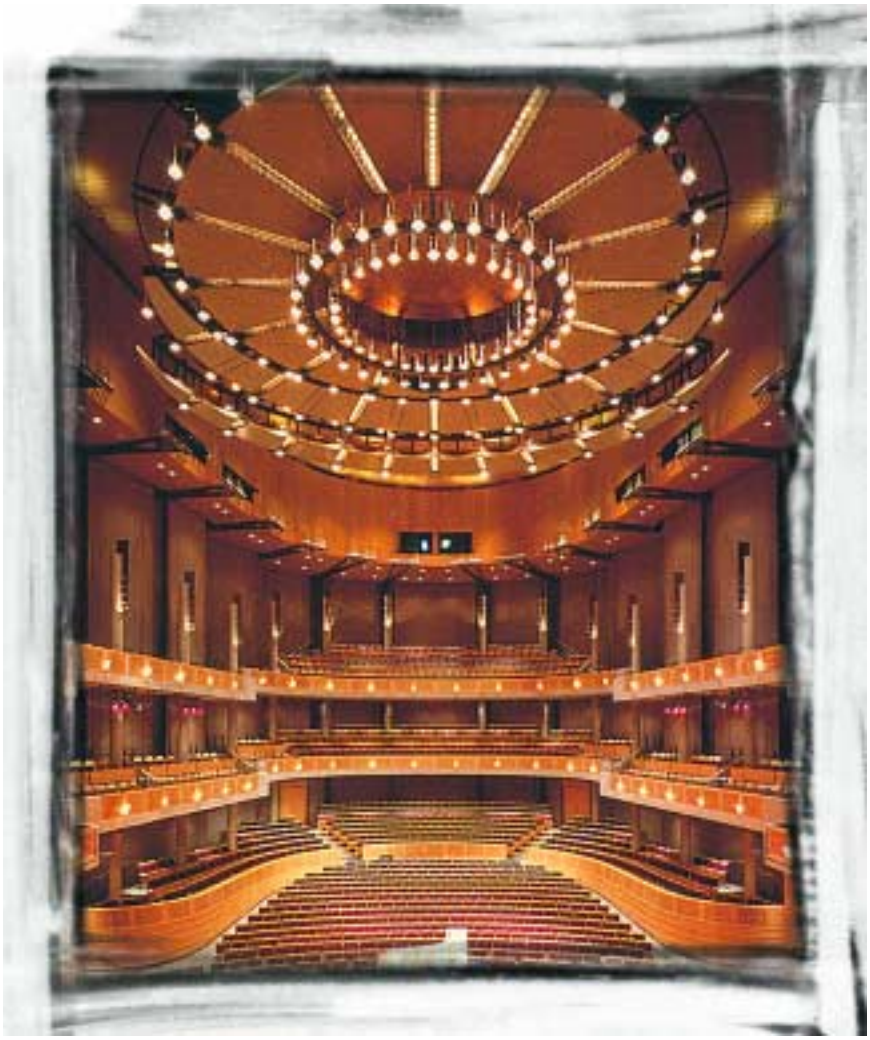

Steel In Harmony at UBC

The Chan Centre for the Performing Arts is the culmination of the "Arts Precinct" development at the University of British Columbia in Vancouver. Serving as a teaching facility, a ceremonial complex and a performance venue for the broader community, the Centre comprises a group of three linked facilities-the 1400-seat Chan Shun Concert Hall, the 298-seat BC Tel Studio Theatre and the 158-seat Royal Bank Cinema.

Integrated into an existing evergreen grove, the three facilities are linked by a two-story, curvilinear glass lobby designed to visually draw in the surrounding forest. Although joined in this way, each facility is given its own identity to express its unique function, and help visitors orient themselves within the Centre.

A number of unusual and complex uses of steel structure are incorporated in the Chan Centre. According to architect Bing Thom, of Bing Thom Architects, Inc. in Vancouver, the design of various elements of these steel structures required the close collaboration of structural consultant, acoustician, theatre consultant, architect and steel fabricator.

Concert Hall

Designed as an inspiring environment for the enjoyment of audience and artists alike, the Hall provides superb sound quality. To ensure this quality, the architects turned to Artec Consultants of New York. "One of their trademarks is the incorporation of adjustable acoustic devices," said Earle Briggs, senior staff member at Bing Thom Architects, Inc. "The main feature of the adjustable acoustics in the Hall is the acoustic canopy, adjustable in height for a variety of performances." Conceived as a chandelier, the canopy is designed to reflect sound back to the performers and the audience, while also providing performance and

house lighting. Another unique feature of acoustical design is the curved walls oriented in a reverse fan shape to provide even distribution of sound.

"We're really building a musical instrument and the audience sits right inside the reverberation chamber", said Bing Thom. "The moveable acoustic canopy is used to modulate the apparent size of the room." Weighing 27 metric tons, the canopy is supported by 22 steel cables, allowing the canopy to appear to float above the concert platform, and reinforcing the concept of the canopy as a chandelier – complete with 400 light bulbs that are both decorative and functional.

Structural engineer Kosta Marcakis of C.Y. Loh Associates Ltd., in Vancouver, said, "a three dimensional frame analysis model was used to calculate the range of cable forces at each suspension point. The model was analyzed under various loading conditions in order to determine the effect of unbalanced loading on both the canopy structure and the cables. An extensive system of structural steel framing was added between the steel roof trusses to support both the horizontal and vertical forces from the canopy suspension cables. For the canopy rigging system to operate safely, the weight of the canopy was balanced with a steel and concrete counterweight which rides in a shaft in the south wall of the Concert Hall."

"Fabrication of the acoustic canopy was a challenge," said Rob Third, of George Third & Son in Burnaby. An 18.5-m (61') ring with 16 spokes radiating out from a central hub, the canopy framework has three structural levels, plus two crescent-shaped extensions stepping out and down at one end. The main ring is 168-mm (6.72") diameter pipe and the spokes are 152 x 51 mm (6" x 2") HSS. All connections are welded. The canopy's large size required that it be in the building before the roof trusses were erected, so it was shipped to the site in segments and set in place on falsework, until the roof structure was erected.

Concrete was considered for the roof structure but rejected, said Kosta Marcakis. "The acoustical requirements of a box within a box was foremost in the minds of the design team. It was necessary to have two separate layers of concrete with a large air space between them for the roof and wall construction". Steel trusses with precast concrete panels slung between them, resting on modified lower chord truss members, were selected. The trusses are composed of W shape chords and HSS web members. Due to the geometry of the Hall, no two trusses are identical. The largest is 32-m (105.6') long, 3.2-m (10') deep and weighs 7.5 metric tons, according to Jack Peel, project manager for Canron Construction Corp. West, fabricator and erector of the trusses.

The resemblance of the Concert Hall to a musical instrument is reinforced by stainless steel cables, which support the lighting catwalk. Like strings of a violin, 22 groups of eight cables ascend from the perimeter columns to the ceiling. With their steel frets, the cables, surrounding wood surfaces and curving forms create the impression of being inside a musical instrument.

BC Tel Theatre

"The Studio Theatre is very different from the Concert Hall," said Bing Thom. "It's essentially a black box." A unique black box—all the seating is situated on twelve moveable towers, each 7.4-m (24.42') tall, weighing 5.4 metric tons and providing three levels of seating. Moving the towers is a breeze—they float on a 2.5 cm (1") cushion of compressed air forced under the towers by an air caster system developed by a division of Boeing Aerospace. "This element of flexibility is very exciting," said Michael Moon, Director of the Chan Centre. "The moveable towers allow for many different kinds of stage positions such as thrust stage, theatre-in-the-

round or an end stage."

Weight of the towers was a concern, said Kosta Marcakis, along with stability both while stationary and during a moving operation. Considering also the need to minimize floor depth to stay within the 2.3-m (7.59') floor to floor height permitted, structural steel was selected. Each of the four corner columns is a 168-mm diameter HSS, with the remainder of the frame consisting of welded built-up beams, W shapes, channels, angles and steel deck.

Since the seating towers, along with the acoustic canopy for the Concert Hall, were essential to the architectural concept, it was important to establish their approximate costs early in the design process, notes Bing Thom. Accordingly, the canopy and seating towers were contracted separately to George Third & Son, enabling the design team to draw on the expertise and experience of this long-established architectural steel fabricator. The remaining architectural and structural steel were tendered as part of the general contract.

Lobby and Canopy

Steel HSS columns with pairs of steel arms at two levels support a unique sloping glass wall in the main lobby and create an almost seamless connection to the forest setting beyond. At night the trees are lighted, adding to the attraction of the outdoor scene. The general impression of open area is further accentuated by the exposed customized steel joists, which support the lobby roof. Connecting the circular entry rotunda to the Concert Hall is a butterfly-shaped steel lobby canopy. The canopy structure cantilevers off both sides of the central 324-mm (13") diameter steel pipe, which spans the 8-m (26.4') between the two buildings. Custom designed tapered steel members function as the cantilever beams. The radically different curved surfaces that comprise the walls of the two buildings further complicate the design of this elegant canopy.

A Winning Combination

Cooperation among all parties involved in design and construction has created an outstanding Performing Arts Centre on the Pacific coast. In the words of Bing Thom, "the input of the steel industry, in particular, was crucial to the development of the more complex elements of the building, i.e. the Concert Hall acoustic canopy, the stainless steel cables and frets, and the Studio Theatre moveable towers."

The Chan Centre for the Performing Arts won the 1997 Steel Design Award from the CISC B.C. Region.

This article is reprinted from Advantage Steel, courtesy of the Canadian Institute of Steel Construction, Inc.

Project Team

Architect: Bing Thom Architects Inc., Vancouver

Structural Engineer: C.Y. Loh Associates Ltd., Vancouver

Owner: University of B.C., Vancouver