CANWEST GLOBAL CENTRE
WINNIPEG, MANITOBA, CANADA

AERCOUSTICS
ENGINEERING LIMITED

ACOUSTICS CONSULTANT:	Aercoustics Engineering Limited
SOUND & COMMUNICATION:	Trizart - Alliance
OWNER:	Manitoba Theatre for Young People
ARCHITECT:	The Prairie Partnership
THEATRE CONSULTANT:	Trizart - Alliance
CONSTRUCTION COST:	8 Million CAD
COMPLETION DATE:	1999

The Forks district is situated at the confluence of the Red and Assiniboine rivers in downtown Winnipeg Manitoba. It has been a meeting place for 6000 years and is now the site of intensive urban renewal. Amidst the museums, restaurants and television studios sits the new CanWest Global Performing Arts Centre, home of the Manitoba Theatre for Young People.

The 315 seat flexible studio theatre is a steel with masonry in-fill structure. Surrounding the theatre on three sides, and acoustical separated from it, is a wood frame construction containing four studios/classrooms, the lobby, washrooms, and a large rehearsal hall.

Canadian National Railway's busy Main Line passes near the site and was a cause for concern, notably with the outdoor roof top mechanical equipment and associated ductwork. Duct work was protected in a gypsum board "dog house" and silenced at the penetration of the theatre wall. Trains are inaudible inside the theatre.

The owner wanted the space to be as flexible as possible and as a result, there are no less than seven catwalks in the room. A 1:25 foam core model was built to study the different catwalk variations. It was decided that for this size of room and for this type of application, the catwalks would be appropriate.

Finishes inside the theatre are painted split face block, wire mesh balcony fascia and a concrete roof. Black duct liner is used on the walls above the catwalks to control detrimental late reverberant energy. Duct work is exposed above the catwalks, with a few small risers running down the side walls as well.

CRITICAL DATA (Theatre Mode)

Seating Capacity	315
Volume	4,590 m^3
Reverberation Time	~1.0 s
Noise Level	~PNC 20
Proscenium Height	N/A
Proscenium Width	N/A

CANWEST GLOBAL CENTRE
WINNIPEG, MANITOBA, CANADA

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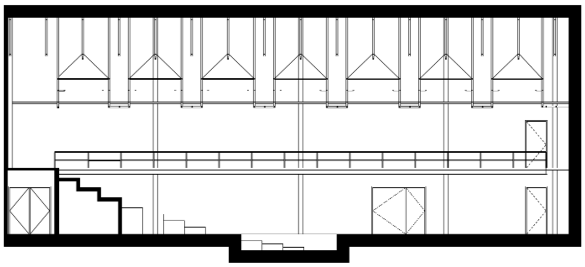
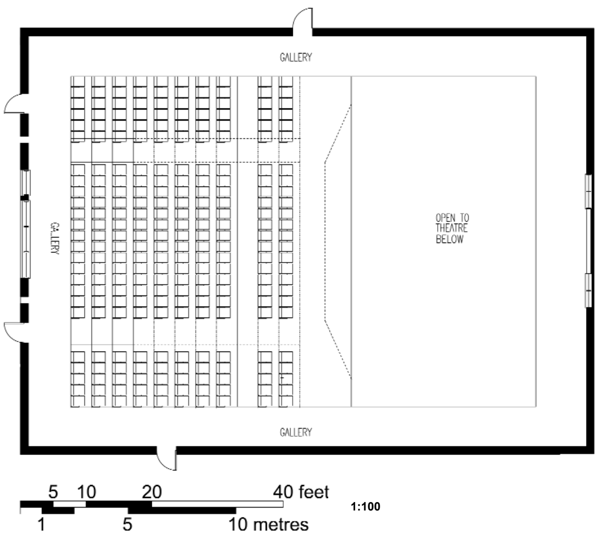


LONGITUDINAL SECTION



ORCHESTRA PLAN

THE ESPLANADE
MEDICINE HAT, ALBERTA, CANADA

AERCOUSTICS
ENGINEERING LIMITED

ACOUSTICS CONSULTANT:	Aercoustics Engineering Limited
SOUND & COMMUNICATION:	Engineering Harmonics
OWNER:	The City of Medicine Hat
ARCHITECT:	Diamond Schmitt Architects Inc.
THEATRE CONSULTANT:	Fisher Dachs Associates
MECHANICAL ENGINEER:	Crossey Engineering Limited
CONSTRUCTION COST:	32 Million CAD
COMPLETION DATE:	2005

The Esplanade in Medicine Hat, Alberta will house a museum, an art gallery, a 150 seat studio theatre and the 700 seat theatre shown here. The building is scheduled to open in 2005, the province of Alberta's centennial.

The 700 seat, single balcony theatre is located in the north-east corner of the building and is surrounded on three sides by a 50 mm acoustic joint. To simplify construction, a corridor between the north façade of the building and the audience chamber has been left unisolated. Carpet on the corridor floor controls noise from footfall.

The room is designed for music and theatre, both community based and professional. One of the more interesting challenges of the design stemmed from the architect's keen desire for visual intimacy, manifest in a low "acoustically transparent" ceiling. A 1:20 scale model was built and a number of ceiling scenarios were tested. The high frequency behaviour of the ceiling was tested in a 1:5 scale "anechoic" model. The final solution, not shown in these images, was a ceiling more than 85% open, made up of 25 mm diameter wooden dowels. Scale model experiments were also performed on the orchestra shell ceiling in an effort to optimise the size of the panels and the openings between the panels.

Air is supplied to the audience chamber through a plenum underneath the orchestra level seats. The mechanical room is located underneath the lobby, beyond the acoustic joint. The system is being designed to PNC-15.

The walls of the audience chamber will be sealed, bush hammered concrete. The balcony facia and the walls surrounding the side wall boxes will have a sand blasted wood finish: 300 x 25 mm boards of varying depths arranged in a random, vertically orientated pattern, mounted on a 32 mm gypsum board substrate. Adjustable acoustic curtains are provided on the side and back walls.

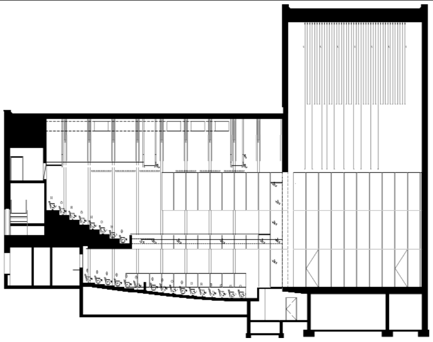
The orchestra pit also has adjustable acoustic curtains and will seat approximately 30 musicians. The stage will be equipped with a full orchestra shell, with finishes to match the box walls and balcony facia. When not in use, the shell will be stored on the upstage wall and in the fly-tower.

CRITICAL DATA (Theatre Mode)

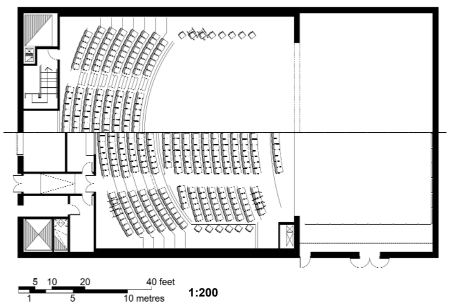
Seating Capacity	700
Volume	5,450 m^3
Reverberation Time	1.2 s
Noise Level	PNC 15
Proscenium Height	10.6 m
Proscenium Width	15.5 m

THE ESPLANADE
MEDICINE HAT, ALBERTA, CANADA

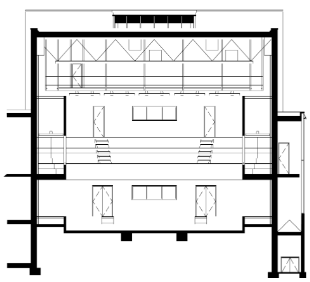
AERCOUSTICS
ENGINEERING LIMITED



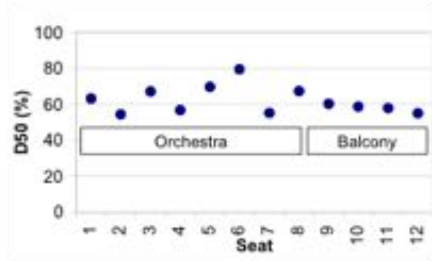
LONGITUDINAL SECTION



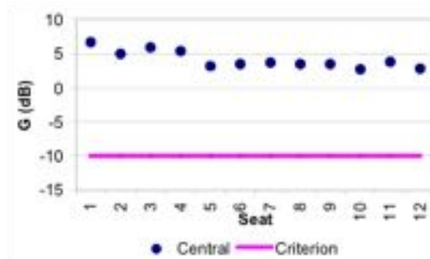
ORCHESTRA & BALCONY PLAN



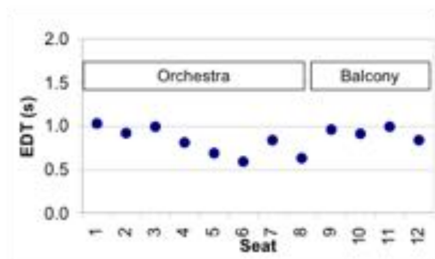
TRANSVERSE SECTION



50 ms DISTINCTNESS

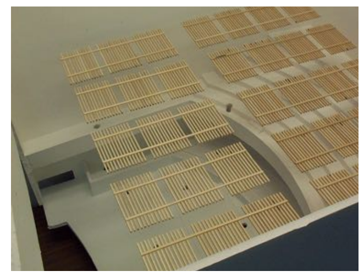


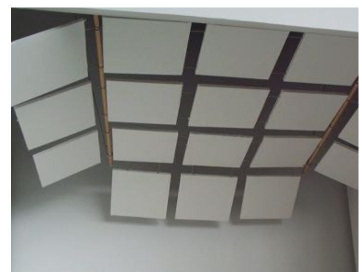
ACOUSTIC STRENGTH



EARLY DECAY TIME

Values predicted with CATT Acoustic Version 8.
Theatre mode, curtains exposed.





1:20 SCALE MODEL

Renderings courtesy of Diamond Schmitt Architects Inc.

EVERGREEN CULTURAL CENTRE
COQUITLAM, BRITISH COLUMBIA, CANADA

AERCOUSTICS
ENGINEERING LIMITED

ACOUSTICS CONSULTANT:	Aercoustics Engineering Limited
SOUND & COMMUNICATION:	Engineering Harmonics
OWNER:	The City of Coquitlam
ARCHITECT:	proscenium architecture + interiors
THEATRE CONSULTANT:	Doug Welch Design Associates
MECHANICAL ENGINEER:	VEL Engineering
CONSTRUCTION COST:	7.5 Million CAD
COMPLETION DATE:	1996

The Evergreen Cultural Centre in Coquitlam, British Columbia includes a 250 studio theatre, lobbies and museum space. A second 600 seat auditorium is anticipated in the next few years. The studio theatre is used as a multi-purpose space, anything from bingo to classical concerts and, of course, theatre.

The interior finish of the performance space is sealed, grout filled split face block. The block provides good acoustic diffusion, maintains acoustic warmth and controls noise intrusion. The architect used the block as a neutral palate to which the colourful balconies were applied. Late in the design it was decided to limit the split face block to the audience area. It was thought that the application of split face on the stage walls would be impractical. As a result, one can easily demonstrate the effectiveness of the split face block, walking from the flutter echo zone on (empty) stage to the clean acoustics of the audience chamber. Under normal working conditions however flutter echo on stage is non-existent, being broken up by equipment, fittings on the wall, etc.

Above the auditorium is a "floating roof" made up of tar and stone ballast separated from the concrete slab by glass fibre insulation.

Heating Ventilation and Air Conditioning (HVAC) services are provided by roof top units located above the loading dock and storage rooms. Ducts are internally lined and exposed in the auditorium. As such they provide good acoustic diffusion and acoustic absorption of late low frequency sound.

Nick Lehoux Photography

Acoustical curtains line the side walls all the way up to the technical level. Mid frequency Reverberation Times can be varied from 1.0 seconds in the theatre mode to 1.7 seconds in the concert mode. Curtains are also used to form the stage portal. There is no hard proscenium arch.

The building opened in October 1996 and has been widely praised by performers and patrons. On opening night, Jon Washburn, the conductor of the Vancouver Chamber Choir interrupted the proceedings several time to comment on the acoustics: "...the more we play, the better it sounds."

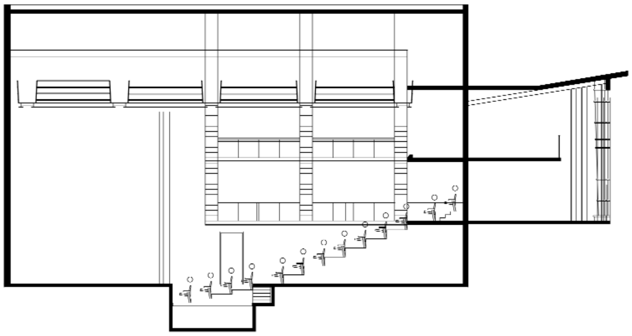
CRITICAL DATA (Theatre Mode)

Seating Capacity	250
Volume	3,160 m^3
Reverberation Time	1.0 s
Noise Level	PNC 22
Proscenium Height	N/A
Proscenium Width	N/A

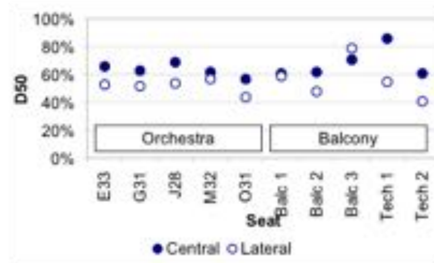
	OCTAVE BAND (Hz)				
	250	500	1000	2000	4000
D50 (%)	49	63	60	69	82
G (dB)	5.3	4.7	4.3	2.1	0.2
EDT (s)	1.3	1.0	0.9	0.7	0.5

EVERGREEN CULTURAL CENTRE
COQUITLAM, BRITISH COLUMBIA, CANADA

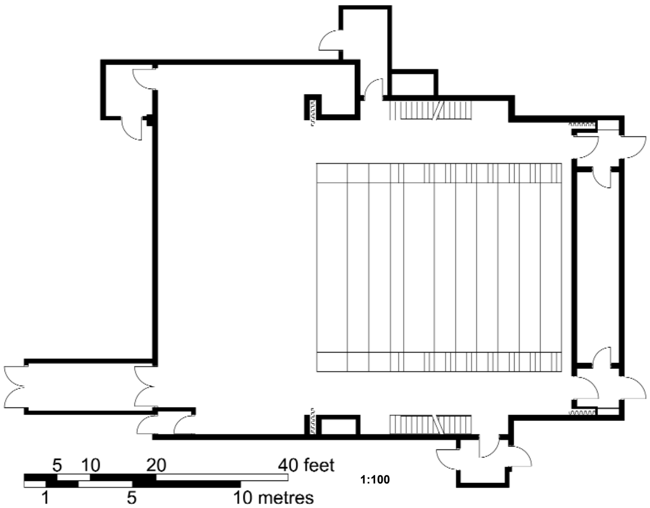
AERCOUSTICS
ENGINEERING LIMITED



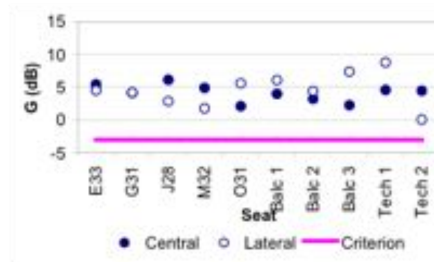
LONGITUDINAL SECTION



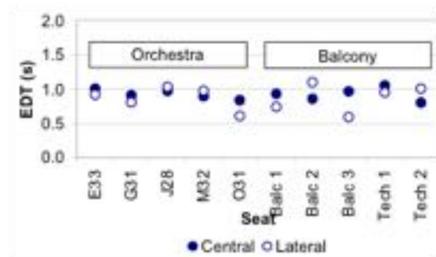
50 ms DISTINCTNESS



ORCHESTRA PLAN

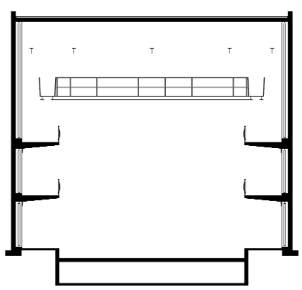


ACOUSTIC STRENGTH



EARLY DECAY TIME

1 kHz octave band data measured in the unoccupied room. Strength criterion based on HVAC ambient noise level.



TRANSVERSE SECTION

Nick Lehoux Photography

Nick Lehoux Photography

HUMMINGBIRD CENTRE
TORONTO, ONTARIO, CANADA

AERCOUSTICS
ENGINEERING LIMITED

ACOUSTICS CONSULTANT:	Aercoustics Engineering Limited
SOUND & COMMUNICATION:	Neil Muncy/Martin van Dijk
OWNER:	City of Toronto
ARCHITECTURAL REVIEW:	Kuwabara Payne McKenna Blumberg Architects
ENHANCEMENT SYSTEM:	LARES/Steve Barbar
DIFFUSER DESIGN	RPG/Trevor Cox
CONSTRUCTION COST:	600,000 CAD
COMPLETION DATE:	1996

When it opened in 1960, Toronto's O'Keefe Centre was one of the premier post-war theatres in Canada. In 1996, the building received a $5M grant from the software developer Hummingbird Corporation and, not long after, assumed that company's name. Part of the grant was used to address the well known acoustical problems, this time with the LARES electro-acoustic enhancement system.

The room is virtually devoid of late reflected energy and, as a result, has been plagued by echoes. One of the more pronounced echoes was off the side wall. It had never been a problem in the past because the side walls reflect very little energy from the stage. The proposed electronic enhancement system design however called for 62 loudspeakers on both side walls. Each speaker was to be individually addressable for multi-media presentations and each one would be capable of producing what can only be described as a head-spinning echo.

The design challenge was formidable. How does one introduce acoustical diffusers onto the flat, yet very elegant side walls and make them look like they belong? Three possible diffusers were proposed, each including a loudspeaker for the enhancement system and based on stepped prime number theory diffusion. The intention was to fit the diffusers into the lattice of 0.3 x 1.2 m recesses in the side walls. Two took the shape of a long right angle triangle with the loudspeaker at one end, the third was a flattened triangle with the loudspeaker in the middle. The latter was the poorest diffuser but best suited the architectural solution.

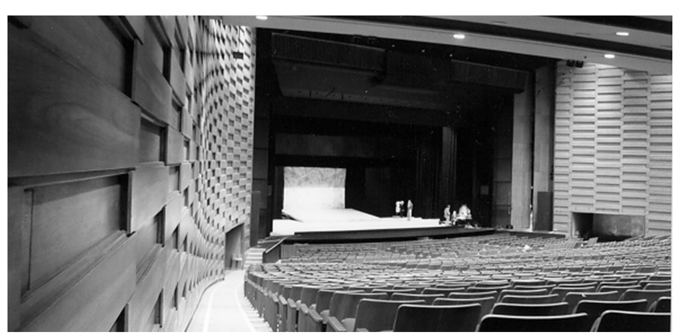
A 1:48 model was built and tested by Aercoustics to confirm the performance of the diffusers. First, the model was calibrated to full scale measurements performed in the theatre then the three different diffusers were tested. The scale model tests suggested that the echo could be significantly reduced, although not completely eradicated.

The problem was eventually solved with the crescent shaped acoustical diffusers designed and optimised by Trevor Cox using Boundary Element Modeling (BEM) techniques. The crescent shaped diffusers fit perfectly with the architect’s concept of a “basket weave” that would thread in and out of the cherry wood side walls. Their simplicity of form belies the complexity of the design challenge. First and foremost, the diffusers break up the echoes and let the LARES system function as it should. Many of the diffusers hide loudspeakers. This means that speakers are attached to the wall rather then hidden inside it. Cutting holes the wall would have been expensive and insensitive.

The LARES system consists of four mainframes, four cardioid B & K microphones placed over the proscenium arch and a total of 312 loudspeakers.

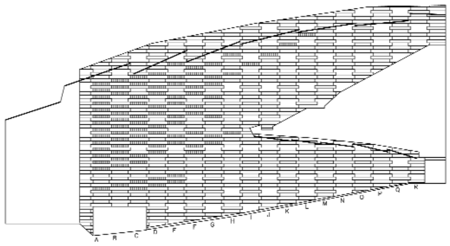
CRITICAL DATA

Seating Capacity	3,200
Volume	18,385 m^3
Reverberation Time	1.1 s
Noise Level	PNC 20
Proscenium Height	9.6 m
Proscenium Width	19.4 m

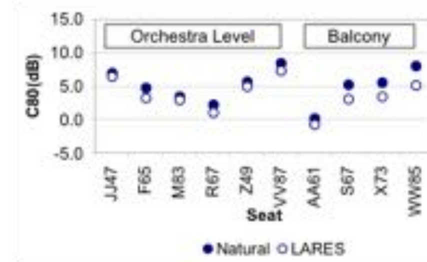

PRIOR TO RENOVATIONS

HUMMINGBIRD CENTRE
TORONTO, ONTARIO, CANADA

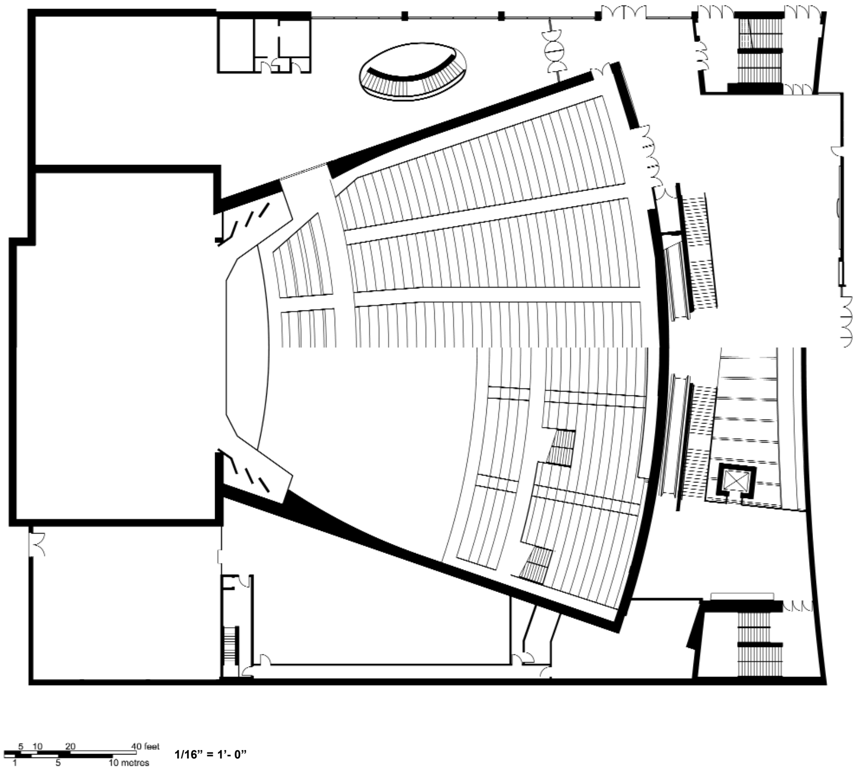
AERCOUSTICS
ENGINEERING LIMITED



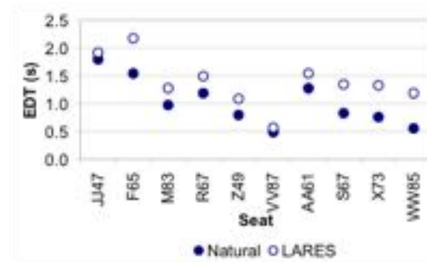
SIDE WALL ELEVATION



80 ms CLARITY

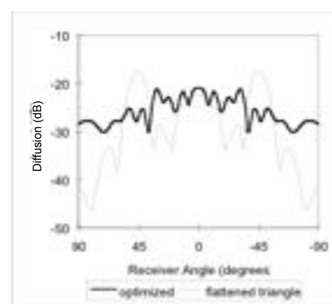


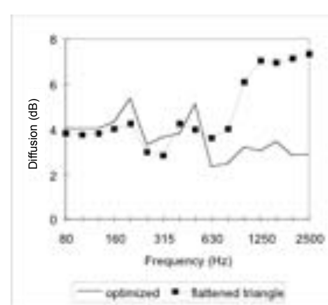
ORCHESTRA & BALCONY PLAN



EARLY DECAY TIME

500 Hz octave band data measured in the unoccupied auditorium.





Courtesy of Trevor Cox.

1:48 SCALE MODEL

ISABEL BADER THEATRE
TORONTO, ONTARIO, CANADA

AERCOUSTICS
ENGINEERING LIMITED

ACOUSTICS CONSULTANT:	Aercoustics Engineering Limited
SOUND & COMMUNICATION:	Novita Ltd.
OWNER:	Victoria University
ARCHITECT:	Lett/Smith Architects
THEATRE CONSULTANT:	Novita Ltd.
CONSTRUCTION COST:	7 Million CAD
COMPLETION DATE:	2001

The Isabel Bader Theatre was a $7M gift to Victoria University, donated by Alfred Bader as a loving tribute to his wife. The unsolicited nature of the gift meant that the building had, in effect, no established program or specific design requirements. Several possible uses presented themselves: lecture space was needed and the university had a rich theatrical tradition. Centrally located on the University of Toronto campus, the prospect of rental income from professional acts was also attractive. Beyond that, it was up to the design team. Local zoning by-laws limited the height of the building. This in turn limited the height of the flytower (a theatrical concern) and the height of the audience chamber (a music/reverberation concern). With this and the reality of a high water table in mind, a conscious decision was made not to build an orchestra pit. The acoustic design focussed primarily on good speech intelligibility.

The design team was essentially the same as that for the Princess of Wales Theatre. Like the Princess of Wales, the structure is mostly poured in place concrete. Inside the house, the concrete is exposed to the acoustic volume through a 25 mm deep wooden lattice. The concrete maintains acoustic warmth while the lattice provides scattering. A special reflector located above the balcony redirects sound to improve speech intelligibility, a strategy borrowed by the design team from their work on the Showplace Centre in Peterborough, Ontario. The seats are fully upholstered, including the back of the backrest and are fitted table arms for lectures. There are no acoustic curtains. With the limited building height, none were required.

Robert Burley/Design Archive

There is a block of offices above the theatre, the floors of which are carpeted to control noise from footfall. Washrooms for the offices have been located beyond footprint of the theatre on floating concrete floors.

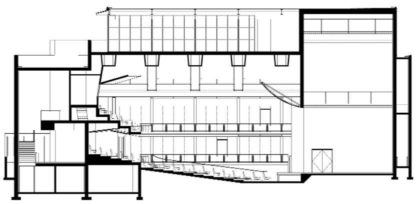
The building has become a lively addition to Toronto's theatre and entertainment scene. It is a premier venue for the annual Toronto International Film Festival, it hosts numerous amateur and professional theatrical productions and, despite its limited height, Allen Pulker of Wholenote magazine noted: "Just a couple of months after its opening, the Isabel Bader Theatre at Victoria University at U of T has become a great hit with the musical community."

CRITICAL DATA

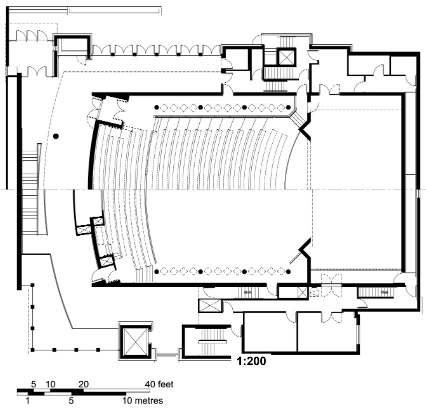
Seating Capacity	503
Volume	3,450 m^3
Reverberation Time	1.1 s
Noise Level	PNC 20
Proscenium Height	6.0 m
Proscenium Width	8.79 m

	OCTAVE BAND (Hz)				
	250	500	1000	2000	4000
D50 (%)	57	64	65	64	67
G (dB)	7.6	7.6	7.5	6.7	6.9
EDT (s)	1.2	0.9	0.8	0.8	0.7

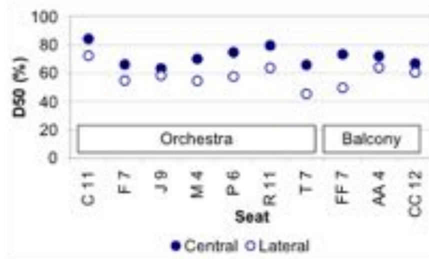
ISABEL BADER THEATRE
TORONTO, ONTARiO, CANADA



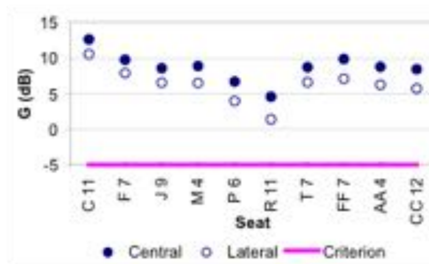
LONGITUDINAL SECTION



ORCHESTRA PLAN

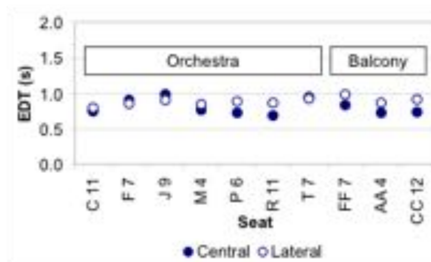


50 ms DISTINCTNESS



ACOUSTIC STRENGTH

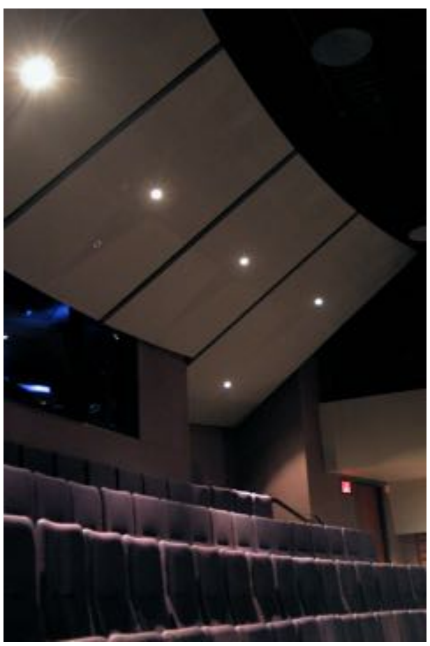
Robert Burley/Design Archive



EARLY DECAY TIME

Robert Burley/Design Archive

1 kHz octave band data measured in the unoccupied room. Strength criterion based on HVAC ambient noise level.



Robert Burley/Design Archive

PRINCESS OF WALES THEATRE
TORONTO, ONTARIO, CANADA

ACOUSTICS CONSULTANT:	Barman Swallow Associates/Aercoustics
SOUND & COMMUNICATION:	Crossey Engineering
OWNER:	Mirvish Productions
ARCHITECT:	Lett/Smith Architects
THEATRE CONSULTANT:	Lett/Smith Architects
ARTWORK:	Frank Stella
FRONT OF HOUSE INTERIOR DESIGN	Yabu Pushelberg
CONSTRUCTION COST:	24 Million CAD
COMPLETION DATE:	1993

Originally conceived as a temporary building, the Princess of Wales Theatre was built specifically to stage the Toronto production of Miss Saigon. The theatre seats 2000 people, none no further than 26 m (85') from the stage. This is achieved in part by two long balcony overhangs, one of which was extended two rows by Miss Saigon director Cameron Mackintosh in an effort to get more people closer to the stage. The results are borne out in the acoustical measurements. Early Decay Times are seen to decrease significantly underneath the balconies as are the acoustic Strength levels. The latter would result in a serious compromise in speech intelligibility were it not for the low ambient noise levels. The room is, in fact, known for its good speech intelligibility. 50 ms Distinctness ratios are high throughout the space. Actors need no microphones, although they are often employed in the musicals that frequent the house.

Architect Peter Smith's design called for a 9 m opening in the ceiling, a tension grid for lighting. This prompted an acoustical concern about a lack of early reflections. The architectural geometry is essentially a horseshoe plan inside a rectangular box. One advantage of a horseshoe shape is that the side balcony facia can operate as useful reflecting surfaces. Using specifically designed software, it was discovered that the side balcony facia provide good early reflections over a significant portion of the central balcony. Facia reflections have advantages over ceiling reflections: (i) they can reach seating underneath the balcony where ceiling reflections cannot; (ii) they are lateral reflections in most seats, which will encourage source broadening during musical passages and (iii) they arrive at listeners in the middle of the room sooner than similar reflections off the side wall. In the Princess of Wales, facia reflections arrive at the centre of the first balcony 17 ms after the direct sound. Side wall reflections arrive in the same area after 31 ms.

The walls are 300 mm poured concrete with 16 mm gypsum board laminated and nailed directly to the wall to prevent absorption of low frequency sound. The ceiling is double layer 16 mm gypsum board with a layer of tar paper in between to increase damping. Primitive root diffusers (PRD) were been designed and installed on the back walls of the theatre and in the orchestra pit. The are no acoustical curtains, no oversized volume and the seats are fully upholstered, including the back of the backrest. The Princess of Wales is a theatre first and foremost.

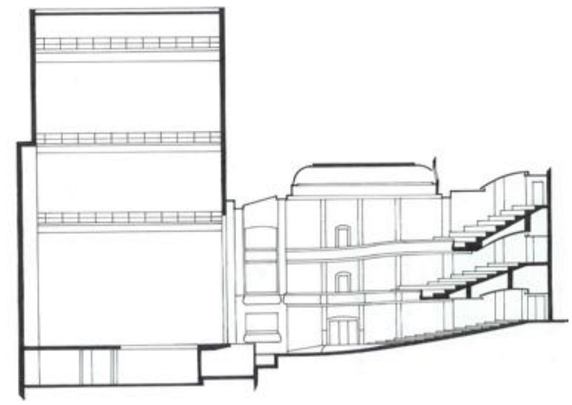
The building is graced with the beautiful work of American artist Frank Stella. In the lobbies, on the proscenium arch and even on the exterior wall of the flytower, Stella's colourful murals give the building an unmistakable sense of excitement. Inside the house, they also play an acoustical role. The balcony facia, originally conceived as convex reflectors, became acoustically scattering sculptural elements as a result of Stella's input.

CRITICAL DATA

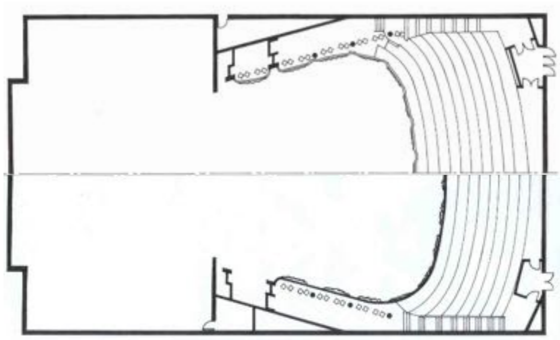
Seating Capacity	2,000
Volume	10,500 m^3
Reverberation Time	1.1 s
Noise Level	PNC 16
Proscenium Height	10.9 m
Proscenium Width	15.0 m

	OCTAVE BAND (Hz)				
	250	500	1000	2000	4000
D50 (%)	53	61	74	85	90
G (dB)	-1.1	-2.2	-2.5	-0.5	-1.1
EDT (s)	1.2	1.1	0.9	0.8	0.8

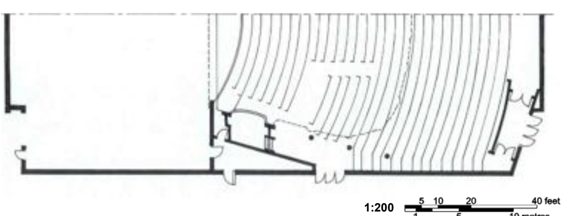
PRINCESS OF WALES THEATRE
TORONTO, ONTARIO, CANADA



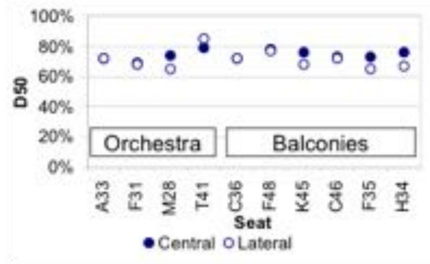
LONGITUDINAL SECTION



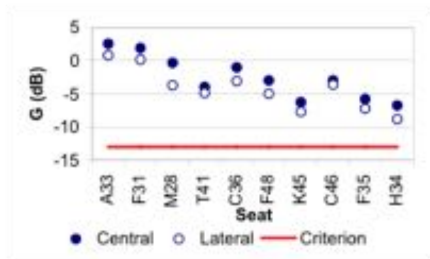
1st & 2nd BALCONY PLANS



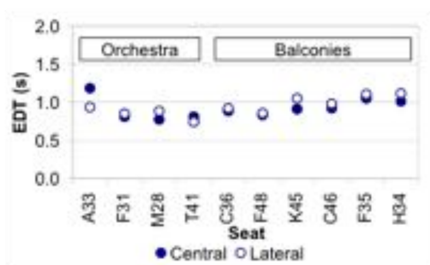
ORCHESTRA PLAN



50 ms DISTINCTNESS

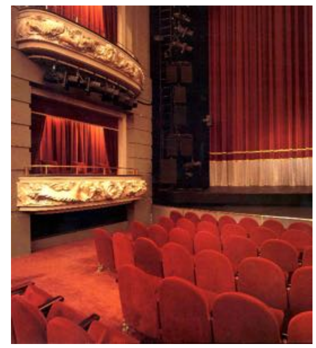


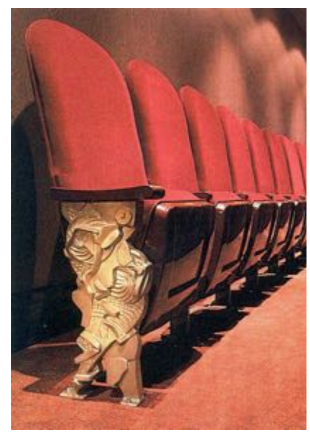
ACOUSTIC STRENGTH

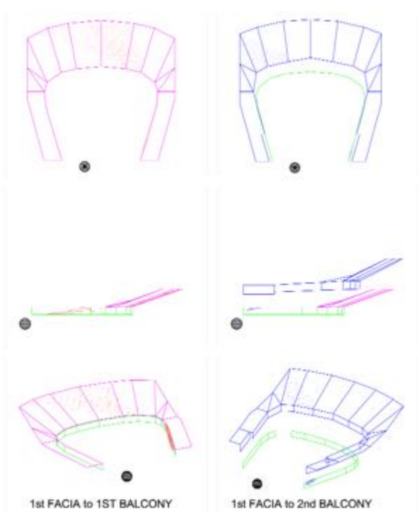


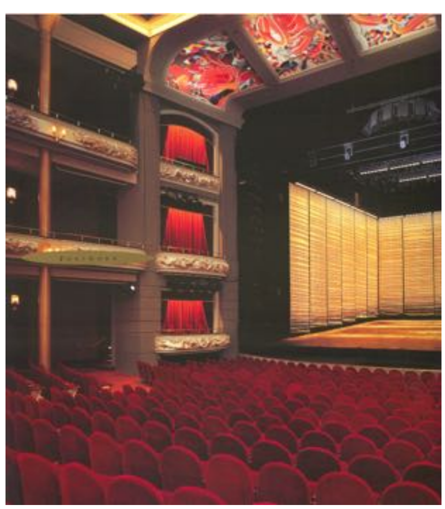
EARLY DECAY TIME

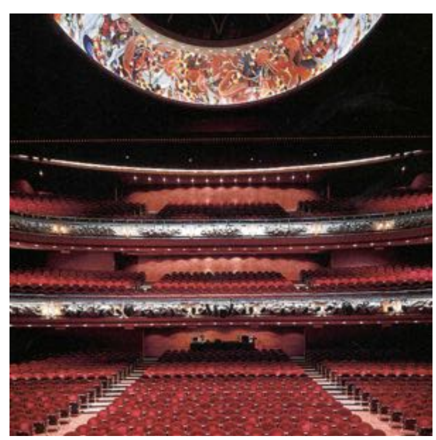
1 kHz octave band data measured in the unoccupied room. Strength criterion based on HVAC ambient noise level.











QUEEN ELIZABETH THEATRE
VANCOUVER, BRITISH COLUMBIA, CANADA

AERCOUSTICS
ENGINEERING LIMITED

ACOUSTICS CONSULTANT:	Aercoustics Engineering Limited
SOUND & COMMUNICATION:	Engineering Harmonic
OWNER:	Vancouver Civic Theatres
ARCHITECT:	proscenium architecture + interiors
THEATRE CONSULTANT:	Doug Welch Design Associates
MODEL MAKER:	AB Scale Model
CONSTRUCTION COST:	20 Million CAD
COMPLETION DATE:	2006

The Queen Elizabeth Theatre in Vancouver, Canada opened in 1959. It is the home of Vancouver Opera and Ballet BC. Although on many levels it can be seen as one of North America's seminal post-war multi-purpose auditoria, its acoustics have never found favour. It now is long overdue for a facelift. The renovation scheme for the Queen Elizabeth Theatre will see the single balcony room converted into a two or three tiered house complete with side boxes.

In many rooms, the Early Decay Time (EDT) is shorter than the Reverberation Time (RT) and, in this sense, the Queen Elizabeth Theatre is no different than any other. It was during an effort to improve EDT in this room that we developed a new understanding of the influence of simple geometric parameters on modern acoustical measurements. In particular, the Height to Width ratio of a room and the influence of side wall boxes. A series of computer and scale model experiments has shown that EDTs, C80 ratios and Strength (G) are negatively influenced by low Height/Width Ratios and deep side wall balconies.

The original building, like most others of its age, uses a sloped ceiling near the stage to direct sound towards the back of the room. We now know that the resulting frontal reflections are undesirable and can, among other concerns, decrease EDTs. In a 1:48 scale model the EDTs were significantly increased by simply removing the slope from the ceiling. But as soon as the side wall boxes were introduced into the model, the EDTs dropped back to their original levels. The design solution came in the form of fin like reflectors to effectively reduce the depth of the side wall boxes by half. These reflectors extend from floor to ceiling. In addition to improving the Early Decay Times they will improve lateral reflected energy and, as a consequence, improve source broadening. Scale model measurements have demonstrated improved EDT/RT ratios: from 51% with the first set of side wall boxes to 75% with the revised "fin wall" boxes.

Renderings courtesy of proscenium architects + interiors

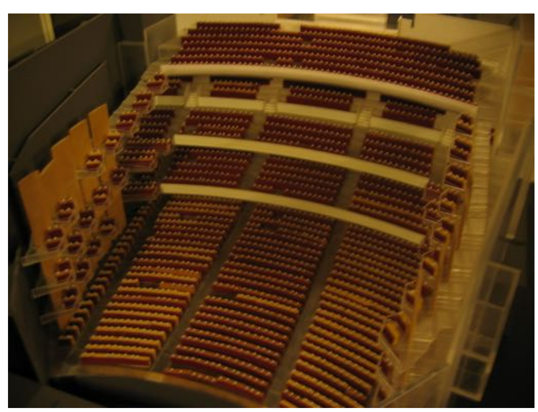
References

O'Keefe, J., The Influence of Height to Width Ratio and Side Wall Boxes on Room Acoustics Measurements, Inst. Of Acoustics, Manchester, October 1999

O'Keefe, J. Acoustical Problems In Large Post-War Auditoria, Inst. of Acoustics, London 2002.

CRITICAL DATA

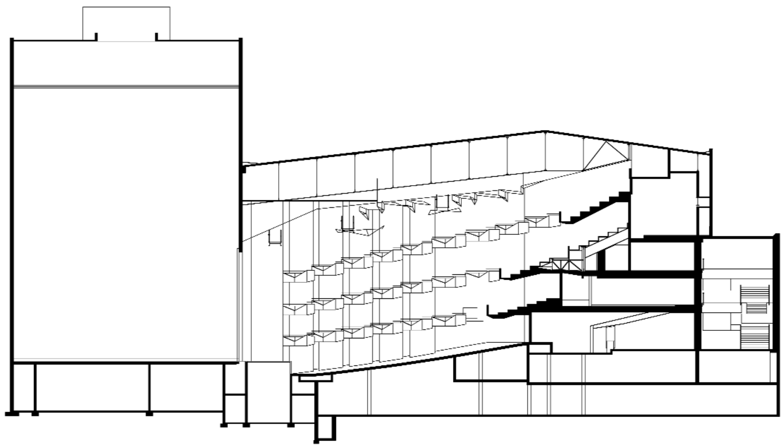
Seating Capacity	2,900
Volume	15,000 m^3
Reverberation Time	1.5 s
Noise Level	PNC 15
Proscenium Height	9.75 m
Proscenium Width	17.07 m



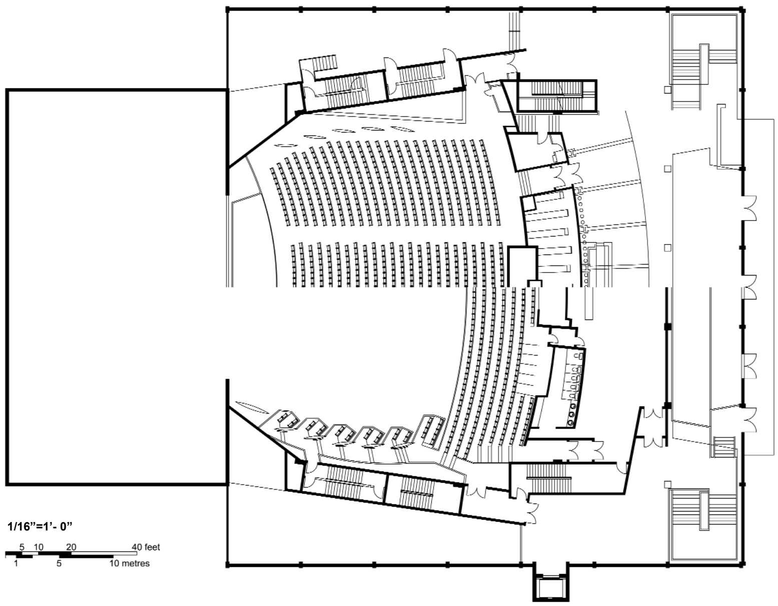
1:48 SCALE MODEL

QUEEN ELIZABETH THEATRE
VANCOUVER, BRITISH COLUMBIA, CANADA

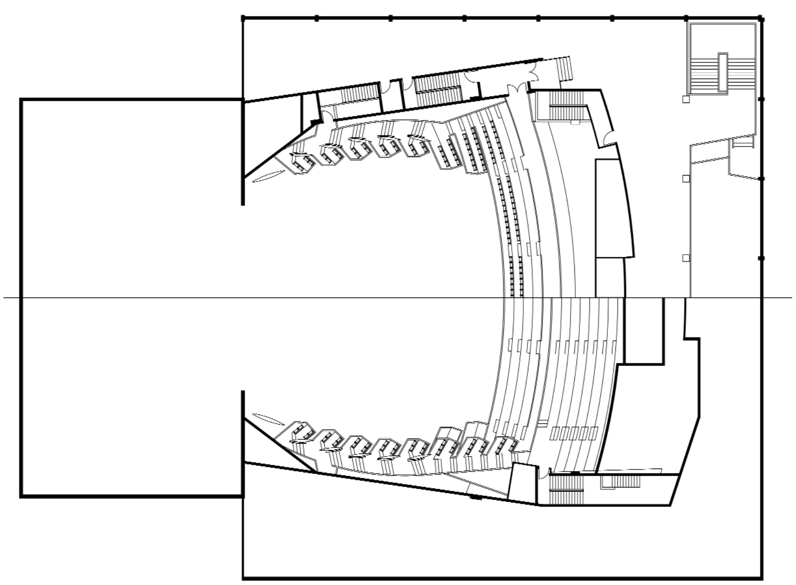
AERCOUSTICS
ENGINEERING LIMITED



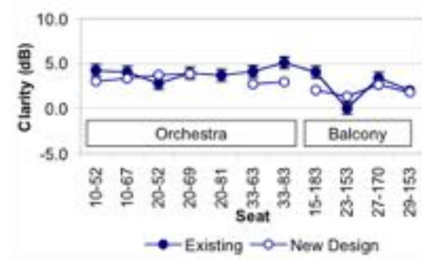
LONGITUDINAL SECTION



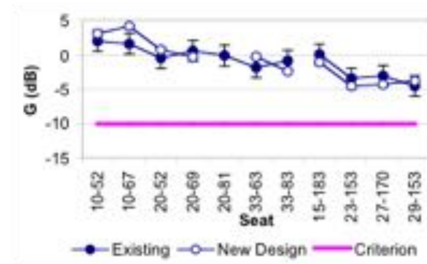
ORCHESTRA & BALCONY PLAN



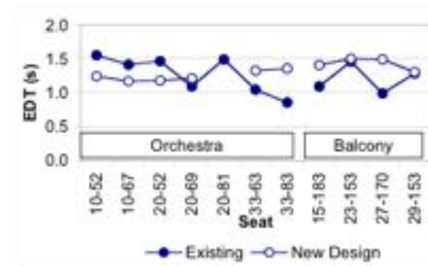
2nd & 3rd BALCONY PLANS



80 ms CLARITY

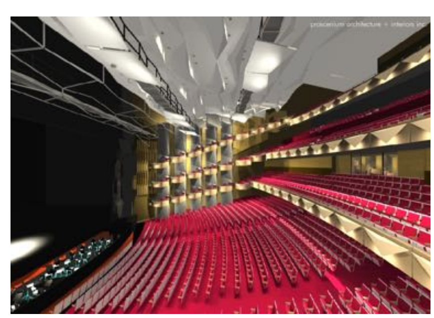


ACOUSTIC STRENGTH



EARLY DECAY TIME

500 Hz octave band data measured in the 1:48 scale model. Strength criterion based on the proposed HVAC ambient noise level.



E. A. RAWLINSON CENTRE
PRINCE ALBERT, SASKATCHEWAN,CANADA

AERCOUSTICS
ENGINEERING LIMITED

ACOUSTICS CONSULTANT:	Aercoustics Engineering Limited
SOUND & COMMUNICATION:	Schick Shiner and Associates
OWNER:	City of Prince Albert
ARCHITECT:	Ellard Croft Architects/Stantec
THEATRE ARCHITECT:	Brinsmead Ziola Architects
THEATRE CONSULTANT:	Schick Shiner and Associates
CONSTRUCTION COST:	10.4 Million CAD
COMPLETION DATE:	2002

The E.A. Rawlinson Centre is a single balcony, 610 seat venue intended for several uses but is perhaps best suited to theatre. It is an important new addition to this city of 75,000 located in the centre of the province of Saskatchewan. In addition to the theatre, the facility includes an art gallery and generous lobby space.

Split face block is employed on the side and back walls of the audience chamber to provide acoustical diffusion and maintain acoustical warmth. The roof is concrete in a corrugated steel deck, again to provide diffusion and warmth.

The orchestra pit seats 25 musicians comfortably and doubles as forestage when not in use.

Ventilation is supplied from a plenum below the orchestra seats and is returned through ductwork located above the cat walks. Mechanical rooms near the stage and audience chamber required careful attention both during design and construction.

Acoustic curtains are provided on the upper reaches of the side and back walls. The Reverberation Time varies from approximately 1.1 seconds to 1.5 seconds.

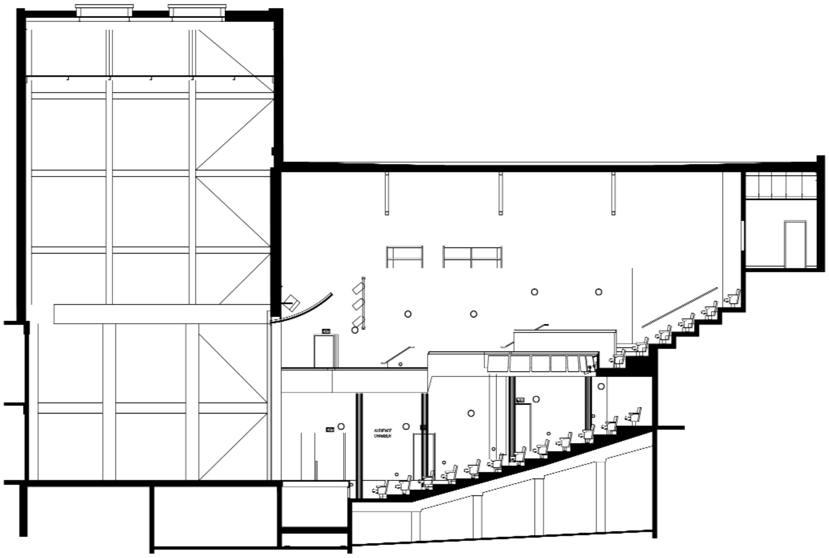
The E.A. Rawlinson Centre was opened by HRH Prince Edward on 20 June 2003. It has proved a huge success with the community and in its first year easily surpassed its expected bookings and revenue.

CRITICAL DATA (Theatre Mode)

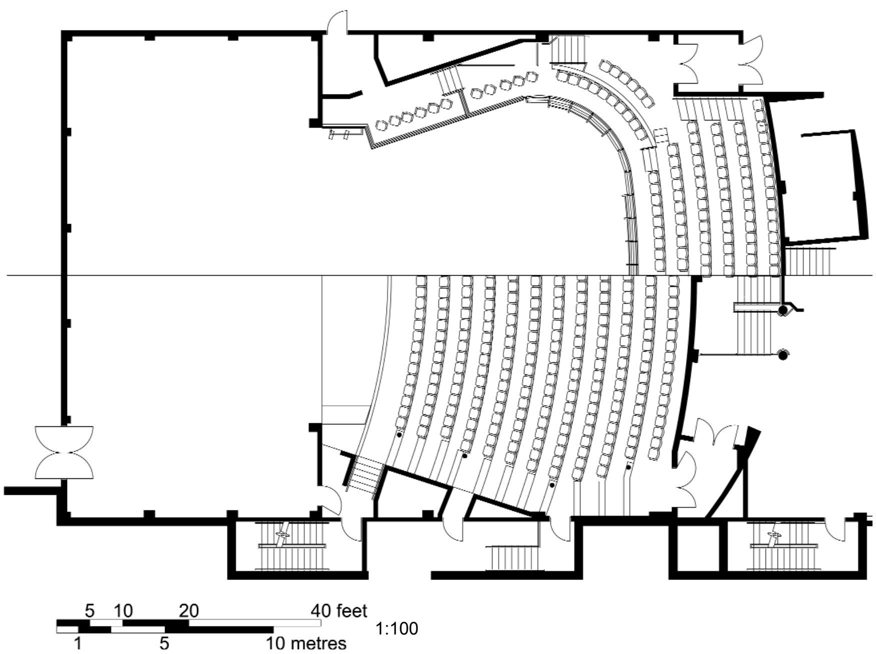
Seating Capacity	610
Volume	4,630 m^3
Reverberation Time	~1.1 s
Noise Level	~ PNC 20
Proscenium Height	7.2 m
Proscenium Width	12 m

E. A. RAWLINSON CENTRE
PRINCE ALBERT, SASKATCHEWAN,CANADA

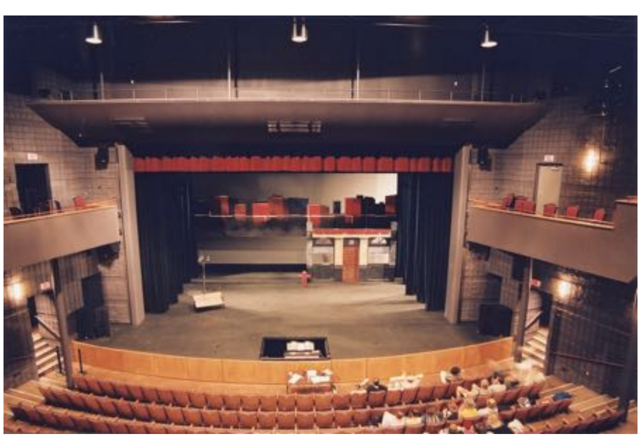
AERCOUSTICS
ENGINEERING LIMITED



LONGITUDINAL SECTION



ORCHESTRA & BALCONY PLANS



SHOWPLACE CENTRE
PETERBOROUGH, ONTARIO, CANADA

AERCOUSTICS
ENGINEERING LIMITED

ACOUSTICS CONSULTANT:	Aercoustics Engineering Limited
SOUND & COMMUNICATION:	Theatre Consulting Group
OWNER:	Showplace Performance Centre
ARCHITECT:	Lett/Smith Architects
THEATRE CONSULTANT:	Theatre Consulting Group
CONSTRUCTION COST:	1.75 Million CAD
COMPLETION DATE:	1996

The construction of the Showplace Performance Centre is a tribute to the people of Peterborough Ontario. Seldom has so little money been invested so wisely. With a budget of only 1.75 million CAD, an old cinema was transformed into a beautiful 626 seat professional theatre. The design was fraught with compromises, some of them acoustical, but the building has triumphed in the end.

The Peterborough Symphony had hoped to use the venue for a light schedule of six performances per year. For orchestral music the roof would have to be raised by at least 5 m (16'-5"), an option that was clearly not feasible. As an alternative, the proscenium was designed as a demountable component. Large panels are mounted in a steel frame. When the audience chamber needs to be acoustically coupled to the stage, as it would be during a symphonic presentation, the panels can be removed. There is no flytower above the stage.

The side walls are convex, fabricated from 2 layers of 16 mm gypsum board on studs on the existing (flat) masonry. The furthest seat from the stage is approximately 29 m, the same distance as the furthest seat in the 2000 seat Princess of Wales Theatre, which the design team had recently completed. In an effort to improve speech intelligibility in these seats, a tilted gypsum board reflector was installed in the ceiling just above the balcony. The same approach would be later employed by the design team at the Isabel Bader Theatre.

The most serious compromise involved the mechanical system. There is no hiding the fact that the room is noisier than one would prefer. With nowhere else to put the air-handling units, a scheme was developed to place them above the audience chamber. Large steel beams mounted on the side wall parapets span the width of the building. The roof top units are mounted on these. The units are properly silenced and vibration isolated. Unfortunately, a donation from a local roofing contractor failed to materialise. The additional mass intended to block airborne noise through the roof was never put in place. The result is a PNC 35 ambient noise level.

Despite all these compromises, the building has been well received in this community of 70,000. At the close of the opening night proceedings, Hal Jackman, the provincial Lieutenant Governor at the time, pointed out a microphone off to one side of the stage. Noting that it had not been used all night, he stated: "… this is how a theatre should work!"

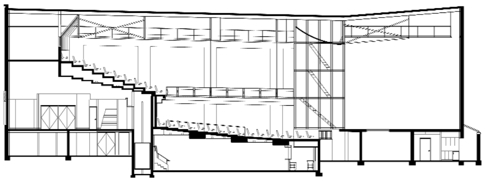
CRITICAL DATA

Seating Capacity	626
Volume	4,100 m^3
Reverberation Time	1.2 s
Noise Level	PNC 35
Proscenium Height	7.77 m
Proscenium Width	14.33 m

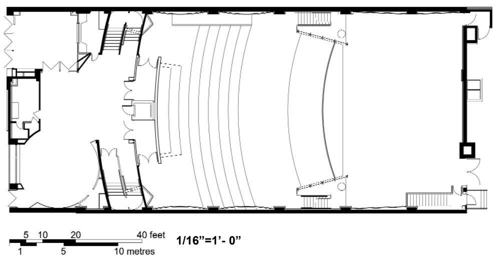
	OCTAVE BAND (Hz)				
	250	500	1000	2000	4000
D50 (%)	55	57	57	56	62
G (dB)	13	13	14	13	13
EDT (s)	1.2	1.1	1.0	1.0	0.9

SHOWPLACE CENTRE
PETERBOROUGH, ONTARIO, CANADA

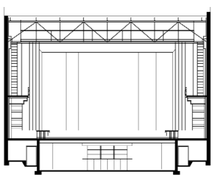
AERCOUSTICS
ENGINEERING LIMITED



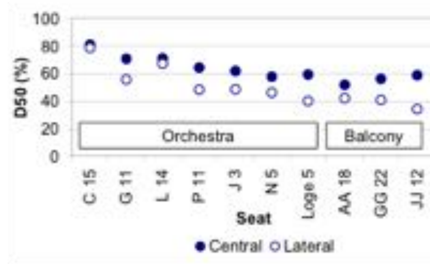
LONGITUDINAL SECTION



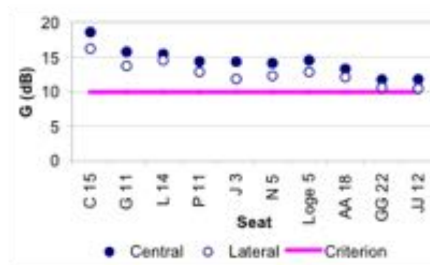
ORCHESTRA PLAN



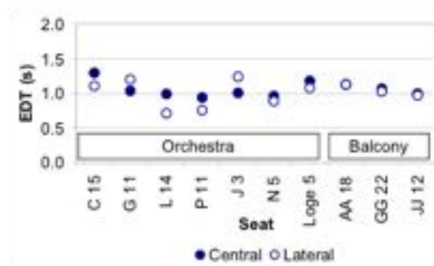
TRANSVERSE SECTION



50 ms DISTINCTNESS

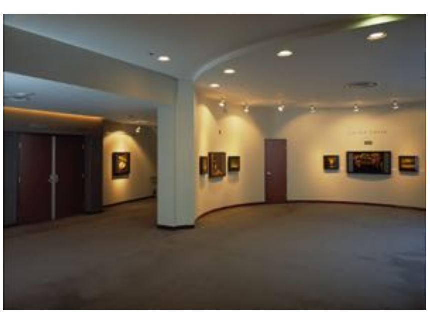


ACOUSTIC STRENGTH



EARLY DECAY TIME

1 kHz octave band data measured in the unoccupied room. Strength criterion based on HVAC ambient noise level.



DOFASCO CENTRE FOR THE ARTS
HAMILTON, ONTARIO, CANADA

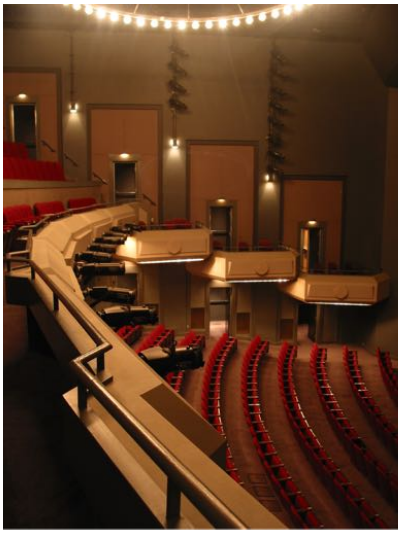
ACOUSTICS CONSULTANT:	Barman Swallow Associates
SOUND & COMMUNICATION:	Brian Arnott Associates/Novita
OWNER:	Theatre Aquarius
ARCHITECT:	Lett/Smith Architects
THEATRE CONSULTANT:	Brian Arnott Associates/Novita
MECHANICAL ENGINEER:	Crossey Engineering Limited
CONSTRUCTION COST:	10 Million CAD
COMPLETION DATE:	1991

The new home for Theatre Aquarius opened in September 1991. It marked the first of many collaborations between Canada's leading theatre architect, Peter Smith, and what was to become Aercoustics Engineering Limited. The building features the 750 seat Irving Zucker Theatre, shown here, a 150 seat performance/rehearsal studio, offices, lobbies and a complete set shop.

The building was the vision of the company's founding Artistic Director, the late Peter Mandia. Having spent years in a multi-purpose venue, Mandia was adamant that the acoustics of the new building would be designed for theatre.

The set shop, across the corridor from the side stage, is separated with two large acoustical doors. Quadratic residue diffusers were designed by acoustician John O'Keefe and fabricated in the new set shop just prior to the opening of the building. The diffusers are located on the back wall of the audience chamber and on the downstage wall of the large orchestra pit.

The walls of the theatre are concrete block with a 16 mm gypsum board finish nailed and laminated to the masonry. Ductwork has been left exposed to the volume of the house but is internally lined with 25 mm glass fibre. There is a short 3 m high ring of acoustic curtains around the top of the side and back walls. These are typically left in place for dramatic presentations but may be removed for musicals.



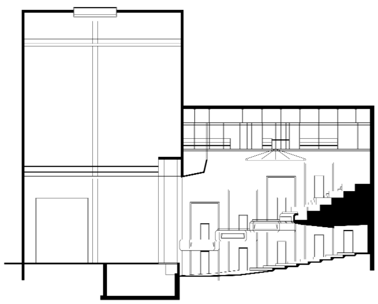
The building opened to excellent reviews. The theatre is characterised by its intimacy, clarity and good speech intelligibility. Nick Krewen of the Hamilton Spectator wrote "...the acoustics are impeccable." The building has since become a destination for building committees and design teams hoping to learn from its example.

CRITICAL DATA

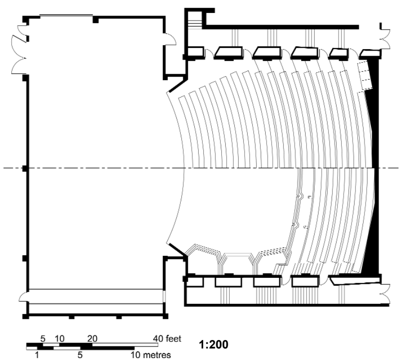
Seating Capacity	750
Volume	4,620 m^3
Reverberation Time	1.2 s
Noise Level	PNC 22
Proscenium Height	8.38 m
Proscenium Width	13.72 m

	OCTAVE BAND (Hz)				
	250	500	1000	2000	4000
D50 (%)	42	54	58	67	70
G (dB)	2.3	5.8	4.4	5.0	3.8
EDT (s)	1.3	1.2	1.2	1.0	0.8

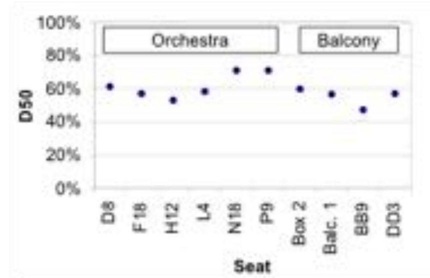
DOFASCO CENTRE FOR THE ARTS
HAMILTON, ONTARIO, CANADA



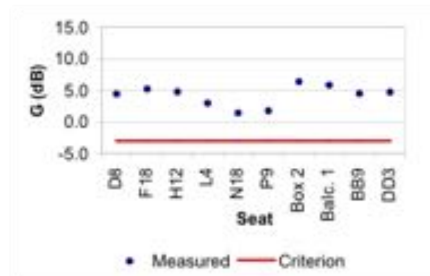
LONGITUDINAL SECTION



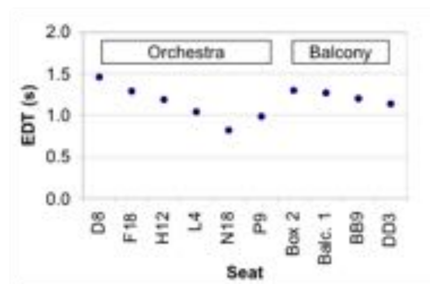
ORCHESTRA & BALCONY PLAN



50 ms DISTINCTNESS

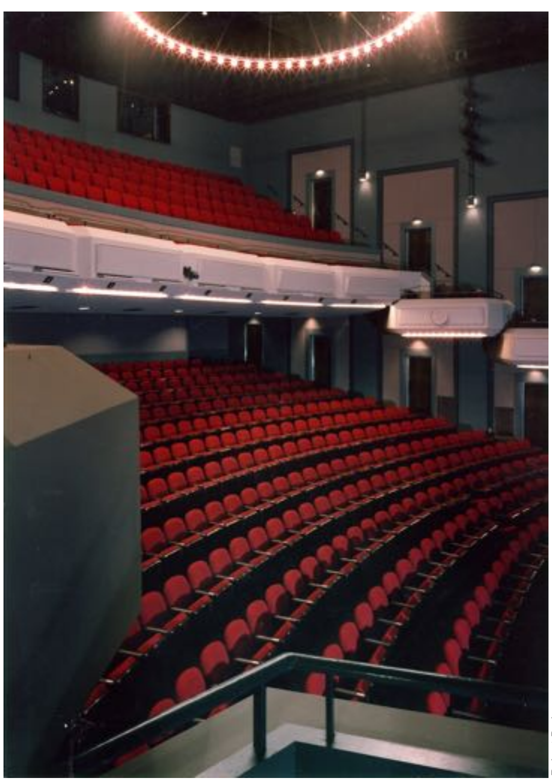


ACOUSTIC STRENGTH



EARLY DECAY TIME

1 kHz octave band data measured in the unoccupied room. Strength criterion based on HVAC ambient noise level.



Robert Burley

Robert Burley

VICTORIA HALL
PETROLIA, ONTARIO, CANADA

ACOUSTICS CONSULTANT:	Barman Swallow Associates
SOUND & COMMUNICATION:	Brian Arnott Associates/Novita
OWNER:	The City of Petrolia
ARCHITECT:	Quadrangle Architects/Philip Goldsmith
THEATRE CONSULTANT:	Brian Arnott Associates/Novita
MECHANICAL ENGINEER:	Crossey Engineering Limited
CONSTRUCTION COST:	6 Million CAD
COMPLETION DATE:	1992

Victoria Hall was a quintessential Ontario town hall. The traditional form took the shape of a town council chamber on the ground floor and a theatre above. These rooms, sometimes called "opera houses", were a source of civic pride. Located in Petrolia Ontario, the lovely Queen Anne style building housed municipal offices, the police station, a fire station, a jail and, of course, the theatre. In 1989, its centenary year, the interior of Victoria Hall was gutted by fire. Only the massive exterior walls were left standing.

The restoration brought a modern aesthetic to the interior whilst maintaining the heritage exterior. Acoustical improvements to the 450 seat theatre include a slightly convex wooden wall finish on the orchestra level, Quadratic Residue Diffusers along the back wall underneath the balcony, and the front edge of the balcony soffit which has tilted down to provide reflections to the back rows.

The original theatre included windows on the side walls that required expression on the exterior façade. Sealed wooden shutters in combination with custom windows were installed to control exterior noise. The council chamber, located directly below the theatre, is isolated with a floating gypsum board ceiling.

Robert Burley

One of the more difficult tasks on this very tight site was controlling Heating Ventilation and Air Conditioning (HVAC) noise. Mechanical equipment is housed in the nearby bell tower and in a small room above the control booth. Access to the latter is from a catwalk in the theatre! A combination careful equipment selection and diligent noise control work limited the HVAC noise to an acceptable level of PNC-20.

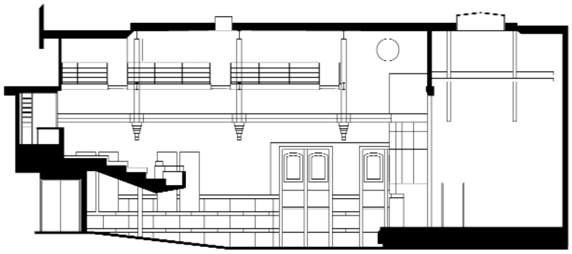
The restoration of this national historic site was completed in September 1992.

CRITICAL DATA

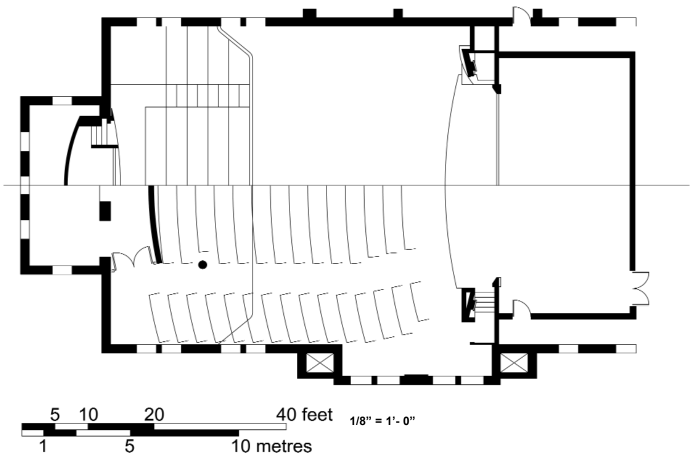
Seating Capacity	425
Volume	2,165 m^3
Reverberation Time	1.0 s
Noise Level	PNC 20
Proscenium Height	6.2 m
Proscenium Width	8.7 m

	OCTAVE BAND (Hz)				
	250	500	1000	2000	4000
D50 (%)	46	55	57	58	62
G (dB)	5.5	6.3	6.7	6.4	6.6
EDT (s)	1.1	0.9	0.9	0.7	0.5

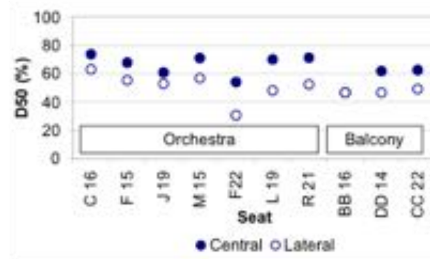
VICTORIA HALL
PETROLIA, ONTARIO, CANADA



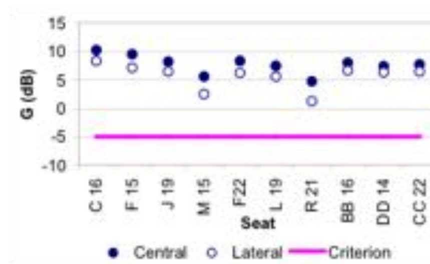
LONGITUDINAL SECTION



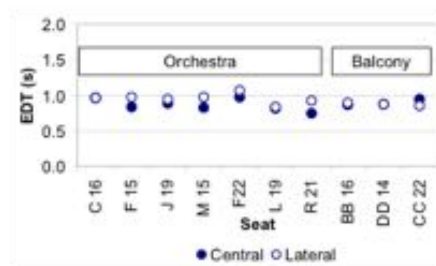
ORCHESTRA & BALCONY PLAN



50 ms DISTINCTNESS

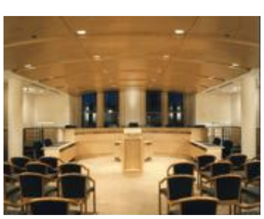


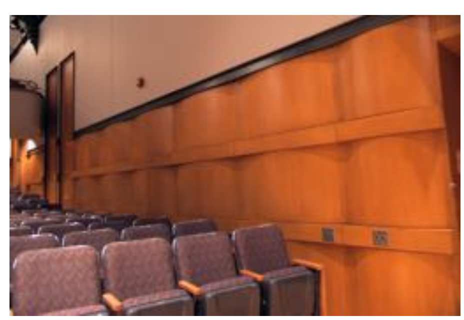
ACOUSTIC STRENGTH



EARLY DECAY TIME

1 kHz octave band data measured in the unoccupied room. Strength criterion based on HVAC ambient noise level.





YOUNG CENTRE FOR THE ARTS
TORONTO, ONTARIO, CANADA

AERCOUSTICS
ENGINEERING LIMITED

ACOUSTICS CONSULTANT:	Aercoustics Engineering Limited
SOUND & COMMUNICATION:	Engineering Harmonics
OWNER:	Soulpepper Theatre Company George Brown College
ARCHITECT:	Kuwabara Payne McKenna Blumberg Architects
THEATRE CONSULTANT:	Theatre Projects
MECHANICAL ENGINEER:	Crossey Engineering Limited
CONSTRUCTION COST:	12.4 Million CAD
COMPLETION DATE:	2005

The construction of the Young Centre for the Performing Arts in Toronto is a joint venture by the Soulpepper Theatre Company and George Brown College. The project is part of an effort to revitalize the historic Gooderman and Worts distillery district. Once the largest distillery in the British Empire, the site will soon house more than 100 shops, including art galleries, restaurants, a microbrewery, ateliers and 3 performance venues. The Young Centre will be the largest of these.

It will include three multi-purpose halls, five studios, and two classrooms, all shoe horned into two 19th century red brick tank houses. The facility is in a high-traffic urban environment, with an elevated highway and railroad nearby. Heritage and building envelope concerns precluded treatment of the existing 350 mm brick walls, either with paint or gypsum board. A survey of existing L1 and L10 levels on the site indicated that the brick could remain untreated and still provide sufficient isolation for a PNC-25 background noise level in the halls. Air handling systems have been designed with this in mind. Computational fluid dynamic simulation was used to minimize the size and amount of the ductwork whilst maintaining quiet airflow.

The large multi-purpose hall (Theatre A) distinguishes itself from the other spaces with a roof raised 3.7 m above the original building. It has a volume of 3070 m^3, seats 350, and is adaptable to thrust, proscenium, and arena configurations.

The fascia of all elevated seating areas in Theatre A have been angled to provide reinforcing reflections. At the ground level, the removable side fascia are angled upwards and direct reflections across the room and towards the seats at the rear of the room; at the balcony level, the side fascia direct reflections towards the rear seats and the rear fascia direct reflections back to the side wall seats. The rear wall surrounding the control booth window at the gallery level is treated with corrugated steel to provide diffusion and break up reflections from the reinforcement loudspeakers to the stage. Drapery at the gallery level allows limited adjustment of the reverberation time.

CRITICAL DATA (THEATRE A)

Seating Capacity	350
Volume	3,265 m^3
Reverberation Time	1.1 s
Noise Level	PNC 25
Proscenium Height	N/A
Proscenium Width	N/A

YOUNG CENTRE FOR THE ARTS
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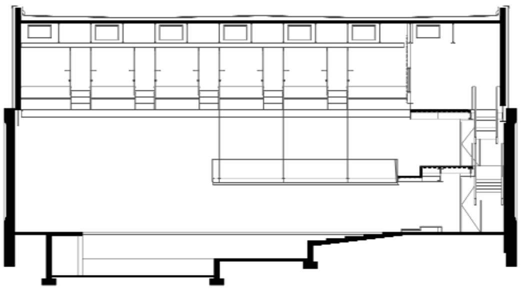
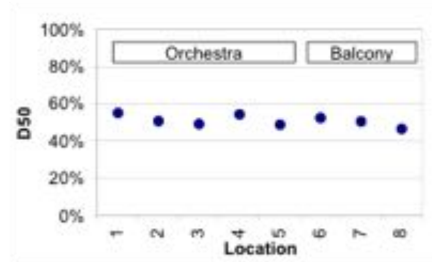
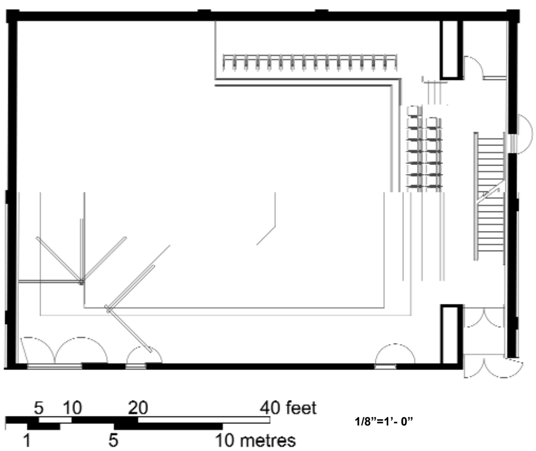


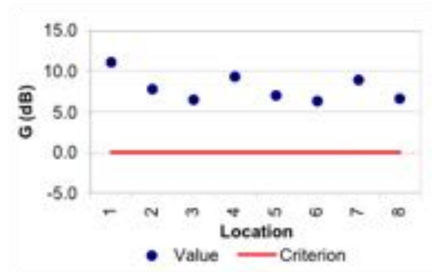
LONGITUDINAL SECTION



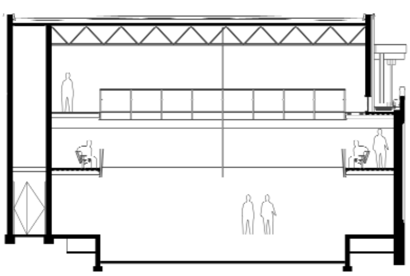
50 ms DISTINCTNESS



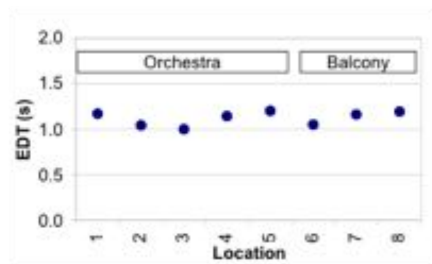
ORCHESTRA & BALCONY PLAN



ACOUSTIC STRENGTH



TRANSVERSE SECTION



EARLY DECAY TIME

Values predicted with CATT Acoustic Version 8.
Thrust stage configuration, curtains exposed.

Renderings courtesy of Kuwabara Payne McKenna Blumberg Architects