



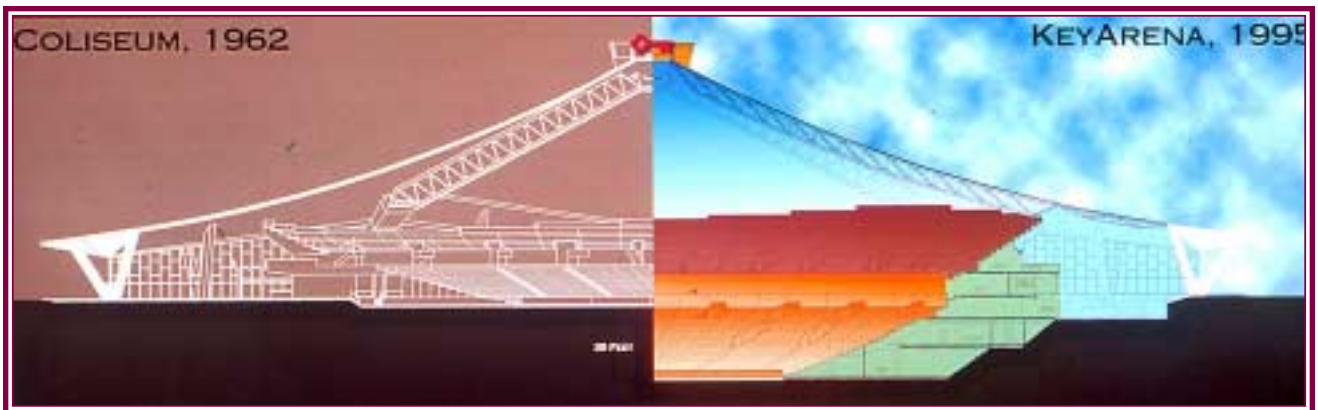
# RENOVATION EXPANDS SEATTLE SUPERSONIC'S HOME COURT

The roofline of the landmark sports center remained the same—but without the leaks

By Brian McIntyre, P.E.

**F**ACED WITH A FUNCTIONALLY OBSOLETE, LEAKING ROOF ON AN AGING AND DETERIORATING 30-YEAR-OLD BUILDING, with no public money to build a new facility, the KeyArena designers did the next best thing: They recycled the entire landmark building—and in the process created what many call the best NBA arena today.

The original Coliseum opened for the 1962 Century 21 Seattle World's Fair as the Washington State "World of Tomorrow" Exhibit. A bowl structure was added in 1964 to convert the building into the Seattle Center Coliseum, home court of the NBA Seattle SuperSonics and home of the Western Hockey League Seattle Thunderbirds. The 400'x400' building was topped with a futuristic aluminum roof composed of four quadrants. Each quadrant was formed on two sides by steel trusses rising 115' above the ground and on two sides by the post-tensioned, 30'-wide concrete



*The main steel trusses of the original 1962 Coliseum (middle) were preserved while the rest of the roof structure was replaced (bottom) as part of the redevelopment of the KeyArena in Seattle. In addition to the new roof, the floor was lowered 35' (top).*



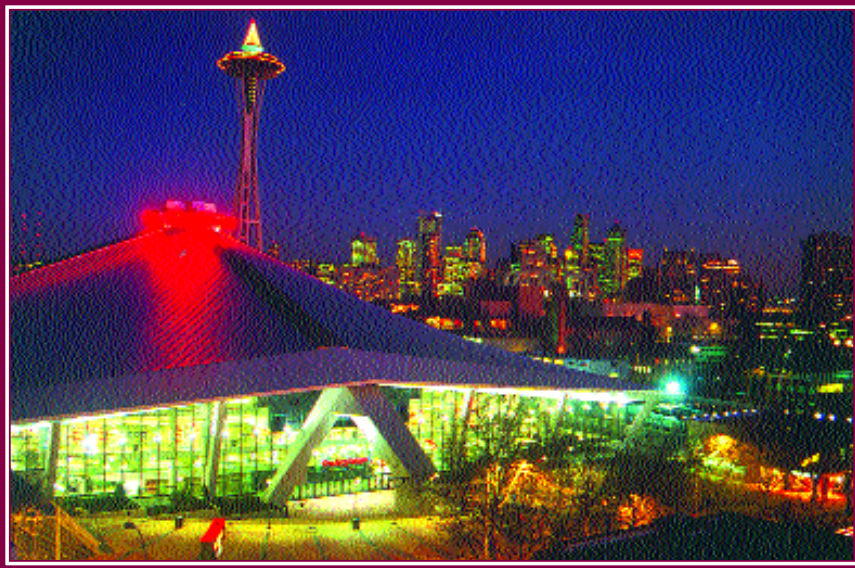
edge beams of the building. Nine hundred individual aluminum sandwich panels supported on tensioned steel cables in a doubly curved hyperbolic paraboloid shape formed each quadrant of the roof.

The roof was an engineering marvel, especially considering that it was done before the days of computer-assisted design. But it had one major flaw. "It leaked from the day it went on," said Bruce Rooney, Director of Redevelopment for Seattle Center. Additionally, the cable net did not provide the strength or stiffness to allow show rigging, catwalks or lighting platforms.

The owner's redevelopment program included:

- Replacing the existing roof with a rigid roof exactly matching the existing geometry
- Increasing the seating from 14,000 to 17,100, including 59 luxury suites and 1,100 club seats





*One of the design requirements was to maintain the unique roofline of the landmark building.*

- Providing for 120,000 lbs. of roof-supported rigging capacity
- Designing for a construction schedule of only 17 months, so that only one basketball season in the home facility would be lost
- Providing for all NBA and ADA standards
- Using no taxpayer funds

#### **PROGRAM SOLUTION STRATEGY**

Meeting the owner's program requirements in the existing building required looking at the

project from an entirely new angle. The solution lay in lowering the floor 35' to create needed volume for a new seating bowl with five levels of concourses. The existing exterior structure was integrated with a new state-of-the-art interior. Existing concrete foundations, abutments and edge beams, four main steel triangular trusses spanning 340' and the curtain wall all were saved. The design was specifically developed so only minor strengthening of reused components was needed to carry all

new loadings, including meeting current seismic requirements.

The original roof could not be fixed because of the flexibility of the supporting cable net. It also had no capacity for hanging loads or distributed lighting. The original cable net weighed 60,000 lbs. per cable. The cables were supported onto the edge beam, which the original design counteracted with permanent, grouted prestressing. Unfortunately, this created a potential reconstruction problem. When the force from the cable net was removed, the permanent prestressing would have caused the edge beam to "blow out" horizontally. The solution was an innovative counter-post-tensioning system, which was integrated into the existing prestressed edge beam to simulate the cable net forces, allowing the use of the major structural elements of the original building.

The breakthrough idea for the roof, however, was to utilize economical straight steel trusses on the straight-line generators of the hyperbolic paraboloid shape. This allowed the curved roof to be constructed almost completely with extremely economical parallel chord trusses. Only a single curved truss along the diagonal of the quadrant was required to match the historic and graceful shape of the old roof and provide the necessary strength and stiffness.

The framing plan was coordinated around a single new column behind the bowl structure in each quadrant. This made it possible to support the curving roof and an additional 450,000 lbs. of load, all without major strengthening of the existing triangular trusses and concrete edge beams.

Structural steel was the only feasible construction material for the roof for several reasons:

- Only steel allowed a structure that was light enough to avoid having to modify the existing foundations
- Only steel allowed the structure to meet current earthquake all

design regulations without any modification to the existing structure

- Only steel gave the roof the necessary strength and stiffness for new catwalks, rigging systems and lighting systems

- Only steel could give us the schedule advantage of being able to fabricate the entire roof while demolition and bowl construction was being done and allow the Supersonics to miss only one season in their home facility

### STRUCTURAL DETAILS

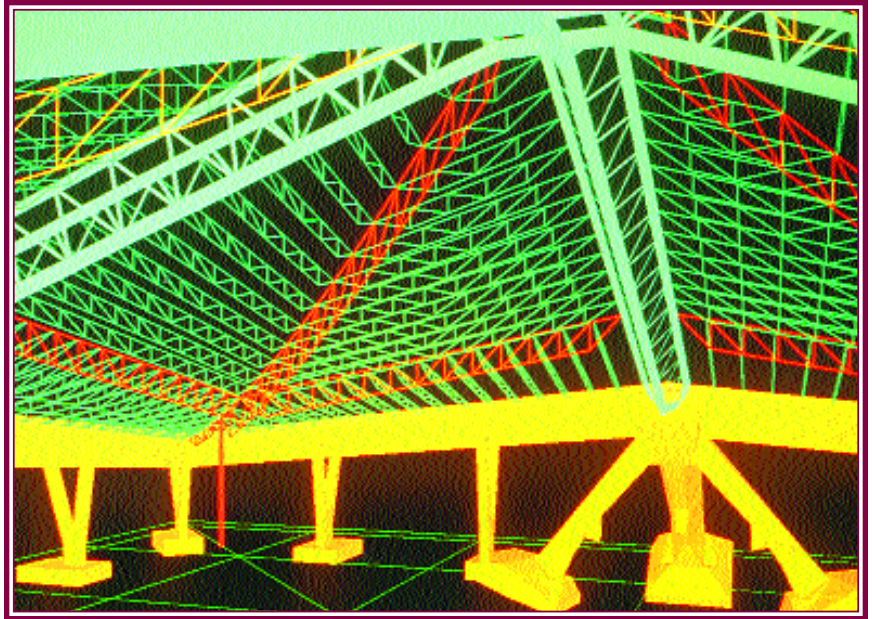
There were many unique details developed that provided the economy, aesthetics and structural performance and ease of construction on this project, including:

- 8" pipes were used for the top chords of the straight trusses to simplify the deck connection to the trusses. This provided the doubly-curved 1½"-deep, 18-gage metal deck diaphragm a continuous surface for fastening to the trusses. Using this approach, the constantly varying pitch of the roof was accommodated without the use of expensive support angles.

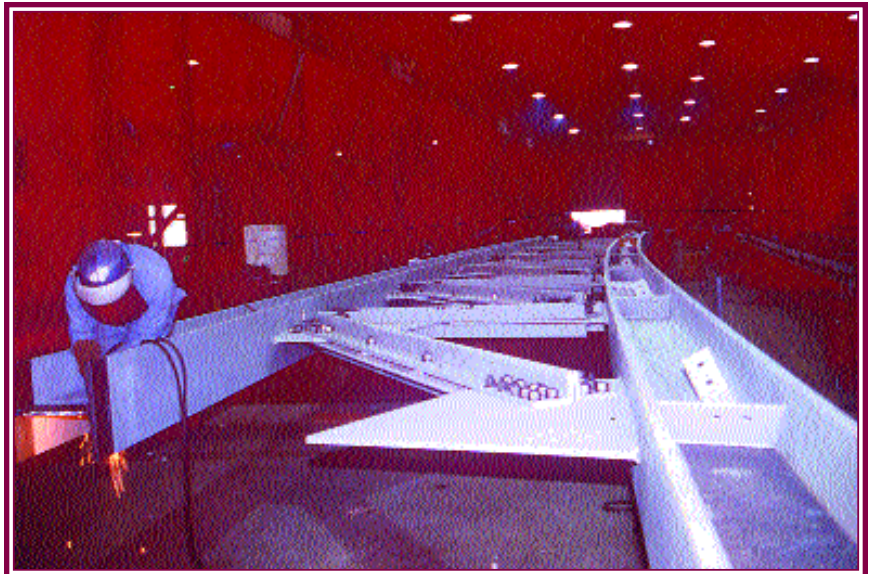
- Double angles were used for the bottom chords, vertical legs and braces. This allowed simple, bolted gusset plates for geometric flexibility and economical connections. Even though each pair of matched trusses had a different slope, the verticals of every truss were kept at 90 degrees to the floor surface to enhance the visual appearance. This was easily accommodated with the gusset plate/double angle system.

- Sloped side bearings were incorporated between the new trusses and the existing triangular trusses along two sides of each quadrant. These slide bearings were an innovative way to eliminate large axial arching loads from overloading the economical two-dimensional long-span trusses. The roof became essentially free from axial forces.

- A new 72'x108' fixed-steel rigging grid was developed using



*The computer model (above) shows the straight, parallel chord trusses and single curved truss. Shown on the opposite page is a curved truss at the fabrication shop.*





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10"-diameter rigging pipes at 8' o.c., accessible at every point by a catwalk. The rigging grid is designed to support up to 120,000 lbs. in hundreds of different patterns with a maximum 5,000 lb. point load. The integrated catwalk system eliminates the time-consuming fall restraint systems required with typical rigging systems and allows the fastest setup of even the heaviest concert tours—in about one-fifth the time of the previous building. A continuous catwalk provides access to the spotlight platforms, lighting banks, mechanical systems, and the center-hung scoreboard.

Architect for the project was NBBJ in Seattle. Fabricator on the project was AISC-member Canron Construction Corporation and general contractor was PCL Construction in Bellevue, WA.

Only 17 months were available for demolition, excavation and construction. The innovative symmetrical steel roof system allowed quadrant-by-quadrant phased construction. This design responded to a schedule that required three tower cranes, 15 trades and 300 people to be working at the same time in the very restricted confines of the 35' excavation.

The cost of a comparable new facility was estimated to be at least \$115 million and did not address the problem of what to do with the aging Coliseum. Renovating the building cost only \$74 million and allowed KeyArena to be the first publicly financed NBA arena to be fully supported by earned income from the building. No taxpayer dollars were required.