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SQUARING THE CIRCLE

AT&T PERFORMING ARTS CENTER, PART II

The Winspear Opera House houses a classic auditorium inside an up-to-date structure

By: David Barbour

According to a statement issued by Foster + Partners, the Margot and Bill Winspear Opera House "redefines the opera house for the 21st century." That's a tall statement, even for a building in Texas, but then the Winspear is designed to contain multitudes. Primarily the home of the Dallas Opera, it will also count among its resident companies the Texas Ballet Theatre, Anita N. Martinez Ballet Folklorico, and the Lexus Broadway Series, which presents national tours for Broadway musicals.

Top: A view of the Sky Canopy, with its 659 separate louvers. Right: The lobby's 60' glass facade creates a sense of transparency.


Photo credit: Nigel Young/Foster + Partners

Two views of the auditorium's classic horseshoe configuration. Top left: The chandelier is in. Top right: It is retracted into the ceiling. The balcony facades reflect sound and light in ways that aid a sense of intimacy. Below: The dramatic entrance to the auditorium.

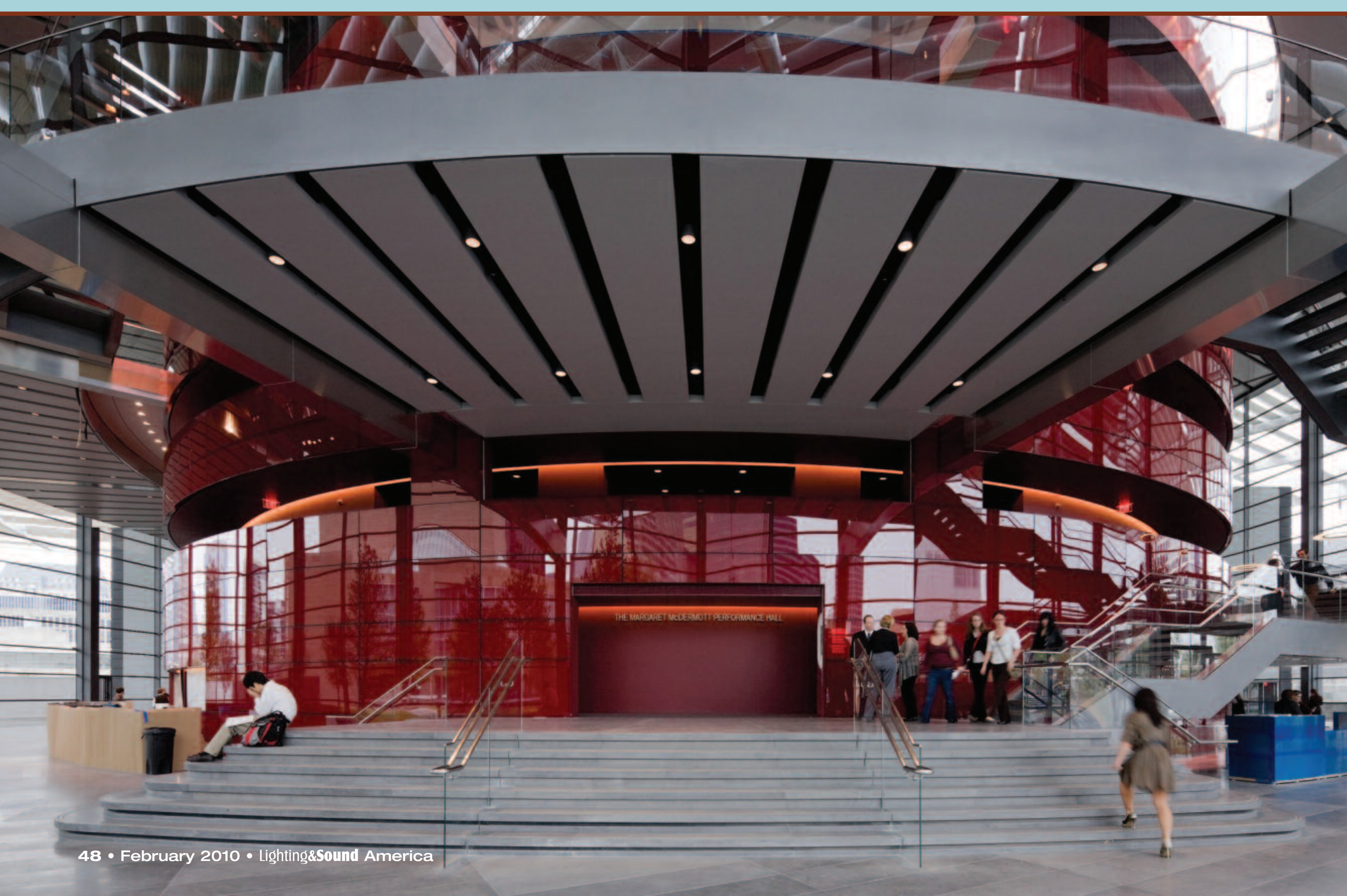

Photo credits: Top right and left: Nigel Young/Foster + Partners

Photo credit: Bottom: Iwan Baan

Even before you get near the building, it casts a long shadow: You find yourself under its 63'-high Sky Canopy, which radiates out in all directions, providing shade. In a notable case of nothing being left to chance, each of the canopy's 659 louvers has been arranged at a fixed angle, following the path of the sun to provide optimal shade for the glass façade and outdoor spaces.

Next, you encounter the Winspear's 60'-tall glass C. Vincent Prothro Lobby, designed to enhance the transparency of the building. (The glass wall is known as the Annette and Harold Simmons Signature Glass Façade.) Indeed, one can look in and see all of the building's extensive social spaces. "This establishes a direct relationship between inside and outside, creating greater accessibility and thus a more democratic building," says a statement from Foster + Partners, the building's architect, in collaboration with Kendall/Heaton, of Houston. It's all part of a plan to "make opera more accessible for a wider audience."

Entering the Winspear, one stands inside a spacious glass atrium with lobbies on several levels, including bars and a restaurant—all wrapping around the giant red drum that contains the auditorium. "The grand staircase, flowing from one side to the other around the drum, links all the lobby spaces, providing an opportunity for the audience to pause, talk, and observe," adds Foster + Partners. "Deep cuts into the drum allow the audience to move horizontally around each of the four balcony levels." Adding to the accessibility, an 84'-wide, 45,000lb. section of the glass façade retracts to a height of 23', opening up the lobby, café, and box-circle-level restaurant to the surrounding Sammons Park.

Indeed, the entire experience of approaching the Winspear is like taking part in a tracking camera shot. The wide view, talking in the canopy and the area underneath, gradually shrinks in focus as one enters the glass box, and crosses past the doors of the drum-shaped auditorium, which is clad in 43,000 sq. ft. of red glass panels. Inside the Margaret McDermott Performance Hall, one finds a classic horseshoe configuration, as one would expect of a space designed by Theatre Projects. According to members of the firm's staff, the theatre's shape was decided upon before the building itself was designed. But the auditorium posed many challenges, particularly in making the principles of the horseshoe work in a large volume while also finding room for the necessary technical amenities.

Inside the drum

The auditorium contains seating for 2,200 people, spread out over the orchestra and four balcony levels; these days, that's a lot of levels, even for an opera house, but it's all part of a strategy for creating a sense of intimacy. The distance from the stage to the balcony is about 90', or, as Foster + Partners notes, "less than the distance between home plate and third base on the baseball field." The balcony fronts are gold-leafed, designed to contrast with the rich dark red interior. When the house lights are dimmed, the lighting from the stage reflects on the balcony fronts, creating a feeling of warmth that literally embraces the room.

The most attention-getting aspect of the room is the retractable LED chandelier, designed by Claude Engle Lighting in collaboration with Foster + Partners. See page 66 for more.

Also adding to the room's luster is the house curtain, designed by the Argentine artist Guillermo Kuitca, which, according to T*he New York Times*, "presents a deconstructed image of the hall's seating on a background of chocolate brown velour. The curtain was built by New York-based firm I. Weiss & Sons. I. Weiss, using a Photoshop image to ensure the correct placement of the image, subjected white velour to a 40' inkjet printer, which dyed the fabric the correct colors. Satin gold appliqués finished off the image."

Benton Delinger, of Theatre Projects, notes that the auditorium's interior is in many ways modeled after of the Bayerische Staatsoper in Munich. "The challenge is that Munich isn't Dallas," says Dellinger, who notes that he and his team worked to preserve the intimacy of the Munich auditorium in a more grandly scaled building. A related challenge was to provide all technical necessities in an unobtrusive manner. "It's the flagship and it required a level of finish that couldn't be ignored," he says. "We had to figure out how to fit the technical world into this highly refined space." Several of those interviewed for this article note that Spencer de Grey, who led the project for Foster + Partners, is himself an opera aficionado, a fact that eased the way to a fruitful collaboration.

The principal stage and wings of the Winspear total 7,560 sq. ft., with the side and rear stages totaling 5,350 sq. ft. The rigging system, engineered and installed by J. R. Clancy, working with Linbeck Construction, includes eighty-five 2,000lb. manual counterweight sets with chain compensation; 18 automated variable-speed point hoists; a Clancy SceneControl 500 control system; a motorized house curtain running at 6-360fpm; three loudspeaker cluster winches and rigging; a motorized, 50'-wide steel-framed Zetex fire curtain; three hard-wired Skjonberg chain hoist control systems; and six side- and rear-stage CM LodeRail gantry crane systems with 20 CM Lodestar dual-brake chain motors, along with stage draperies and curtain track from Stage Decoration and Supplies and H & H Specialties.

The variable-speed point hoist system is possibly the most interesting part of the rigging installation. "There are 18 point hoists," says Michael Nishball, of Theatre Projects. "They are a flexible means of rigging scenery at any point on the grid, independent of the counterweight system. The hoists can track upstage and downstage on the gantry system, giving designers the kind of flexibility that you don't normally find in a road house. Each has a capacity of 600lbs. and can travel up to 400' per minute.

"Basically," Nishball continues, "they track just below the loft steel, leaving the grid clear. I wanted to improve on the point hoist systems you find in other theatres in the U.S., where there's a single wire rope muled and diverted to fixed hoists around the perimeter of the stage house. We created a compact and quiet hoist that moves easily at grid level; with the SceneControl 500 integrated controller, they can even make odd-shaped scenery dance."

The understage machinery, says Nishball, includes "two flexible orchestra pit lifts and three seat wagon systems, which were contracted by SECOA, with lifts furnished by Serapid. We have a house mix position lift for an audio console or seat wagon; this helps to cut down on changeover time and has become a comfortable tech table position. We have abundant forestage rigging holes and operable doors for the loudspeakers. In an opera house, nobody wants to see loudspeakers when not in use. This was very complicated, as we're hoisting them through two curved surfaces; the geometry is complex. I can't say enough about Clancy's tenacity in solving this geometry in the field."

Serapid provided 12 lift columns for the two proscenium lifts and one sound cockpit lift. The upstage proscenium lift is 390 sq. ft. and the downstage is 550 sq. ft., while the cockpit lift is 175 sq. ft. The lifts are comprised of the company's LinkLift columns, which feature square links that work like building blocks to form a tower stack. The shape and locking technique make it capable of extra-high rigidity and strength.

Another clever feature is a series of retractable load-rated tubes that extend 3' out of the edge of the stage. "The tubes can receive stage-edge protection grating," says Nishball. "They can receive footlights, monitor speakers, or a robotic camera track, for occasions when they might tape or broadcast a performance. They can also mount scenery on the tubes, if they want to cantilever scenery out over the pit."

The auditorium is fitted with an ETC Net3 networking system and a lighting package that consists of ETC Source Fours plus three Lycian SuperArc 400 and three Lycian SuperStar 2.5 followspots, 30 Philips Vari*Lite VL1000 TS automated units, and 80 Wybron color scrollers. Control is via an ETC Eos console. An optional Jands Vista T2 desk is intended for productions with short schedules and/or a heavy moving-light complement.

Jules Lauve, project manager for Theatre Projects, says that a key goal, in accord with Foster + Partners' design intent, was to keep the room as clean-looking as possible. "They didn't want to see lighting and sound positions," he says. "That's where the collaboration of the theatre consultant, architect, and acoustician can make a difference." A good example is the concentric ceiling, which consists of a dome and a pair of convex circles, one nestled inside the other. "We worked with Bob Essert [the acoustician] to make sure any ceiling modifications kept the acoustic properties he sought, while preserving the two main front-of-house lighting positions," says Lauve. "We opened the tilt of the center dome slightly, so the lighting positions' slot is wider along the centerline, allowing for double-height stacking of lighting instruments."

In addition, Lauve says, Theatre Projects and the rest of the design team found a novel way to get proscenium boom and box boom lighting positions into the house. "At house left and right, a tall, narrow wall conceals the box-boom position in a spot where, typically, a slight cavity between the proscenium and auditorium would capture sound—a negative for early reflections of sound emanating from the stage and bouncing into the room. The wall next to the booms consists of fabric stretched over a frame. It was a team solution to find the appropriate angle of the wall and the right density of the fabric." A PA loudspeaker system that is appropriate for most amplified events that may play the hall when opera is not presented—and which, rest assured, won't be used for opera performances—is contained above three sets of bomb-bay doors located at left, right, and center positions in the forestage reflector. J. R. Clancy provided the 1,000lb.-capacity drum hoists and linear actuators for opening and closing the doors. The spoken-word amplification system, a set of Renkus-Heinz ICONYX speakers, is hidden in acoustically transparent slots in the proscenium walls. The seats are a custom design by Foster + Partners, in collaboration with John Runia and Carol Allen of Theatre Projects, and realized by Series Seating, of Bogota, Columbia.

Reverberating in circles

Robert Essert, of London-based Sound Space Design, the Winspear's acoustician, says that, after years in its old home, the Music Hall at Fair Park—a fan-shaped auditorium designed in the '60s style—"they were ready for classically propor-

The glassed-in lobby provides attendees with plenty of room for social interactions on several levels. The drum facade is covered with 43,000 sq. ft. of red glass panels.

tioned opera house. The questions were, how many tiers we should have—three or four?—and how high is it when you get to the fourth tier."

Like his colleagues, Essert notes that the Bayerische Staatsoper "impressed the client the most—and it happens to have the same seat count as the Winspear. Also, the proscenium is a similar size. I don't think, however, that any of us realized that the Munich house poses awesome difficulties for the singers on stage. It's a great place to hear music, but it's harder for the singers. It focused us on the proscenium zone, especially the size of the boxes and their relation to the proscenium."

Essert continues: "A big part of our work was deciding what the orchestra pit parameters would be. The company wanted to have the pit covered more than you see in some European theatres, because they understand that some of their own singers are not the biggest voices in the world. But you have to strike a balance and decide how many players will go under an overhang, which isn't great for them, to allow the singers to reach out over the orchestra. We were talking about having only a medium and a large pit, but I felt we needed a Broadway-sized pit as well, which can accommodate only about a dozen players, and would accommodate more audience seating."

Another issue, Essert says, "was the exact degree that each balcony was subtly tipped down." The result is "a subtle slope, a balance between horizontality for acoustics and Theatre Project's desire not to have a big gap between the mezzanine and balcony. Each tier is tipped differently." In terms of the auditorium's overall layout, "We were looking for big, broad curves, to undo what can be negative in a horseshoe—when it is a pure cylinder, it can make echoes that are difficult for the orchestra. To deal with this, we added a number of three-dimensional forms that undo the focusing. The sides of the walls are convex, pillowed gently in broad sweeps that are 15-18' wide. The architect built niches, about 6" wide, where one curve meets the next; there are little vertical gaps that draw attention to the differences in the bowed panels. We wanted hard balcony fronts, not soft or perforated, to function as a primary reflecting surface without slapping the sound back and making an echo. They're bowed in profile, with a gentle curve."

Overall, Essert says, "we have a richness of scale and form and texture, so it's not all the same effect on one frequency. The waves on the balcony fronts scatter high-frequency sounds and project consonants from the singers. The broad sweep of the balcony front profile affects the middle frequencies—which, in opera, are made up of power frequencies and the vowels. The big convex shape affects the lower frequencies as well." He notes that the ceiling, which consists of two convex rings, is also designed "to spread the sound to the rear balconies and undo a bit of focusing in the slight dome that is found in the center." The plaster on the walls has "a rough final texture, to scatter the high frequencies a bit more." Also, he says, "The floors are timber; we recommended that they be hard, not carpeted, which is best for opera." Air is distributed from the pedestal of each seat.

In addition there is an adjustable

Photo credit: Iwan Baan

The Guillermo Kuitca house curtain was manufactured by I. Weiss.

Photo credit: Iwan Baan

acoustic system, to make the room suitable for non-operatic events. "There are motorized horizontal travelling fabrics and vertical banners, which can be deployed in a few minutes for amplified speech events, pops concerts, and musicals," says Essert. These were also supplied and installed by J. R. Clancy, using Chaintrack from the British firm Triple E, which is distributed in the U.S. by Rose Brand. Chaintrack can navigate corners with a radius of only 40mm, enabling it to double back on itself; this, coupled with the facility to store curtains flat rather than bunched, proved useful here. Fourteen Chaintrack systems were installed on three levels in the auditorium, with drapes varying in length from about 10'-19.5'. Clancy also supplied the modified PowerLift systems for raising/lowering acoustical curtains.

The curvatures and the acoustical flexibility were calculated using computer modeling; Essert notes that the Sound Space team worked in this way on the lobby as well, looking for a way to handle the reverberance of a space defined by the drum surface and a 60'-high glass curtain wall. As a result, he says, "We got the architect to put carpeting in some places; we also added sound-absorbing ceiling at the top of the room. And, near the café, the architect designed a ceiling of gypsum board with gaps built into it, where the sound gets trapped."

Essert also ensured the acoustical isolation of the auditorium from the surrounding noisy environments. "The U-shaped area behind the stage, which contains the dressing rooms and offices, is structurally separate from the opera house," he notes, adding that, at the front of house, there is a partial separation between the lobby and auditorium, which isolates the auditorium from the mechanical room located under the lobby. Overhead noise is a big issue, he says, because the Winspear is located directly under a flight path to Love Field, which is used by many corporate jets. "The rush hour is 6-8pm," he notes. "At the top of the building, the drum pops out of the canopy, so we have a double solid masonry wall; one is 12" and one is 8", with a certain amount of air space between them. The air vents on the top of the fly tower, to get rid of effects smoke, uses a triple vent system with acoustical lining to isolate the aircraft and traffic noise."

The sound package, specified by Engineering Harmonics, of Toronto, and supplied by Clair Brothers' Dallas office, includes 36 Renkus-Heinz STLA-9 line-array elements, 12 Renkus-Heinz DCF215F flying subs, four Renkus-Heinz DR18-1 onstage subs, 13 Meyer MM-4s for front fill, 70 Tannoy CMS501DC units for under-balcony fill, eight Renkus-Heinz PN82/9s for overbalcony coverage, and two Renkus-Heinz PN-15/4-3 ceiling speakers. For stage effects, there are two Renkus-Heinz PN-15/4-2s, four PN–151/9s and six PN-81/12s. Also available are eight Renkus-Heinz CF-121M monitor wedges, eight Shure PSM-700 in-ears monitors, with earpieces, and a Sennheiser infrared hearing assistance system. Sound is mixed on a Yamaha PM5D console.

Support spaces

The support rooms are found in the back side of the building, facing the Woodall Rogers Freeway, which runs along the edge of the entire property. Here one finds the dressing rooms, storage space, a loading dock, and Nancy B. Hamon Education and Recital Hall, which morphed, during the planning process, from a rehearsal room to a space for receptions, recitals and lectures. Essert notes that the room has acquired acoustic finishes and an Acoustac banner system from the Bronx-based firm Pook Diemont & Ohl. Also added was a grid for lighting and sound gear, and a small control room.

Overall, Lauve cites the role of Doug Curtis, ATTPAC's vice president of design and construction and Jeff Innmon, the center's project manager on the Winspear, as "providing a spirit of teamwork that extended through the entire team." He also mentions "Linbeck Construction, the general contractor, and all of their subcontractors, the value of which became most apparent near the end of the project, when things typically get tough. But the spirit of teamwork had been built throughout the process." The result, he adds, is an opera house that "brings together the best of today and tomorrow." Other key players in the project included the firms Buro Happold and Thornton Tomasetti, Inc. (structural engineers), and CHPA Consulting Engineers and Battle McCarthy (MEP engineers).

The opening production in the Winspear was *Otello*, directed by Tim Albery, featuring a production design by Anthony Baker and lighting by Thomas Hase. It was well-received, and early reports on the acoustics are highly favorable.

This is just the beginning of the story of the AT&T Performing Arts Center. Next up are City Performance Hall and the Annette Strauss Artists Square. We'll report back as they open.

The Retractable LED Chandelier

By: Mike Wood

Engineering a centerpiece attraction at the Winspear Opera House

It's only a chandelier, isn't it? Just a few lights. What could be so technologically interesting about that? Well, that's what I was thinking almost two years ago, when I first heard about the proposed chandelier at the Winspear Opera House in Dallas. (See page 46 for the feature story.) However, once I grasped the scale of the proposal, it became clear that this wasn't your ordinary, everyday chandelier, if there is such a thing. It all started with an artist's concept picture from the project's architect, Foster + Partners, and the architectural lighting consultant, Claude R. Engle.

This showed a 40' diameter ethereal construction with seemingly unsupported bars of light hanging in a roughly pyramidical shape from the main auditorium ceiling. Discussion revealed that the intent was to have over 300 illuminated bars, which would reach down 50' in front of the two top balcony tiers in a three-dimensional structure to provide a centerpiece for the room while the audience was being seated before the performance. At show time, these bars would rise until the ends were flush with the ceiling, where they would form a star field before finally extinguishing at curtain up. The bars themselves needed to be illuminated as evenly as possible, should match the warm white of the existing incandescent house lighting, and complement the white gold leaf on the balcony fronts. The chandelier was a key part of the room's artistic design and would be the center of attention—both literally and metaphorically—of the audience before the curtain went up. Okay, that was the concept, but how do you actually build it?

Figure 1: Concept. (Photograph courtesy of Foster + Partners)

The architects had considered a fiber-optic solution but had not been able to find a way to raise and lower it 50' while keeping the suspension invisible to the audience and solely illuminating the final 6' portion of each fiber.

J.R. Clancy was already heavily involved in the Winspear installation. As there was a significant rigging implication to making this chandelier raise and lower safely and quietly over the heads of an audience, the company was also invited to bid for the chandelier addition, which left the project manager, Robert Degenkolb, the task of coordinating an engineering concept that would meet both the artistic and engineering requirements. The chandelier is primarily an artistic installation, with the illumination for the room coming from conventional luminaires, so it needed an engineering design that wouldn't interfere with the aesthetic concept and was essentially invisible without compromising safety and reliability. At that stage, J.R. Clancy brought me in to assist with development of the illuminated rods; it turned into a joint project, with Clancy taking the lead and providing all of the hoists, control, structural support, rigging, and suspension while Mike Wood Consulting and Scott Ingham, of Ingham Designs, provided the illuminated rods, drive electronics, data distribution, programming, and control.

The first task for the team was to develop the rods themselves, as those would be the only portion the audience would see, and, once they were working, everything else in the engineering design would follow from that decision. The team experimented

All photographs by Mike Wood except where indicated with various materials and illumination sources before ending up with an acrylic rod and a custom four-channel RGBW LED illuminator that was optically coupled to the top of the rod. We tried many different types of surface finishes to ensure even illumination but, in the end, simplicity was best, and a polished cast acrylic rod gave the solid bar of light that was needed. Cast acrylic performs much better than an extruded version for light transmission in this kind of application; the cast material is easier to machine and form and doesn't have the entrained air bubbles and imperfections present in the die extruded product. Those imperfections glow like little stars within the rod; they're very pretty, but not what was wanted here. A custom 6'-long cast rod, with the ends polished optically flat, was selected. For illumination, four standard 3W RGBW LED dies were packaged with a custom lens so that the exit angle matched as closely as possible the TIR (total internal reflection) angle of the acrylic; therefore, as little light as possible was wasted in coupling to the top end. The use of TIR in a solid rod is optically identical to the fiber-optic solution that the lighting consultant first envisaged; it's just that it is 318 separate 6'-long rigid fibers rather than flexible bundles. Although the main desire of the lighting consultant and architects was for white light, as previously mentioned, the white had to be controllable to get the right color temperature and warmth to match the color scheme of the room, so an RGBW array gave the flexibility needed.

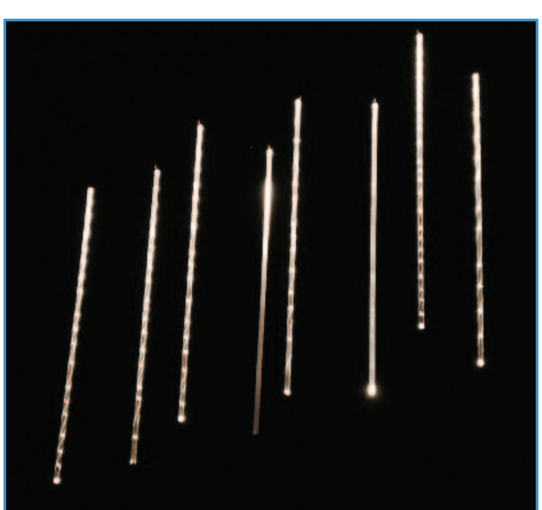

Figure 2: Rod testing.

Figure 2 shows an early trial with various patterns and surface finishes. The plain polished rod (third from the right) performed the best and met the architect's and lighting consultant's requirements.

Once a basic rod shape and style had been agreed upon, the project could proceed to a mock-up of the entire chandelier—or at least half of it! J.R. Clancy took over a local theatre in Syracuse for a day and constructed a full-scale model using black cord and white rope of the same diameter as the acrylic rods. Some effective use of the stage lighting installation completed the job, as shown in Figure 3.

Figure 3: Early trial using white ropes as a proof of concept and scale. (Photograph: Robert Degenkolb)

With this 1:1 model to approve the overall scale and, in particular, the diameter and length of the illuminated rods, the architects and owners signed off on the project, and we had the green light to proceed to a detailed design.

Although we were using 3W LEDs, we wanted to run them at very conservative levels—the installation needs to last at least 10 years with daily usage, and the key to getting a good life from LEDs is good thermal management. Each acrylic rod was capped with a head, which formed the enclosure for the LEDs and their associated drivers, and also provided secure mechanical suspension for the rod. The head was also the heat sink for the LEDs; the thermal design, using heat flow analysis, was specified to allow at least 50% headroom on the expected power usage. The final head design was an interesting collaboration between the mechanical engineers, whose main concern was the safety aspects of hanging a 6' rod over the audience; the electronics engineers, with their requirements for heat flow, EMI shielding and connectivity; and the understanding by all that this was in view of the audience and therefore had to fit the aesthetics of the design. It seemed like the simplest component in the installation—just an aluminum extrusion—but it turned out to be one of the most complicated and critical parts of the design.

Nothing on this project was simple—not even the cabling. Each rod head was suspended from a single custom cable, which contained a shielded twisted pair for data, a pair of wires for 24V DC, and three synthetic fiber suspension members. The whole assembly was enclosed in a matte black sheath to produce a final cable that was just 0.25'' in diameter. This cable had to pass over sheaves and blocks onto a motor drum hoist without breaking, so ultra-flex insulated conductor cables of a type more commonly seen in moving lights were used for the construction. Before committing to the production run, Clancy ran both proof load testing and an accelerated simulated life test, confirming that we could successfully pass data and power through the system over the life of the cable with the specified connected load. The head and rod only weighs about 5lbs; however, we had a concern that there could be problems if the rods ever knocked and entangled with each other, so minimum 8:1 safety factors were used in the development of the suspension system.

Now to the hoists: There are 318 rods in total, and the ideal situation would be if there was one hoist per rod. However, cost put that possibility out of the running very quickly, and a solution using fewer hoists had to be found. In the final installation, the 318 rods are distributed over 44 lifting mechanisms, each of which controls up to eight rods. In the chandelier's operational shape, those 318 rods are at widely different height bands, but each hoist has to be connected to eight rods, which are all at the same position. To make this trickier, the overall conical shape of the chandelier means that rods at the same height are never adjacent and the ceiling itself isn't flat; instead, it is both domed and at an angle. To accommodate these requirements, the hoist cable routing in the grid from each hoist is incredibly complex. A three-dimensional layout had to be prepared (Fig. 4) so that none of the cables interfered with each other as they passed over or under multiple other cables on their route from hoist drum to loft block.

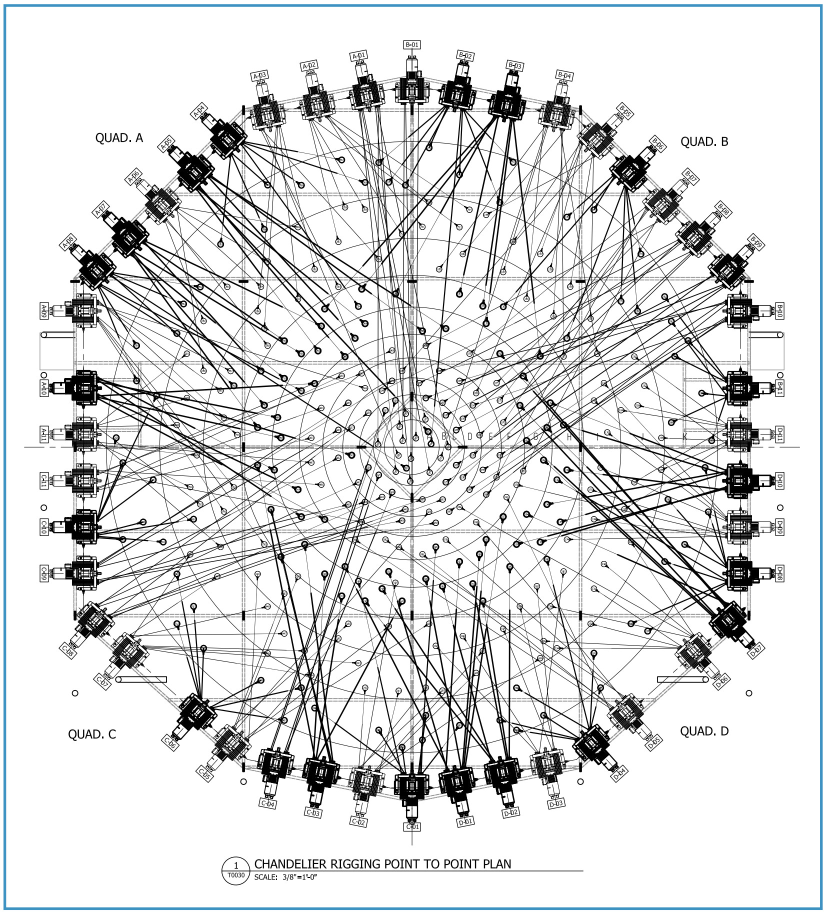

Figure 4: Hoist and cables grid layout. (Drawing courtesy of J.R. Clancy)

Figure 5: A (not so) tangled web.

Figure 5 shows how that translated to reality in the installation. After a lot of work by skilled installers, it ended up being remarkably tidy.

Also visible in Figure 5 are the tops of tubes in the grid that provide guides and protection for the rods when they are parked in the void between the plaster ceiling of the auditorium and the grid. Figure 6 shows those tubes as seen from the surrounding catwalks. The tubes also contain twin stacks of brushes, which serve to both keep the rods clean and to provide a light block.

As mentioned above, each hoist raises and lowers up to eight rods, and every LED in each of those eight rods can be individually controlled from data sent down the cable. We had concerns about hanging 318 long antennas in an opera house and so wanted to minimize that data; we also wanted every rod and its circuitry to be completely identical and interchangeable. The best solution was to have an intelligent data distributor on every hoist, which took in DMX512 data, then formatted it and rebroadcast it down the eight cables, with each rod only receiving its own data. This has the added benefit that the heads are all being fed with home runs, so no addressing or networking is needed. The net result is a vast reduction in the amount of data passing down the cables, which mitigates the risk of electromagnetic noise causing interference with the sound systems. That, coupled with the silent operation of the hoists, meant that we passed the scrutiny of the audio consultants—pretty important in an opera house! To further reduce data flow, each rod has a processor and does all its own cross-fading, interpolating, and smoothing of the incoming eight-bit data to an internal 16-bit and adding pseudo thermal delay so that the output matches an incandescent dimming curve. Key to maintaining the incandescent illusion is avoiding the final "blink" as LEDs turn off, so a great deal of care was taken with the final 10% of dimming. This is particularly important with house lights as, by their nature, they nearly always turn off into a blackout where the slightest imperfection is apparent.

The data distributor is mounted on the rotating portion of the hoist, with power and data fed to it through a data-quality commutator. The software in the data distributor and heads watch for any glitches in the data feed through the commutator and hide it so the output remains smooth. We were helped in this by the application—with normal entertainment lighting, speed of response is critical but, in this case, immediate response can take second place to smooth operation. The cross-fade speed is provided as a programmable operational parameter so, if the Winspear staff wants to change the fade rate through the ETC Mosaic system, they can.

Figure 6: Guide tubes between grid and plaster ceiling.

Figure 7: Hoists.

Figure 8: Finished chandelier.

Figure 7 shows some of the installed J.R. Clancy hoists suspended from a Unistrut grid that is attached to the underside of the building structure. At the front of each hoist is a mounting frame diverter assembly that directs each lift line to the ceiling tubes. The diverters incorporate a spring-loaded overload assembly that stops the individual hoist in the event a lift line becomes snagged during operation.

The hoists are controlled by a JR Clancy SceneControl 500 through a wired touch-screen pendant interface. The pendant plug-in stations are located so that the operator has a good view of the moving rods at all times and allows for individual, group, and preset control of the rod positions. Interestingly, the lighting control room is not normally one of those stations, as it has no view of the chandelier! The pendant also provides a wired E-stop connection to the system and allows for password-protected adjustment of the variable speed hoist drives to reconfigure the system.

Control of the 1,590 channels driving the 318 illuminator heads (each uses five control channels—four colors and a timing channel) is provided through two linked ETC Mosaic show control systems which, in turn, are triggered from the ETC Unison Paradigm and AMX touch panels distributed throughout the building. Programming made full use of Mosaic's ability to map an array of channels to a matrix which dramatically simplified the process. Programming each of those 1,590 channels by hand would have been painful. Instead, we were able to overlay moving patterns and cloud imagery to give a constantly shifting dynamic to the chandelier.

Figure 8 shows the final chandelier. You can't tell from the photo, of course, but the programming is quite subtle; each rod is continuously shifting its color and brightness on either side of the defined warm white by a small amount, and no channel is ever stationary. This movement is not enough to be overt, but it gives the whole thing the kind of life that you get with a candle flame chandelier. We also programmed in red-shift as the chandelier dims so that, again, it matches the color shift in the incandescent house lights on the balcony fronts. These fades are timed to match the one-minute movement of the chandelier as it flies out so that, when the rods reach their top preset with their bottom ends level with the ceiling, the rods have dimmed down to a

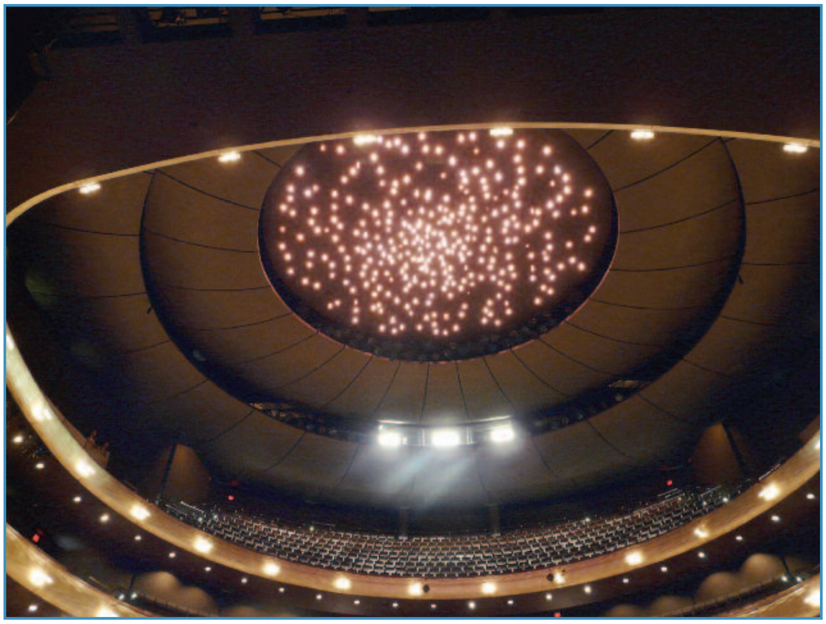

Figure 9 - Star field.

very warm star field glimmer with a superimposed twinkle (Fig. 9).

The Winspear Opera House is now open, and the chandelier runs every night in front of an audience with no idea of the engineering complexities needed to perform such a simple effect. Instead, it's an art installation that, I hope, compares well with the original artist's concept of Figure 1. That's as it should be—we are in the business of theatricality and illusion, after all.

The installation was supervised by Robert J. Degenkolb, of JR Clancy, and Mike Wood and Scott Ingham, of Mike Wood Consulting and Ingham Designs, LLC, respectively, and was performed by Joel Svoboda, Ken Eggers, Charlie Hulme, Byron Payne, and the International Association of Iron Workers Local 263 (Dallas/Fort Worth).

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