*Innovative Design and*
*Excellence in Architecture with Steel*

*National Winner*

# Lake Superior College

As part of the merger of the community and technical colleges in Minnesota, the state embarked on an ambitious plan to enlarge and modernize an existing facility in Duluth. The first phase included 69,900 sq. ft. of new space and 11,220 sq. ft. renovation.

The existing facility is located on a steeply sloped site overlooking Lake Superior. Years of uncoordinated renovations and additions had resulted in circuitous and disorienting circulation patterns. In addition, the building lacked a clearly identified main entrance from the primary parking

area. "We knew that the addition and renovation had to provide a sense of organization to the facility," explained Gary Mahaffey, FAIA, a principal with The Leonard Parker Associates, Architects, Inc., in Minneapolis.

The heart of the $10.8 million first phase is a two-story high concourse connecting the existing space to the new addition. Remarkably, the space actually begins outside the building with an anodized aluminum-clad wall. This two-story-high serpentine wall picks up the shape of an

*A sinuous aluminum wall below is matched by a curved line of trusses above. Photography by George Heinrich*

*One of the keys to the excitement in this project was the visual continuation of the main entry road into the building through the design of an undulating anadozed aluminum-clad wall.*

approaching roadway and continues its twists and turns into the building. "It's a manifestation of natural forces, an intrusion of nature into the building," explained Charles Orten, project architect with The Leonard Parker Associates. In addition to creating visual interest, the wall leads to a clearly delineated main entrance.

The space through the main entrance is both organizationally and stylistically brilliant. Organizationally, the two-story-high space provides ground floor access to all of the previously disconnected wings of the existing structure and access to the new addition. Stylistically, the space is marvelous to see. The sinuous curves of the exterior wall are continued and further accented by a curving steel trusses on the ceiling. "The steel truss geometry is a function of the serpentine wall geometry below," explained Orten. Each of the 35 separate truss shapes, located 9'-4" on center, spans the 32' between the pipe columns on the north and south walls of the concourse. The ridge and lower chord of the system follow the curve of the wall below. A constant roof pitch of 22.5 degrees is maintained as is the vertical distance of the eave and an undulating ridge and north eave. Up lights illuminate the warm wood roof deck, the bowed shape of which is reminiscent of the wood hulls of sailing ships on the nearby Great Lake.

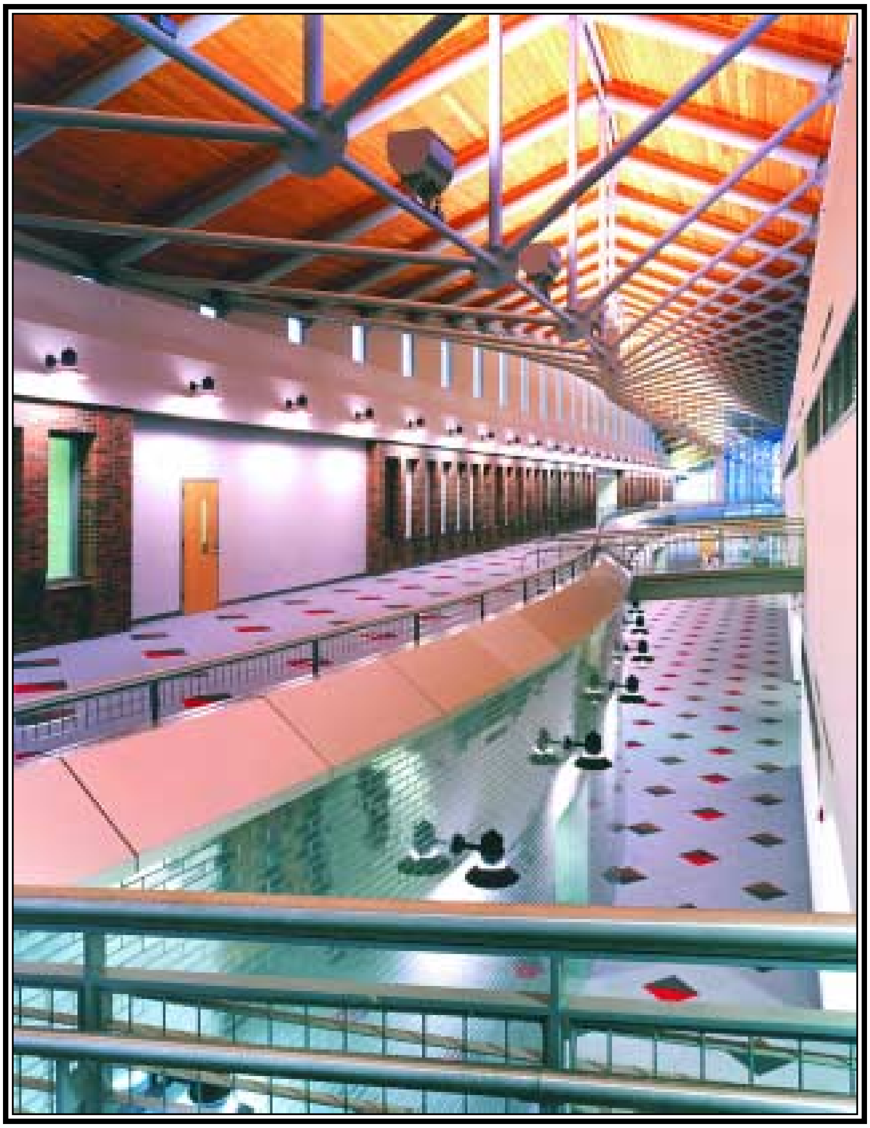
"Each truss is different dimensionally," explained John Meyer, P.E., project structural engineer with Meyer Borgman Johnson in Minneapolis. "The truss system is self-supporting for wind action. The trusses sit below the roof of the new structure and are supported on both the old and new structures."

Steel tubes were used for torsional stiffness. "We used two lines of tube to transfer torsion to the steel columns," Meyer added. "The architect layed out the curvature and elevation and we mutually worked on the types of members and connection plates, and on how many web members would be allowed." The round truss members are joined by round, ½"-thick, steel gusset plates. STAAD-III, as well as an older, no-longer-available program, PFrame, were used for the structural design.

Subtle references to ships also are recalled in the sloping, gang-plank-like bridges spanning bwetween the serpentine wall and the new addition. Two 12"-deep steel channels support each bridge and the protective steel grid of the guard rail.

In addition to the main concourse, the new construction included a two-story structure housing additional classroom space. The ground floor of the addition is concrete slab on grade, while the walls of the first story are reinforced concrete. Steel columns frame the second story and the roof consists of structural steel girders and steel joists.

Another interesting architectural feature is a white-clad aluminum tower housing the main stairwell for the new addition. The stand-alone welded steel frame is almost 70' high, with the top used to conceal mechanical equipment. The structure is a braced frame with a combination of Virendeel and diagonal bracing, according to Meyer. The four corners of the square tower consist of 35" square tubes while the bracing is primarily 16" square tubes with some W16, W18 and W21 beams to handle lateral buckling.



## Project Team

**Project:** Lake Superior College, Duluth, MN

**Architect:** The Leonard Parker Associates, Architects, Inc., Minneapolis

**Owner:** Minnesota State Colleges and Universities

**Structural Engineer:** Meyer Borgman Johnson, Minneapolis

**General Contractor:** General Contractor: Max Gray Construction, Hibbing, MN

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# The Discovery Museum Entrance Hall

As the first step in a phased expansion, the Discovery Museum in Bridgeport, CT, added a new main entrance both to enliven a dated, 30-year-old building and to reflect the center's mission.

"The Children's Museum has an emphasis on both art and science," explained Lawrence A. Chan, AIA, a principal with Chan Krieger & Associates in Cambridge, MA. "It features exhibits on fine arts as well as interactive science exhibits. As such, we wanted the architecture to be supportive of the mission of the museum."

The 5,670-sq.-ft. entrance hall consists of a new entrance and arrival court, a multi-level lobby to receive and orient visitors, a central public stair, an exhibit gallery, a classroom, and a complete renovation and upgrade of the existing mechanical and fire protection system. Construction cost on the project was $925,000, with the mechanical system adding an additional $395,000.

The most dramatic portion of the new addition is the main entrance and stair, which is housed in a steel and glass block box. "We wanted to use the material as a teaching element," Chan explained. "We chose the material and color palette carefully so that as you walk up the stairs, the light changes and it becomes an interactive experience." The choice of colors for the rest of the addition, which con-

sists of glazed brick, also was carefully considered to bring life to the existing structure. The architecture is designed to evoke a sense of wonder about the place—indeed about architecture itself—as an important exemplar of the union of art and science. The design help to provoke the curiosity that young people bring to learning.

Design elements include: articulation of the structure; expressing opaque and transparent geometric volumes;

*Inside and out, during the day and at night, the new main entrance hall creates an interactive space to be explored. Photography by Peter Vanderwarker*

### Juror's Comments:

*The detailing and composition of materials is meticulously handled on both the exterior and interior of the structure. This building speaks volumes to children with delightful chapters on color, movement, scale, proportion and, ultimately, architecture itself.*

abstracting the patterns of a polychromatic palette; layering and refracting translucent surfaces; and filtering and manipulating the selective use of natural light—its radiance, transmittance, reflection and shadow.

As with the glass block, the use of exposed steel was designed as a learning experience. "We wanted to show that it wasn't just a stair or a room, but also a structure. We wanted to show the beams connecting to the columns and how the structure is supported."

Early in the design phase, it was suggested that the exterior steel be clad for weather protection and insulation. "But cladding looked clunky. Also, if we had clad the exterior, there would be no relationship between the inside and outside if one side was exposed and the other covered."

The inside of the new lobby consists of glass, exposed steel and terrazzo floor tile and birch plywood wall cladding. "The pattern and color of the tile picks up and plays off the pattern of the glass and steel," Chan explained. "We paid a lot of attention to details. Event the spacing of the stiffeners in the columns was carefully considered."

### Project Team

**Project:** The Discovery Museum Entrance Hall, Bridgeport, CT

**Architect:** Chan Krieger & Associates, Cambridge, MA

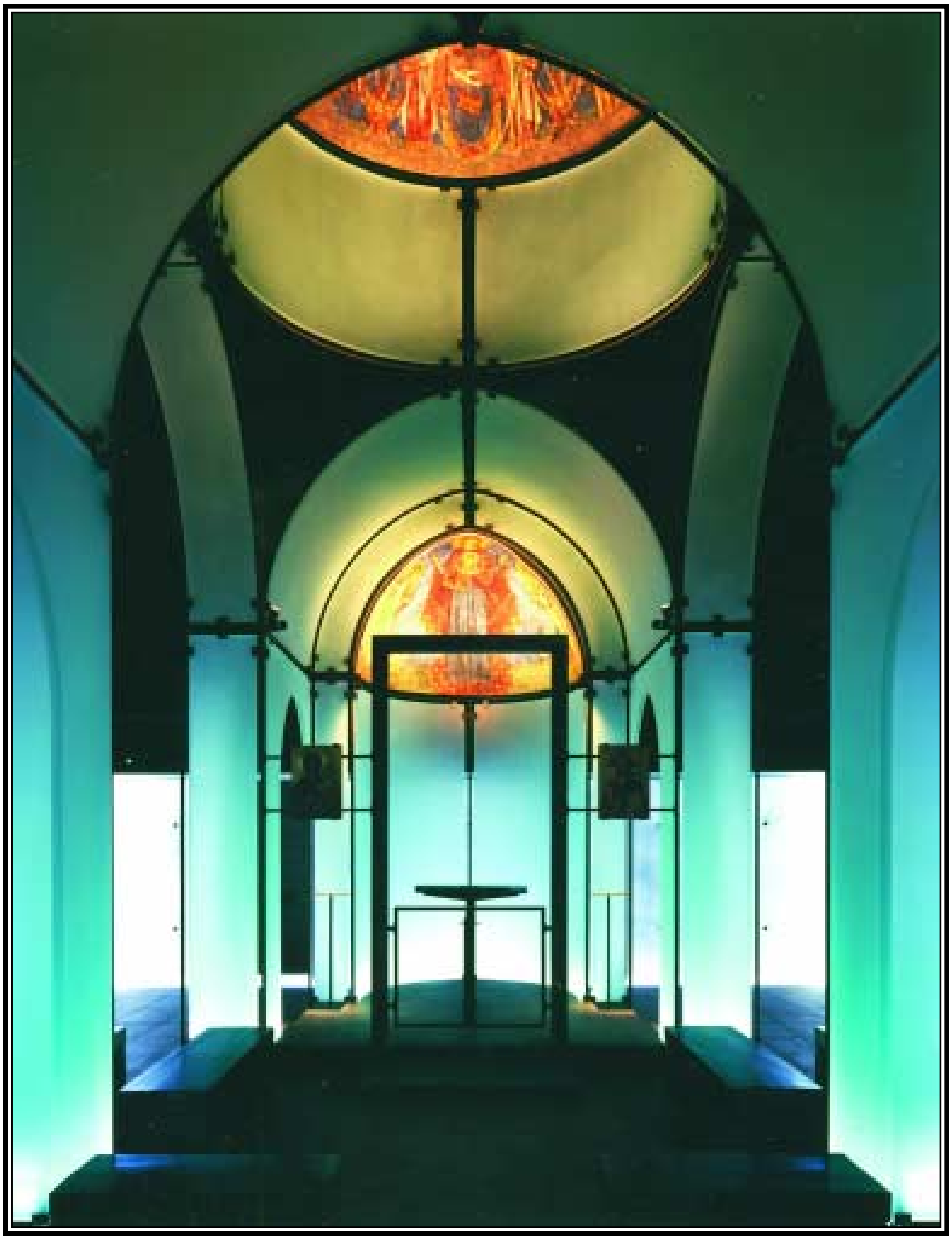
**Owner:** The Discovery Museum

**Structural Engineer:** Kasper Associates, Inc., Bridgeport, CT

**AISC Member Structural Steel Fabricator:** Post Road Iron Works, Inc., Greenwich, CT

**Construction Manager:** Philip Helms, P.E., Boston

**General Contractor:** Shankle Construction, Trumbull, CT



The chapel is contained within a steel shell, which in turn is contained within a concrete box. As a whole, the design represents a metaphoric reliquary box. Photo right and opposite top by Paul Warchol Photography. Photo opposite bottom by Jock Pottle/ESTO

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# Byzantine Fresco Chapel Museum

When the Byzantine Fresco Foundation was approached about purchasing two 13th century artworks, they were suspicious. Indeed, it turned out that the pieces were stolen from a chapel in Cypress. After contacting the rightful owner—The Church of Cypress— the foundation made arrangements to "ransom" the pieces. Since the original chapel is in the Turkish-controlled part of Cypress, the church and Cypriot government gave approval to the foundation to restore and display the pieces in Houston on a long-term loan arrangement.

The question was, however, in what type of structure to display these important historic and religious artifacts. An early design by one architect called for creating a larger-scale replica of the original chapel. However, that design was rejected since it was felt by the foundation that the replica architecture would overwhelm the authentic artworks.

Francois deMenil, a New York-based architect was familiar with the project due to his family's involvement with the foundation and offered his design services. His innovative solution was to create an ephemeral Byzantine-inspired structure to hold the frescoes, enclose that structure in a black box and further enclose that room inside a larger building.

"The exterior of the building is a mediating box that handles the transposition from the new city to the old artwork," deMenil explained. Though basically a rectangle in plan, the concrete walls do reflect the shape of the chapel within. A wonderful architectural touch is the exposed steel roof beams, which turn downward prior to reaching the perimeter walls. "It's an indicator that another structure is contained within the outside building."

Indeed, a second, plate steel box exists inside. A skylight spans the space between the outside and inside

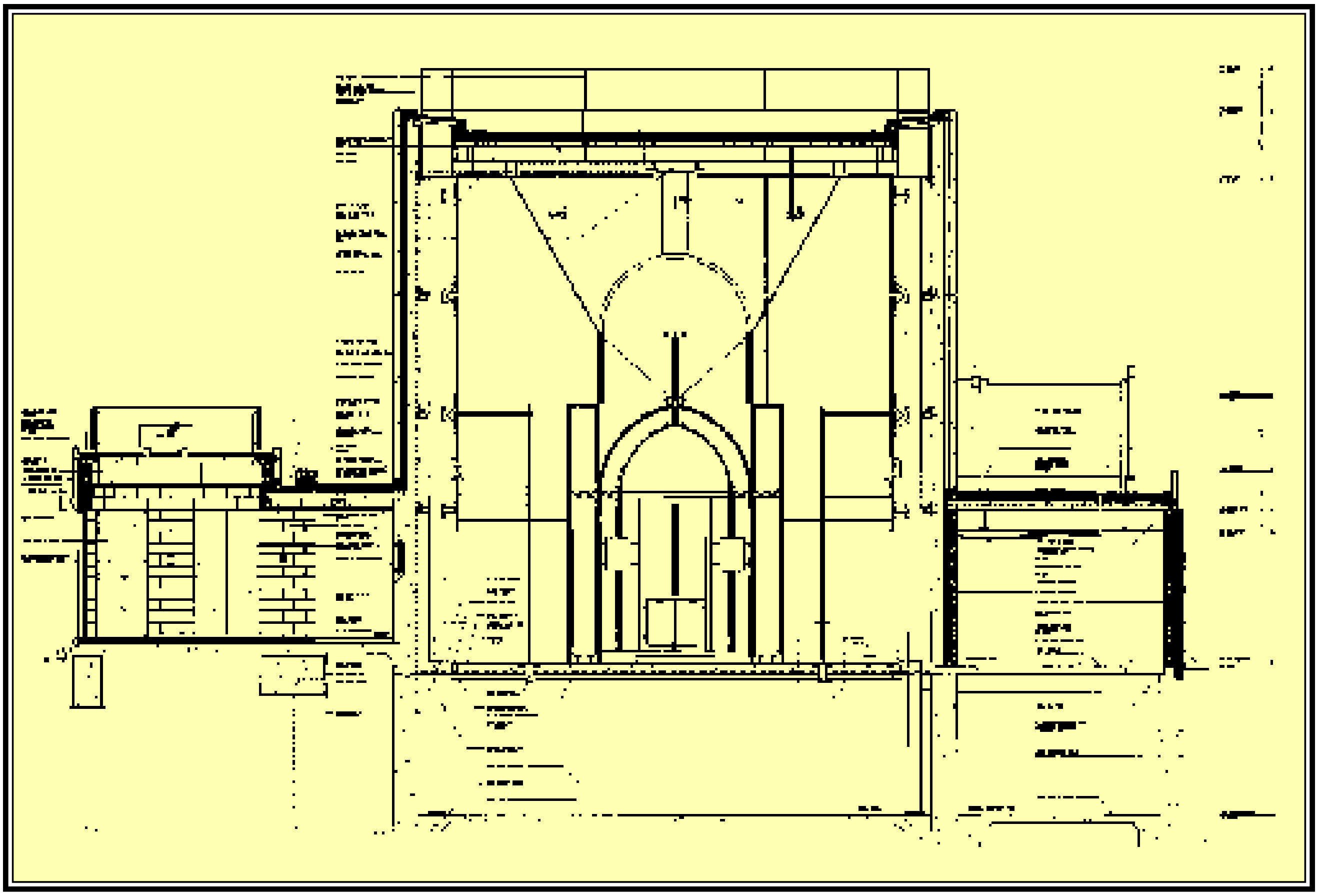

*Photo by Paul Warchol Photography*

buildings, bringing daylight in to "dematerialize" the concrete shell. Finally, inside the steel room is the Greek Orthodox chapel itself. While the shape is clearly reminiscent of Byzantine chapels, its use of materials is like no other. The walls are opaque glass supported on steel rod and pipe.

"There's a progression of material from rough to opaque to ephemeral, from rubble stone on the outside, to concrete, to steel to glass. It's appropriate for a journey from the profane to the sacred," deMenil explained. The transposition of the relics to a contemporary site is accomplished through a metaphoric reliquary box: a steel liner embedded in a mediating concrete shell. A reliquary box derives from the tradition of housing sacred objects in small casket-like cases, sometimes one within another. The dislocation/relocation of the sacred works is addressed through an inversion of material presence. The ethereal soul is solidified and made opaque in the restored frescoes.

The steel rod and pipe were critical to the design, according to deMenil. "There is a connective tissue required to connect the dome element to the apse. We needed a material with a certain amount of presence, but also one that would not be overpowering." Also, the black-painted steel marvelously reflected the black space around the chapel.

The rod and pipe are welded together and steel "shoes" hold the glass in place.

The structural steel elements of the surrounding structure are integral to the building's concept and design. Exposed roof beams derive their geometry from the structure of the glass and steel chapel within. They are carried by exposed interior pipe columns that brace the exterior concrete walls and support the plate steel reliquary box.

## Project Team

**Project:** Byzantine Fresco Chapel Museum, Houston

**Architect:** Francois deMenil, Architect, PC, New York City

**Owner:** Byzantine Fresco Foundation, Houston

**Structural Engineer:** Ove Arup and Partners, New York City

**Façade Engineer:** ARUP Façade Engineering, London

**Architectural Metal Conservator:** Robert Pringle, New York City

**Glass Consultant:** Carpenter Norris Consulting, New York City

**Architectural Lighting:** Fisher Marantz Renfro Stone, New York City

**General Contractor:** W.S. Bellows Construction Corp., Houston

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# City of Tempe Police Substation

As part of the movement towards community-based policing, a new 28,000-sq.-ft. police substation in Tempe, AZ, was designed to encourage public interaction with police personnel. The challenge, of course, was to also create a functional and secure facility.

### *Juror's Comments:*

*A parade of playful forms in the desert sun, welcoming the public to a place they'd rather not go. The simple, elegant counterpoise of cantilevered trellis expresses the lightness and strength of structural steel. The detailing and integration of the structural steel details are handled in a subtle manner, which creates an interesting series of compositions.*

*The low-slung Tempe Police Substation is designed to welcome the public. Photography by Timothy Hursley*

The architect's response to this complex program was a low-rise structure with three separate, yet interrelated areas: public; secured patrol; and training. The center and symbolic heart of the building is the community room, with the rest of the functions spiraling out from that central point. "The main building is concentrically wrapped around the community room," explained John F. Kane, , AIA, with Architekton in Tempe.

Since land is relatively inexpensive, a low-rise, spread out design was most cost effective for the multi-use facility, which includes a shooting range, patrol functions, administrative space and a community room. While the building itself is masonry and concrete block, the roof structure is steel, as are the window lintels and some exposed architectural steel elements-most notably an impressive walkway overhang.

"The idea behind the walkway is to provide a counterpoint to the heavy massing of the building," Kane said. Steel was chosen for the walkway both for its airy appearance and to pick up the aesthetics of the window lintels.

A curving, daylight lit circulation

spine facilitates the relationship of the different function areas within the structure. Topping the circulation is a Kalwall ceiling, which is separated from the masonry structural components with expansion joints. Exposed steel lintels, utility bridges and soffit frames provide detail to the otherwise plain walls. Curving steel pipe is used to define and celebrate key nodes within the project and to add scale to the volumes in which they exist. "We used steel in the details as a sculptural, space planning element," Kane explained. Typically the lintels are W12 beams, some of which are curved in plan.

The roof structure is a combination of rolled beams and open web joists with a metal deck roof. In addition, there are some interior pipe columns to support loads in some large open areas, according to Les Selberg, P.E., of Drotter/Priniski & Associates in Phoenix.

## Project Team

**Project:** City of Tempe Police Substation

**Architect:** Architekton, Tempe, AZ

**Owner:** City of Tempe

**Structural Engineer:** Drotter/Priniski & Associates, Phoenix

**General Contractor:** Sun Eagle Corporation, Chandler, AZ

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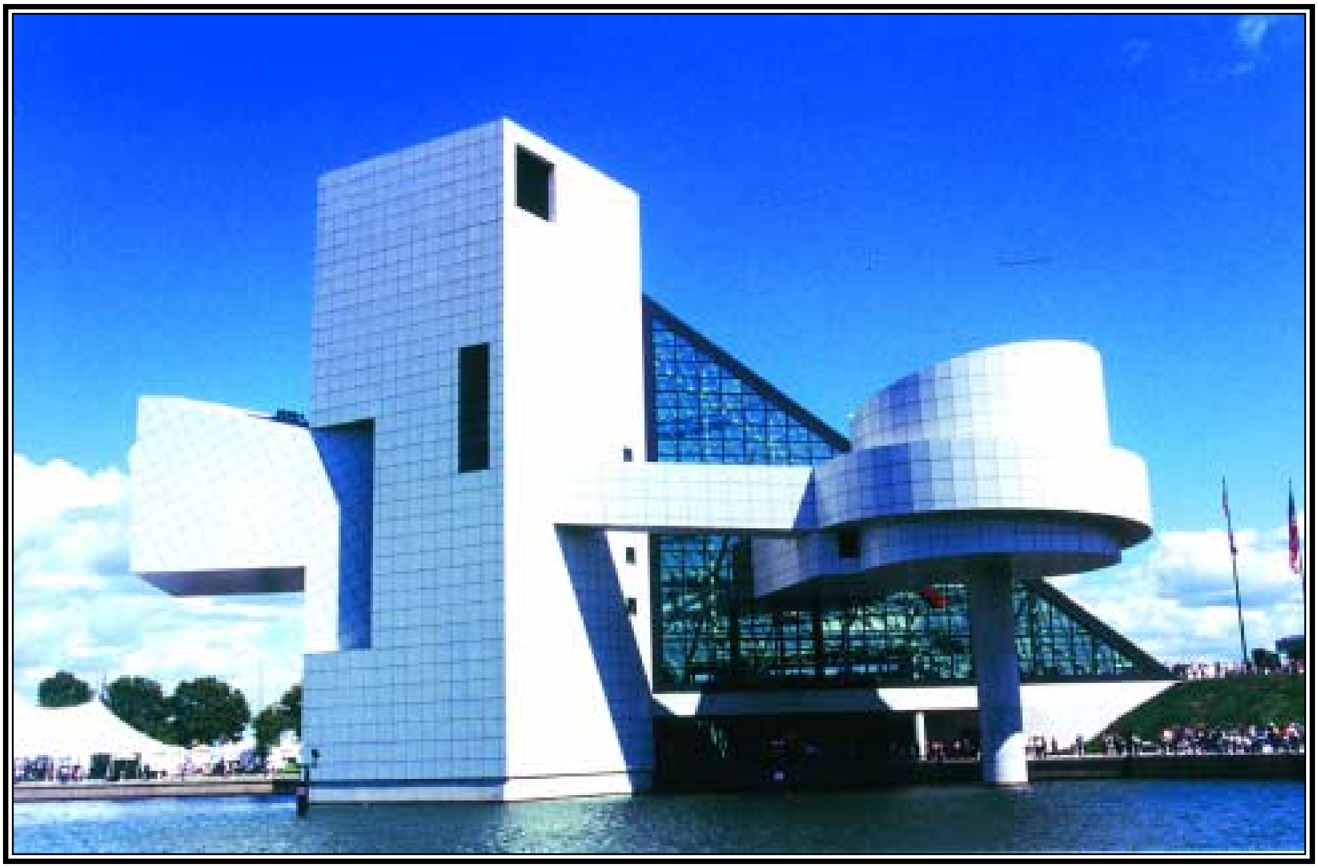
# Rock and Roll Hall of Fame

The Rock & Roll Hall of Fame and Museum has been designed to express the dynamic music it commemorates and to serve as an emblem of the city that introduced the term "rock and roll" in the mid-1950s. The 143,000-sq.-ft. building provides a center of entertainment and learning while revitalizing the city's economy: constructed at



a cost of $92 million, the museum is expected to generate more than $70 million in tourist revenue annually.

Activities within the Hall of Fame are visible through its transparent tetrahedral lobby. The building invites participation as it celebrates urban life and contemporary culture. In plan and elevation, the design juxtaposes simple geometric forms to combine diverse functions within a unified whole. Symmetrical and asymmetrical masses are balanced in a contrapuntal rhythm expressive of rock and roll and, like an explosive musical chord, the building's sculptural components reverberate out from center.

The multi-level design is threaded internally by crisscrossing stairs, escalators and bridges-a system that insures flexible circulation while animating the building by the festive and continuous flow of its visitors. The building rises from a subgrade restaurant to a ground level lobby. From there the visitor proceeds to the various media spaces, a theater-in-the-round and ultimately, to the tower that houses exhibition halls for artifacts and memorabilia. At the head of a ceremonial flight of stairs is the Hall of Fame itself-a contemplative skylit chamber that comprises the literal and symbolic apex of the entire design. A rock and roll archives, to be executed as part of the complex, will

*The fabulous array of shapes and images presented in the design of the Rock and Roll Hall of Fame creates a suitable home for its subject. Finished photography by Timothy Hursley*

### *Juror's Comments:*

*A wonderful composition of geometric volumes and shapes, as well as solid and transparent planes of materials. This composition results in a very recognizable building structure.  Exuberant forms, clashing geometry, all resolved with a three bar coda of a pyramid.*

distinguish the Hall of Fame as a comprehensive center for the study and enjoyment of modern music.

The structure is reinforced concrete to the lower level, and structural steel with concrete slabs on metal deck above the lower level. There are exposed, painted steel pipe columns and bow trusses at the sloped and vertically glazed main entrance/circulation space, and painted steel tube curtain wall supports at the glazed walls.

*(This project also won an AISC Engineering Award of Excellence. For more information on this project, see the March 1997 issue of MSC.)*

## Project Team

**Project:** Rock and Roll Hall of Frame and Museum, Inc., Cleveland

**Architect:** Pei Cobb Freed & Partners, New York City

**Associate Architect:** Robert P. Madison International, Inc., Cleveland

**Owner:** Rock & Roll hall of Fame and Museum, Inc.

**Structural Engineer:** Leslie E. Robertson Associates, New York City

**General Contractor:** Turner Construction Co., Cleveland

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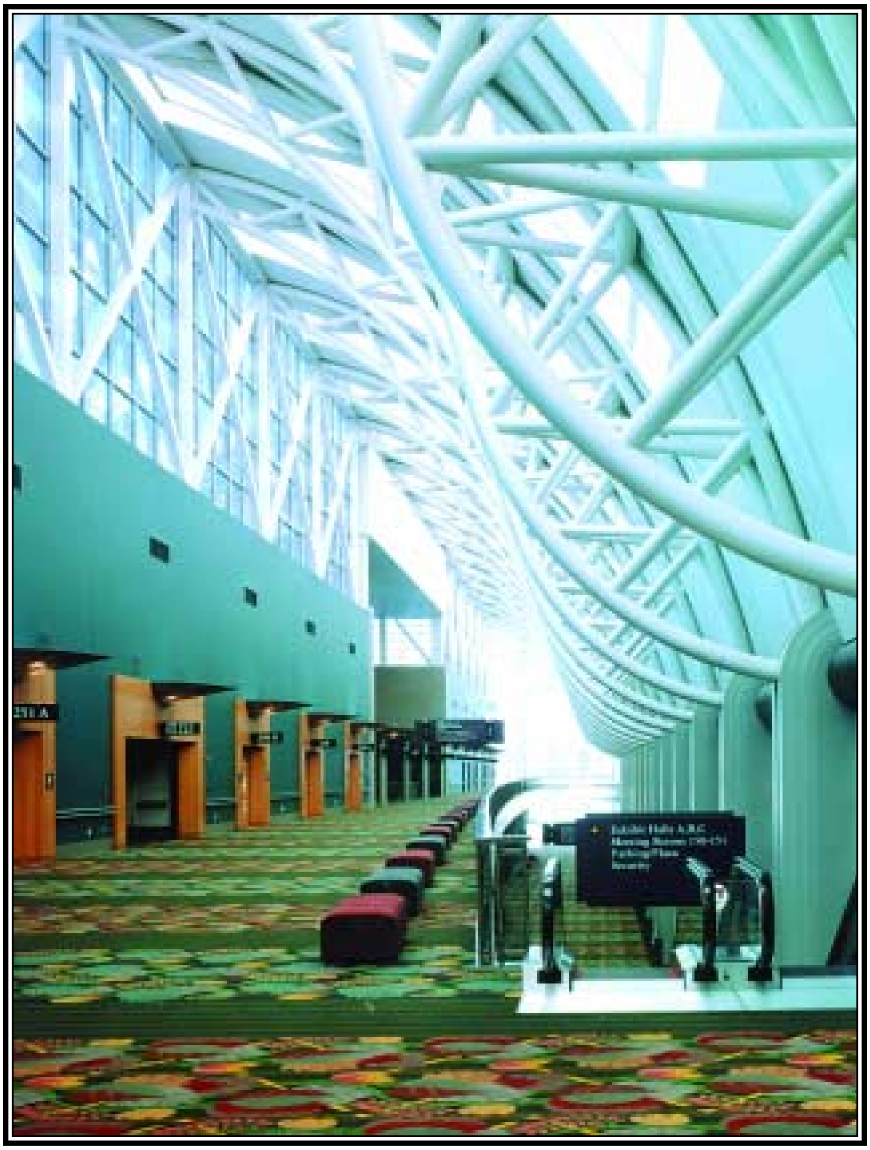
# Salt Palace Convention Center

While not previously well known as a convention center, the opening of the new Salt Palace should skyrocket the city to the forefront of many meeting planners minds. Located in a prominent downtown location across from the Mormon Temple and adjacent to the existing Arts Center, the dramatic new center features a 270'x450' exhibit hall, 36,000-sq.-ft. ballroom, and 54,000-sq.-ft. of meeting rooms.

*The 110'-high entry tower clearly designates the new convention center's main entrance.*



*The main concourse features "banana" trusses on one side and "snowflake" X-bracing on the other.*

## Project Team

**Project:** Salt Palace Convention Center

**Architect:** Thompson, Ventulett, Stainback & Associates, Atlanta

**Associate Architect:** Gillies, Stransky, Brems, Smith Architects, Salt Lake City

**Owner:** Salt Lake County Commissioners Office

**Structural Engineer:** Reaveley Engineers & Associates, Inc., Salt Lake City

**AISC Member Structural Steel Fabricator:** SME Industries, Inc., Salt Lake City

**General Contractor:** Hughes Hunt, A Joint Venture, Phoenix

Though the functional elements of the Salt Palace are largely hidden behind windowless walls, the public areas are open and inviting-and truly visible. Indeed, the dramatic main entrance-a 110' high tower-is visible from miles around and serves as a beacon identifying the project to conventioneers in nearby hotels. "The tower is a symbol of the building," explained H. Preston Crum, AIA, senior principal with Thompson, Ventulett, Stainback & Associates, the project's Atlanta-based architects.

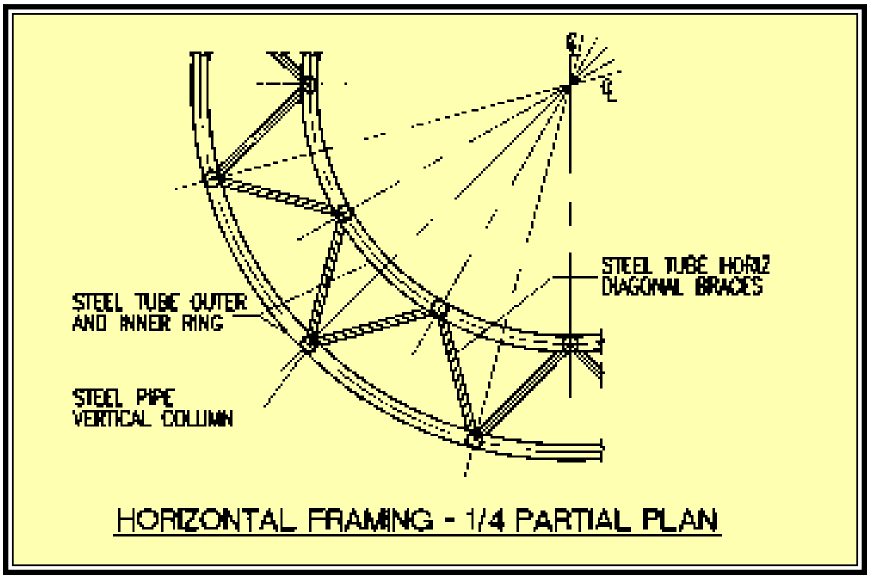
The initial design of the convention center did not feature the tower and instead had a horizontal entry largely integrated into the design of the neighboring Arts Center. "The client felt it wasn't dramatic enough, though," Crum said. The 48'-diameter tower features a series of exposed arching steel members that set the tone for the highly visible steelwork on the inside of the center. "We call it the 'gull' tower because the steel members are reminiscent of seagulls in flight," Crum explained. Seagulls are an important image for Salt Lake City and its large Mormon population. In addition, the top and bottom of the tower are designed in a stylized "beehive" motif to reflect Utah's state nickname.

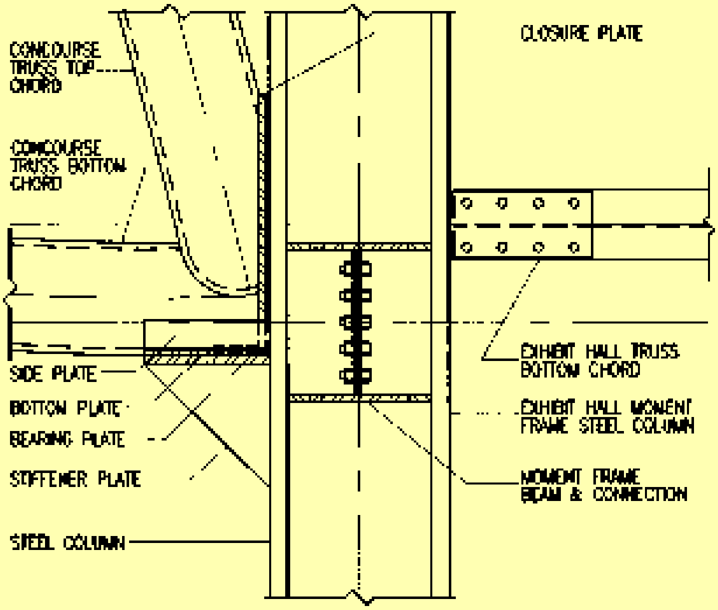
The use of exposed steel continues throughout the public circulation areas. Most dramatic is the use of "banana" trusses in the grand concourse to create an exciting and unforgettable 600'-long ceiling. "The nature of buildings such as this is that there is not a lot of windows in the functional areas," Crum said. "We wanted to flood the circulation areas with natural light and we wanted to take advantage of the light on the exposed structural members." The 70'-long, 13-ton steel pipe trusses have an S-shaped bottom chord that narrows as it rises, explained Ronald J. Reaveley, P.E., president of Reaveley Engineers & Associates, Inc. While not the most efficient structural shape, its design instead reflects its architectural purpose. "Architecture is about the play of light on form, so we wanted to provide some interesting form," Crum stated.

Similarly, the main lobby features large tree columns, also made up of round hollow structural sections, that emphasizes the height and drama of the space. "The lobby is flooded with natural light to emphasize the soaring quality of the space," Crum explained.

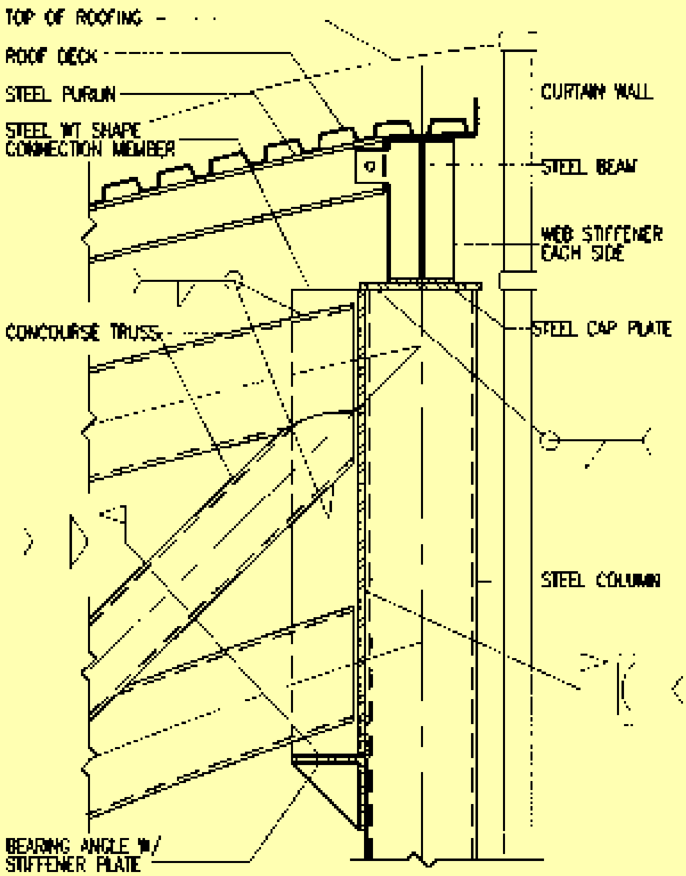
While the dramatic steel members make the space memorable, it also made the engineering more difficult. Complex 3D structural computer analysis was required to model and design the curving steel pipe frames and trusses, Reaveley explained. These steel frames and trusses must support snow and wind loads required for the Salt Lake Valley as well as UBC Seismic Zone 3 lateral loads.

*The tree columns create an interesting interplay between light and form. Also, note the "snowfllake" design on the doors, which is similar to the design created by the bracing on the window walls.*






BOTTOM OF TRUSS - CONNECTION DETAIL




TOP OF TRUSS - CONNECTION DETAIL

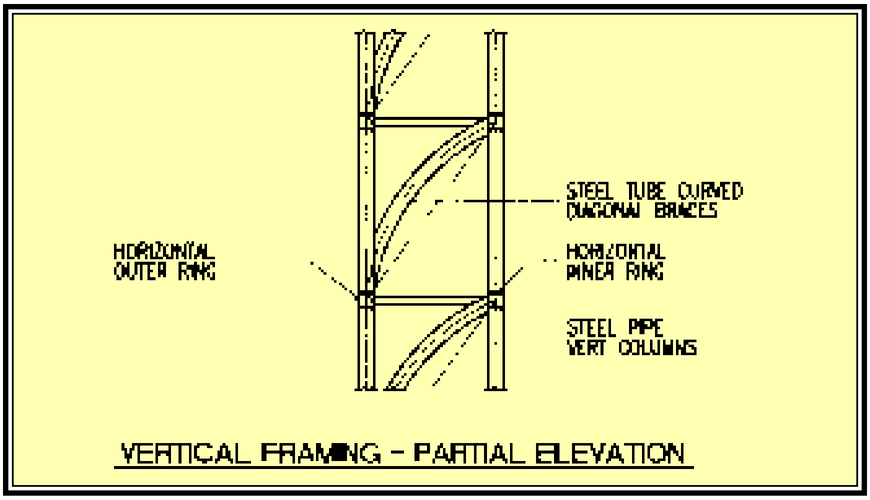
Visual imagery abounds. For example, X-bracing carefully detailed into a “snowflake” design interrupts the large expanses of glass. That same image is picked up throughout the center in such areas as doors, ballroom walls and air conditioning vents.

## *Juror’s Comments:*

*A celebration of steel to create both form and space. Highly imaginative use of structural steel as both functional support as well as intricate decoration. It’s exciting and graceful with many ideas to hold your attention.*

The Exhibit Hall presented its own set of unique challenges. Provisions for future expansion of the 120,000-sq.-ft. space to the south and west required that no restricting lateral force resisting elements such as shear walls or braced frames be located along these walls. Moment resisting steel frames utilizing jumbo-sized steel wide flange columns and long-span steel roof trusses were designed to meet these needs. The roof framing system utilized 270’-long continuous two-span steel trusses. Innovative design of the two-span continuous steel roof trusses resulted in significantly shallower trusses and lighter weight truss members than would have been required with a traditional single span design. This design also incorporated extremely stringent deflection requirements to accommodate the operable partitioning wall system below. Significant reduction in structural steel weight and cost of the structural roof framing system was a direct benefit of this design approach.

The 36,000-sq.-ft. Grand Ballroom also was designed with a provision to expand to the south. The lateral force resisting structural system for this area is composed of both structural steel vertical cross bracing and concrete/masonry shear walls. The temporary south shear wall consists of reinforced masonry spanning horizontally between columns to resist the lateral wind and seismic loads applied to this 50'-high wall. When the future ballroom expansion occurs, this masonry shear wall will be totally removed and the lateral capacity of this element will be moved to the new south wall location. The Grand Ballroom has movable partitions that allow for multiple smaller groups to utilize the subdivided space simultaneously. The 186'-long steel trusses were designed to deflect less than 4" (L/744) due to full roof snow loading so that the movable partition walls will operate properly.



VERTICAL FRAMING – PARTIAL ELEVATION

The transition connecting the new Salt Palace facility with the architecturally significant Abravanel (Symphony) Hall/Arts Center along the front façade presented many complex conditions. A new large masonry colonnade now straddles the main entrance of the existing Arts Center, providing a sympathetic tie between the existing and new facilities. This connecting element gives the appearance of a masonry structure but is in fact a steel truss/column frame wrapped with masonry veneer.

The meeting room floors offer 54,000-sq.-ft. of space, which can be divided into as many as 53 areas for groups ranging up to 1,800 persons. Proprietary structural floor vibration analysis techniques developed by Reaveley Engineers and Associates on earlier scientific research laboratory projects

*The steel members in the entry tower are designed to give the impression of sea gulls in fllight.*

were used to design the suspended meeting room floors. Vibration performance criteria was discussed with the owner and other design team members and then used to size the meeting room floor framing members to provide the desired vibration performance properties. No human perception of floor vibration has been reported to date, which is unusual in long-span suspended convention center meeting rooms.

After opening in February 1996, the Salt Palace Convention Center booked more than $104 million of convention business in 1996 alone. The tourism income generated by the influx of additional tourist guests is a major economic benefit for the Salt Lake Valley and the State of Utah.