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BUILDING A JEWEL BOX IN THE SKY

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COVER



BUILDING A JEWEL BOX IN THE SKY

UNIQUE SOLUTIONS PROVIDED ACCESS FOR THE SPACE NEEDLE'S "CENTURY PROJECT" RENOVATION.

BY MATHIEU GRUMBERG

How do you lift a 72,000-pound donut 500 feet in the air? With 12 traction hoists, an elite skilled trade crew, and very, very carefully.

"The donut" was the nickname given to the 106-foot-diameter starter platform that provided access for the recent \$100 million renovation of the

Space Needle. BrandSafway erected the donut on top of the Space Needle's Skyline roof, which was itself 100 feet in the air, hoisted it 400 more feet, and secured it beneath the structure's iconic "Tophouse." After building out the platform to its full size (135 feet in diameter and 174,000 pounds), BrandSafway erected a 28-millimeter weather barrier that could withstand a 115-mph wind





load using Systems Scaffold and track sections. When finished, BrandSafway had built the highest, most weather-protected, and safest temporary suspended work platform — ever. Its erection and progress made nightly news headlines.

Shortly after the initial lift, Karen Olson, chief marketing officer, Space Needle LLC, told Patrick Lynch, ArchDaily's news editor: "This renovation project was a giant game of three-dimensional chess. Getting the elevated platform in place was our first big move. It hadn't ever been done before. Our construction partners had to use a great deal of ingenuity and creativity to develop this plan. That plan — and great weather — allowed us to have a successful platform raising, which allowed us to remain open during construction."

Executing a design from Olson Kundig, general contractor Hoffman Construction oversaw subcontractors that included BrandSafway (access), Front, Inc. (glazing



Custom clamps maintain alignment with the canoe beam, while a tab and slot design further increases strength.



A view of Seattle and the underside of the QuikDeck Suspended Access System. This angle shows how the trusses pivot on central nodes to allow for custom shapes.

advising), Tihany Design (Loupe area), Herzog Glass (barrier glass), Arup (electrical, mechanical and structural engineering), Breed Production Tooling & Design (glass placement robot), Apex Steel (structural steel installer) and Fives Lund, LLC (rotating glass floor).

Key renovation elements included installing 176 tons of specialty glass and structural modifications so that the Space Needle could offer a seamless exterior line of sight to one of the world's most dazzling cities. The new Oculus Stairs, made of glass, steel,

and wood, wind down from the upper observation deck to the Loupe — the world's first and only revolving glass floor — which allows a view of the ground 500 feet below.

Dubbed the Century Project, the Space Needle renovation ensured that



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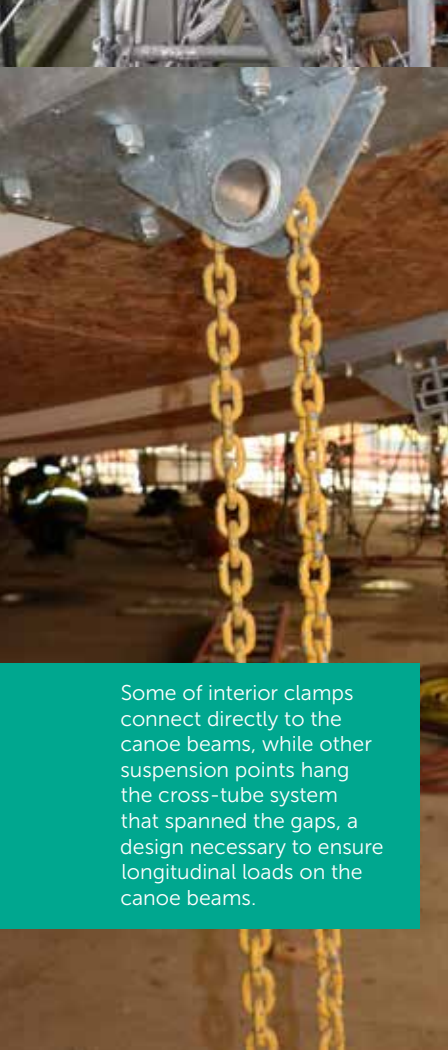
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A view of the Loupe's glass floor. Clamps supporting the QuikDeck can be seen at the left.



On the north side of the Space Needle construction site, BrandSafway created a second-story loading platform using Systems Scaffold, systems stairs, steel I-beams, and aluminum decking with plywood on top.



Some of interior clamps connect directly to the canoe beams, while other suspension points hang the cross-tube system that spanned the gaps, a design necessary to ensure longitudinal loads on the canoe beams.

this icon will continue to define the Seattle skyline into the next century.

“The Space Needle became the visual icon of the city and a symbol for the spirit of Seattle. The original designers of the Space Needle dreamed big, and we continued their vision with this renovation,” said Olson. “With glass walls, glass barriers, glass benches, and even glass floors, visitors can feel like they’re floating over the city. The Space Needle has always featured some of the best views of the Pacific Northwest. Now it offers some of the most thrilling.”

“We built a jewel box in the sky,” said Bob Vincent, project manager, Hoffman Construction. “We wanted to execute the project beautifully to create a happy client while making sure our workers and the general public stayed safe. That’s why we partnered with BrandSafway to provide an access platform for all our crews while we were 500 feet in the air.”

Suspension Challenges

The Space Needle rises on three pairs of legs that surround a central core for freight

and passenger elevators and mechanical and structural elements. At the top, structural steel elements include a ring beam, a large box beam that wraps the core, and 42 “canoe beams” or custom I-beams, that radiate out and curve upward to support the Tophouse elements. Renovation required access for the skilled trades to work below and around the Tophouse perimeters at both its lower level, the enclosed observation area, and upper level, the open-air observation deck.

Erecting 500 feet of traditional scaffold was possible, but drawbacks included material and labor expense and inhibiting foot traffic, which went against the owner’s desire to remain open during renovation. Because of the property’s small footprint and proximity to other structures, tower cranes could not be located in the right areas. As a result, this unique structure demanded an innovative suspended access solution.

“QuikDeck was a new system that we learned about through BrandSafway,” said Vincent. “The big challenge at the Space Needle was that we needed to work 500 feet

in the air, and we couldn’t lift an entire work platform up at once. The system allowed creating a starter platform, lifting it to a fixed point and then building out. It’s like a Transformer happening in the sky, which was a huge advantage over trying to lift a completely built-up platform or traditional scaffolding. This system is certainly something we’d like to use in other applications.”

The system uses 8-foot trusses that connect to a central node via a pin and retainer clip system, with no special tools required. Once pinned, the trusses pivot outward to form squares or triangles. Workers then secure 3/4-inch-thick sections of structural grade-one plywood with oil-sealed edges to provide a flat, stable, and sturdy work surface with a load rating of 25 to 75 lbs. per square foot. Grade-100 chain running through the central node extends upward and connects to beam clamps attached to the structure at hand. Once a starter platform has been erected, the system’s modular design allows a “leapfrog” style construction to build out the work surface.



Notice how the ends of the square tubing overlap. This design provided a small degree of adjustment for good fit-up, and the bolts secured the ends in place.



“Once Hoffman agreed on the new platform system, we had to figure out how to attach suspension points,” said Sean Drew, project manager at BrandSafway. “The structure provided us with some engineering challenges.”

Specifically, the canoe beams are stitched together rather than continuously welded. As a result, the beam clamps would need to be long enough to capture enough of the skip welds to handle the forces applied. Additionally, to eliminate the possibility of twisting, third-party engineering firm Magnusson Klemencic Associates determined that the canoe beams could only handle loads

pulling in the direction of the beam and could not handle side loads.

“Since the system’s central nodes could not always be located in line with the canoe beams, we designed special beam clamps and a cross-tube system that spanned the gaps between the beams,” explained Paul Jolicoeur, technical manager, product applications, and the principal BrandSafway engineer for the project. “We could locate a suspension point anywhere around the outer and intermediate perimeters of the Space Needle.”

BrandSafway’s Infrastructure Services Group custom-designed and fabricated the beam clamps and cross-tube system. The cross-tubes feature a square tube within 6-5/8-inch-diameter round tube. The inner square tube can telescope to provide field adjustment and then bolts securely in place. In all, BrandSafway, Hoffman and third-party engineers spent the better part of a year developing the design.

“Our confidence level was much higher because we used Autodesk Navisworks,” added Jolicoeur. “We could import

Hoffman’s 3D model, confirm clamp locations, evaluate loads and check for clashes. You name it, we could model it and share data with the other engineering teams.”

Protection and Staging

More than one million people visit the Space Needle each year. To protect them, BrandSafway erected an elaborate series of overhead falling-object protection systems over the main entrance, valet parking area, and gift shop, all located on the south side. On the west side, 225 feet of standard sidewalk protection using Systems Scaffold, steel plank, and 3/4-inch plywood wrapped around the Space Needle, a monorail to downtown, and the Museum of Pop Culture.

The main construction entrance was located on the north side of the property. Here,

BrandSafway erected a series of overhead protection, stairs, and loading platforms for material removal and loading. A crane lifted material to a second-story location, where it would then move via freight elevator or by hoist. The Space Needle, as well as the final platform, featured a small notch to accommodate the hoist.

“This was a very complex project with a lot of safety challenges,” said Drew. “Yes, we erected overhead protection, but our goal was to eliminate dropped objects in the first place. We implemented a policy for 100-percent tethering of equipment and tools and used zippered bags to contain smaller items.”

“Nothing dropped on this project. Everything stayed in the air,” states Vincent. “Working 500 feet off the ground creates different dynamics than just working on the outside of a building.”

In addition to dropped objects, the wind load was a major concern. “Before we erected the weather barrier, the first wind-storm hit. We went up there, 100-percent tied off, to do a sweep of the area to make sure nothing could





blow off,” says Vincent. “The wind blew 56 mph. People thought they might be nervous, but the platform was rock solid.”

Lift and Build

The Skyline-level conference rooms, located at 100 feet, prevented hoisting a completely pre-built platform from ground level. As a result, Jolicoeur designed the starter platform so that it could be built on the Skyline roof. Because of its modular design, the platform components were easily hand-transported in the freight elevator.

Ultimately, the donut consisted of 12 major sections. Three curved segments, each with three subsections, were 16-foot wide. Three 8-foot-wide “bridge” segments provided clearance for the Space Needle’s legs as they flare out at the top. After securing all the platform sections, 12 two-part Tractel motorized wire rope hoists, each with an 8,800-lb. capacity, were secured to a platform node. A hoist spreader beam further secured the hoist to nodes on either side.

“We custom-designed and fabricated the hoist spreader beam and hoist connections for this project so that we could simultaneously lift all platform sections,” says Jolicoeur. To secure the platform after

the lift, a rope access team installed a dozen beam clamps in precise locations designated by Jolicoeur.

“The clamps weigh 200 pounds each, so the rope access crew rigged a series of ropes from underneath and over the side of the Space Needle so that they could easily maneuver them,” says Jolicoeur. “Each clamp has eight bolts that require 90 to 100 foot-pounds of torque. The work done by the rope access team was amazing.” This work also included installing 12 sheave blocks, pre-threaded with 800 feet of wire rope for the hoist, on structural steel elements of the Space Needle’s Tophouse.

After starting access work on September 5, 2017, all components were in place for a lift on the clear, calm night of September 15. BrandSafway stationed one worker on each of the sections to monitor the hoists, eight workers on the Skyline level to manage the wire ropes, and three workers on some of the Space Needle’s cross-bracing elements at the 200-foot level, also to watch cables. All personnel were secured with lifelines at all times. After starting, progress moved cautiously. The crew would lift for 10 feet, stop, recheck lifelines and cables, relevel the platform, and then move up another 10 feet. After reaching its final

height, the workers secured the platform to the pre-installed beam clamps. The process took two nerve-wracking hours.

“This was a very complex job. I was incredibly nervous because no one had ever done a lift like this before, but I have great trust in our engineering department and crew,” said Drew. “Paul Jolicoeur provided incredible support, and Site Foreman Jake Willis watched over the crew to keep everyone safe.”

Dismantle

During erection, the team could pass materials through several holes in the Loupe’s glass floor. With the Loupe now complete, bringing platform and barrier materials out through the freight elevator wasn’t possible. The only option was lowering them down via the Space Needle’s hoist.

“Because we had to maintain the structural integrity of the platform, as well as manage the forces from the wind, the engineering work for the dismantle was at least as challenging as the erection,” says Drew.

“We divided the dismantle into 12 steps and calculated loads for every step, again working with Hoffman and Magnusson Klemencic Associates for review and modification,” says Jolicoeur. “Once approved, we developed step-

by-step safety procedures so that Willis and the 21-person dismantle crew could prepare for literally every action.”

One of the larger challenges involved shifting the beam clamps to restore the area underneath. BrandSafway would loosen the clamp and slide it along the canoe beam. Ironworkers from Apex Steel would add welding reinforcement where the beam had been, and then painters would remediate any paint damage.

The final challenge involved removing the last sections of the starter platform. A four-person team from Global Rope Access in Squamish, British Columbia, transferred suspension points to the hoist and removed the final beam clamps. The event made the evening news.

“The bottom line for us is having a safe project,” said Vincent of Hoffman Construction. “BrandSafway had no injuries, no recordable incidents, and no dropped objects. That’s fabulous, and something BrandSafway and their crew should be very proud of.”

About the Author

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