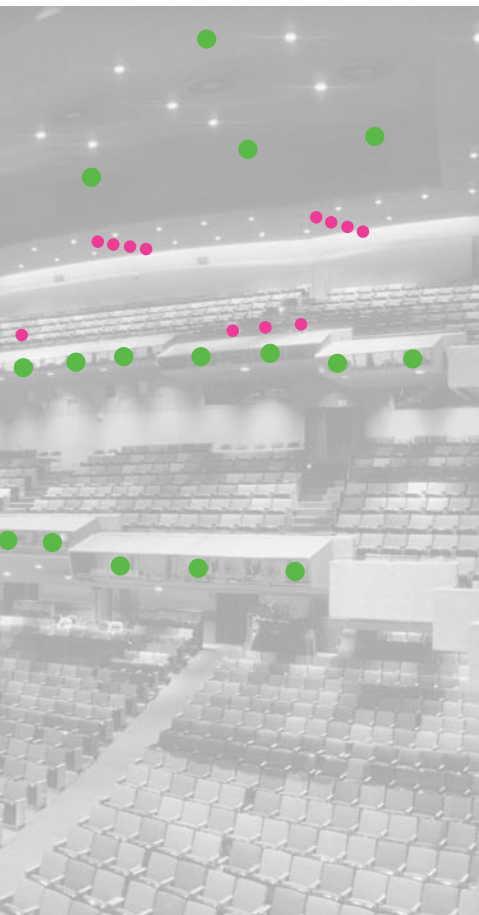


CONSTELLATION SYSTEM OVERVIEW

System Design Goals

Discussions between Meyer Sound’s Constellation team of experts and Cal Performances’ representatives produced two fundamental goals for the project. The first was to provide an enhanced level of natural-sounding reverberation throughout the hall when desired for selected types of performances. The second goal was to improve projection of sound into the hall, and to allow musicians onstage to clearly hear each other, when the orchestra shell is not in place—essentially by adding a “virtual orchestra shell” as an alternative to the hall’s mechanical one.

Other factors created additional requirements. Cal Performances’ need to develop a workable solution for Zellerbach Hall reached a critical juncture in 2006 as the program approached a gala celebration of its 100th anniversary. The program for the evening was intended to portray the range of events presented by the organization. Featured artists included the Mark Morris



Constellation
System Configuration

- UPJ-1P
- UPM-1P
- UPM-1P Behind Curtain
- STEREA-4/4C
- Microphone

Meyer Sound Solution

- 67 Stella-4/4C loudspeakers
- 27 UPM-1P loudspeakers
- 10 UMS-1P subwoofers
- 11 UPJ-1P loudspeakers
- 24 Cardioid Constellation microphones
- 20 Omnidirectional Constellation microphones
- 1 MS-Constellation processor
- 2 MS-CONST-EXP processors
- 5 MS-VRAS processors

Project Partners

Installation Contractor

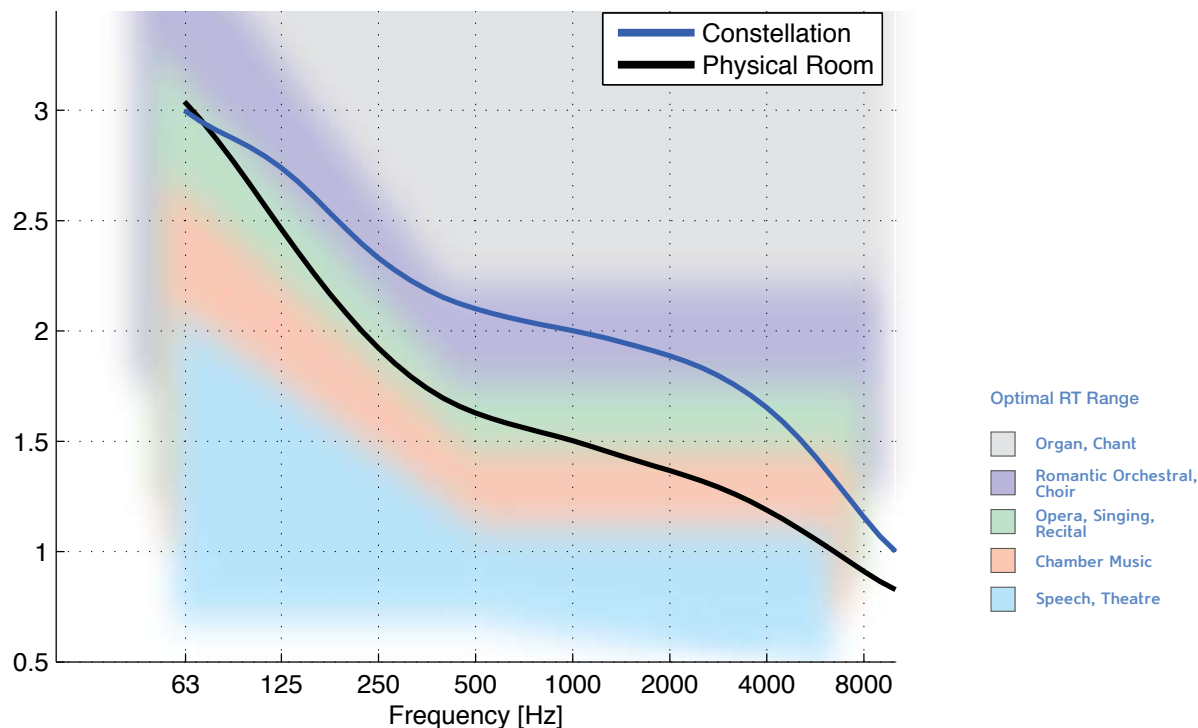
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Dance Group; San Francisco Symphony music director Michael Tilson Thomas accompanying *Phantom of the Opera* star Lisa Vroman on piano; contemporary music ensemble Alarm Will Sound performing the works of John Adams; and the San Francisco Opera Orchestra accompanied by a chorus of over 200 voices.

The spectrum of performance styles represented in the event could not be optimally supported by a single acoustic; multiple acoustic signatures were needed. Further, the logistics required to accommodate the range of performers made it untenable to consider using the orchestra shell. Thus, the necessity of having a Constellation system installed and functional by the time of the fast-approaching gala became a de facto third goal—in fact, a requirement.

Differences in stage configuration also dictated a need for presets that supported the acoustical needs of each event type, yet produced a consistent overall subjective quality in the acoustics.

Last, but far from least, was the requirement that the system sound natural in a critical listening situation. The caliber of both the artists and the audience would be very high for the event, and both the audience and the performers needed to be comfortable with the sound of the hall.



A broad range of acoustical characteristics can be provided by Constellation according to the needs of the venue. This graph of reverberation time over frequency shows the range of responses available to Zellerbach Hall, from that of the pure physical acoustics (without Constellation) to the longest setting of the Constellation system in use there.

Constellation System Configuration

Zones and Components

Every installation of Constellation is custom-designed for its intended venue, and, because the system is scalable, the design of each system is tailored to the size, shape, age and finish of the particular room in which it will be installed.

To achieve the design goals at Zellerbach Hall, the Constellation system is divided into four discrete zones: house left, house right, house rear and stage. Each house zone is driven by a separate Constellation MS-VRAS processor, while the stage zone uses one processor to generate early reflections and another to generate reverberation. These processors and the MS-CONST-EXP expansion processors provide physical and processing inputs and outputs for connection to the 44 condenser microphones (for picking up both direct and ambient sound) and the 109 self-powered loudspeakers of four different types that produce the acoustical effects. Each loudspeaker in the system is driven by its own processor output.

An MS-Constellation processor acts as the communications hub, receiving input from the browser screen that controls the system, and providing an Ethernet connection for system maintenance and programming. There are also two CONST-EXP expansion processors to provide additional inputs and outputs.

Mid and high frequencies are supplied primarily by an early version of Meyer Sound's Stella-4 installation loudspeaker, supplemented by UPM-1P ultracompact wide coverage and a small number of UPJ-1P compact VariO loudspeakers. For natural enhancement of wideband sources, such as orchestra, the system incorporates UMS-1P ultracompact subwoofers to provide energy down to 63 Hz.

Stage (Early Reflections) Zone—Constellation Ensemble

The stage house in Zellerbach Hall is typical of multipurpose venues: open wings to the side and an open fly loft above. A dedicated Constellation subsystem, known as Ensemble, creates both early reflections and a reverberation characteristic scaled to the semi-enclosed space of a dedicated concert hall stage or an orchestra shell. Replicating the early reflections created by Zellerbach Hall's mechanical orchestra shell greatly enhances the musicians' ability to hear and respond to each other, as well as projecting additional early sound into the front area of the house. The stage subsystem employs two dedicated MS-VRAS processors, one each for early reflections and reverberation, to achieve this.

The early-reflections zone derives its source signals from 16 cardioid microphones hung over the stage and the section of the auditorium nearest it. These microphones pick up the stage sound with the highest direct-to-reverberant ratio of any microphones in the system. The post-processing, mid- and high-frequency reflections in this zone are produced by overhead UPM-1P ultracompact wide-coverage loudspeakers, and UPJ-1P compact VariO loudspeakers mounted around the stage. Low-frequency response is provided by UMS-1P compact subwoofers.

Left, Right and Rear Reverberation Zones

These three zones are individually mixed and tuned to work seamlessly with the physical room acoustics in their respective areas of the hall. However, all three zones combine to provide the desired depth and fullness of ambience throughout the auditorium seating area. Input for these zones comes from a combination of 10 cardioid and 20 omnidirectional condenser microphones suspended overhead. Mid- and high-frequency reverberant energy is supplied primarily by the 61 Stella-4 units, 28 of which are mounted on the side walls, with the rest divided between overheard and balcony mounting. These are supplemented by 12 UPM-1P cabinets. Low-frequency reverberation energy is created by eight UMS-1P subwoofers, also mounted both laterally and overhead.

User Interface

The basic user interface offers the utmost simplicity, with simple selection of ON and OFF available from a secure web page accessible only through a single dedicated router. More advanced functions are accessible via Ethernet for system testing, maintenance and preset modification. Network access can be password protected to allow use only by authorized personnel.



EARLY REFLECTIONS AND ORCHESTRA SHELLS

In formulating the Zellerbach Hall design proposal, a primary objective was to create an enhanced early-reflection zone in the front of the auditorium.

In physical acoustics, early reflections and room reverberation can be thought of as distinct attributes that together define the acoustical characteristics of a space. Early reflections enhance the presence of directional sounds from the stage, while room reverberation helps blend sound sources and creates an ambience that immerses an audience in sound.

The idea of an orchestra shell is to create an acoustic amplifier, a carefully constructed reflective shell that redirects sound radiating from the performers to the rear of the stage, and back out towards the audience. This projected energy adds intimacy and presence (as well as level) for those in the front of the auditorium.

As important as the benefits to the audience are the advantages for the musicians. The reflections from the shell bounce around the performing area, enabling musicians onstage to hear each other better. This frequently gives the musicians confidence and elicits better performances.

However, orchestra shells take up a lot of room onstage, and when one is not needed for a performance, substantial time and effort are involved in dismantling it and erecting it later. Further, while mechanical orchestra shells can be effective, they are limited. They do one most excellent trick—which comes at a high logistical cost—and that's it.

Constellation allows both the mix and the intensity of early reflections and late reverberation to be changed independently, enabling the system to redefine these relationships appropriately to each type of event, simply by calling a user preset with one button press.

This capability is demonstrated most dramatically by Constellation Ensemble. Ensemble delivers the performance of an orchestra shell from a collection of critically placed microphones and small loudspeakers deployed unobtrusively around the stage area, driven by its own VRAS processor. Not only is there no setup or teardown to support, but much more flexibility is gained. A venue could have presets that provide a variety of "virtual orchestra shells" optimized for different types of ensembles.



Calibrating and tuning the system.

Installation, Calibration and Tuning

The design of a Constellation system is a highly complex task, requiring expertise and experience across the disciplines of acoustics, digital signal processing and sound system configuration. The Meyer Sound team of experts charged with ensuring that Constellation system design goals are met to the end user's satisfaction ranges from a GRAMMY-winning classical recording and live mixing engineer to a PhD acoustician. This team combines the design requirements with measurements of the pure physical acoustics to obtain the basis from which the system design is derived.

Installation of the system is simple by comparison. The self-powered nature of Meyer Sound loudspeakers eliminates the need for dedicated amplifier space or loudspeaker cable runs. The Stella-4 loudspeaker offers even greater ease of installation: it is supplied with DC power and balanced audio in a single cable, and its low-voltage DC supply reduces induced noise and meets building code requirements without use of a wiring conduit. Ceitronics, the installation contractor for Zellerbach Hall's Constellation system, exercised careful, professional installation practices to ensure the components were installed exactly as specified. However, no unique tooling or procedures were required.

After installation, the Constellation team returns to tune the system. As with the design phase, the delicate final tuning process is both an art and a science. Constellation incorporates a regenerative component, making the hall's acoustics an integral part

of the system, as well as an in-line component. Like any system, regenerative systems can involve an inherent risk of feedback, which makes their design and implementation a delicate process in which an ad hoc approach cannot produce consistent results.

Designing and tuning a Constellation system are accomplished using a systematic methodology, tempered by an exquisite sensitivity to the specific needs and characteristics of each venue's physical acoustics. The Constellation team conducts these processes using proprietary techniques and powerful tools, such as the award-winning SIM 3 audio analyzer.

While the inclusion of a venue's physical acoustics in a Constellation system is key to its natural sound, all of the care required to properly create a regenerative system is undermined if any of the system components are not extremely linear in both their magnitude and their phase responses. Nonlinearities introduce coloration and can cause instability in a system, even if it is correctly designed and installed. All Meyer Sound products, including the microphones, loudspeakers and processing employed in a Constellation system, are engineered and rigorously tested to ensure linearity across their entire operating frequency ranges and at all dynamic levels.

Constellation is capable of independently controlling important acoustic properties of a room, such as intimacy, loudness, clarity, envelopment, warmth, etc., so a large number of different settings are evaluated as part of the final tuning, to ensure that the presets will meet the needs of venue management, as well as work harmoniously with the physical acoustics. At Zellerbach Hall, Meyer Sound's John Pellowe worked closely with Cal Performances' director Robert Cole to determine which settings best accomplished both goals.

One of the ways in which ability comes into use is that Zellerbach Hall's Constellation system provides different presets for use during rehearsals, when the hall is empty, and in performances, when it is full of acoustically absorptive audience members, thus requiring that more reverberant energy be put into the room. These presets enable musicians in rehearsal to hear music with the same acoustic qualities it will be heard with in performances.

At the conclusion of the tuning process, standard measurements were taken to confirm that the design goals had been achieved. While some systems attempting an electroacoustic solution to achieve variable acoustics are incapable of verification using standard acoustical measurement techniques, the measurements verifying the performance of a Constellation system can be replicated by any acoustical professional.

“Performing at Zellerbach Hall with the Constellation system, one can deeply appreciate how far technology and science have developed. The hall’s acoustics come to life in response, and one can tell that the audience and musicians are having a new and extraordinary experience”

Kent Nagano

Music Director,
Berkeley Symphony Orchestra
1978–2008

Music Director
Montreal Symphony Orchestra

Music Director, Munich Opera



The Outcome

Constellation Gets a Gala Reception

The Constellation system at Zellerbach Hall made its debut at the gala celebration for Cal Performances' 100th anniversary. The breadth of the offerings in the single performance was summarized by one review of the event as being an "eclectic smorgasbord of artistic and musical styles, a veritable spectacle of biblical proportions at times."

The celebration constituted an acid test of Constellation's versatility, throwing dance, recital, electronic and choral music into the same program as a number of speeches, and even a film screening.

"Constellation solved a major problem as we planned our Centennial Celebration Performance and Gala," says director Robert Cole. "It was the only way we could pull it off."

The system worked admirably, and the event achieved everything it was intended to. The *Oakland Tribune* commented, "Meant to celebrate and honor the last hundred years of Cal Performances, the gala proved a success." The achievement of the Constellation system at the gala further cemented Cole's commitment to it, as expressed by his comment, "The success of the Gala experiment indicated to us that we could pursue Constellation further."

A Solution That Continues to Improve

As the quintessential multipurpose venue, Zellerbach Hall has proven to be the ideal candidate for testing Constellation's capabilities. Combined with the venue's location within a few miles of Meyer Sound's headquarters, and the company's long-standing relationship with Cal Performances, Zellerbach continues to provide excellent opportunities for evaluating the Constellation system under a variety of circumstances and adding further refinements.



The Mark Morris Dance Group

“I heard the [Constellation] system without even hearing the system...It’s a miracle sound system...It makes a very big and subtle difference in the sound.”

Mark Morris

Choreographer

In conversation with
Director Robert Cole

2007 Western Arts
Alliance Conference

Just after the Centennial Gala, the system received its first test on a single production with the highly successful U.S. premiere of the Mark Morris production of Henry Purcell’s *King Arthur*. Since then, Cal Performances has come to rely on on the ease of changing the hall’s acoustics for a wide variety of performances, often scheduled within days of each other. The ’08–’09 season features a talk by New York Times journalist Seymour Hersh the day after a piano recital by Richard Goode; a Jerusalem Symphony Orchestra concert the day following two days of performances of electronic artist Laurie Anderson’s piece *Homeland*; and performances on three consecutive days as widely varied as a Krystian Zimerman piano recital, jazz vocalist Diane Reeves, and the Australian Chamber Orchestra.

“Given the huge range of events that we present,” observes Cole, “we rely on Constellation to give us flexibility in pursuing our ongoing objective of achieving the finest possible musical and artistic results in every performance at Zellerbach Hall.”

Better Acoustics Contribute to Better Performances

The system now installed at Zellerbach Hall enables audiences to experience music with all the warmth and resonance of a premier concert hall, while a play in the same space exhibits increased intelligibility. Musicians enjoy an improved ability to hear each other, creating an onstage acoustical experience conducive to ensemble musicmaking.

The result is an artistic victory that goes beyond the fortunes of Cal Performances or, for that matter, Meyer Sound.

“Enhancing the sound in Zellerbach Hall has been a labor of love on the part of many talented people—not the least of whom is Robert Cole,” says John Meyer, CEO of Meyer Sound. “Robert and I agree that through our collaboration, we’ve taken the audible experience to new levels.”



CONSTELLATION SYSTEM COMPONENTS

Constellation is a complete, fully integrated electroacoustic architecture solution that encompasses expert services along with advanced technology. Every system begins with in-depth consultations and analysis by Meyer Sound's Constellation team, and continues through system calibration and tuning.

Constellation Processors

At the heart of every Constellation system are highly sophisticated digital processors that employ Meyer Sound's patented VRAS algorithm.

The MS-Constellation processor contains the communications hardware required in a Constellation system. It receives the user's preset selections and issues the right commands to run them on the MS-VRAS processors.

The MS-VRAS processor is the unique technological core of Constellation, providing powerful digital signal processing for the VRAS algorithm.

MS-CONST-EXP expansion processors provide additional inputs and outputs for the MS-VRAS processors.



Microphones

The Constellation system utilizes precision-calibrated omnidirectional and cardioid Constellation condenser microphones, carefully placed over the stage and spaced throughout the room, to pickup both direct and reverberant sound.



Loudspeakers

Effectively reproducing the characteristics of a natural acoustical environment requires loudspeakers of extraordinary linearity and consistency. Every loudspeaker in Meyer Sound's extensive self-powered line fulfills this requirement, though normally only more compact models—several developed with Constellation in mind—are specified for this application.

Stella-4 Installation Loudspeaker

Incorporating a single 4-inch cone transducer, the self-powered Stella-4 offers exceptional performance in a sleek and discreet package that blends into wall and ceiling architecture. Maximum peak SPL of 108 dB, combined with an operating frequency range of 100 Hz to 20 kHz and ultra-low distortion, provide the accuracy required for creating a natural-sounding room characteristic. Stella-4 receives balanced audio and DC power through a single 5-pin Phoenix connector. Installations often use the Stella-4C, a version made to fit in standard backcans. Ceiling or wall mounting is accommodated through the use of an included bracket or via third-party accessories such as OmniMount. Low voltage (12 – 18V) DC powering provides the benefits of self-powering with no requirement for conduits. The Stella-188 external power supply provides eight outputs carrying power and audio, and accepts eight discrete audio inputs on a single 25-pin D-sub connector.



UPM-1P Ultracompact Wide Coverage Loudspeaker

The award-winning UPM-1P is a self-powered, bi-amplified, three-way system capable of high sound pressure levels with low distortion and uniform directional control. High-frequency reproduction is provided by a one-inch metal dome driver, while low-mid reproduction is handled by two five-inch cone transducers. Both low-mid drivers work in parallel for low frequency power, with one driver rolling off above 320 Hz to maintain a uniform directional pattern through the crossover region. In addition to a two-channel power amplifier (350 W total), the internal electronics module also includes frequency- and phase-correction circuits, driver protection and a laser-trimmed, differential input stage for superior common-mode rejection.

UPJ-1P Compact VariO Loudspeaker

The self-powered UPJ-1P loudspeaker combines the advantages of high power, compact dimensions and the arraying flexibility afforded by a VariO rotatable high-frequency horn. The UPJ-1P is capable of 128 dB SPL of peak output (@ 1m) using a 10-inch neodymium magnet low/mid driver and a three-inch diaphragm high-frequency compression driver. An internal, two-channel class AB power amplifier with complementary MOSFET output stages provides 300 W of total output.

UMS-1P Ultracompact Subwoofer

The UMS-1P is a small but remarkably potent self-powered loudspeaker system. Housing dual 10-inch drivers in a bass reflex cabinet, the UMS-1P produces a peak SPL of 127 dB (@ 1m) over an operating range of 25 Hz to 160 Hz. An internal two-channel power amplifier provides 450 W of total burst power. Compact dimensions allow discreet ground placement or mounting on trusses over suspended ceilings. The UMS-1P extends Constellation system bandwidth to the lowest bass octaves to create a natural acoustical response for all kinds of music, including orchestral and organ.





ABOUT CONSTELLATION ELECTROACOUSTIC ARCHITECTURE

A 21st-Century Approach to Venue Acoustics

Constellation electroacoustic architecture is a major breakthrough in acoustical science that solves a challenge faced by many contemporary performance venues. In the past, performance spaces were acoustically designed for a specific purpose: theatres were optimized for plays, concert halls for music, lecture halls for speech and cinemas for surround sound. But today's venues must cater to a wide variety of performance types and community events, and an acoustical signature ideal for one type of performance can impair the enjoyment of another.

This dilemma usually resulted in compromises, with acoustics designed to be minimally acceptable for all performances, but ideal for none. Some venues attempted mechanical systems to vary the acoustics, including orchestra shells, retractable draperies and secondary chambers. But such solutions are inherently costly and often produce mixed results.

In contrast, Constellation offers a complete solution that allows venues to immediately alter the room's acoustical signature while remaining invisible to the eye. The result is optimum acoustical characteristics for both the audience and the performers onstage. At a musical concert, the listening experience has the enveloping warmth and resonance of a concert hall, while a play in the same space exhibits excellent intelligibility. Musicians onstage hear themselves better, fostering superior ensemble performances.

With Constellation, a venue can fill its schedule with a diverse mix of events and performances of all kinds. Constellation is scalable as well as flexible, making it suitable for venues of any size and type.

A Certified Solution

Constellation is provided as an integrated, turnkey solution that encompasses the patented VRAS digital technology, Meyer Sound's long-established excellence in loudspeaker design and manufacture and the support of the company's highly trained staff of professionals. This approach ensures that every Constellation system is correctly designed, properly installed and rigorously calibrated to meet all of the agreed-upon project goals.

Experience is a crucial element in the proper design of electroacoustic architecture, and Meyer Sound's team of specialists offers an extraordinary range of talents and skills. The Constellation team includes not only qualified technicians, but also a staff scientist with a PhD in acoustics and a GRAMMY-winning classical music recording engineer.

Once the system is installed, calibrated and tuned, the user takes control with an easy-to-use interface. Adapting room acoustics to the ideal response for any performance is as simple as pressing a button or clicking a mouse.

Adaptable Features

Constellation technology allows implementation of a variety of acoustical effects, both in the audience seating area and onstage. Some features require additional loudspeakers, microphones or processors, while others are implemented in the software presets. Of course, not all features are necessary or appropriate for every venue.

Ensemble

Constellation Ensemble provides an electronic version of the traditional orchestra shell, improving the listening experience—and often the performances—of musicians onstage. Because it is not a fixed shape and does not require any setup, Ensemble provides increased flexibility and reduced labor costs. For events involving large or widely spaced groups of performers, such as dancers or large choirs, Ensemble ensures that everybody on the stage is enveloped in a uniform field of natural sound.

VoiceLift

The VoiceLift feature significantly boosts intelligibility for events where the audience needs to understand presenters clearly. By adding early reflections that bring presence and immediacy to the spoken word, VoiceLift ensures that every word is heard clearly without the use of a sound-reinforcement system. VoiceLift enhances the clarity and impact of a speaker in corporate meetings as easily as it allows the dialogue of a high school play to be heard in the back rows of an auditorium. In more complex productions, VoiceLift can even eliminate the need for an experienced audio operator.

Crowd Enhancement

Constellation allows everybody at an event—whether a church congregation or fans at a sporting event—to feel fully engaged in their surroundings. In church services, the reverberant field created by Constellation reinforces congregational singing, moving worshippers to a greater feeling of participation. (Unlike pure physical acoustics, though, Constellation can be turned off when it's time for amplified contemporary praise music.) Similarly, Constellation can enhance the sensation of crowd involvement at sporting events in venues that have relatively dry physical acoustics.

ABOUT CAL PERFORMANCES

Cal Performances is the principal performing arts production and presentation organization for the University of California, Berkeley. Its stated mission is to “inspire, nurture and sustain a lifelong appreciation for the performing arts.”

As a continuing entity within the university, Cal Performances traces its origins to the day in 1906 when legendary French actress Sarah Bernhardt appeared at the Greek Theater to perform her interpretation of Racine's *Phedre*. (Although several names have applied to the university's presentation organization, all are part of the direct lineage of the present-day Cal Performances.) Other notable performers of worldwide stature who have come to Berkeley under the aegis of Cal Performances include Isadora Duncan, George Gershwin and Marcel Marceau. Recent performances span an eclectic mix of global genres and styles, including dance (Joffrey Ballet, Mark Morris Dance Group, Guangzhou Ballet), classical music concerts (Bach Festival, Yo-Yo Ma), jazz (Jazz at Lincoln Center with Wynton Marsalis, Sonny Rollins), world music (Brazilian Guitar Festival), comedy (Garrison Keillor), folk (Arlo Guthrie) and opera (San Francisco Opera).

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