The Four Seasons for the Performing

by Don Barber • Photos by Michael Filer

THE CANADIAN OPERA COMPANY *had been dreaming of having a house of its own for more than 50 years. It had been resident in the O'Keefe Centre (or the barn with many names) since the late 1950s. At more than 3,200 seats, it was too large for proper acoustics, with even prime seats in the first row of the balcony seeming to be leagues from the stage and an orchestra pit that could be crammed with no more than 76 musicians – much too small for Artistic Director and Conductor Richard Bradshaw's vision of performing Wagner's four-opera cycle* Ring of the Nibelung *with a 100-piece orchestra.*

In the 1980s, the COC decided to aim for a compact seating capacity of 2,000. In opera house design, "smaller is better," and the COC took this seriously as a statement of acoustical aspiration.

The dream started becoming a reality in May, 2002 when the federal government identified $25 million and the provincial government donated the land, worth $31 million. The Four Seasons Hotel group became the naming donor with $20 million. More donations followed and construction started April 11, 2003, with the official opening three years and three months later on June 11, 2006.

The final result has been a triumph. The R. Fraser Elliott Hall is horseshoe-shaped with four balconies that envelop the performers. There's lots of beech and maple wood with taupe-coloured surfaces.

There is not a note of ostentation or pretension; it displays a simple elegance that is not the stuffy old gilt stucco and red velvet culture palace of the opera snob or the privileged rich. It is a warm and inviting hall.

In opera, clarity of text and natural vocal tone are important, but so are warmth and resonance of the orchestral sound. Singers need to feel the room as if they are playing an instrument and the musicians need to be able to hear each other across a broad orchestra pit so they can play together in tight ensemble. There is a high degree of intimacy and envelopment in the room that allows a singer to perform at the quietest pianissimo and be able to carry emotion to the last row. The acoustics help the audience and performers to feel that they are closer to each other than they really are – that the room feels shorter than it really is.

The lead acoustician on the job was Bob Essert of Sound Space Design. His accomplishment clearly speaks for itself.

AT RIGHT: Isolation pads.

Quiet, Please

For the full range and scope of the sound to be appreciated, the first critical mandate is that there can be no background noise. The hall must be an oasis of silence.

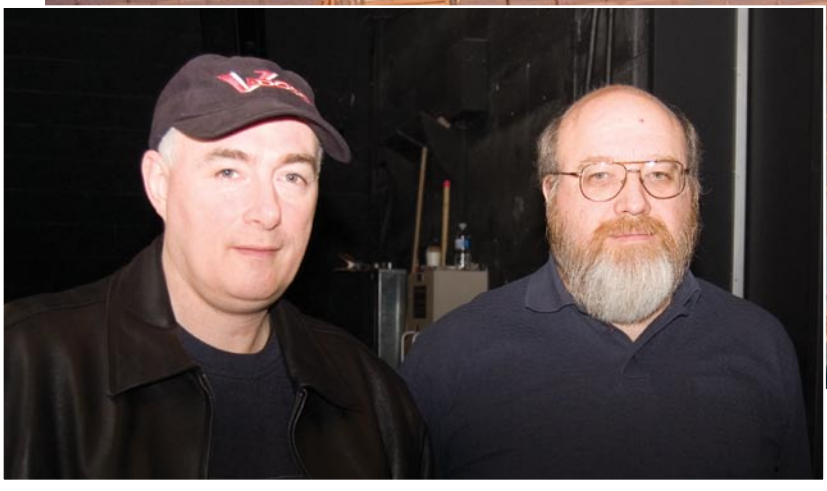
The Four Seasons Centre for the Performing Arts (FSC) is situated amongst possibly the busiest and noisiest blocks in downtown Toronto – bounded by University Avenue, and Queen, York, and Adelaide Streets. There's traffic noise, the subway is right next door, and streetcars travel both ways along Queen Street. Traffic, news, and hospital helicopters pass overhead, planes land and take off at the Island airport, and tour buses arrive at the hotel next door or to and from the Elizabeth Street Bus terminal nearby.

All these are sources of ground-borne vibrations that could be transmitted through the building's foundation and air-borne noise that could enter through the air vents and returns. There's also internal noise from HVAC heaters, chillers and fans, power transformers, lighting fixtures, and plumbing – and, of course, those pesky patrons and performers.

To eliminate the ground-borne transmission, the whole building is constructed on high-performance rubber pads. This structure serves as an exo-skeleton to the performance space, which is its own acoustically-isolated inner building, suspended on yet another set of isolation pads and divided from the outside world by a 50mm "acoustical joint." There is nothing in the stage and audience space that is solidly connected to the outer building. John O'Keefe of Aercoustics Engineering was responsible for sound insulation and noise control. The decision to incorporate the acoustic joint was the single most important factor in accomplishing the noise rating of NR1, which roughly translates to non-existent.

Any of the HVAC, plumbing, or electrical equipment is housed in the outer building

CENTRE *Arts*



ABOVE: R. Fraser Elliott Hall, performer's perspective from stage.
AT LEFT: Martin Van Dijk (left) & Al Merson (right).

where it is mounted or suspended on rubber isolators. Any connections between the outer building and the acoustically-isolated inner building are flexible ("if I can move it with my finger, then it's flexible"), so, for example, any electrical conduit that goes from the outer to inner building employs BX as it crosses the acoustical joint. There are no toilets in the inner building so that the plumbing turbulence cannot transfer into the performance space. The integrity of the gap had to be perfect; therefore, as the project proceeded, any place the gap was to be enclosed was digitally photographed to show there were no pop cans or drywall pieces stuck in between. The gap was then injected with "acoustic goop."

All entrances and exits (with a couple of exceptions because of fire code) have two acoustically-sealed doors providing a sound and light lock.

Air was a big challenge; since you can't seal that off or people would suffocate, how do you stop all that outside noise from getting in? The answer: miles of vents lined with acoustic insulation. The air intake vents actually travel over the underground parking lot; in order to get rid of any outside traffic noise or horns honking in the parking lot, there are many small-diameter ducts, and as the sound travels along with the air it bounces back and forth many times along the lined ducts and eventually the sound energy is absorbed and the air continues on. At this point the air will have its own turbulent noise, so the vents are gradually expanded into ever-larger dimensions and the turbulence dissipates as well. The air is then ducted in below the audience and enters the hall through holes in the columns that support the seats and vents in the orchestra pit. Return air rises up and exits at roof level through a padded tunnel that takes several 180-degree bends, so any outside noise trying to get in that way is dissipated by the same energy absorption process.

The Pit

O'Keefe was careful to point out that the pit air comes in by vents but exits via the auditorium. They didn't make the mistake that some designers have made, which is to have return air vents in the pit. This has the unhappy result of sucking any stage smoke or fog effects straight down into the pit, obscuring the musicians' view of the conductor and their music.

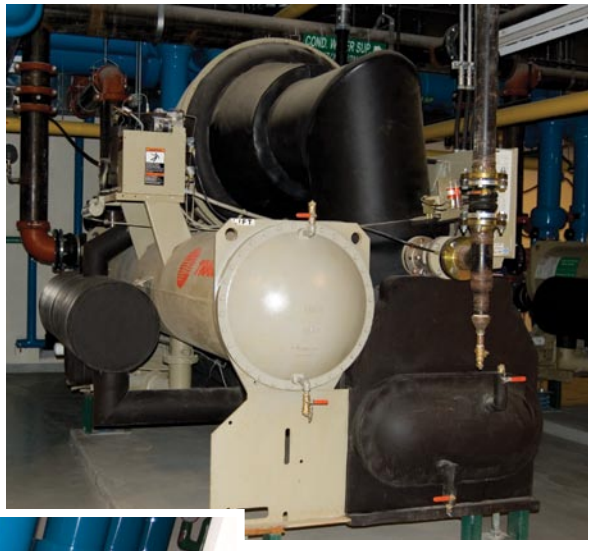
The design of the pit has a great impact on the sound of the orchestra, the balance between orchestra and singers, and ultimately on the distance of the audience from the singers. The pit geometry is flexible. The floor is comprised of two large platform lifts, each of which can be set at an elevation between stage level and 2.7 m below stage.

There are moveable panels to contain the playing area and acoustic curtains to absorb sound when appropriate.

The proscenium is carefully designed to project the voices from the stage; however, the overhead arch and the first row of ceiling panels are specifically designed to reflect sufficient sound back at the stage for the singers to hear and across the pit for musicians on the opposite side to hear each other.

Seen And Not Heard

With the incredibly tight construction schedule, and with the Canadian debut of the *Ring Cycle* looming, it was hard to find time to measure the results of all the careful acoustic design and noise isolation work. There was always someone hammering or vacuuming into the wee hours with the carefully-planned acoustic doors being left open. Eventually they found quiet time, and that's exactly what they got. Unfortunately, the opera also uses a lot of lights; even here noise was a consideration with the FSC being the world's first major installation of sine wave dimmers. But modern opera lighting design also incorporates moving fixtures, which have fans in them. Fans make noise, and in this case the Vari*Lite 3500s installed made more than 25dB of it. The fixtures had originally been auditioned for the COC and Stratford Festival and had been considered suitably quiet, but between the time of testing and delivery there had been several burn-outs on Broadway productions and the fans had been changed to more efficient (read noisier) ones. The designs had already been set for the first season so the hall was not as wonderfully quiet as it was intended to be. Since then, to ameliorate the problem as much as possible, most of the automated fixtures have been moved to the upstage side of the proscenium and a quieter fan solution is being sought.



Carefully sealed HVAC equipment. Only a barely-audible hum is discernable in this room.

The stage is not as quiet as the house, with a rating of NR15 due to the backstage equipment. Scene changes can be noisy endeavors; to cut down on some of the noise, a 4" pad of duct lining material is pinned to the wall behind the fly lines.

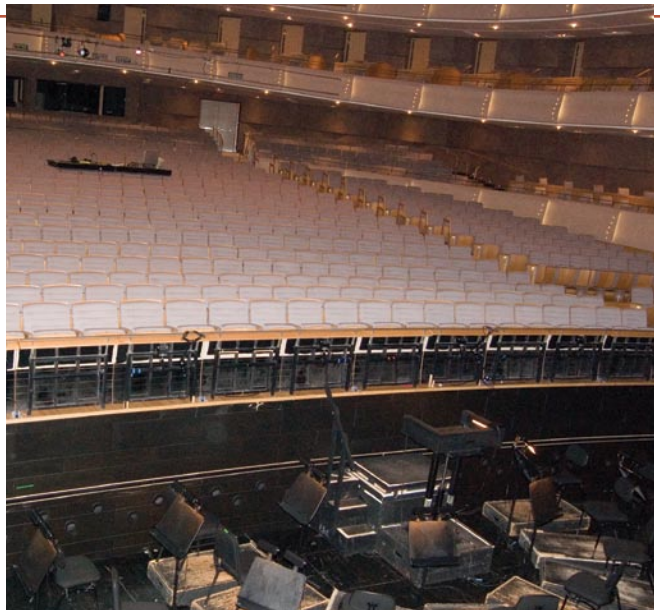
15dB of stage noise is still very quiet, and the hall is so clear that every sound is heard.

With the ballet on stage, every squeak of a leather shoe being dragged or a point landing can be heard quite clearly.

During an early ballet performance, dancers gabbing offstage could be distinctly heard in the house. They were quickly admonished to perform with their bodies and keep their mouths zipped.

Equipment Specs

Beyond the acoustic performance of the hall there are also technical support systems required. The design of these systems went to Engineering Harmonics. This includes video, such as the FOH colour camera that sends a stage image to the lobbies and various production offices and back stage areas, and a conductor shot required for off-stage voices. There are wiring and access systems for recording, and headset communication systems for the running crew and to the dressing rooms. There are program sound and paging requirements for the lobby and dressing rooms, and there is on- and off-stage monitoring; the harpsichord which plays the continuo part is miked and sent to backstage Meyer UPM and UPJ monitor speakers. Al Merson is Head of Sound for the COC, and he says that, depending on the individual singer or scene, it can really be quite loud. During the early design and specification process, Martin Van Dijk of EH dubbed Merson the "D-Glazer" because eyes would start to glaze over any time there was a meeting involving sound equipment. Merson became the interpreter from the technical specifications to the "what do we need this for?" and "what's that?" questions from the COC.



AT LEFT: View of the orchestra pit from stage.

The Canadian Opera Company's directive to the design team was for a perfectly quiet hall with excellent acoustics that would provide full and balanced un-amplified sound to every seat in the house – and they got what they asked for.

Despite the purists, there are also sound reinforcement and sound effects system requirements. The COC didn't have a vision for sound design. It was aware something was needed, but hadn't really gone down that road. Phil Giddings of Engineering Harmonics enlisted the aid of Roger Gans, Sound Designer for the highly successful San Francisco Opera, to bring an understanding of the sound design requirements for modern opera and ballet. Just as modern lighting design relies heavily on intelligent moving fixtures, sound design brings into play the sensibility of cinema surround sound that audiences are used to experiencing. Gans did not do the actual systems design, but he was able to instill the philosophy of sound design as it applies to opera and ballet. The orchestra and the singers on stage don't need to be amplified, but there are instances where the acoustic sound needs to be blended with amplified sound.

There are often offstage chorus vocals that are reinforced into the house. In one of *The Rings* scenes there is a Dragon off-stage in a cave; the offstage singer is processed through a Lexicon PCM91 digital reverb to make the effect. Later, the Dragon is on stage, but the voice is still offstage with a different "not-in-a-cave" dragon voice.

A thunder effect is done with the traditional thunder sheet played on cue by a musician in the pit, but there's a contact mic, a DI, and some "whacky" EQ employed to expand it into the effects speaker system.

An organ played in the pit has to seem to be coming from a visual set piece location on stage.

It was also understood that the Hall would not be used exclusively for opera and ballet, and that Broadway-style musicals (which are amplified) may appear, as well as concert performances, specifically with the Toronto Jazz Festival. These amplified shows do not want the same level of reverberance, so an acoustic drape system can be deployed to dry up the reverberation and create a clear, amplified sound.

There is actually a substantial sound system in the hall, although the full design fell under some budget cuts. The job of fitting the sound system requirements into the budget envelope and of integrating the speakers in particular into the architecture and the acoustic space was taken up by Dave Clark, formerly of Engineering Harmonics.

The main system consists of a centre position with a Meyer CQ-1 focused out and a UPA-1P firing down, with two Meyer UPJ speakers at the outer position of the proscenium. In a learn-the-hard-way incident, Clark discovered that the CQ-1 is a stand-alone box that doesn't play well with others because the bass speaker is flipped out of phase – if you introduce another enclosure, the bass gets cancelled. The solution was to high-pass the UPA so it's not getting any bass and let the CQ-1 do the bottom end work.

Up the proscenium walls are what Clark calls the "chimneys" – a vertical space behind the acoustic proscenium walls with speaker positions. This was an area where the full system was cut back, but sensibly so. There is access at every level, with Unistrut mounting points running the full length so the system can be added to easily at any time on a temporary or permanent basis. Optionally, there are rigging points for visiting systems. During the Jazz Festival an L'Acoustics D-Vdosc system was brought in for a Keith Jarrett concert. The spec was for 14 line array cabinets per side. The rental house brought only 26 boxes, so there were some complaints from the front rows that it wasn't loud enough. Unfortunately, the front fill system also supplied proved to be too noisy to use and there was no time to integrate the house front fill system. The solution was to turn it up louder – and everyone seemed satisfied. This scenario indicates that a full house system complement would be the only guarantee of enough horsepower with quality and consistency for all performances.

Because of the requirement to integrate into the hall, the budget priority was put on the surround sound and delay systems. Unlike cinema surround sound, where the speakers are clearly visible high on the side and back walls and at some distance from the seats, in the opera house the seats are very close and the speakers cannot be visible. They also cannot interfere in any way with the acoustic properties of the hall.

The FX system starts on stage with a Meyer UPA-1P, two Meyer MSL-4 speakers, and two Meyer PSW-2 subs. The solution in the house was to deploy many (56) Meyer MM4 cabinets built into enclosed spaces in the ceiling just where it meets the wall at each of the five levels. Each speaker is run off a channel of the 8-channel QSC amps. There are 10 Meyer MM4s in the pit rail for front fills, which move with the rail to any of three locations, depending on the size of the orchestra.

A further 48 MM4s provide various box and balcony fills. These were also built into enclosures in the balcony ceilings and mounted on yokes for focus. The delay speakers are also high-passed above about 300 Hz to prevent any bass energy travelling back into the hall.

The surround and delays are controlled through nine various BSS BLU Soundwebs that were programmed by Darryl McClean of McClean Media Systems.

There is a patchbay access point, so that any production employing a matrix engine such as LCS or TiMaxx can access the system as it wishes.

Merson says the hall is "stunning." When they were first commissioning the hall in late April, 2006, an audience was invited to a number of concerts to assess the acoustic results: one with a full 80-plus orchestra, chorus, and a large ensemble singing; one with a smaller 45-plus orchestra, no chorus, and small ensembles or solo voices; and one concert of solo voices with piano accompaniment. Merson relates that his favourite moment during the commissioning process was at the end of one solo piece when the singer held the last note and the pianist used the sustain pedal. "The sound went on forever."

Merson's mix position is enclosed in a booth; a window opens, but not where the console is located, and even at that it's very difficult to mix when you're not in the acoustic space. A house mix position was identified, but the removable seats got cut from the budget.

The Yamaha DM2000 doesn't have a designer remote or any sort of compatible MIDI interface, so Merson uses a KVM switch on Cat5 and sits in a wheelchair seat with his laptop.

He can only execute a single change at a time, but at least he can hear the results. For larger mix requirements, they just use up some seats at the back.

The culmination of all the careful design, engineering, and construction, was the Canadian debut of Wagner's *Ring Cycle,* which opened to tremendous response and rave reviews on September 12, 2006. The "drama and richness" of the score, with "voices heard in superb relief" were all noted and remarked upon. What nobody seemed to notice was the large degree of technology supporting all this, nor did they seem to mind that much of the sound was being augmented behind the scenes – with great care being given to integrate seamlessly into the whole production without really being noticed. ■

Don Barber is an audio consultant and designer, and can be reached at don.barber@sympatico.ca or www.donbarbersound.com.