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41 PAGES OF NEW PRODUCT DEBUTS**

BY R. DAVID READ

A new home for the Norwegian National Opera, Repertoire Ballet Company and host to touring performance companies opened recently in a spectacular waterfront setting in downtown Oslo, Norway. Since its grandiose opening, the facility has garnered rave reviews from local and international critics for both its architectural-acoustics and the artistic, technical excellence of performances presented in the new space.

A Long Time Coming

The previous facility for the Oslo Opera, constructed in 1881, had long drawn the wrath of critics and audiences alike for its deplorable, noisy HVAC system, uncomfortable seating, poor sightlines and dismal acoustics. Oftentimes, however, building opera houses is not too high a parliamentary priority.

After 120 years of fits and starts, the Norwegian Parliament in 1998 re-addressed the issue for the umpteenth

time; this time, it gained a consensus, and authorization for the commencement of planning was realized. The government's agency for building development and operation (Statsbygg) was directed to commence drawing up plans for what was to become the largest expenditure for a Norwegian cultural facility since the construction of the Nidaros-Domen Cathedral some 700 years prior.

Several sites within the urban environment of Oslo were considered, with the Bjorvika¹ Peninsula neighborhood ultimately chosen for the new performance venue. A waterfront location overlooking the Oslo Fjord, in what had been an industrial and rail yard complex, was deemed worthy of redevelopment, and it was decided that the new Opera House would be built adjacent to Oslo's Main Railway Terminal. One of the avowed intents was to revitalize the neighborhood and spark

redevelopment in a critical portion of the Oslo urban landscape.

Planning

Critical criteria in hand, Statsbygg commenced an international architectural competition for proposals for the new facility. The critical elements were for a facility that would encompass a main salon, a secondary performance space, a rehearsal space/recording studio, and the necessary stagecraft production and administrative spaces to comprise a self-contained, functional whole. From some 240 submissions, the Norwegian architectural firm of Snøhetta was awarded the design contract. What emerged was a stunning architectural accomplishment complete with superior acoustics and highly technically advanced stage-management systems.

Once selected for this imposing task, Snøhetta prepared the design plans and



MODERN CLASSIC ARTS

Acoustics are prime at Oslo's new opera house.

Norway's first and only facility devoted to grand opera rises from the icy depths of the Oslo Fiord and makes a stunning addition to the Oslo landscape.

Jaro Holian-Statsbygg

Contributing Editor R. David Read travels the world for Sound & Communications, covering trade events and significant architectural-acoustical developments.

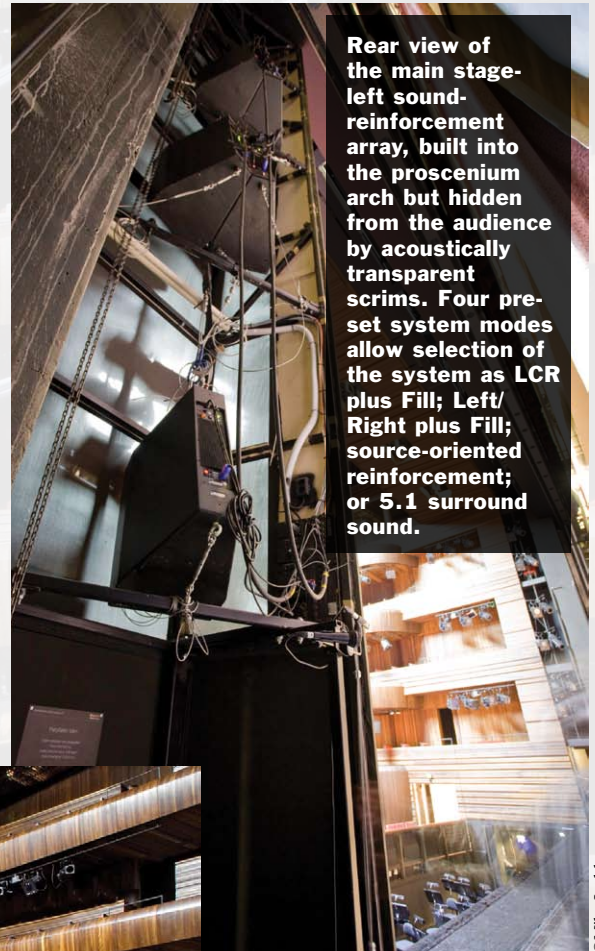
assembled its team. High on the list was selection of an architectural-acoustic designer. Snøhetta appointed the joint-venture team of Norway's Brekke Strand Akustikk and internationally acclaimed London-based Arup Acoustical Consultants to attend to acoustical matters, and the aptly named Theatre Designers of London was appointed to collaborate.

Acoustics

From the very beginning, Statsbygg made clear that acoustic considerations were to be given prime concern, specifically stating that "excellent acoustics for traditional proscenium-type grand opera is expected." It was also made clear that the spaces would be used for a variety of presentations and that acoustical accommodation for the varying styles of performances would be an absolute necessity.

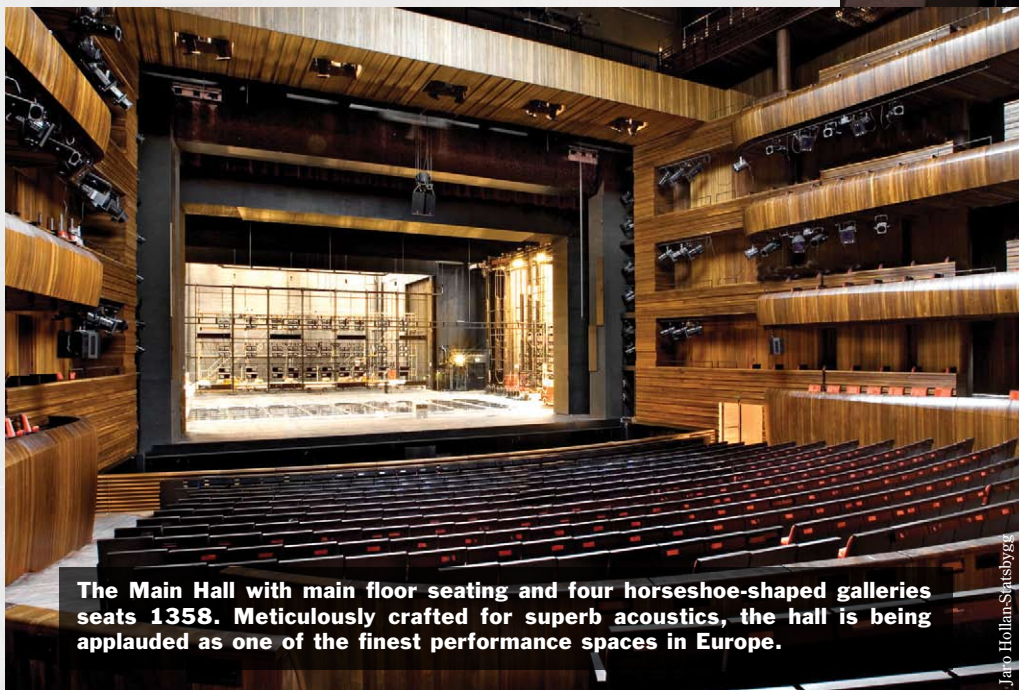
lon. Gorgeous, curva-linear, wooden walls and soffits were constructed of solid oak, fabricated and fitted by Master Shipbuilders, and then installed in place.

In conjunction with government planners, the architects and consultants toured many of Europe's major opera houses and painstakingly examined the elements that made such venues superior, mediocre or less than satisfactory. With that information in hand, it was "back to the drawing board." The consensus was that the "horseshoe"-shaped seating galleries of the traditional opera house design had proven to be the most suc-



Rear view of the main stage-left sound-reinforcement array, built into the proscenium arch but hidden from the audience by acoustically transparent scrims. Four preset system modes allow selection of the system as LCR plus Fill; Left/Right plus Fill; source-oriented reinforcement; or 5.1 surround sound.

©Mike Lethby



The Main Hall with main floor seating and four horseshoe-shaped galleries seats 1358. Meticulously crafted for superb acoustics, the hall is being applauded as one of the finest performance spaces in Europe.

Jaro Hollan-Statsbygg

Fortunately, the acoustical and theater planners had arrived on the scene in the early days of the project. Hence, their recommendations as to surface material selections, wall-ceiling contours and the adoption of early reflection versus delayed echo-producing focusing were added to the design during initial planning. In final form, there is not a parallel surface to any of the interior walls of the Main Sa-

ccessful approach for providing satisfactory results in facilities of this nature². However, it was noted that conditions relative to reverberation and relative acoustics in such halls required further clarification—and perhaps some adjustments.

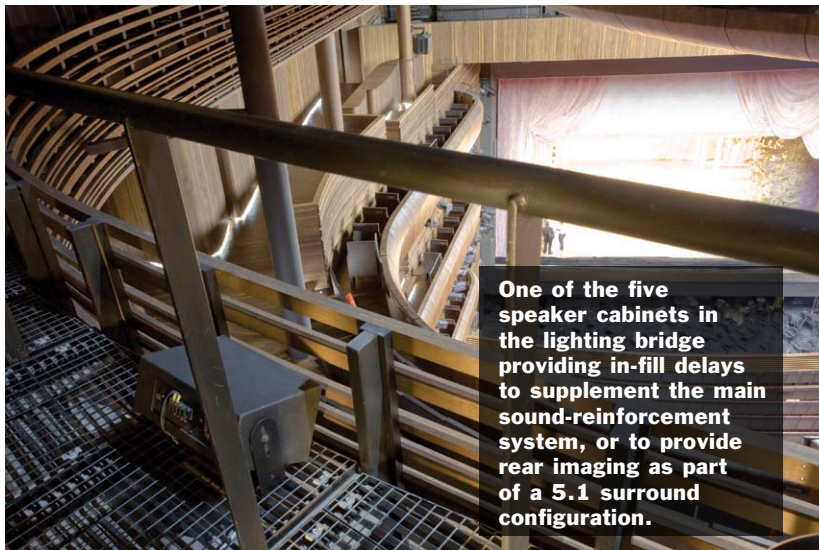
Mapped The Halls

Using modern technology design mapping and auralization procedures,

the acoustical consultants were able to predict, with a reasonable degree of accuracy, how the halls would perform under real-world conditions. Rob Harris, Director of Arup's Performing Arts Sector, stated, "We carried out acoustic analysis of the developing design using room acoustics software, then fed the results back into the design process. This allowed the designers actually to listen to the room before it was built. More than 200 versions of the

model were made to investigate the effects of proposals. In addition, we built a 1:50 scale model of the Store Sal [Main Hall] room to carry out further tests."

As work progressed, it became apparent that a modified approach to traditional methods of architectural-acoustics was warranted. Jeremy Newton, Auditorium Acoustic Designer at Arup, commented, "We needed to max-



One of the five speaker cabinets in the lighting bridge providing in-fill delays to supplement the main sound-reinforcement system, or to provide rear imaging as part of a 5.1 surround configuration.

©Mike Lethby

imize the volume while still providing intimacy in the relatively small space. So, we exposed the room structure and formed the idea of ‘ears’ for the room, stepping out the auditorium walls at a high level above the seating tiers. The room is narrow low down, providing clarity and intimacy, and wide at the top, providing reverberance.

“Because the ideal acoustics of a hall are different for different performances, the house includes a large area of curtains. These can be extended into the room, using computer-controlled motors, to provide a less resonant acoustic [atmosphere] for contemporary [electronic] opera and for the occasional amplified concert.”

Implementation

Ultimately, Statsbygg interviewed some 60 prospective prime contractors and suppliers. In the AV sector, the agency vetted a number of prospective systems integrators based on their presentations, record of prior activities, and financial stability to bond and perform the proposed work. Oslo-based Benum Group found itself on the short list.

Although a major supplier of AV products in Scandinavia, Benum realized its shortcomings in its ability to provide adequate personnel and necessary capital to perform the impending task within the given timeframe. Consequently, Benum brought in Finnish building implementer YIT as a joint-venture partner.

Per their agreement, Benum would provide the materials, resources and labor for the sound reinforcement and stage management aspects, and YIT would focus on the cabling infrastructure, completion of the video, communications elements and the Bosch life-safety public address portions. In subsequent negotiations, the Benum and YIT proposal was further modified on value-engineering principles and flexibility issues to include the participation of Amsterdam, NL-based Rapenburg Plaza as the electronic technology stage management supplier.

Stage Manager-Oriented Concept

In a carefully worded, concise, 78-page document, the specifications pertaining to the fabrication and operational aspects of the stage manager consoles for the Main Hall and the Secondary Hall are described in minute detail. This is a highly complex piece of apparatus that, during performances, is staffed by two operators: One handles the stagecraft elements, whereas the other monitors and adjusts the technical interfaces.

In addition to handling the normal “stage management” functions, the operators monitor, control and adjust the parameters for the following ancillary functions: stage and house light-

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ing; house automation, ventilation and HVAC operations; door lock, unlock conditions; monitoring and response characteristics in the event of fire or security alerts; generation of video text messaging for announcements; monitoring of stage rigging, stage mechanics and prop placement; fault monitoring of IR, radio paging, assistive-listening systems and the blind positioning/guidance system.

During rehearsals and performances that don't require a live audio mixer, the stage manager can assume limited control of the audio sound-reinforcement system, adjust the acoustical curtains, select the desired configuration of the sound-reinforcement loudspeakers, and cue/play recorded accompaniment for stage monitoring fold-back and house playback.

Inasmuch as the stage in the Main Hall is comprised of 16 movable sections that can be deployed independently in various configurations, plus the largest stage turntable currently installed in any European theater, these elements can be activated as required to support the presentation. When activated, the electronic technology built into the stage manager's console controls and monitors the placement of these mechanical elements. There is no "fly-floor" per se; all stage rigging is automated and can be preset to activate on cue.

Interestingly, the 78-page document did not contain a single reference to any specific manufacturer's brand or model number, the inference being that the party submitting the tender offer was solely responsible for the performance requirements.

A provision that caught this writer's attention was the requirement that system commissioning would conform to testing procedures that guaranteed 99.998% reliability for the hardware and 98.7% software reliability. Certainly, this was not a document for consideration by a novice or a faint-of-heart integrator.

Configuring The Halls

In the Main Hall, and to a lesser degree in the Secondary Hall, performances fall, roughly, into three categories:

Rapenburg Plaza

Rapenburg Plaza is a 12-employee, Amsterdam-based, 14-year-old systems integration company that specializes in show control technology throughout Western Europe. Initially founded by Sierk Janszen and his partners, the firm was previously known as Ground Zero and reflected the founders' backgrounds in touring sound. Their design and installation work is evident in numerous museums, theme parks and corporate facilities in European countries.

For additional information, go to www.rapenburgplaza.nl.

- Presentation of traditional opera/ballet with live musical accompaniment (no amplification).
- Presentation of contemporary opera with amplified accompaniment and ballet with pre-recorded musical accompaniment.
- Concerts and performances requiring a high degree of electronic amplification.

According to one source, the Oslo Opera House is not only the city's first-ever purpose-built opera house, it features a highly sophisticated au-

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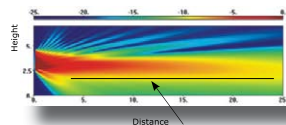
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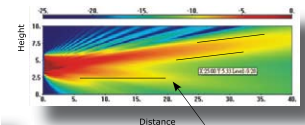
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The below pictures show how the sound beam from the Messenger speaker provides uniform volume (SPL) in various seating arrangements.

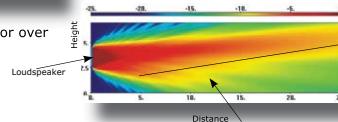


Volume at ear level on a flat floor over a distance of 75'

Worldwide Patented,
US Patent No.
US20040028238A1



Volume at ear level on a three level (Orchestra, main floor, and balcony) installation over a distance of 120'



Volume at ear level on a stadium (rising) floor over a distance of 75'



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Equipment

- 1 Avocent AMX series KVM Server IP secure router/safeguard
- 75 beyerdynamic DT231 headphones
- 10 beyerdynamic DT770-Pro headphones
- 10 beyerdynamic DT990 headphones
- 25 Clear-Com 4215EBLX4D system installation interfaces
- 11 Clear-Com 4294EBLX4D central control assemblies
- 30 Clear-Com CC-260 double-earmuff headsets w/mics
- 25 Clear-Com CC-95 single-earmuff headsets w/mics
- 40 Clear-Com FS-BP wireless belt packs
- 10 Clear-Com RS-601 single-channel intercom belt packs
- 1 Clear-Com system control/routing assembly
- 9 Crown PZM 6D pressure zone mics
- 1 Denon DCD-1500A CD player
- 1 Digidesign DX64 PC interface
- 1 Digidesign HD3 Pro Tools core system
- 18 DPA 4021 compact cardioid condenser mics
- 30 DPA 4061 lo-sens black miniature mics
- 30 DPA 4088 adjustable miniature cardioid headband mics
- 7 Dynaudio AIR 20 intelligent 3-way active near-field monitors
- 2 Dynaudio AIR 6 2-way active near-field monitors
- 1 Dynaudio AIR Base 12 active subwoofer
- 1 Fostex CDR500 CD recorder/player
- 6 Fostex FR2 field memory recorders
- 1 Fostex PH100 headphone amp
- 11 Genelec 8030 control room monitors
- 1 Genelec 8030A full-range speaker
- 2 Genelec 8040A full-range speakers
- 2 LA Audio DA82 analog distribution processors
- 1 Leitch SPG1601 master time sync system
- 4 Medialon V3 Lite show control programmers
- 2 Medialon V3 PRO show control programmers/servers
- 2 Neumann M149 universal tube mics
- 2 QSC CX 1102 2x700W/8 ohm power amps
- 1 QSC CX502 2x500W power amp
- 7 Renkus-Heinz DR18-2 Dual 18" self-powered subwoofers (Main Hall, Main system, Mobile)
- 2 Renkus-Heinz PN112 Single 12" self-powered subwoofers (Rehearsal Rooms)
- 15 Renkus-Heinz PN121M PowerNet self-powered active, portable speakers (Monitor)
- 12 Renkus-Heinz PN61 2-way full-range self-powered, active fill speakers (Main Hall, Stage front, Monitor)
- 14 Renkus-Heinz PN81/12 PowerNet self-powered speakers (Rehearsal Rooms 2, 3, 4, B, C, D and E)
- 34 Renkus-Heinz PN81/9 2-way full-range, active self-powered speakers (Main Hall, Lightbridge, Monitor Mobile Stage, Surround)
- 6 Renkus-Heinz PN82/12 PowerNet self-powered speakers (Rehearsal Rooms)
- 52 Renkus-Heinz PNX61 2-way, full-range active fill speakers (Main Hall, Fill/surround)
- 4 Renkus-Heinz PNX81/9 2-way, full range, active gallery fill speakers (Main Hall, Fill balcony 3)



©Mike Lethby

- 4 Renkus-Heinz ST4/4-2T 3-way 2 wide RPA speaker clusters (Main Hall, Side fills)
- 2 Renkus-Heinz ST4/9 3-way biamped full-range speakers (Main Hall, Top side fills)
- 1 Renkus-Heinz speaker network/control system
- 7 Rufo equipment racks
- 4 Schoeps BLM03C mics
- 4 Schoeps CCM4L/MK41 super-cardioid mics
- 10 Schoeps CCM4LG cardioid compact mics
- 8 Schoeps CCM4LG/MK-4 handheld mics
- 10 Shure Beta 58A vocal mics
- 15 Shure Beta 87C vocal mics
- 12 Shure KSM44 studio mics
- 6 Shure KSM137SL cardioid condenser mics
- 2 Shure UA845E 500-900MHz antenna combiners
- 4 Shure UA860WB passive omnidirectional antennas
- 4 Shure UA870WB wideband UHF wireless directional antennas
- 40 Shure UR1 bodypack wireless transmitters
- 10 Shure UR2/Beta 87C wireless mic, handheld transmitters
- 40 Shure UR4D wireless receivers
- 2 Stage Tec Aurus 24-fader audio mixer consoles
- 1 Stage Tec Aurus 40-fader audio mixer console
- 4 Stage Tec I/O matrixes
- 1 Stage Tec Nexus Star facility router
- 2 Stage Tec Nexus Star secondary facility routers
- 2 Stage Tec OMUX optical fiber multiplexers
- 1 Stage Tec orchestra I/O device
- 1 Stage Tec portable, mobile I/O
- 1 Stage Tec rehearsal hall I/O device
- 3 Stage Tec stage manager I/O devices
- 2 TASCAM CDD01-Pro CD players
- 3 TC Electronic TC 6000 w/AES3 I/O signal processors
- 1 Track The Actors TTA FX Stagetracker 16-channel system
- 2 Yamaha CDR-HD 1500 digital magnet hard drives

- 2 Yamaha DA824 8-channel 24-bit DA converters
- 1 Yamaha DME64 + DME24 signal processing, output matrix router fold back
- 2 Yamaha DME64N digital mixing engines for main speakers
- 1 Yamaha LS9 portable audio mixer
- 2 Yamaha MY16AE 16-channel digital I/O cards
- 2 Yamaha MY8AE 8 AES/EBU digital format I/O devices
- 6 Yamaha MY8DA96 96kHz Series mini YGDAI cards
- 1 Yamaha SPX2000 special effects mixer
- Yamaha cross-link, cascade cables

List is edited from information supplied by The Benum Group.

Main Hall Stage, Equipment Room

- 1 custom interface for Bosch paging system
- 2 Elka DMX to EIB-Bus translators
- 2 Guntermann & Drunck Catvision KVM
- 3 HP ProCurve 2626 managed Ethernet switches
- 2 HP ProCurve 8 port Ethernet switches
- 2 HPS-DT170 17" touchscreens
- 2 Kiss-Box 4-Beltfader units
- 1 Kiss-Box DMX transceiver
- 2 Kiss-Box HIN (Human Interface) controller
- 2 Kiss-Box I03 Card-cage w/input, output cards
- 2 Kiss-Box I08 Card-cage w/input, output cards
- 12 Kiss-Box LCD 4-button units
- 1 Kiss-Box LTC SMPTE transceiver
- 2 Kiss-Box Midi transceivers
- 35 Kiss-Box Mobile Cue-Lights, switch control box
- 2 Kiss-Box POE 4 port Ethernet switches
- 2 Medialon V4 Pro show control software w/19" industrial servers
- 3 Moxa 1015 Nport servers for camera control
- 2 Moxa Nport 4 port serial servers
- 2 Phihong 16 port POE Midspan

Main Hall Sound Booth, Lighting Booth (each)

- 1 HPS-DT170 17" touchscreen
- 1 Kiss-Box Midi transceiver (Sound Booth only)
- 1 Kiss-Box DMX transceiver (Lighting Booth only)
- 1 Kiss-Box LTC SMPTE transceiver (Sound Booth only)
- 1 Kiss-Box Midi SMPTE transceiver (Lighting Booth only)
- 1 Kiss-Box I03 Card-cage w/input, output cards
- 1 Kiss-Box POE 4-port Ethernet switch
- 1 Medialon V4 Pro show control software w/19" industrial server (Sound Booth only)
- 1 Medialon V4 Lite software w/19" industrial server (Lighting Booth only)

Secondary Auditorium Stage, Equipment Room

- 1 custom interface for Bosch paging system
- 2 Elka DMX to EIB-Bus translator
- 2 Guntermann & Drunck Catvision KVM
- 2 HP ProCurve 2626 managed Ethernet switches
- 1 HP ProCurve 8 port Ethernet switch
- 2 HPS-DT170 17" touchscreens
- 2 Kiss-Box 4-Beltfader units
- 1 Kiss-Box DMX transceiver
- 2 Kiss-Box HIN (human interface) controllers

- 1 Kiss-Box 103 Card-cage w/input, output cards
- 1 Kiss-Box 108 Card-cage w/input, output cards
- 12 Kiss-Box LCD 4-button units
- 1 Kiss-Box LTC SMPTE transceiver
- 1 Kiss-Box Midi transceiver
- 15 Kiss-Box Mobile Cue-lights, switch control box
- 2 Kiss-Box POE 4 port Ethernet switches
- 2 Medialon V4 Pro show control software w/19" industrial servers
- 2 Moxa 1015 Nport servers for camera control
- 1 Moxa Nport 4-port serial server
- 2 Pihong 16-port POE Midspan

Secondary Auditorium Sound Booth

- 1 Medialon V4 Lite software w/19" industrial server
- 1 HPS-DT170 17" touchscreen
- 1 Kiss-Box Midi transceiver
- 1 Kiss-Box LTC SMPTE transceiver
- 1 Kiss-Box POE 4-port Ethernet switch

Secondary Auditorium Lighting Booth

- 1 HPS-DT170 17" touchscreen
- 1 Kiss-Box DMX transceiver
- 1 Kiss-Box Midi SMPTE transceiver
- 1 Kiss-Box POE 4-port Ethernet switch
- 1 Medialon V4 Lite software w/19" industrial server

List is edited from information supplied by Rapenburg Plaza.

dio system throughout its three main spaces: the large hall (Main Hall); a second, flexible auditorium, the Scene 2 (small hall); and the rehearsal and recording hall.

The audio systems are designed to endow the Opera House with exceptional capabilities as a multi-purpose venue, complementing the halls' outstanding natural sound quality. All three spaces are served by a fully digitally networked audio distribution and control system, comprising a Stage Tec Nexus system with Aurus mixing consoles and TC Electronics TC6000 processors, with numerous audio distribution boxes located at strategic points throughout the halls and other public spaces.

The Main Hall and the secondary performance hall also feature state-of-the-art sound-reinforcement systems based around Renkus-Heinz self-powered and externally powered loudspeakers, with Yamaha DME64 digital processors. Also provided is a choice of switchable configurations to suit the type of performance, from solo voice through small band and orchestra to a rock band.

Signal routing to the main loudspeaker arrays (located in left and

right movable loudspeaker "towers") can be effectively configured to create two "systems within a system," with the upper loudspeaker cabinets handling vocals and the lower cabinets handling instruments to maximize separation and clarity. There is also a flown center cluster to provide an LCR sound image across the stage.

Electro-Acoustic Design

The audio system was designed and specified by consultants Artifon AB of Sweden and COWI AS of Norway. Alf

Berntson at Artifon was responsible for the main halls and the complex, custom-designed Stage Management System for both main auditoriums. Frode Bye at COWI was closely involved in signal distribution and other aspects.

In accordance with the design, Benum, YIT and Rapenburg Plaza fabricated and provided more than 200 audio distribution outlet boxes, the Renkus-Heinz loudspeaker system, Stage Tec consoles, a Clear-Com wireless and wired communication system, the Medialon-distributed paging for

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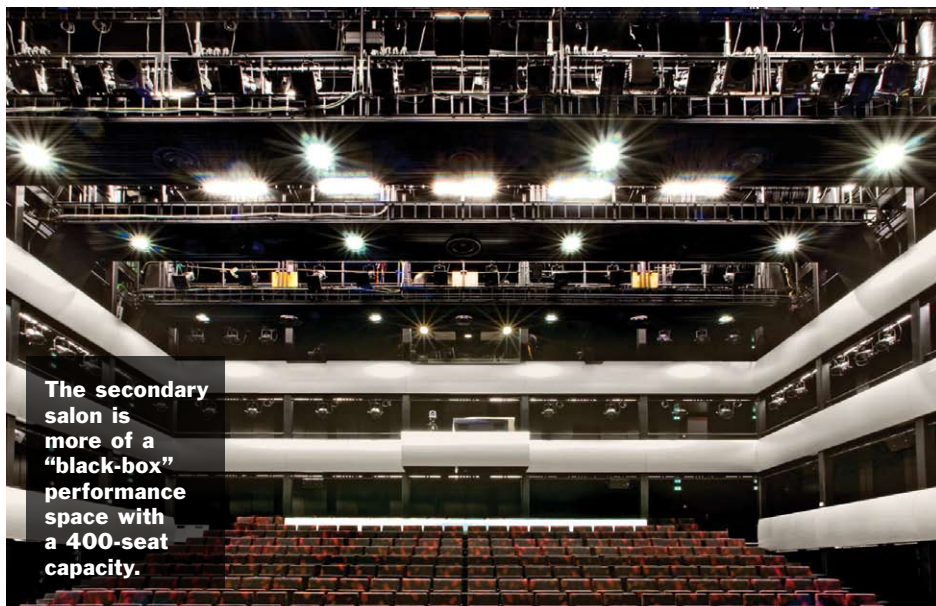
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The secondary salon is more of a “black-box” performance space with a 400-seat capacity.

Jaro Hollan-Statshygg

the orchestra, the video distribution and text messaging systems, the ADA-compliant guidance systems and the life-safety public address system.

Evaluation

Electro-acoustic evaluation for loudspeaker system design purposes was carried out, using a combination of EASE, EASERA and Norsonic NOR118, by Renkus-Heinz Senior Vice President of R&D Ralph Heinz, Robert Nilsson of DAT, Alf Berntson of Artifon and Benum’s Sverre Jøssund.

The main room itself, which seats

1370, has an RT_{60} of about two seconds, and movable curtains are provided to cover the gallery areas when unoccupied. Loudspeakers on each movable (stage right/left) loudspeaker tower are hidden behind specially tested, acoustically transparent cloths. All house reinforcement loudspeaker devices are completely separate from the venue’s Bosch fire-safety system.

The loudspeaker system is specified to handle anything up to and including a full rock concert, and is interfaced with a Yamaha DME64 digital mix engine and, in turn, to the Stage Tec

Nexus network via AES/EBU.

It provides four individually selectable modes, electronically configurable via the DME64’s 64-way output matrix, allowing instrumental and vocal signals to be routed to different combinations of loudspeakers to suit the type of performance. Mode 1, “Song System,” configures the main proscenium system as Left-Center-Right plus Fill; Mode 2 is the “Instrument System,” configured as Left/Right plus Fill; Mode 3 is designated “SOR” (Source Oriented Reinforcement); and Mode 4 provides 5.1 surround sound.

As illustrated, the audio mix for the Main Hall can be controlled from the stage manager’s console, the rear-of-hall audio control room or an FOH console in the audience seating area. When not in use, the FOH console can be lowered on its integral elevator to below floor level and concealed by moving in rows of semi-permanent seating. The 42-channel FOH console is used primarily during pre-performance (rehearsal) sessions. Settings determined at the FOH are “mirrored” into the control room console and the stage manager’s control point; hence, cues once set can be activated by the SMPTE time-coded sequencing. And the FOH can be lowered into its below-floor position and the seating configuration can be restored.

YIT Corporation

Founded in 1912 as a Finnish subsidiary of Sweden’s General Engineering Company, YIT established a reputation as a civil engineering and construction company, with emphasis on infrastructure projects. Acquired by legendary Finnish businessman Ragnar Kreuger in 1926, the company grew into one of the principal civil engineering firms in Finland.

After several mergers and acquisitions during the 1970s and 1980s, the company went public and, now, is traded on the Helsinki Stock Exchange. Growing remarkably, YIT now operates in three primary markets: commercial development and operations; residential, commercial and public works construction; and technology-telecommunication design and installation. The firm now has more than 27,000 employees and maintains offices throughout the Scandinavian and Baltic Rim countries. Its operations also extend to Russia, most of the northern tier of European countries and into the Middle East.

No stranger to opera houses, YIT was the prime contractor for the Finnish National Opera House.

For more information, go to www.yitgroup.com.

The Benum Group

Founded by Bjorn Benum in 1971, the organization has expanded to include facilities in Oslo, Norway; Copenhagen, Denmark; and Stockholm, Sweden. It is Norway’s principal distributor for many North American and European AV products.

Returns from the two channels are divided on a $\approx 60/40\%$ basis, with integrated systems having the larger share. The company operates in two primary channels: The Pro Audio systems integration channel provides system engineering functions from the Oslo offices, and Copenhagen-based Benum Nordic AS is responsible for the MI/consumer operations. The combined companies have an annual earnings of about NOK126 million (\$18 million USD) with an equity value of about NOK (Norwegian Krone, base value of the Norwegian currency) 24.5 million.

In addition to the Oslo Opera House, Benum has provided fixed-installation AV systems in numerous auditoriums, performance spaces and broadcast/recording facilities throughout its three-country range. In addition to ongoing work at the Operan, Benum currently is renovating the sound-reinforcement system for the MayorHaus, which is the site for the annual Nobel Prize Award Ceremonies.

For more information, go to www.benum.no.

Two Renkus-Heinz ST4/4-2T full-range cluster cabinets per side, and a pair of centrally flown ST4/4-2Ts, form the main LCR system, plus one ST4/9 and four PN61 per side as front-fill, augmented by four DR18-2 subwoofers, all are self-powered and controlled over Renkus-Heinz's proprietary R-Control network. The R-Control network also controls a row of four compact PN61 self-powered cabinets along the stage front, which provide front fill.

"The ST Series cabinets were selected for their low distortion and coloration," said Benum's Peder Krohn, "combined with compact dimensions relative to their maximum output level. The latter was important because of the need for the complete system to be aesthetically unobtrusive yet be able to deliver high SPLs, when required, for jazz and rock performances, as well as very pure vocals and solo instrumentals."

Under-balcony fills are provided by passive PN81/9 and PN61 loudspeakers, driven by QSC CX502/1102 amplifiers, while the surround and delay fill system comprises 52 PN61 externally powered compact cabinets, again QSC-driven. Finally, four more PN81/9 cabinets are flown from the lighting bridge for further delays.

Tracking The Artist

Although not a portion of the original specifications, at the time of this writer's visit to the facility, work was in progress to install and test the three-dimensional aspects of the audio system. A TiMax localization system, which is derived from 16 console insert points, was scheduled to be supplemented with a TTA Stagetracker performer-position tracking system. This 16-track system consists of an interface between a performer's wireless microphone and a 2.4MHz transponder worn by the performer. As the performer(s) move about the stage, the audio is "panned" automatically from stage right to stage left and vice versa: As the performer moves upstage, an appropriate amount of signal delay is introduced to provide the perception that the actor has moved away from the audience.

The audio localization can be real-
(continued on page 117)



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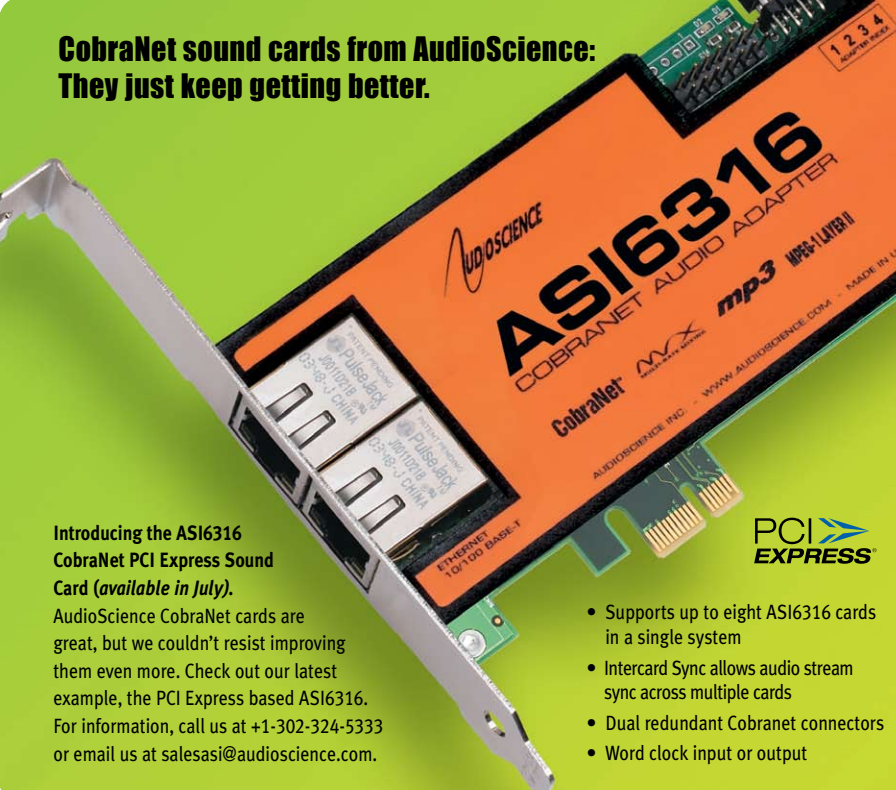
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tends to renovate its aging theater next year, enhancing sound and lighting systems, installing new seats, and improving access for disabled students and audience members. Expected to carry a \$14 million price tag, the renovations will commence in Spring 2010 and take about two years. The project will be funded through Measure S, a nearly \$360 million bond measure. While the theater is being renovated, Guthrie Hall will be used by the department for its productions. The renovations will not add additional space but, rather, will permit the department to make better use of the space. The work will also entail an uplift for the outside of the building and new landscaping.

The Great Outdoors

In Houston TX, Miller Outdoor Theatre recently completed its \$2.4 million remodeling. Some 125 performances are scheduled for this season, which has already begun. Performances last year attracted more than 300,000 people. Improvements included installing more than 1700 new seats under the canopy; installing a permanent sound and light booth; resurfacing concrete in the seated area; installing fans on the stage; and re-grading the hill. The re-grading should address problems with acoustics that have caused noise complaints from nearby residents. Theater sound system improvements

might also address the issue.

In Cherokee NC, the outdoor production "Unto These Hills," which dramatizes the history of the Cherokee Indians, will open its 60th season in the newly modernized Mountainside Theatre. The \$1.8 million renovation to the 2800-seat open-air theater commenced this Winter and is intended to create a safer, more comfortable and



convenient theatergoing experience. Enhancements include upgraded seating with wider aisles and seats that are more comfortable, new food concessions, reserved box seating and other conveniences.

In Boulder CO, the Flatirons Theatre soon will be showing movies again, along with hosting live performances and charity events. The developer is renovating the 12,000-square-foot theater portion of the building. Although it has been years since movies were screened in the 1000-seat theater, the space has been used for live music

performances and community events. High-quality sound and lighting systems will be installed to attract world-class performers, but the venue is also intended to give local artists their start. Vis-à-vis movies, independent films will be shown, providing a way for local filmmakers to get their work seen.

Generational Entertainment

In Graham TX, the Graham Memorial Auditorium soon will be renovated to ensure the facility is available to host concerts, plays and other performances for generations. The work will commence in four phases. Phase one entails rebuilding the roof and adding air conditioning. Phase two is to rebuild the lobby inside the auditorium. Phase three encompasses building an addition along the side and rear of the auditorium. The addition would be used for dressing rooms, practice rooms and a community multi-purpose room. Finally, phase four calls for patching, painting and landscaping.

Traditionally, the Summer season has been associated with leisure, arts and entertainment. It is the perfect time of year to patronize local theaters and auditoriums. So, next time you go, enjoy the seamlessly integrated audio, video and lighting, for the face of live entertainment has surely changed. ■

MODERN CLASSIC ARTS

(Continued from 67)

lized by all the various loudspeaker systems or combinations thereof, including the full 5.1 surround sound capabilities. Although not yet implemented, the system can also be DMX interfaced with the lighting system to "follow" the performer automatically as he/she moves about the stage.

'Universally Lauded Acoustics'

That an international opera house should begin life with universally lauded acoustics is a singular achievement in a critical world. To equip it with an audio system to match is another, and the result is best left to the quote from Ståle Wikshåland's review of the first

modern ballet/music performance, "A Modern Place," in *Dagbladet*, one of Norway's largest newspapers: "...The sound system is a dream, the quality and tone of the pre-produced and the live sound material is of another world, tactile, intimate and without a trace of distortion..."

Ken Ruben Theodorsen, the Opera/Ballet Technical Director for Audio, added, "Since we started with our first performance, we have been playing to 98% sold-out houses." The house is "scaled," with ticket prices between NOK 700 and 2000 (\$100 to \$300) per seat. He noted, "We have some marvelous technology placed at our disposal and we are still in the process of learning how best to utilize all the aspects of a truly unique system."

The Oslo Opera House can well take its place as one of the major performance venues constructed in recent years. ■

Footnotes

¹ This writer's Americanized keyboard and word processor will not permit use of many of the characters predominant in Nordic languages. Hence, I ask my Nordic friends to forgive me for not accurately spelling or accenting certain place names and other proper nouns.

² For more information on this, consult Bernak, Leo, *Concert Halls and Opera Houses-2nd Edition*, Stringer-Verlag, New York, 2004 *Ibid*, *Concert and Opera Houses: How They Sound*, ASA, New York, 1996 Makrinenko, Leonid I., *Acoustics of Auditoriums in Public Buildings* (translated from the original Russian by Mrs. RS Ratner), ASA, New York, 1994 Talaske, Richard H. and Boner, Richard E., *Theatres for Drama Performances*, ASA, New York, 1985 Talaske, Richard H., Wetherill, Ewart A. and Cavanaugh, William J., *Halls for Music Performances*, ASA, New York, 1982