What's COOL in STEEL?

Photo courtesy of Esprit Corp.

THREE NEW AND UNUSUAL PROJECTS demonstrate the lighter side of steel, even where there's serious structural work to be done. A stunning stairway in New York, a wild and wonderful climber in Phoenix, and a treetop playground in Philadelphia all use steel both to support and to delight.

Photo courtesy of Esprit Corp.

Shmerykowsky Consulting Engineers

Cantilevered HSS stair treads provide a stunning look at the center of Esprit's flagship store in Manhattan. The stairway is supported by the HSS wall framing, and in turn supports glass panels with built-in handrails. To see more photos of this project, visit **www.modernsteel.com/photos**.

INDIVIDUALLY CANTILEVERED HSS TREADS MAKE FOR ONE VERY COOL NEW YORK STAIRWAY.

Take the Stairs

BY MARCO SHMERYKOWSKY

FLAGSHIP STORES in midtown Manhattan are designed to impress. The Esprit flagship store, which opened its doors in March, is no different. Esprit and architects Barteluce & Associates chose an eye-catching feature wall and monumental stair, lit and looming at the heart of the new store. Shmerykowsky Consulting Engineers, design engineer of the base building that became home to the new store, was chosen to tackle the tough task of turning an inventive, appealing design into a structurally sustainable reality.

The base building includes three floors—cellar, ground and second. The team at Barteluce & Associates imagined open bays at the center of the ground and second floors, through which a stainless steel-clad monumental stair would rise from the cellar to connect each floor with the next. Anchoring this stair would be the "feature wall," a 25-ft-wide steel-framed structure rising approximately 40 ft and in which glass panel display cases would be embedded to show off Esprit's latest wares. The symbiotic unit of stair and feature wall—an amalgam of stainless steel, clear glass, and gray steel plate—would evoke, in miniature, the sleek modernist look so ubiquitous among New York high-rises while retaining the functionality essential to any retail space.

The stair was to zig-zag up from the cellar, with one flight running east-west to an intermediate landing then another flight running north-south to reach the ground floor. At the ground floor, a north-south flight would reach an intermediate landing between the ground and second floors before another flight running east-west reached the second floor. For the east-west runs, hollow structural sections (HSS) served as the treads. Along this run, each individual HSS tread would cantilever out from the feature wall. These cantilevered treads would be essential to the visual appeal of the stair, creating a gravity-defying illusion of one step floating above another.

Glass panels with built-in handrails would sidle up to the east-west stair runs on one side while the feature wall (with its own built-in handrails) would block off the other. The north-south runs took a pair of glass panels: one that would run continuously from the far edge of the intermediate landing and another that would frame a 90° angle with the single east-west run panel. Glass railings would also surround the open bay at the first and second floors.

Every trace of artifice, every seam, every bolt and rivet and weld was to vanish beneath glossy cladding. It was all going to look so easy, a leisurely little revolt against Newton. But, as anybody in construction can tell you, make no mistake, there's nothing harder than making it look easy.

The toughest question for the engineers? How to support that all-important monumental stair through the feature wall. But that wasn't the only problem. Millwork designed to encase the structural frame was to extend beyond the footprint of the slab opening. Differential deflection between the slab and the stair could potentially damage the proposed millwork. To address this issue, the engineers decided to connect the feature wall to the structural framing at the ground and second floors. Although these connections, which were engineered between the W21×62 girders and the structural frame's HSS posts, would help to minimize the differential movement between the two structural systems, they also would have the effect of transferring loads from the ground and second floors through the structural frame to the foundation. Thus, designing the stair structure meant starting from the bottom up.

With the base building supported on a pile foundation, spread footings were out of the picture. Enter three new concrete grade beams: a 2-ft-wide, 3-ft, 6-in.-deep cast-in-place concrete grade beam which spans approximately 25 ft in the east-west direction, supported by two additional 3-ft-wide by 3-ft, 6-in.-deep concrete grade beams which span in the north-south direction between the existing pile caps. The load-bearing capacities of these new beams would later allow for the engineering of connections which would reroute loads from the ground and second floors to the foundation, thus neutralizing potential differential deflection.

Next up was reframing the bay in which the stair and feature wall were to be placed. The original plan of the base building consisted of a column grid that established framing bays approximately 25 ft by 25 ft in plan, while the architectural design called for a 24 ft by

16 ft open atrium space. To create this new bay, existing W16×26 floor beams were cut at the ground and second floors. These floor beams were re-supported on new W21×62 girders that spanned between the existing wind girders located on the column lines.

Engineers also had to account for the glass railings designed to surround the new bay. At the slab edges on the ground and second floor, a series of segmented bent plates were engineered to extend the floor slab from the beam centerline up to the required opening edge as defined by the architect. A continuous angle was attached to these bent plates using a full penetration groove weld to support the glass panel's mounting shoes. Special attention was given to the welding details to allow the mounting shoe to achieve a tight fit within the limitations established by the architectural requirements.

The five HSS 12×8 posts of the feature wall's structural frame bore on the smaller aforementioned concrete grade beam, using base plates and anchored bolts. To guard against the possibility of differential deflection, these posts were connected to the new W21×62 girders at the ground and second floors. Vertical elements were crisscrossed with HSS 12×8×¼ members, providing structural docking bays for the stringers of the north-south stair runs and also framing space which would eventually be enlivened with display cases.

But most important were the HSS 12×12×⅝ support sections that would support the cantilevered treads of the east-west stair runs between the cellar and ground floor and between the ground and second floor. These sections do the kind of structural work solo that's usually reserved for pairs, ensuring that cantilever deflections would be limited under both superimposed dead and live loads. Every other element in the structural puzzle, every other support, was designed to accommodate these stringers. The HSS 12×12×⅝ support sections, and by extension the monumental stair, defined the engineering of the feature wall, not the other way around.

To provide lateral resistance, a single C12×27 member was installed at the roof level, spanning the entire 25-ft width of the frame and connected to the bottom flange of each beam it passed. With its web horizontal, the C12×27 connects to the HSS 12×8 posts by a series of vertical slotted holes, accommodating the roof beam deflection while also providing lateral support for the feature wall.

With the structural frame ready, so came the treads. The cantilevered HSS 12×4×½ treads for the east-west runs were perhaps the most critical element of the architectural design. The fabricator went to great lengths to ensure that each of these HSS tubes was precisely wrought. An all around bevel weld would connect the treads along the east-west run to their stringers, which meant that the tip of each HSS would have to align flush with the edge of the stringer. Precise welding sealed the deal.

For the north-south runs and adjoining intermediate landings, a trio of HSS 5×3×½ stringers was pressed into service. More conventional than their east-west counterparts, the north-south runs are supported by a pair of HSS 12×8×¼ girders lined up with the structural frame of the feature wall and the W21×50 wind girder in the ground floor slab. The ¼-in. bent plates that would serve as steps were then welded to triangular pieces attached to the girders to ensure that they remain level. And with treads attached, and some cladding here and there, well, that was that.

Even with all the technical details revealed, all the hows and whys answered, by their appearance alone the stair and feature wall still manage to awe. That's making an impression.

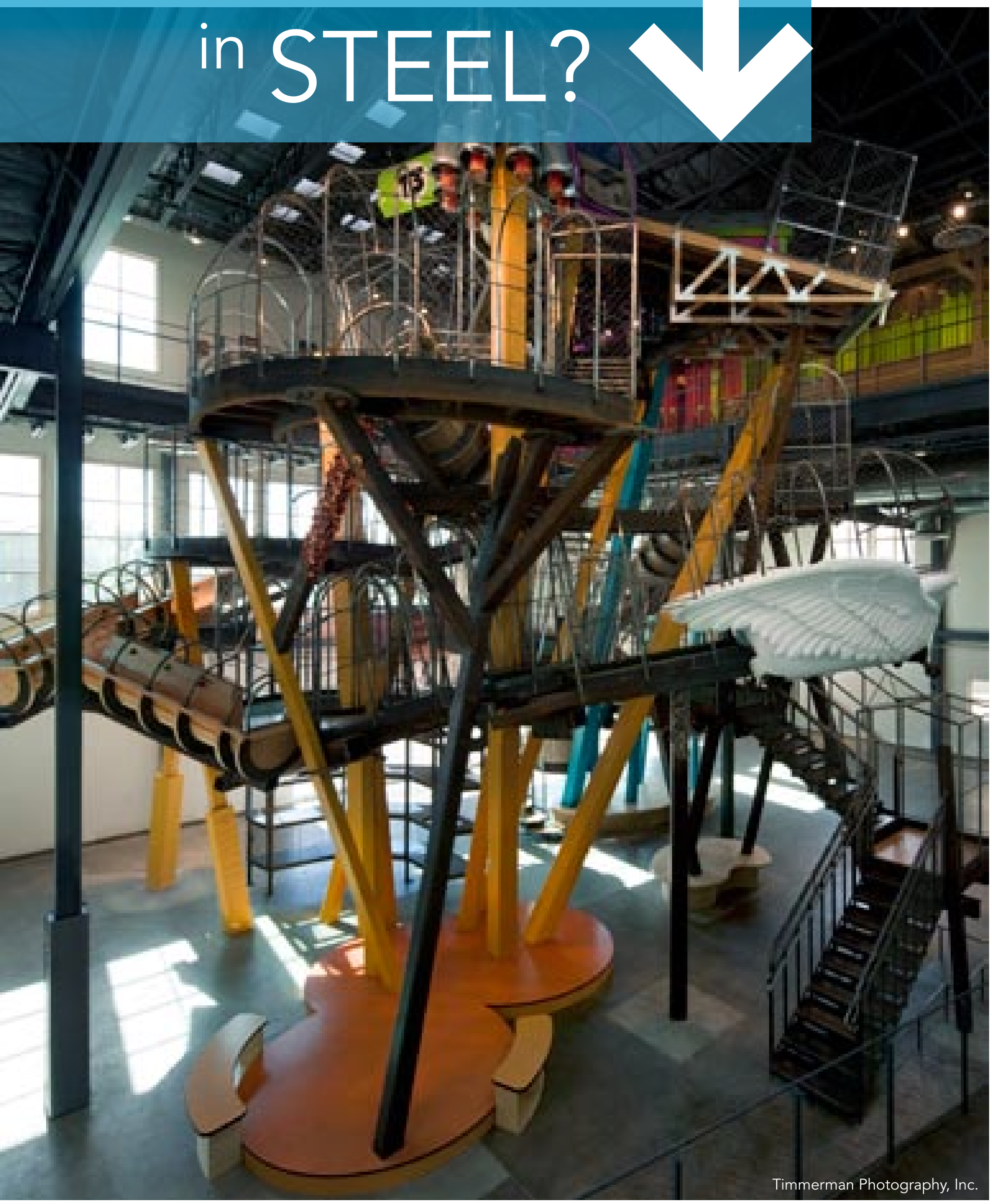
Marco Shmerykowsky is a principle engineer at New York-based Shmerykowsky Consulting Engineers.

What's **COOL** in STEEL?

THE CHILDREN'S MUSEUM OF PHOENIX IS NOW HOME TO A VERY COOL CLIMBER FOR KIDS OF ALL AGES.

An Imaginative Climber

BY DEREK MARTIN,
KEN SCHACHERBAUER,
AND TODD BRUSH



The Schuff-Perini Climber in the Children's Museum of Phoenix required hundreds of connections, 95% of which were bolted together on site.

REMEMBER TREE CLIMBING as a kid and the thrill of being up high, scrambling around on teetering branches? Well things have progressed quite a bit in the 21st century. Climbing apparatuses now come in all sorts of shapes and sizes, including one of the nation's largest, the Schuff-Perini Climber. The climber, which recently opened to the delight of hundreds of ecstatic, adventurous children towers 37 ft, is constructed with 50 tons of structural steel and required BIM, 400 AutoCAD hours, and 37 subcontractors and vendors.

This structurally complex maze of HSS fits with exact precision inside the Children's Museum of Phoenix. In fact, it was constructed inside the existing, very busy, museum.

The three-story climber embraces the museum's philosophy of using ordinary objects in weird, crazy ways. Destination points on the structure include a claw-footed flying bathtub with steel reinforced wings; a rocket ship with real car door fins powered by sand buckets posing as rocket thrusters; a wooden row boat with dangling legs; a slanted attic rooftop looming 28 ft above ground level and inviting exploration; and an 18-ft-long plank that leads to a school of flying fish made from a variety of recycled items.

With four options to ascend the climber, children can crawl, walk, zigzag, and climb on tube steel columns and beams, a water-park slide lined for traction, a ladder, plywood ramps, and see through fiberglass grating. An attached observation deck is accessible from the third floor of the museum for non-climbers to experience the journey.

To keep young explorers secure, the structure is completely enclosed in stainless steel woven wire netting (the same material used in zoos), which allowed the design-assist team to create something far from ordinary.

Planning and Construction

"Envision starting out with a pile of pick-up sticks," said Fred Noelke, principal of Bakkum Noelke Consulting Structural Engineers, Phoenix, the project's EOR. "Unlike other structures there is no inherent structural form to balance beams and columns on. Establishing stability was a major challenge."

Without the use of technology, planning and building the structure would have been cost prohibitive. Building Information Modeling (BIM) in particular was integral to the success of the project. Using RISA structural software allowed designers to analyze the complex asymmetrical structure—no two pieces of steel were at the same angle—and account for the unusual loading from all its appendages (bathtub, boat, rocket, gangplank, etc.). Calculations included determining each appendage's weight, center of mass and how it would interact with the entire structure, all while taking into account bouncing bodies.

How Did This Happen?

"The impetus to move forward on such a colossal undertaking, especially for a young museum like ours, was Dave Schuff, chairman of Schuff Steel Company," said Nancy Stice, director of exhibits for the Children's Museum of Phoenix. "We invited Mr. Schuff to take a tour of the project, which he patiently did, dodging rambunctious, loud children with every step. After the tour Mr. Schuff said matter-of-factly, 'So I guess you want us to build the climber?'" That single sentence, sealed with a handshake, catapulted into motion an iconic museum piece.

Schuff Steel donated materials, including fabrication and erection, and its professional services. In addition to providing construction management and supervision, Perini also lined up the donations of time and materials from the other 37 subcontractors. A complete list of participants can be found on the museum website, **www.childrensmuseumofphoenix.org**.

In acknowledgment of the project's major donors, the museum christened the structure Schuff-Perini Climber.

More than 400 hours went into building the 3D model for the Schuff-Perini Climber, but that's what made its precision fabrication possible. This image courtesy of Schuff Steel Company. To see additional photos, go to **www.modernsteel.com/photos**.

Working closely with the EOR and steel detailer, Todd Brush, lead project coordinator for Schuff Steel Company, spent more than 400 hours inputting every steel piece into AutoCAD. In addition to ensuring the structure was, in fact, erectable, Brush was responsible for guaranteeing that the climber could fit inside an existing, operational museum.

To build the climber, a 12-ft–wide, 7-ft-tall wall opening was cut into the museum's exterior wall. All 50 tons of steel had to be brought in through this one opening, which created more assembly and added roughly three times the number of connections. The largest member was 34 ft 10 in. long, 9 ft wide, and weighed 5,000 lb.

The detailer used Schuff's AutoCAD model as the basis for its complete 3D model built in Tekla Structures software. Together the detailer and fabricator developed the various connections, which were then incorporated into the model. From the model, they extracted a complete set of fabrication and erection drawings.

The atypical structure required working through hundreds of connections to establish accurate measurements for each piece of fabricated steel. It was especially challenging to determine the types of connections to use on all of the various angles while keeping on-site welding to a minimum. In the end, 95% of the structure was bolted on site. After fabricating all of the steel in 45 days at its Phoenix plant, Schuff sent seven of its most skilled ironworkers to erect the structure. Once the steel was erected, Perini and its subcontractors added the climber's finishing pieces, including the wire netting.

Ken Schacherbauer is vice president of field operations, Perini Building Company, Phoenix. Derek Martin is project manager and Todd Brush is lead project coordinator with Schuff Steel Company, Phoenix.

What's COOL in STEEL?

STRONG BUT WITH A LIGHT LOOK, STEEL TOWERS AND NETTING MAKE THIS A VERY COOL PLAYGROUND IN THE TREETOPS.

A Treehouse for All

BY IVA KRAVITZ

THE MORRIS ARBORETUM of the University of Pennsylvania, a 92-acre public garden in the Chestnut Hill section of Philadelphia of trees, gardens, sculptures, and water features, has a popular new attraction—a fully accessible, sustainably designed, 450-ft steel and wood walkway that whisks visitors into the treetops five stories above the forest floor.

Out on a Limb, one of the most elaborate tree canopy walks in North America, was designed by Metcalfe Architecture & Design, Philadelphia, to entice families with an engaging experience to learn about and appreciate trees, while at the same time increasing the arboretum's attendance and membership.

This unusual structure, built with unusual care by its designers, engineers, and construction managers, evolved from a visitor-centered design approach. Market research led to the goal of connecting families with nature in a fun way by incorporating the design elements of "playing to learn" and a slight perception of danger to increase the "cool" quotient. Visitors enter the walkway on level ground but as the land gradually falls away they find themselves in the treetops, experiencing trees in an entirely new way.

The entry, a "moongate" trellis of 10-ft wooden hoops, leads to a walkway sectioned into 30-ft lengths, each ending in a balcony or observation area. This meandering path configuration choreographs time and space for observation and reflection. Visitors can rest in an Asian/Adirondack teahouse-style pavilion that stands on a combination of 8-in.-diameter steel HSS and 10-in.-diameter cedar columns. Or they can cross a suspension bridge to a hanging, people-sized bird's nest with woven twig walls and three enormous blue "eggs" in its center. The nest invites imaginative and interactive play. Further along the walkway, two expanses of rope netting sag intentionally and skirt two huge trees, creating "wading pools in the sky" that invite people to sit along the edges and dangle their feet or jump in and roll around.

Paul Warchol

Visitors to the Morris Arboretum's Tree Adventure can cross a suspension bridge to a giant bird's nest where they can sit on huge robins eggs.

What's COOL in STEEL?

Lead designer Alan Metcalfe says incorporating both wood and steel into the towering structure was done to avoid the impression of cuteness.

"I didn't want the structure to reference a traditional treehouse hidden in the woods, and using steel became both an excellent aesthetic choice as well as a practical one," Metcalfe says.

Everything visitors touch and feel as they walk along is warm wood and visually heavy, Metcalfe, says, while the elements they do not touch, such as the towers, are cool metal and visually lighter and open.

"I wanted a machined feel," Metcalfe said. "The steel made it clear what was manmade and what was natural. It also suggests the industrial past that was part of the site's history. I was very pleased with the lattice-like openness we could achieve in steel. It is a great look."

Steel was an excellent construction material because it is very strong, durable, and recyclable.

"Steel structures have good strength to weight ratios, are very reliable and lend themselves to designs that want to be visually light," said Jon Morrison, P.E., a principal at CVM Engineers, Oaks, Pa., the structural EOR. "Unlike conventional exposed timber structures, properly finished steel structures need less maintenance and inspection. Their life expectancy is easily 25 years, probably much more."

In particular, maintenance requirements of hot-dipped galvanized steel, used for all of the Out on a Limb steel, are very low. The matte finish is corrosion-resistant and does well in the mid-Atlantic temperature zones.

Out on a Limb was built with a commitment to sustainable design in the selection of materials, construction methods and processes, and the minimal use of energy.

While the walkway winds through old-growth trees, it never touches them. "Micropile" foundations were carefully placed to avoid any contact that might disturb the trees' root systems. Arborists assisted with the placement by using giant leaf blowers to blow away the soil surrounding the roots. This was especially important at the Chestnut Oak, a 250-year-old tree that is the centerpiece of the exhibit and is surrounded by structure and decking.

Tree protection continued via extensive layers of mulch with stabilizing fabric, to insulate the roots from traffic on the soil above. To safeguard the trunks, a protective casing of wood slats was placed around the trees in the construction site from the ground level to 6 ft upward. This technique was replicated 30 ft up to shield the upper trees from the construction cranes.

Off-site pre-fabrication of the structure also minimized site and tree disturbance. Many of the wood pieces were assembled in Vermont; they arrived by truck and were boomed in by crane and bolted to the foundations. Similarly the large steel sections, specifically the towers that support the boardwalk and the elements of the tripod that supports the bird's nest, were assembled nearby and trucked to the site.

Even the bird's nest, modeled on a gondola-type ski lift, which weighs approximately 8,000 lb. and is suspended on a steel tripod, was assembled on site, with its upper and lower halves being attached after it was transported in. It was designed as a shell, and then covered in woven twigs. Metcalfe notes there was a sigh of relief in his office when Philadelphia's building department ruled that it was not a building. It is considered an "outdoor structure." Because it had no enclosed spaces it was considered a large area of refuge rather than a building, so it did not require a more complicated design with multiple exits.

The entire lightweight structure is a series of tall towers and ramps that weaves its way through the forest. The use of steel provided the

A teahouse-style structure supported 50 ft in the air on a combination of steel HSS and cedar columns is at the center of Out on a Limb, the Morris Arboretum's 450-ft walkway through the treetops. To see more, go to **www.modernsteel.com/photos**.

Paul Warchol

ability to create a strong and redundant framework. Sited in an ever-changing natural environment, each individual section is structurally independent and can be relocated if needed. The structure does not hang on the trees, which safeguards the trees and prevents a falling tree from destroying the structure. However, if a falling tree damages a section, the rest of the project will remain standing. And, should important trees be destroyed, the steel sections can, with some effort, be boomed to another location.

Locally cut hardwoods used in the structure combined with structural steel, stainless steel "Invisinet," ultra high molecular weight polyethylene climbing nets and polyester bridge netting, to create a structure with a very light footprint on the earth.

The teams designed and analyzed the structure in three dimensions using a suite of programs; Sketch-up to initially explore preliminary ideas, then AutoCAD and RAM Steel as the project moved closer to its final form.

For more information on this project, visit the Morris Arboretum website, **www.business-services.upenn.edu/arboretum**. MSC

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