

## WORLDWIDE OFFICES

### Meyer Sound Headquarters

2832 San Pablo Avenue  
Berkeley, Calif., 94702  
USA  
T: +1 510 486.1166  
F: +1 510 486.8356  
sales@meyersound.com  
www.meyersound.com

### Meyer Sound Nashville

T: +1 615 244.2472  
nashville@meyersound.com

### Meyer Sound Sierra Madre

T: +1 626 836.0446  
F: +1 626 836.4883  
sierramadre@meyersound.com

### Meyer Sound Australia Pty Ltd.

T: +61 7 3252.4433  
F: +61 7 3252.3380  
australia@meyersound.com  
www.meyersound.com.au

### Meyer Sound Belux

T: +32 2 567.2710  
F: +32 2 567.2709  
belux@meyersound.com

### Meyer Sound Brazil

T: +55 11 3816.0401  
brazil@meyersound.com

### Meyer Sound Canada

T: +1 250 549.2558  
F: +1 250 549.2668  
canada@meyersound.com

### Meyer Sound CIS

T: +7 095 943.0091  
F: +7 095 947.9140  
russia@meyersound.com

### Meyer Sound España S.A.

T: +34 90 216.0245  
F: +34 90 018.0762  
spain@meyersound.com

### Meyer Sound Lab. Germany GmbH

T: +49 2602 99908.0  
F: +49 2602 99908.99  
germany@meyersound.com  
www.meyersound.de

### Meyer Sound México S. de R.L. de C.V.

T: +52 55 5631.8137  
F: +52 55 5630.5391  
mexico@meyersound.com  
www.meyersound.com/spanish

### Meyer Sound Portugal

T: +351 91 512.8686  
portugal@meyersound.com

### Meyer Sound UK Ltd.

T: +44 7887.777150  
uk@meyersound.com

## CASE STUDY

Westfield High School  
Houston, Texas



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## Constellation at Westfield High School

Constellation electroacoustic architecture, part of Meyer Sound's line of digital audio products, marks a breakthrough in acoustical design for performance venues. Constellation can instantly modify a venue's acoustics at the touch of a button, thus enabling the acoustical characteristics of a room to be tailored to achieve the optimal response for any type of event. This extraordinary flexibility, combined with natural sound quality and a lower cost compared with that of most physical or mechanical alternatives, makes Constellation the preferable option for multipurpose performance venues.



## SUMMARY

### Westfield High School Adopts a New Approach to Venue Acoustics

Located in suburban Harris County, north of Houston, Texas, Westfield High School is home to the Philip K. Geiger Center for the Performing Arts. The 1,200-seat Geiger Center auditorium regularly hosts a wide variety of internal events, including band and choir concerts, theatre performances, the school's one-act-play competition, guest speakers, class meetings, senior talent and fashion shows, and an annual musical theatre production. It is also the site of regional events, including state band competitions, an annual performance of the *Nutcracker* ballet by an outside dance company, and music events for nearby elementary and middle schools.

The diverse calendar of events and variety of performances presented a challenge for Westfield High. While the auditorium's physical acoustics worked well for reinforced sound, acoustic music was not as well supported as it would be in a recital or concert hall. The physical room did not provide the acoustical energy to audiences and musicians alike that characterize a rich, enveloping audio experience. In 2006, the school overcame this hurdle by installing Meyer Sound's groundbreaking Constellation electroacoustic architecture.

Now, equipped with Constellation, Westfield High can deliver the acoustics suitable for each performance and guarantee an optimal listening experience for audiences and performers alike, regardless of the presentation type.

## Challenges

- The need to support a diverse calendar of events, from spoken word to choral and orchestral music
- The venue's fundamental acoustical characteristics were best suited for reinforced sound
- Alternative variable acoustics approaches, such as architectural modifications, were insufficient and/or prohibitively expensive
- Limited time allowed for acoustical renovations

## Requirements

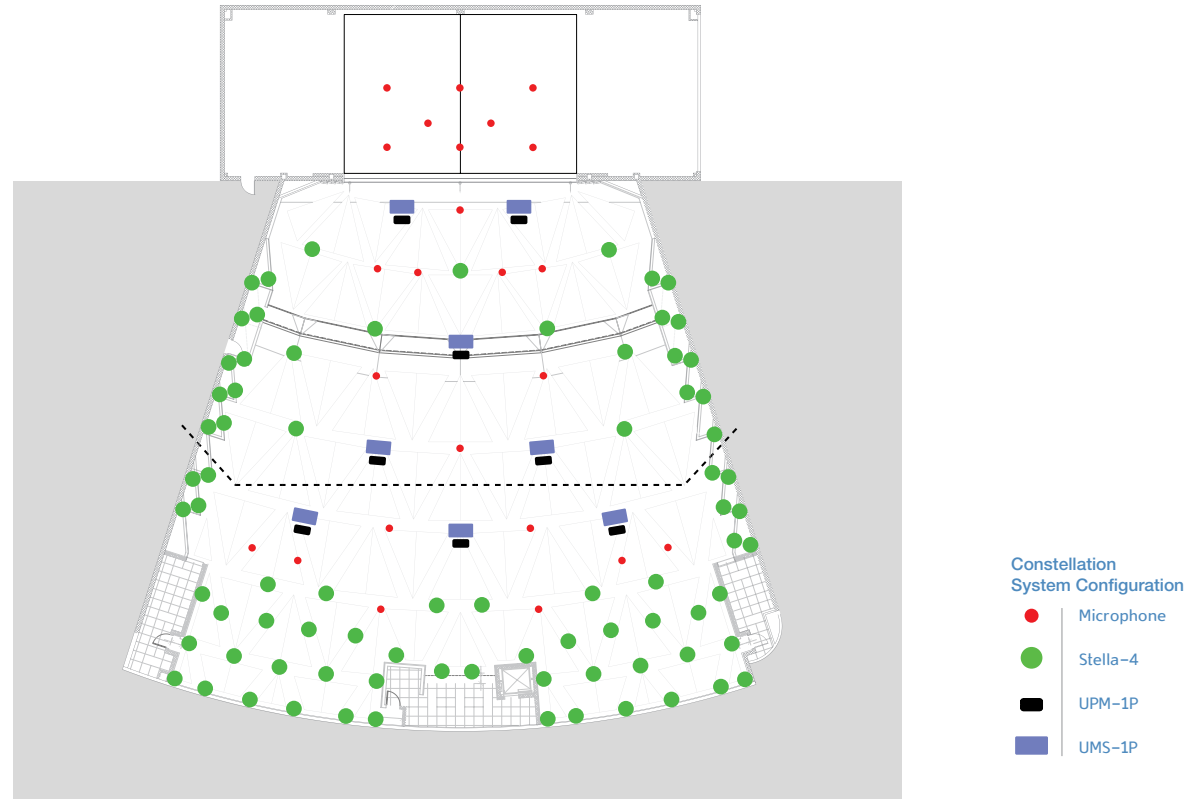
- Provide acoustical signature suited to each type of event
- Meet fixed budgetary requirements
- Minimize impact on room aesthetics
- Ease of use for staff operators

## Benefits

- The room is instantly adaptable to provide optimal acoustics for any event
- Audiences and musicians feel more involved in performances
- The venue is more attractive for community events and regional competitions
- Students have the opportunity to learn about acoustics and digital audio processing

*“This new environment offers the listener a much better experience. We have done demonstrations for the audience on what the system is capable of, and it always leaves them speechless when we go from completely off to the ‘choir’ setting. It still brings tears to my eyes when I hear it. Amazing!”*

**Jodie Rhodes**  
Director of Bands



The Constellation system employs a large number of microphones and loudspeakers, the placement and tuning of which are complex and critical. These figures show the loudspeakers deployed in Westfield High School's auditorium. The system is carefully calibrated to ensure optimal energy levels emanating from every direction.

## CONSTELLATION SYSTEM OVERVIEW

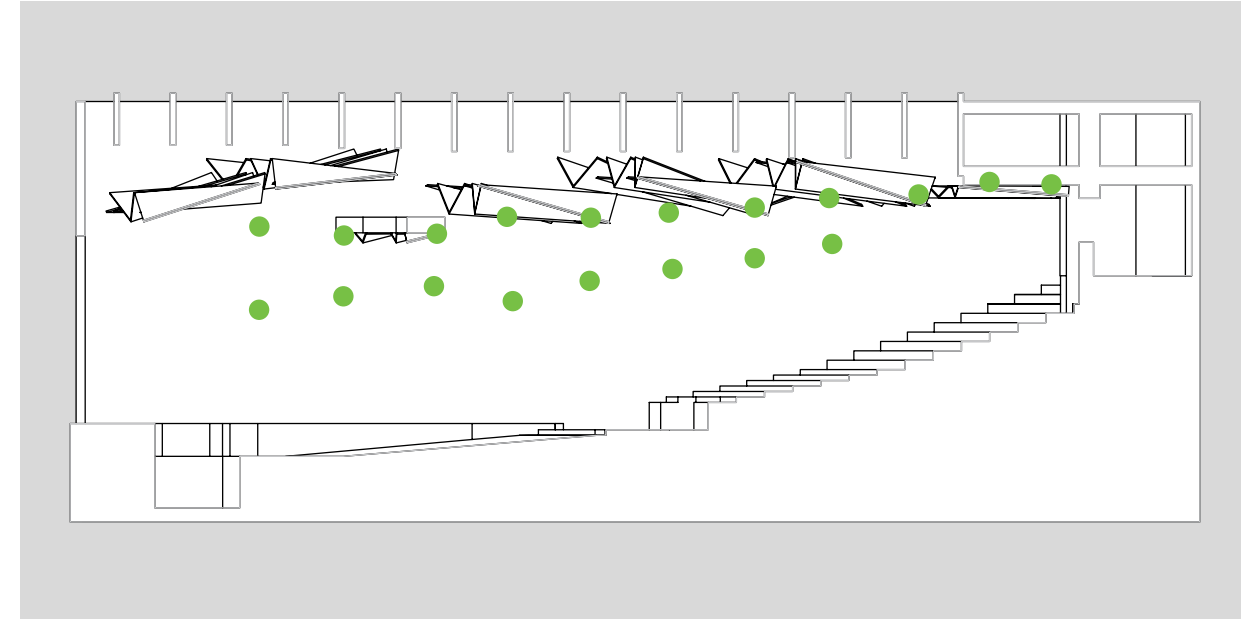
Constellation electroacoustic architecture combines advanced digital processing and transducer technologies with decades of research into the acoustical attributes of exceptional listening spaces. At Westfield High School, Constellation enables natural-sounding variable acoustics that can instantly be modified for any type of event at the touch of a button on an LCD touch screen.

### System Design Goals

Among the Geiger Center's most prominent events are marching-band competitions, which allow no sound reinforcement. Consequently, a critical design parameter was that the system must serve strictly as acoustical enhancement, not source amplification.

In physical acoustics, early reflections and room reverberation can be treated as distinct attributes that together define the acoustic 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.

Constellation applies this same approach, allowing both the mixture and the intensity of these two attributes to be changed, via simple user presets, for different types of events.



A Constellation system is constituted of a regenerative component (microphones picking up sound from the reverberant field of the room and sending a processed version back into the reverberant field through system loudspeakers), and a non-regenerative component (early reflections generated from stage sources).

In formulating the Westfield High design proposal, the first objective was to create an early reflection zone in the front of the auditorium. By forwarding energy from the stage outward, these augmented early reflections add presence and provide a greater sense of intimacy and immediacy for both spoken word and musical performances.

The auditorium features front and rear seating areas constructed on different levels, and each area is treated as an independently controllable reverberation zone. The processing applied in these zones augments the physical room reverberation.

The requirement was to augment the room's natural 1.2-second mid-band reverberation time with settings appropriate for spoken word, as well as for a wide range of student performance ensembles, including concert band and choir.

### Meyer Sound Solution

- 84 Stella-4 prototype loudspeakers
- 8 UPM-1P loudspeakers
- 8 UMS-1P subwoofers
- 24 Omnidirectional Constellation microphones
- 1 MS-Constellation processor
- 2 MS-VRAS processors

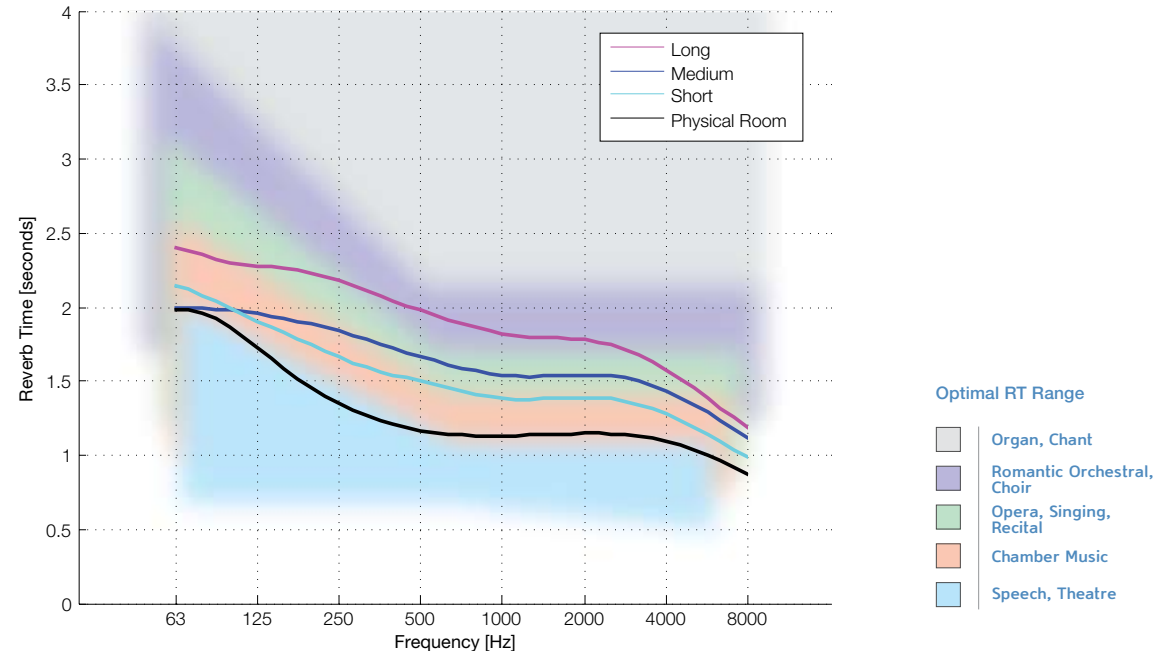
### Project Participants

**Facility Owner**  
Westfield High School  
Spring Independent School District  
16713 Ella Blvd  
Houston, TX 77090  
(281) 586-1300

**Acoustical Consultant**  
Hoover & Keith  
11391 Meadowglen, Ste. D  
Houston, TX 77082  
(281) 496-9876

**Installation Contractor**  
Hairel Enterprises  
1925 Longmire Road, Bldg. 7  
Conroe, TX 77304  
(936) 539-1135

**Architect**  
Information  
to come



Constellation tailors room response in terms of both reverberation time and the frequency content of the reverberant field. As a result, the acoustical signature of the room can be optimized for the needs of each type of performance or event.

## Constellation System Configuration

### Zones and Components

To achieve the design goals, the Constellation system at Westfield High is divided into three zones: an enhanced early reflection zone, and front and rear reverberation zones. Each zone is driven by a separate Constellation MS-VRAS processor, which provides multiple inputs and outputs for connection to the 24 condenser microphones (which pick up direct and ambient sound), and the 100 self-powered loudspeakers of three different types that produce the acoustical effects.

Westfield High’s Constellation system uses a combination of an early version of Meyer Sound’s Stella-4 installation loudspeaker and the UPM-1P ultracompact wide coverage loudspeaker. For natural enhancement of wideband sources, such as orchestra, the system incorporates UMS-1P ultracompact subwoofers to provide energy below 63 Hz.

The first processor contains eight phantom-powered microphone inputs and 16 line-level outputs. It is the communications hub of the system, as the touchpad controller connects to its RS-422 port, and its Ethernet port is used for programming the system.

### Early Reflections Zone

The early reflections zone derives its source signals from eight microphones hung over the stage, within the auditorium’s acoustical shell. These microphones pick up the stage sound with the highest direct-to-reverberant ratio of any of the microphones in the system. The zone’s MS-VRAS processor drives two Stella-4 loudspeakers from each of the five outputs used. These loudspeakers were deployed overhead, just in front of the stage.

The natural-sounding early reflections are produced by five overhead UPM-1P loudspeakers, 10 overhead Stella-4 loudspeakers, and 20 lateral Stella-4 loudspeakers, mounted on the side walls at two levels. Low-frequency response in this zone is provided by five subwoofers.

### Front and Rear Reverberation Zones

These two zones are mixed and tuned separately to blend with the surrounding physical room acoustics; however, both zones work in concert to provide the depth and fullness of ambient sound required for performances. The front zone uses the eight stage microphones, as well as eight additional microphones over the front of the audience. The rear zone uses eight microphones hanging over the rear audience area. Post-processing, mid-high reverberant energy is supplied by three overhead UPM-1P cabinets and 54 Stella-4 units: 42 overhead and 12 on the side walls. The low-frequency reverberation component is serviced by three UMS-1P subwoofers.

### User Interface

The basic user interface offers the utmost simplicity for Westfield High’s staff and volunteers. Four presets are available on the touch-screen control surface: off (physical room), short, medium, and long.

*“The most telling moment for me was when the band was playing with the system on, and as soon as it was purposely turned off, about half the students suddenly stopped playing because they had lost the early reflection cues that they’d been hearing so clearly. The sound all seemed to get sucked back onto the stage.”*

**Daniel Wright**  
Installation Project Manager,  
talking about a Constellation demonstration at a rehearsal



### Installation, Calibration, and Tuning

The design goals of Westfield High School's Constellation system were created from the specifications given by the high school's staff and the acoustical consultant. The system design to achieve the stated goals was based on measurements taken by Meyer Sound's Constellation team in the room.

Once the complexity of the design was finished, installation was simple by comparison. The self-powered nature of Meyer Sound loudspeakers eliminated the need for an amplifier room or long loudspeaker cable runs. The Stella-4 loudspeaker is supplied with DC power and balanced audio in a single cable. The Stella-4 runs off of a 12 – 18 V DC supply, which reduces induced noise and eliminates the need for running a wiring conduit to it.



*“We do all of the recording for our bands in the hall, and your first impulse is to leave it as dead as possible, to be like a recording studio. But we’ve learned that you don’t hear as well on stage when you do that. So when we record in there, we use the same reverb setting we would in concert. It makes the performers play better because they can hear themselves, and the other players in the band, more clearly. With Constellation, we have had nothing but rave reviews for how it feels in here from performers and conductors.”*

**Jason Hall**  
Percussion Instructor and Facility Manager,  
Philip K. Geiger Performing Arts Center

While the installation contractor used careful, professional installation practices to ensure the components were installed exactly as specified, no unique tooling or procedures were required.

Once the components were installed, the Meyer Sound Constellation team returned to calibrate and tune the system. Calibration and tuning of a Constellation system, like its design, are complex procedures requiring highly trained and experienced staff. The Constellation team conducted these processes using proprietary methods and powerful tools, such as the SIM 3 audio analyzer.

At the conclusion of the tuning process, standard measurements were taken to confirm that the design goals had been achieved. These measurements can be replicated by any acoustical professional.



## The Outcome

### Optimized Acoustics for Each Performance at the Push of a Button

The four Constellation presets programmed by the Constellation design team vary in their reverberation times and early reflection content. Each preset is recalled by a button on the touch-screen controller. For each event, Westfield High School's technical crew chooses from the appropriate presets:

- For most spoken-word presentations, assemblies, and dramatic productions, the "Off" preset is chosen to use the auditorium's unassisted reverberation time of 1.2 seconds.
- Some spoken-word events sound best using the short setting, which has a reverberation time of 1.4 seconds. Along with the slightly longer reverberation time, this preset includes Constellation's VoiceLift feature, which improves intelligibility so that presenters can be heard and understood clearly without having to speak into a microphone. This preset includes a higher ratio of early reflections to reverberation than the other two settings.
- The high school's popular concert and stage band events use the medium setting, with a reverberation time of 1.6 seconds.
- The 1.9-second reverberation time of the long setting is the appropriate choice for choral and orchestral music.

### A System That Pleases on All Fronts

It was no surprise when the initial round of tests proved that the system met all goals set by the acoustical consultants. After all, the Constellation team combined the world's most advanced acoustical measurement tools and human ears with decades of experience recording the world's greatest orchestras to fine-tune the system's response.

"It was a pretty dramatic experience," observes consultant Reggie Keith. "You're looking at one room and then somebody pushes a button. All of a sudden, you're hearing a different room." Keith sees the system as a good value for the school. "For the cost of this one system, Westfield actually got three more rooms," he says.

### A Breathtaking Chord

Constellation has allowed audiences at Westfield High School to experience live performances as they should sound. The system brings presence, immediacy, and exceptional clarity to spoken-word presentations, while the audience is immersed in richness and warmth during musical performances.

The high school staged a short demonstration of the Constellation system for the audience at one of the first performances to use it, with memorable results. "Shortly after installation, in our first Christmas concert, the concert band struck a full chord with the system off, and then the same chord with Constellation on the long setting," recalls director of bands Jodie Rhodes. "You could hear a gasp sweep through the audience. It took their breath away. We'll never forget their look of complete astonishment."

### A Richer Environment for Performers

Westfield High uses its Constellation system for both recordings and live shows. During recordings, Jason Hall, the facility manager, chooses the system's medium preset, generally used in concerts. Hall started doing this when he noticed that the system was enabling the performers to better hear themselves and the other players, resulting in better performances. "With Constellation, we have had nothing but rave reviews from performers and conductors for how it feels in here," he states.

### An Attractive Venue for Events Large and Small

Since its installation in late 2006, Westfield High School's Constellation system has been used in scores of events, assemblies, productions, and conferences of all kinds. Westfield High students have presented dozens of band concerts, solo and duet recitals, dance performances, dramatic plays, and the well-known musical comedy *Little Shop of Horrors*. Outside community groups have rented the facility for many productions, including the annual performance of *The Nutcracker*. The Geiger Center auditorium has also become a preferred site for statewide band competitions and festivals.

"The added fullness and clarity of Constellation give us an edge that nobody else has," says Rhodes. "It has been a selling point to bring music festivals here and attract more outside groups. The more the word gets out about what our facility can do, the more we see coming in. We've noticed a definite increase over the last year, which generates revenue and helps to maintain the facility."

*"Shortly after installation, in our first Christmas concert, the concert band struck a full chord with the system off, and then the same chord with Constellation on the long setting. You could hear a gasp sweep through the audience. It took their breath away. We'll never forget their look of complete astonishment."*

**Jodie Rhodes**  
Director of Bands



## 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 pick up both direct and reverberant sound.

### User Interface

Once Constellation is in place and fully calibrated and tuned, it is put under the user's control with an intuitive, easy-to-use touch screen interface.



## 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 four-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, provides the accuracy required for creating a natural-sounding room characteristic. Stella-4 receives balanced audio and DC power through a single five-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 (12–18 V) 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.



### 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 (@ 1 m) 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.



Note: Because Westfield High School was one of the first Constellation installations, some units in this facility differ slightly in appearance or model designations from the currently available equivalent products.



## 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. Because Constellation is scalable as well as flexible, it is suitable for venues of any size and type.

### A Certified Solution

Constellation is provided as an integrated, turnkey solution that encompasses 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 WESTFIELD HIGH SCHOOL

Westfield High School is one of 34 schools in the Spring Independent School District serving portions of suburban Harris County, north of Houston, Texas. With a growing enrollment topping 4,000 students, Westfield High has earned widespread recognition for academic excellence, as well as for noteworthy achievements in sports and the performing arts. For the past two years, Westfield High has been in the top five among larger Texas high schools in the Lone Star Cup, an independent survey that combines excellence in academics and athletics.

The strong and varied music program is a particular point of pride at Westfield High. Year after year, the school's marching bands, concert bands, and choirs have earned top placement in competitions at both state and national levels. Many of Westfield High's award-winning musical performances were under the baton of the longtime director of bands, Philip K. Geiger. When he retired, the school recognized Geiger's contribution to the music program by naming its new performing arts center in his honor.