

Innovative Design in Engineering and Architecture with Structural Steel

IDEAS² awards



Bronx County Hall of Justice, Bronx, N.Y. (a Merit Winner in 2008).

2009 IDEAS² Awards Jury

Mark S. Carter, President, American Steel Fabricators Inc., Greenfield, N.H.

Raymond S. Clark, AIA, LEED AP, Principal and Managing Director, Perkins+Will, Chicago

Mario J. Elcid, P.E., Senior Staff II—Structures, Simpson Gumpertz and Heger, New York

Keith Grubb, Senior Engineer—Research, AISC, Chicago

Christina Koch, LEED AP, Editor in Chief, *eco-structure* and *metalmag* magazines, Hanley Wood Business Media, Chicago

Mike Moravek, Senior Vice President, The John Buck Co., Chicago

George Karl Tuhowski III, General Superintendent, Leopardo Construction, Hoffman Estates, Ill.

THE DESIGN AND CONSTRUCTION INDUSTRY RECOGNIZES THE IMPORTANCE OF TEAMWORK, COORDINATION, AND COLLABORATION IN FOSTERING SUCCESSFUL CONSTRUCTION PROJECTS TODAY MORE THAN EVER BEFORE.

In support of this trend, AISC is proud to present the results of its annual IDEAS² Awards competition. This program is designed to recognize all team members responsible for excellence and innovation in a project's use of structural steel.

Awards for each winning project were presented to the project team members involved in the design and construction of the structural framing system, including the architect, structural engineer of record, general contractor, detailer, fabricator, erector, and owner.

New buildings, as well as renovation, retrofit, or expansion projects, were eligible. The projects also had to display, at a minimum, the following characteristics:

- A significant portion of the framing system must be wide-flange or hollow structural steel sections;
- Projects must have been completed between January 1, 2006 and December 31, 2008;
- Projects must be located in North America;
- Previous AISC IDEAS² or EAE award-winning projects were not eligible.

A panel of design and construction industry professionals judged the entries in three categories, according to their constructed values in U.S. dollars:

- ✓ Less than \$15 million
- ✓ \$15 million to \$75 million
- ✓ Greater than \$75 million

The judges considered each project's use of structural steel from both an architectural and structural engineering perspective, with an emphasis on:

- Creative solutions to the project's program requirements;
- Applications of innovative design approaches in areas such as connections, gravity systems, lateral load resisting systems, fire protection, and blast;
- The aesthetic and visual impact of the project, particularly in the coordination of structural steel elements with other materials;
- Innovative uses of architecturally exposed structural steel;
- Advances in the use of structural steel, either technically or in the architectural expression;
- The use of innovative design and construction methods such as 3D building models; interoperability; early integration of specialty contractors such as steel fabricators; alternative methods of project delivery; or other productivity enhancers.

Both national and merit honors were awarded. The jury also selected one project for the Presidential Award of Excellence in recognition of distinguished structural engineering.

National Winner—Under \$15M
ARMSTRONG OIL & GAS—DENVER

This adaptive reuse of an early 1900s industrial machine shop has helped to launch a new identity for an established local business—Armstrong Oil and Gas—in lower downtown Denver (LoDo). Charged with bringing new life to an underused building, the design team planned the enclosed program around existing elements and created generous, sophisticated spaces filled with daylight, natural ventilation and views of the Denver skyline.

The existing corrugated steel roof over the main second floor office had deteriorated over the years due to water infiltration and was replaced with corrugated zinc roofing. The original structure consisted of four gabled steel trusses with riveted connections, with wood framing spanning between.

Two of the trusses were salvaged, while two were replaced with new trusses using double steel angle members to replicate the historic trusses, but with welded connections to differentiate between the old and new. The gable trusses are approximately 24 ft wide and 6 ft tall. The top and bottom chords are double 3x3x¼ steel angles, and the diagonals are 2x2x¼ or 3x3x¼ angles. Sawtooth trusses over the second-floor office area were built with the same-size members. The wood framing was replaced with an 18-gauge steel deck clear spanning between trusses, and the existing cupola vent was replaced with a steel-framed and glazed monitor to provide additional light and ventilation to the office.

To create the centralized courtyard, which now provides abundant natural light and ventilation to all of the interior spaces, the

center section of the original roof was stripped away. Additionally, existing heavy timber roof beams and wood decking was removed to express the steel frame, and the wood was repurposed into many of the custom-fabricated interior furnishings.

Primary vertical circulation is provided by two folded steel plate stairs—using ¼-in. plate—that cantilever off of a central tube structure. A new catwalk made of steel angles and bar grating is suspended on steel rods from the existing roof framing and links the upper lounge and second-floor offices through the double-height space of the “war room.”

The mixture of old and new exposed materials impressed juror Raymond S. Clark, who praised the building for its “excellent combination of ornamental steelwork, structural elements, and refurbishment and reuse of historical steel members.”

The building was upgraded for earthquake and wind loads by integrating new brace frames and creating moment-resisting rigid frames from the new steel columns and trusses that form the saw-tooth roof. Where new openings were made in the existing brick walls, the lintel was created by sandwiching the head of the opening with a steel channel on each side, secured in place with through-bolts. The expressed lintel not only contributes to the historic aesthetic of the space, but also allowed for a safe and economic construction sequence; by installing the lintel first, the brick could be removed and the need for temporary shoring avoided.

The building maintains its existing shell and structure, eliminating tons of waste from local landfills while preserving a venerable landmark in downtown Denver.



photos this page by Frank Ooms Photography

Owner
 Armstrong Oil and Gas, Denver

Architect
 Lake | Flato Architects, Inc., San Antonio

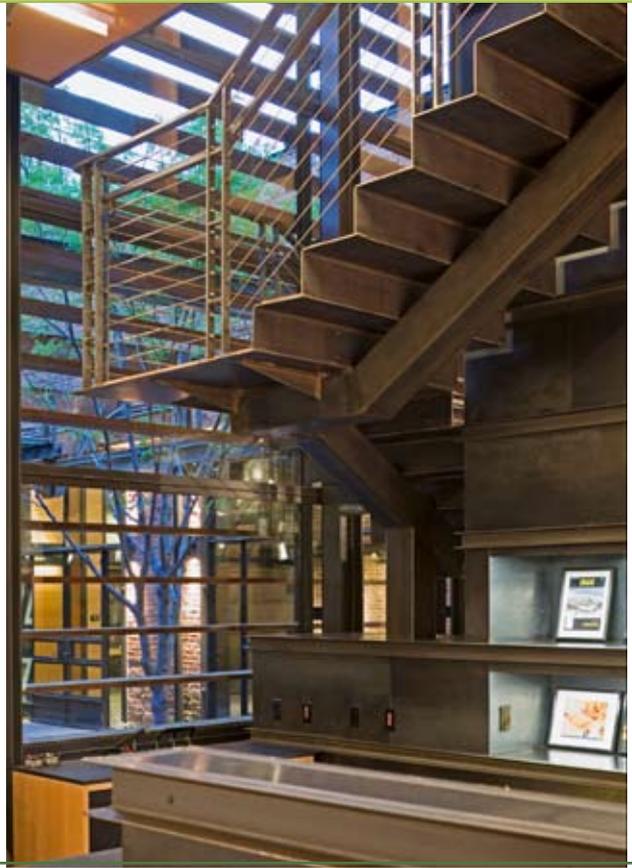
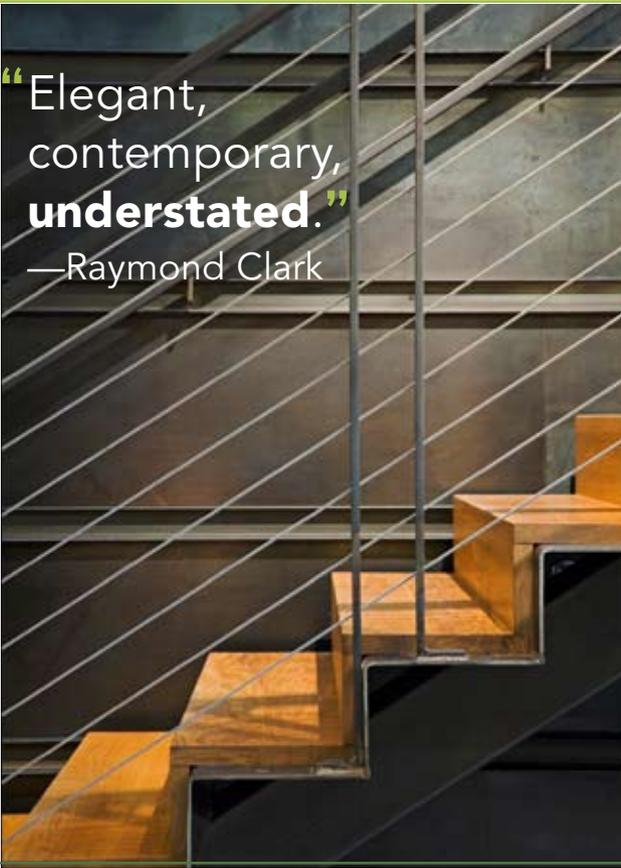
Associate Architect
 Bothwell Davis George Architects, Denver

Structural Engineer
 McGlamery Structural Group, Denver

General Contractor
 Sprung Construction, Denver

“Elegant,
contemporary,
understated.”
—Raymond Clark

photos this page by Frank Ooms Photography



Merit Award—Under \$15M
HOLOCAUST AND HUMAN RIGHTS CENTER OF MAINE—AUGUSTA, MAINE

The Michael Klahr Center (MKC), the new home of the Holocaust and Human Rights Center of Maine (HHRC), is a 6,300-sq.-ft. one-story building on the campus of the University of Maine at Augusta.

The massing for the MKC creates a bold visual exposition of the HHRC's mission to educate future generations about the Holocaust and other human rights abuses. Four flower-like petals spring forth from the ground around that central focal point, reminding visitors of the rebirth of freedom after the long, hard winter of World War II.

Because the HHRC was charged with building the MKC on a total budget of only \$1.8 million, structural steel proved essential to realizing the architect's vision for the building. Although the sculptural forms of the petals could have been well-suited to cast-in-place concrete, the expense of the curved formwork and the construction schedule demanded a different structural system. In response to the sculptural demands of the petal architecture, Simpson Gumpertz and Heger, the structural engineer for the project, developed a structural system consisting of a grid of HSS sections using curved HSS8x8s as the ribs along "meridians" of the spherical petal sections and straight HSS4x4s along "parallels" of the petals.

These grids, moment connected in-plane and strategically braced in certain bays, enable the petal structures to act as shells. Selecting steel for the petals allowed for portions of the petals to be shop-fabricated, speeding up construction considerably.

The petal structure made quite an impression on the jury. George Tuhowski called the project "striking aesthetically and an excellent example of the design flexibility that steel can provide," while juror Raymond Clark commented on the "excellent detailing and use of flowing curved elements to achieve what one would expect to be executed in concrete."

For more on this project, see "Blooming Knowledge" in the January 2009 issue of MSC, available in the Archives section at www.modernsteel.com.

Owner

University of Maine at Augusta

Architect

Shepley Bulfinch Richardson and Abbott, Boston

Structural Engineer

Simpson Gumpertz and Heger, Inc., Waltham, Mass.

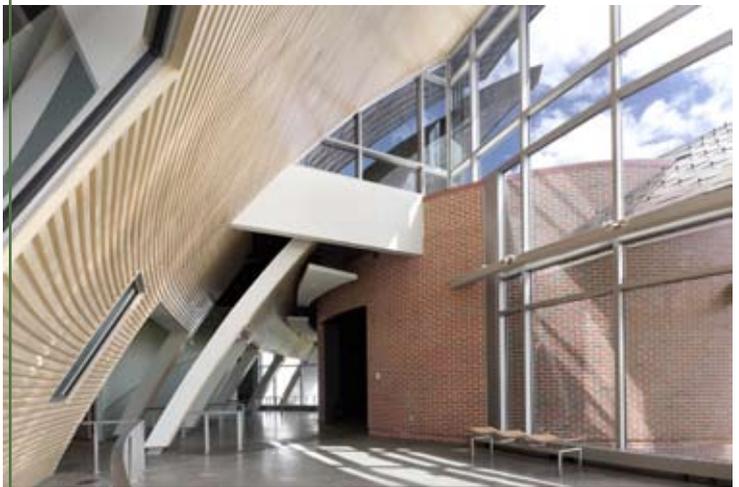
General Contractor

Wright-Ryan Construction, Inc., Portland, Maine



“Striking aesthetically and an excellent example of the **design flexibility** that steel can provide.”

—George Tuhowski



photos this page by Esto Photography

Merit Award—Under \$15M

RAYMOND AND SUSAN BROCHSTEIN PAVILION—HOUSTON

“This design is absolutely **delightful.**” —Mark Carter

Carl Mayfield Photography



The Raymond and Susan Brochstein Pavilion is at the center of the Rice University campus in Houston, Texas. Completed last year, the \$7 million structure plays host to formal and informal gatherings.

Designers addressed lateral torsional buckling concerns for the stacked steel bar grid and analyzed various required cambers to meet the exacting requirements of a flat and level finished trellis structure with a leading edge of only $\frac{3}{4}$ in. This delicate steel grid is held 17 ft in the air by slender $4\frac{1}{2}$ -in. square billet columns with concealed fixed bases. The architect required submission of a sample of the column to verify the hot rolled billet would have acceptably square, unrounded corners.

To ensure the aesthetic integrity of the trellis versus constructability, designers closely coordinated all details during the design phase. Splices in the structural steel members were coordinated with the architectural grid to create manageable lengths and were detailed with mortised joints and decorative head steel bolts. The steel fabricator and erector met the architecturally exposed structural steel tolerances, which were required to align and attach the prefabricated aluminum trellis frames to the top of the steel grid, without any need for field-modifying the shop-fabricated steel. The finished trellis forms an open shaded area for exterior seating surrounding the pavilion.

Four 77 ft by 15 ft clear glass curtain walls form a square and enclose the pavilion. The exterior steel columns supporting the structural steel roof were limited to the smallest structural steel wide-flange shape of W4x13. These exposed columns are spaced at 7 ft all around the perimeter and are integrated as part of the glass wall support system. Each vertical mullion is placed in front of and attached to a W4 column. Each horizontal mullion is in front of and attached to a horizontal ST2x4 $\frac{3}{4}$ spanning between the W4 columns. This allows the sizes of the aluminum mullions to be minimized and enables the architect's desire for an unencumbered visual connection between exterior and interior. Likewise, the view from interior spaces to the exterior is unencumbered, since the structure has no interior columns other than those concealed within the 14 ft by 49 ft service core. This required spans of 42 ft to the W4 exterior columns, created with W18 beams that are partially exposed by the perforated metal ceiling. The beams are spaced at 7 ft on center and coordinated with the perimeter curtain wall, shrouded skylights, sprinklers, and the perforated metal

panel ceiling which partially exposes them. The building was detailed with AutoCAD and analyzed with Risa3D.

Jurors noted the link between form and function. “A great use of innovative design and modeling that shows the importance of the integrative approach to design,” said George Tuhowski. Mark Carter was “impressed mightily by the grace of the structure and the practicality of its use” and called the design “absolutely delightful.”

Owner

Rice University, Houston

Architect

Thomas Phifer and Partners, New York

Structural Engineer

Haynes Whaley Associates, Inc., Houston

General Contractor

Linbeck Group, LLC, Houston



Merit Award—Under \$15M

MUSEUM OF FLIGHT, T. EVANS WYCKOFF MEMORIAL BRIDGE—SEATTLE



photos this page by Lara Swimmer Photography



“A progressive, **innovative** connector to the local heritage.”
—Mike Moravek

The Museum of Flight in Seattle is one of the largest air and space museums in the world, attracting nearly 500,000 visitors each year. A recent addition to the museum—a symbolic 340-ft pedestrian bridge—helps to better circulate these visitors and also provides an eye-catching icon to the industrial area where the museum is located.

A conventional, utilitarian public works bridge would have been possible but inadequate to convey the spirit of the museum and the area’s aviation history. Instead, the design of the bridge is inspired from the metaphor of the contrail, a stream of crystallized vapor created in a plane’s wake. The metaphor is carried out in the bridge’s unusual tube truss design, made of crossing circular steel pipe sections surrounding an inner glass enclosure and culminating in what juror Mike Moravek deemed “a progressive, innovative connector to the local heritage.”

The unique structure of the bridge evolved from the design collaboration between SRG Partnership (architect), MKA (structural engineer), and Jesse Engineering (steel fabricator). The design team conceived a structural design that did not rely on conventional truss webs, but instead distributed

the vertical shear in the bridge structure through a matrix of curving steel pipes. This exciting and dynamic form had the potential to be overly complex and unachievable within the project budget. However, using standard steel member sizes, constant radius pipe bends, and predetermined “fish-mouth” end cuts, the complex design was fabricated economically.

The main truss, 200 ft long, is made of a series of crossing 5-in.-diameter pipe hoops tilted at 45°. The elliptical cross section swells slightly in the center, narrowing at its ends to heighten the sense of movement. Lightweight materials and a composition of transparent, translucent, and metallic surfaces soften the reflected light, at times appearing to dissolve against the sky.

Using a steel truss allowed the structural depth to surround the partially enclosed interior space and more successfully reference the language of the existing museum architecture. The bridge uses approximately 10,000 linear ft of steel pipe at a total steel weight of 190 tons. The contrail configuration used approximately 151 pieces of tube rolled to different radii, as the bridge was wider at the middle

than the ends (all the pipes were rolled at a constant radius but as the width changed, so does the radius.). Shorter pieces needed to be cut to fit between the full hoops to make the truss that surrounded the main chords, which were made of 10-in.-diameter pipe; the pipes for the chords were purchased in 60-ft lengths, then spliced together.

For more on this project, see “Taking Flight” in the December 2008 issue of MSC, available in the Archives section at www.modernsteel.com.

Owner

Museum of Flight, Seattle

Architect

SRG Partnership Inc., Seattle

Structural Engineer

Magnusson Klemencic Associates, Seattle

Steel Fabricator

Jesse Engineering Co., Tacoma, Wash. (AISC/NSBA Member)

Detailer

MKE Detailing, Inc., Seattle (AISC/NISD Member)

General Contractor

Sellen Construction Co., Seattle

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National Award—\$15M to \$75M

POOL/ICE RINK AT FLUSHING MEADOWS CORONA PARK—FLUSHING, NEW YORK

While New York never realized its dreams of becoming the host city for the 2012 Olympic Games, it did get a nice pool as a result of being a candidate city. Although planned as a recreation and community competition facility, the design of the new pool at Corona Park in Flushing, N.Y. was commissioned at the time when New York was in the hunt for the 2012 Games.

At the time, New York had limited indoor swimming facilities, and the new natatorium was programmed as the venue for water polo and synchronized swimming competitions. As such, the building design solution had to be economical both with respect to initial building cost as well as operational costs after the Olympic events. As part of this goal the building volume was to be kept to a minimum to bring down heating and cooling costs. To achieve this goal and accommodate the possibility of the Olympic seating, a cable-stayed suspended roof structure was chosen for the building, which also contains an ice rink.

Bracing members in the wall stabilize the hinge between the masts above the roof and their support columns, as well as provide part of the lateral support for the building. For the façade cladding, insulated precast panels were specified. Their mass is used to

resist any uplift loads that could result from unbalanced roof loads transmitted through the cables to the wall at the ice rink. Lateral bracings composed of HSS sections are provided in the end and center transverse walls of the building, as well as the exterior sidewalls of the ice rink.

The roof supporting masts each anchor twelve 3-in. structural strand cables, of which six support part of the pool roof and six part of the ice rink roof. The roof in elevation is waved with the high elevation over the pool to accommodate the sight lines for the proposed outside seating at an Olympic event. The low elevation over the ice rink was designed to keep the building volume to a minimum for energy use considerations. The roof cables are anchored to W36x300, spaced 30 ft apart and span the length of the roof, equilibrating the compression component resulting from the cable forces. These members are the deepest of the roof structure.

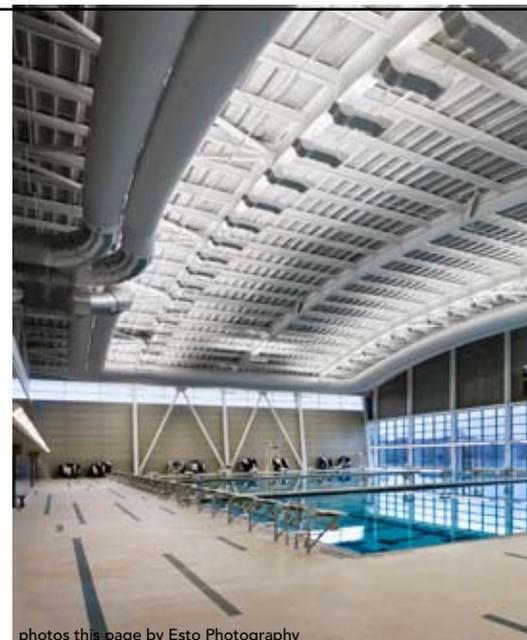
The roof deck is comprised of 2-in.-thick lightweight concrete channel planks. These are exposed to the interior and were employed in lieu of metal deck in light of the corrosive pool environment. They also provide sufficient dead weight to resist wind uplift on the roof. The connections of the roof plank were designed to ac-

commodate the movements of the cable-stayed roof, and no concrete topping was specified for the planks. As a result, the roof planks do not provide a shear diaphragm to distribute lateral loads to the wall bracing. Instead, HSS members address shear in the roof surface, and these tie into the bracing in the walls. The structure above the pool deck consists of steel columns and girts, which support the precast insulated wall panels as well as the glass façades that face south.

Because the roof structure equilibrates the horizontal force components of the roof cables, no expansion joint is used in the 450-ft-long structure. Thus the lateral bracing is concentrated and configured in such a way that it does not constrain the building against thermal movements but still provides resistance to seismic and wind lateral loads. It could not be in the pool section where the wall framing is to be removed for clear viewing of the swimming events, thus it had to be placed in the ice rink section. The interaction between the precast wall cladding and the thermal movements of the steel required careful design of the precast concrete connections so that the precast would not restrain the steel movements.

Mario Elcid praised the "great innovative roof structure," noting that

"The flexibility...is very creative."
—Mario Elcid



photos this page by Esto Photography

its “flexibility to accommodate additional seating for an Olympic event is very creative in saving on unnecessary structural steel.”

The steel of the roof as well as the exterior columns are exposed to view. The roof structure is coated with a high-performance two-part epoxy, shop-applied and touched up in the field where required. The columns, girts, and bracings are coated with an intumescent paint for fire protection, matching the color of the roof structure.

HSS sections varied from HSS6x6 for minor posts to HSS16x16x $\frac{3}{8}$ for building braces. The HSS in the roof are generally 8x8x $\frac{3}{8}$, and girts in the walls are generally HSS10x8x $\frac{3}{8}$. Total steel usage for the project is 1,500 tons.

Owner

New York City Economic Development Corporation

Architect

Hom + Goldman, New York

Associate Architect

Handel Architects, New York

Structural Engineer

Geiger Engineers, Suffern, N.Y.

Steel Detailer

ADF Groupe, Inc., Terrebonne, Quebec
(AISC Member)

General Contractor

Bovis Lend Lease LMB, Inc., New York



Merit Award—\$15M to \$75M

ARIZONA STATE UNIVERSITY POLYTECHNIC CLASSROOM BUILDINGS—MESA, ARIZONA



“Innovative, environmental, efficient.”
—Raymond Clark

photos this page by Bill Timmerman Photography



Five new academic buildings at Arizona State University’s Polytechnic Campus in Mesa more than double the campus’ instructional lab and classroom space. These 245,000-sq.-ft facilities house four distinct but interrelated academic colleges. Integrated with three existing buildings to create a cohesive complex, the buildings are configured around four courtyards and linked by a series of open-air atriums, building portals, and arcades.

The buildings put their utilities and structural steel on display, reflecting the campus’ straightforward philosophy. Through this pragmatic approach to the architecture, practical and repetitive configuration, and concentration on landscape integration, the new pedestrian-friendly campus promotes students and faculty to stay on school grounds to interact and learn.

“These buildings integrate structural

steel in a thoughtful way while including many complementary uses of steel for aesthetics and programming reasons,” expressed juror Christina Koch. “The open-air aspects of the buildings encourage students to stay within them even after class is over.”

The primary materials for the five new academic buildings consist of steel, CMU, and glass. The 2,200 tons of steel used include: painted structural steel, painted flat and corrugated steel siding, and weathered perforated sun screens. Steel was used at every scale within the project. At the largest extent, the painted structural steel frame is exposed throughout the campus and celebrated within the open-air atriums and on several anchor buildings. Within this steel framework, lightweight corrugated and flat-seam metal siding respond to the aridness of the desert and prevent heat build-up within the wall cavity. Similarly, the weathered

perforated corrugated steel sunscreens, which alternate transparencies within the corrugations based on orientation, protect the glazing from the intense east and west low-angled sun.

Documents for the fast-track project, ranging from master planning to construction, were completed in seven months. In order to meet schedule requirements, the structural steel frame had to be designed and steel ordered way ahead of the balance of the building design. To do this, the team agreed on “kit-of-parts” design philosophy that repeated throughout the project. The typical 30-ft. square bays used W16x31 interior beams and W21 exterior beams supported by W24x62 girders. The exterior 21-in. deep floor beams that are exposed throughout the atriums maintain a 6½-in. width despite the variation in weight at the rigid frames, thus simplifying the masonry above and below the beams.

After the structural frame was established and steel ordered, the building design continued with the goal of working around the steel frame already established. Steel joists were used at the roof of the three-story structures except at mechanical equipment where steel beams were substituted. The two-story structures featured vaulted roofs framed with exposed steel beams. To manage the cost of architecturally exposed structural steel used in the project, all AESS members and connections were identified on the structural plans. All exposed edges, bolts, welds and copes were discussed with the steel fabricator, Schuff Steel, who was selected early in design to work in a design-assist capacity.

Although typical BIM software was not used on the project, all of the design meetings used a combination of SketchUp, RAM Structural System, and Tekla Structures to work through design issues. When DPR, the contractor, and Schuff determined that the desired suspended walkway system would push erection costs outside the budget, structural engineer Paragon and Schuff traded RAM analysis models back and forth to quickly design and price options. A cantilevered walkway system was selected and brought the project back in line with the budget.

All exposed steel was power-cleaned in the shop. One coat of primer was applied (Tnemec Series 88HS Alkyd) followed by two coats of high-quality, corrosion-resistant paint (Frazee Duratec II 203). The project has a goal of LEED Silver certification, though it is trending toward Gold as the certification process concludes over the next few months. The exposed steel and straightforward finishes were key to the sustainable design approach that limited the waste of materials.

Owner

Arizona State University, Tempe, Ariz.

Associate Architect

Lake|Flato Architects, San Antonio

Associate Architect

RSP Architects, Tempe

Structural Engineer

Paragon Structural Design, Phoenix

Steel Fabricator, Erector, and Detailer

Schuff Steel Company, Phoenix (AISC Member)

General Contractor

DPR Construction, Phoenix

President's Award for Excellence in Engineering—\$15M to \$75M
THE ADDITION AT 185 BERRY STREET (CHINA BASIN LANDING)—SAN FRANCISCO

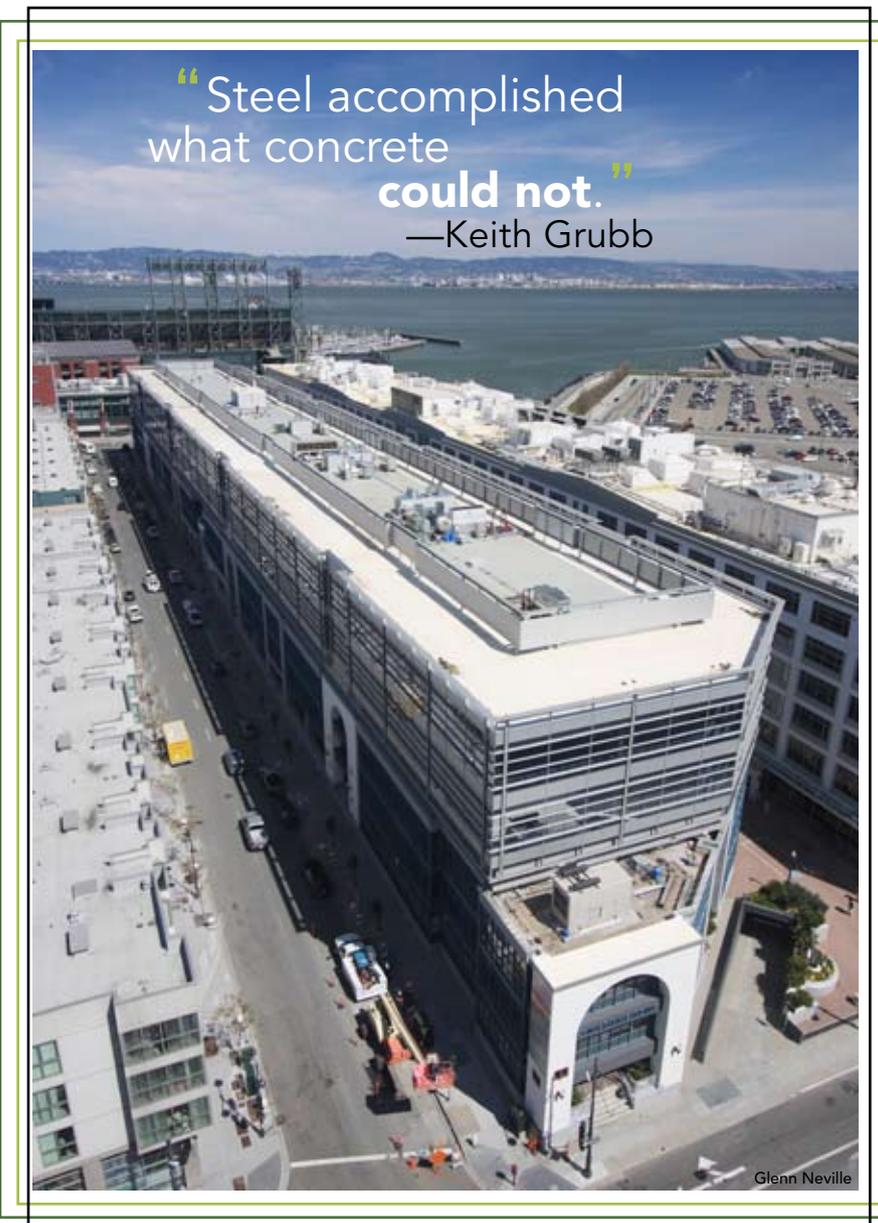
The building at 185 Berry Street in San Francisco might look like any other building upon initial inspection. However, the structure houses a technically innovative application of seismic isolation to create mass damping in vertical building expansion.

The goal was to expand an existing three-story, 216,000-sq.-ft building by 150,000 sq. ft in two new stories, with minimal disruption to the tenants. The existing building was 825 ft long (north to south) and 110 ft wide. To accommodate the long length of the building, two expansion joints were located approximately at the third points, dividing it into three separate structures. The addition is a continuous, approximately 800-ft-long structure, bridging these three independent structures below.

Engineer Simpson Gumpertz and Heger (SGH) constructed a 3D, non-linear model of the three wings in RAM Perform (now CSI Perform). The frame non-linearities were modeled using discrete plastic hinges with properties based on relevant tabulated values in FEMA 356, modified using moment curvature analyses. The frame beam flexural capacities in the model were obtained using the composite action provided by the floor slab along with the existing prestress.

The non-linear time history analysis confirmed that the base isolated addition was not detrimental to the existing structure. However, the peer review team wanted SGH to demonstrate that the building and the addition possessed the necessary toughness of a code compliant structure. To do so, SGH performed a reliability analysis using data from incremental dynamic analyses. The results showed that the structure with the base isolated addition had a higher reliability than the base structure without the addition, clearly illustrating the beneficial effect that isolation/mass damping would have on the overall performance of the building.

The project employs 87 seismic isolation bearings, all supplied by Dynamic Isolation Systems (DIS). The design of the isolation system presented a significant challenge: isolating a relatively light superstructure while keeping the isolators stable at a displacement of +/- 45.5 in. (1.5 times the code required maximum displacement of +/- 30 in.). This required an isolation system consisting of 45-in.-diameter lead-rubber bearings and a new combined system of sliders in series with elastomeric bearings where the sliders provided +/- 30 in. of displacement and the additional +/- 15 in. of displacement was ac-



commodated in the 24-in.-diameter elastomeric bearing. Prototype testing demonstrated the bearings' stability.

SGH provided a grid of large structural steel members above and below the isolators to resist the moments from the displaced isolators. To protect the relatively thin prestressed concrete roof slab, an interlocking shear transfer system consisting of concrete pads connected to

the roof and steel shear lugs connected to the lower steel grid were used. The connection of the concrete pads to the existing roof employed 6-in.-diameter pipes cored into the slab as well as threaded rods epoxy grouted into the slab. Contractor Hathaway Dinwiddie Construction used ground-penetrating radar to locate the post-tensioning cables and reinforcing steel, both in plan and elevation, and carefully laid out all of

the existing elements before coring. This attention to detail paid off. Although the HDC used 780 cores and approximately 2,800 dowels, they only damaged one cable.

The use of seismic isolation as a means of mass damping a building with a new addition impressed the jury. "Steel accomplished what concrete could not," said Keith Grubb. "An innovative structural solution that will have applicability to future renovation projects in seismic zones."

Added Mike Moravek, "This may be the future direction of engineering additions in high seismic areas."

For more on this project, see "On the Grid" in the June 2008 issue of MSC, available in the Archives section at www.modernsteel.com.)

Owner

McCarthy Cook, San Francisco

Structural Engineer

Simpson Gumpertz and Heger, Inc.,
San Francisco

Associate Architect

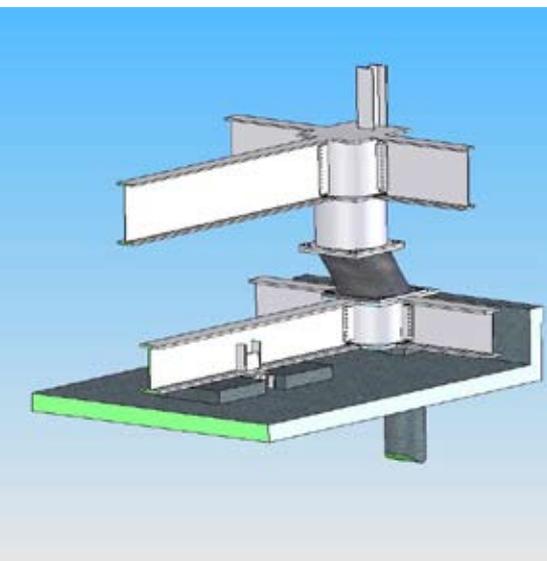
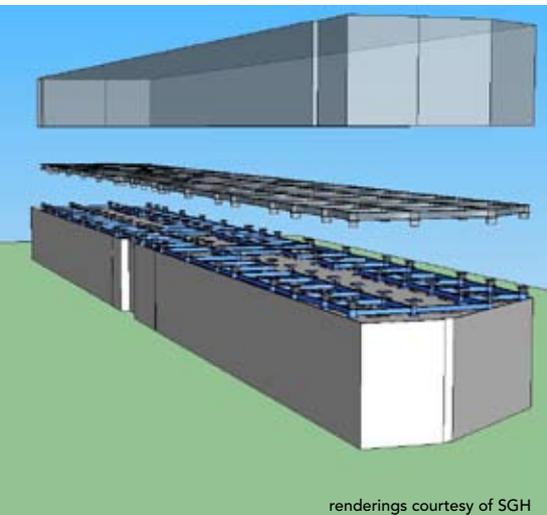
Helmuth Obata and Kassabaum, San
Francisco

Steel Fabricator

Herrick Corporation, Pleasanton, Calif.
(AISC Member)

General Contractor

Hathaway Dinwiddie Construction
Company, San Francisco



National Award—\$75M and greater

CALIFORNIA ACADEMY OF SCIENCES—SAN FRANCISCO

Green roofs are becoming more and more popular. One of the newest and largest tops the California Academy of Sciences new \$488 million home in San Francisco's Golden Gate Park.

The visually striking building features an undulating 2.5-acre living roof with a perimeter steel canopy supporting photovoltaic cells, a large glass skylight supported by a tensile net structure, a freestanding 90-ft-diameter planetarium dome, five separate iconic aquarium tanks and a 90-ft-diameter glazed dome housing a rainforest exhibit.

The steel canopy covers an area of 52,200 sq.-ft and is supported by light steel framing totaling 75 tons, while the structural steel package—which included the internal structural framing of African Hall, the planetarium, and the roof—totaled 1,500 tons.

With seven "hills" mimicking the seven hills of San Francisco, the roof structure, detailed with StruCAD and blanketed with 1.7 million native California plants, consists of a grillage of curved steel beam sections—some spanning up to 96 ft—that support a contoured concrete slab. The curved steel beams form a structural skeleton whose concrete skin was applied from above with the aid of temporary timber formwork to achieve a carefully contoured finished surface. This temporary formwork was taken into account in the design of the long-span steel beams as "shored composite construction," thereby achieving significant savings in steel tonnage.

Temporary shoring of the roof framing, which spans 98 ft above the main exhibit hall, was required in order to support the temporary construction dead and live loads required to place concrete on the framing. The curved final geometry made any calculation of the camber required nearly impossible otherwise, and the shoring towers were removed only after the concrete roof diaphragm had fully cured.

In addition to providing the necessary structural supports to achieve the aesthetic aspiration, the living roof plays a critical role in the building's seismic performance. The site of the Academy lies within 10 miles of the San Andreas Fault, and in

its lifetime the building is likely to be subject to very strong ground shaking. A standard building code approach required the use of ground anchors on the building to prevent the Academy from overturning during a seismic event.

Pushing the boundaries of conventional design, structural engineer Arup agreed that instead of the building aggressively resisting an earthquake by tying it down, the structure should work with the seismic forces, dissipating the energy in an elegantly simple manner: through rocking at the foundations. As such, the roof steel framing collects and redistributes seismic forces to the concrete shear walls located in four buildings at each quadrant of the building site. Principal steel elements are extended and "casted into" the shear wall with shear studs welded to the overlapping steel section, creating a robust "locking" mechanism between the steel to concrete seismic force transfer mechanism. Steel framing above the north and south entries were locally strengthened to create "chord and strut" elements. These elements were detailed to tolerate 1 in. of relative horizontal displacement when buildings move relative to each other during a seismic event.

Owner

D.R. Young Associates, San Rafael, Calif.

Architect

Renzo Piano Building Workshop, Genova, Italy

Associate Architect

Stantec, San Francisco

Structural Engineer

Arup, San Francisco

Steel Fabricator, Erector, and Detailer

SME Steel Contractors, West Jordan, Utah (AISC/NISD Member)

General Contractor

Webcor Builders, San Francisco



photos and rendering courtesy of Webcor

"It's a testament to the innovative shapes steel can create."



—Christina Koch



National Award—\$75M and greater
BANK OF OKLAHOMA CENTER (BOK CENTER)—TULSA



photos by Architectural Imageworks, LLS – Gayle Babcock

“ Only **steel** could have provided the building’s curves. ”

—Christina Koch



Practically in the center of the country, the city of Tulsa, Okla. seems as good as any as a focal point for athletic and concert events. Add the new \$178 million, 18,500-seat Bank of Oklahoma (BOK) Center, and there’s even more incentive for teams and musicians to drop in. Beyond providing a new venue for Tulsa, the City also envisioned the BOK Center as a new architectural icon as well as the anchor of its downtown revitalization effort.

Revitalizing an area takes years, but the architectural goal was immediately met. “Aesthetically, this is the most remarkable stadium project I have seen in a long time,” said juror Christina Koch. “Only steel could have provided the building’s curves, and the metal façade is a nice complement.”

“Best in class of any arena to date,” agreed juror George Tuhowski.

The irregular shape and geometry of the 600,000-sq.-ft arena required sev-

eral different innovative engineering solutions that could only be achieved with steel. Six different exterior wall geometries utilize wide-flanged columns that slope at 10° from vertical to define the building envelope. This gave the appearance of truncated cones wrapping into each other that interconnect with varying sloping “sliver” roofs. These six distinct, sloping perimeter walls support very spacious and scalloped floor plates, allowing patrons to see daylight at almost every viewpoint from the concourses. With constantly changing roof diaphragm elevations, transferring lateral loads provided additional challenges that were overcome by inventive bracing configurations utilizing HSS sections, wide-flange members, and built-up steel sections.

Supporting the architectural focal point, the glass Icon Wall, was no small feat. This portion of the structure is bolstered by a sloping, radiused

8-ft-deep steel box girder cantilevering 80 ft over the main entrance. The cantilevered structure supports both the main entry roof and a 75-ft-high sloping glass curtain wall system. The Icon Wall is laterally supported by 4-ft, 8-in.-deep architecturally exposed vertical pipe trusses set at 17 ft, 6 in. on center, spanning up to 75 ft in height in combination with sloped pipe trusses that support the Icon Roof.

Inside, high above the spectators, the long-span roof consists of two box trusses clear spanning 330 ft. The box trusses have a flat bottom chord and taper from a 30-ft mid-span depth to an 18½-ft end depth. Infill trusses spaced at 37½ ft frame between the box trusses and from these trusses to the perimeter steel ring beam. The selection of this framing system allowed for easy erection, early erection stability, and a flexible rigging capacity of 150,000 lb for center-stage shows and 120,000 lb for end-stage shows. The

**Owner**

City of Tulsa, Oklahoma

Design Architect

Pelli Clarke Pelli Architects, New Haven, Conn.

Architect of Record

Matrix*Odell (Joint Venture), Tulsa

Structural Engineer

Thornton Tomasetti, Inc., Kansas City

Steel Fabricator

Schuff Steel Company - Midwest Division, Overland Park, Kan. (AISC Member)

Steel Detailer

Dowco Consultants, Ltd., Burnaby, British Columbia (AISC/NISD Member)

Steel Erector

National Steel Constructors, Plymouth, Mich. (AISC Member)

General Contractor

Tulsa Vision Builders, Tulsa

project uses approximately 4,500 tons of structural steel in all.

Due to the complex geometry of the project, structural engineer Thornton Tomasetti used Tekla Structures software to lay out the columns in the curved, sloping walls to “best fit” the steel structure into the architect’s building envelope, which was prepared in Rhino. Throughout the design process, the team used the 3D model to visualize and coordinate the structural steel transitions and framing with the architect’s vision. Through the use of the interaction between this software, the design team was able to anticipate and resolve coordination issues before setbacks surfaced in the field. The approach worked so well throughout the design process that it became a project requirement for the construction team to share the 3D model amongst the different trades for coordination purposes.

Marjorie Lund



Benjamin Benschneider Photography



“...work[s] **harmoniously** to achieve efficient designs in structural steel.”

—Raymond Clark

Soundview Aerial Photography



Merit Award—\$75M and greater

SWEDISH ORTHOPEDIC INSTITUTE—SEATTLE

Sitting atop First Hill overlooking downtown Seattle, the new Swedish Orthopedic Institute comprises seven occupied floors, four stories of underground parking, and a two-story penthouse. It covers an entire city block and connects via a sky bridge and tunnel across a city street to the main Swedish Medical Center.

The 372,000-sq.-ft building is the first in Seattle to employ the design of special steel moment frames using AISC 358-05 (Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications). The City of Seattle Department of Planning and Development approved the use of this design methodology for this particular project prior to the official code adoption of AISC 358. Structural engineering firm Lund & Everton LLC worked with the City to develop the proper use of the new standard and establish the special inspection program to assure its proper installation.

“This project deserves recognition for utilization of advanced design techniques while proposed code modifications were still under review,” noted juror Raymond Clark. “It demonstrates that the design community and code enforcement agencies can work harmoniously to achieve efficient designs in structural steel.”

AISC 358-05 allowed the designers to use large beam sections (W27 and W30) as the columns in the moment frames, saving over \$5.00 per sq. ft in construction cost. The moment frames are a reduced-beam section (RBS) system located primarily on the perimeter of the tower. Other prequalified moment frame systems were compared with this frame and the RBS produced the least material cost and fastest installation. Plus, it allowed the team to decrease steel tonnage on the project by 500 tons; total tonnage for the job ended up at 2,500 tons.

According to the project’s architect, NBBJ, the driver for the structural layout was the need for large column-free spans on the surgery floor and a grid that would also be efficient for both the inpatient nursing unit and physician office configurations stacked above. The architects and engineers looked at many options for floor layout and systems and developed a tower floor plan with only 12 (steel) interior columns in the 22,000-sq.-ft footprint.

The RBS system has beam/column connections with bolted webs and welded flanges. The welding of the beam flanges proceeded faster than expected, saving erection time. The column-free bays for the surgery layout in the tower are 37 ft, 2 in. by 30 ft. Trusses over the post-surgery recovery room create a 60-ft by 105-ft column-free area.

A building information modeling (BIM) approach was used to speed the design and ensure the coordination between disciplines. RamSteel 3D software was used for gravity framing, Etabs for the lateral analysis, and Bentley Structural for the BIM model (Soft Steel was used for the detailing). The use of BIM technology was one of the key drivers in compressing the original construction schedule from 22 months down to 19 months.

Owner

Swedish Medical Center, Seattle

Architect

NBBJ, Seattle

Structural Engineer

Lund and Everton, LLC, Vashon, Wash.

Steel Fabricator

Fought and Company, Inc., Tigard, Ore. (AISC Member)

Detailer

Steel Systems Engineering, Inc., Sherman Oaks, Calif. (AISC/NISD Member)

General Contractor

Sellen Construction Company, Seattle

Merit Award—\$75M and greater**UNIVERSITY OF ILLINOIS MEMORIAL STADIUM—CHAMPAIGN, IL**

Built in 1923 in a classical revival architectural style, the University of Illinois Memorial Stadium plays home to the Fighting Illini football team. After more than 80 years of use, though, the stadium was in need of upgrades. An expansion plan, completed in time for the 2008 season, brought the historic landmark into the 21st century, involving the addition of 49 luxury suites, premium clubs, a north end-zone seating bowl, and a training facility, enlarging concourses, and replacing restrooms and concessions.

In many stadium expansions, the suites and additional levels are added adjacent to and outside an existing seating bowl. However, this addition was constructed inside and above the existing facility.

The primary challenges were related to construction phasing, sequencing, logistics, and tight working quarters. The project plan called for the main existing transfer trusses in the interior of the west stadium to be partially demolished to receive the new structure. To prevent damage to the historic façade and colonnades, the existing structure had to be shored, jacked, reinforced, selectively demolished, re-jacked, and supported prior to the completion of the new structure, all while minimizing any movement. The historical masonry façade and other brittle elements were continuously monitored during the process to verify they were not damaged.

Slabs on composite metal deck, supported by composite steel beams, and steel transfer trusses were designed to support the new facility. Using steel allowed the new system to integrate with the old, transfer between two different structural grids, and meet the fast schedule demands, as well as provided the flexibility to adjust connections and configurations in the

field when reacting to uncovered surprises and tolerances in the existing structure.

The material properties of the structure's 1920s-era steel are far different from that of today's steel. As such, material testing was conducted on the existing steel to establish the new welding and bolting provisions necessary. Testing revealed welding was possible, but drilling and bolting to the existing riveted structure was used for all connections with high loads.

"In an era when so many stadiums are torn down to build new, it's nice to see a stadium utilizing steel for a renovation that respects its historical significance," said juror Christina Koch.

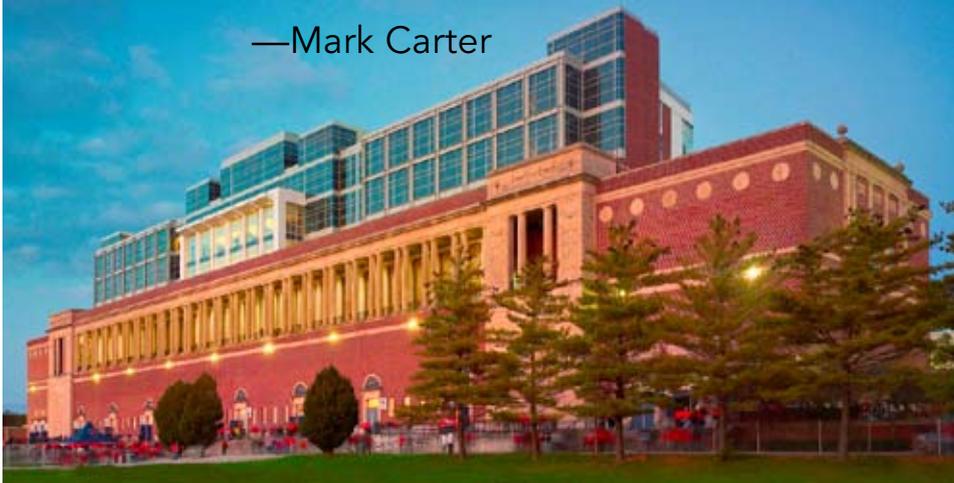
Column loads from the radial structural grid between the upper story suites were transferred to the smaller, orthogonal existing grid supporting the lower bleachers and historic façade. As a result, no single column continued directly from the roof to the foundation. Transfer girders and trusses, both new and existing, were designed to provide a load path for the columns.

The new design required the existing trusses to be cut in half while they were still supporting the upper half of the building. Where existing trusses were cut, an 8-ft-deep perpendicular transfer truss constructed of 12-in. wide-flange sections was erected to support the existing trusses. In addition, a second transition from the 45-ft column spacing of the existing stadium to a 30-ft radial column spacing of the upper levels occurred two levels further above using transfer girders. Total steel used was approximately 3,300 tons.

For more on this project, see "Big Draw" the February 2009 issue of MSC, available in the Archives section at www.modernsteel.com.

"Steel design, sustainability, and constructability win again; with a **beautiful result.**"

—Mark Carter



photos by Brad Feinknopf

**Owner**

University of Illinois, Champaign

Architect and Structural Engineer

HNTB Architecture, Kansas City

Associate Architect

Isaksen Glerum Wachter, LLC, Urbana, Ill.

Steel Fabricator and Detailer

Blattner Steel, Cape Girardeau, Mo.
(AISC Member)

General Contractor

Hunt Construction, Indianapolis