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High Roller:

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Reinventing the Wheel

Top: Some 2,000 individual LED fixtures are programmed to light up the High Roller at night. Lighting design was provided by Abbey Rosen Holmes, of NYXdesign LLC. Left: The High Roller observation wheel rises 550' at the eastern end of The LINQ, a new retail corridor combining new and existing properties.

The High Roller creates a new focal point on the Las Vegas Strip

By: Judith Rubin

At 550' high, the High Roller is a new icon in the Las Vegas skyline and has been validated by Guinness World Records as the tallest observation wheel in the world. Positioned at the easternmost end of The LINQ, Caesars Entertainment's new strip-within-the-Strip opening onto one of the busiest street corners in the universe, the High Roller, which opened on March 31, is a focal point for the Caesars and Harrah's properties now consolidated under Caesars.

Rotating sedately with a maximum throughput of 1,120 people per half-hour circuit, the High Roller is packaged as a full guest experience complete with themed environment—and an engineering breakthrough. Its unique single-tube design facilitated the spherical shape of its twenty-eight 40-passenger stand-up cabins—described by

pop culturist Charles Phoenix as “bubblicious.”

The High Roller is owned and was executive-produced by Caesars Entertainment Inc. The Caesars team included Greg Miller (executive vice president, development, Caesars Entertainment) and contractors Randy Printz (project management) and David Codiga (executive project director). Heading the external team were creative director Phil Hetteema, of Pasadena-based The Hetteema Group (THG, producer and concept designer), and architectural design company THG of Nevada LLC, formed by Hetteema and John Kasperowicz, AIA (design architect). Wheel engineering and design were provided by Arup North America Ltd., whose project manager was Jason Krolicki.

Additional designers included Abigail Rosen Holmes, of NYXdesign LLC, to light the wheel (under contract to



Components of the spherical cabins were fabricated by suppliers in various parts of the globe, and had final assembly in the Las Vegas warehouse of Leitner-Poma.

Caesars), featuring Martin Professional fixtures provided by Las Vegas-based 4Wall Entertainment. Lisa Passamonte-Green, of Santa Clarita, California-based Visual Terrain (contracted to THG), provided concept design for lighting the wheelhouse building, which features gear from ETC and Philips Color Kinetics. Illuminating Concepts executed the design and commissioning of the building's lighting under the architect of record, Klai Juba Wald Architects Ltd.

Kevin Ruud, of Vegas-based Design Horizons Inc., was AV and show control systems designer. Ruud was contracted to National Technology Associates (NTA), whose project manager was Nevin Edwards. NTA was contracted to Bombard Electric, working in turn under general contractor Richardson Construction.

THG's team also included project designer Jodi Roberdes, designers Kye S. Lee and Juan Acuna, project director Anthony Pruett, project coordinators Diana Cimadamore and Corinne Cunningham, and general manager Deborah Saale. Mark Goerner provided cabin concept design, with concept art and illustration by Michael Abbott, Michael Marquez, and Michael Scheffe, and interior design and color selection for the wheel, cabins, and wheelhouse by Maureen Johnston and Laura Garrett. Additional credits appear below.

Theme team

Miller, Codiga, and Printz are all past creative execs with Disney and/or Universal credentials. Kasperowicz, Holmes, Passamonte-Green, and Ruud are all seasoned Disney alumni, along with wheel engineering consultant Frank Weigand, of The TWT Group. Lance Heywood, of Heywood Engineering, designer of the wheel's PLC-based integrated ride control system (IRC), has extensive experience working on amusement rides. Theme park credentials also show up in the High Roller's day-to-day management: Eric Eberhart (general manager; 15-plus years with Disney) and James Donahue (operations manager; four years with Paramount Parks).

"Theme park experience is really significant for a project like this," says Hetteema, "because designing and building it is such a multidisciplinary endeavor, mashing together all the theatrical disciplines, plus architecture, plus engineering."

"Entertainment design is a spiral," says Kasperowicz. "You keep revisiting; new information comes in from the perimeter and you have to be flexible to adjust for it, without messing up your process."

Kasperowicz and Hetteema coordinated with The LINQ's design and planning architect David Schwarz Architects to determine wheel placement relative to The LINQ and the Strip, and with Klai Juba Wald to develop concept design



drawings into construction drawings.

Choosing Arup to engineer the High Roller was, to Hetteema, a “no-brainer, not just because of prior experience with big wheels” [design development on the London Eye and reference design for the Singapore Flyer], “but because they are of the same school as us: Their stock-in-trade is anything unusual, around the world. The look of the wheel and its configuration were our responsibility. Arup figured out how to make it stand up and, with sub-consultants, to make it move.”

Single ring/spherical cabin breakthrough

The High Roller cabins stick out around the rim—a design attribute the London Eye and Singapore Flyer share, but “it was Arup’s engineer, John Lyle, who said, ‘I wonder if we could do this with a single ring,’” says Hetteema. “They went back and did some counts, and then we were able to say, ‘That means we could do a spherical cabin.’”

“The London Eye has two slewing bearings and a large truss rim supporting the cabins,” says Krolicki. “We got that down to a single slewing bearing and a single rim for the High Roller; that’s unprecedented and is what allows the spherical cabin. The concept of 360° views led to the cabin shape. Elongated cabins, such as on the Eye or Flyer, direct your view. The idea of the High Roller is that you’re going for a flight—so it’s important that when at the



The High Roller’s single-ring wheel design made it possible to have the spherical cabins with unobstructed views, standing 2m out from the wheel rim. You can see the Venetian and the Palazzo in this view.

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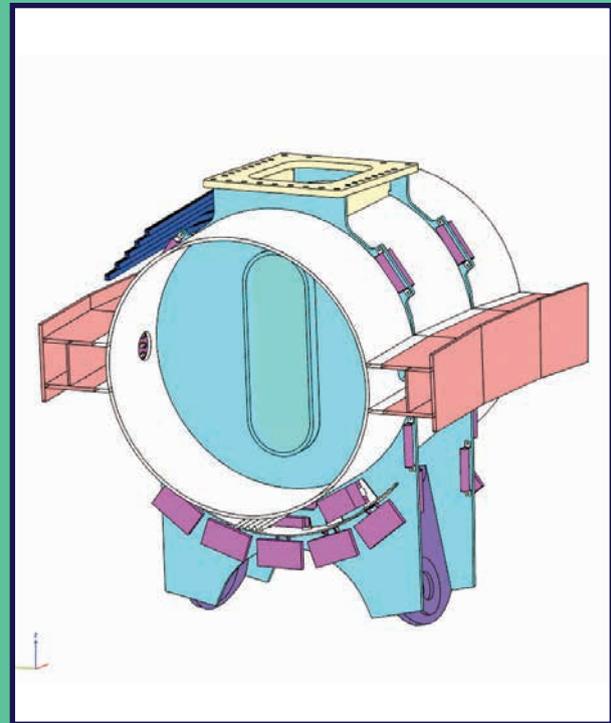
On the maintenance platform of the High Roller, the drive systems and the emergency retraction systems are visible.



Close-up of the hub-and-spoke construction of the High Roller.



The High Roller under construction. Segments were attached at the bottom; the wheel would be rotated to add the next section. This picture was taken from the roof of the parking garage of Caesars Palace.



Cross-section diagram of the wheel rim, at a point where the cabin connects on the top and the spoke cables connect at the bottom.

Photos: Kevin Raud; Diagram: Courtesy AtUp



In the fourth-floor rack room, the gear includes 7th Sense servers and Alcorn McBride V16 Pro controllers.

top you're not nested within a structure like the traditional Ferris wheel; instead, you're flying above it. We were able to stand the cabin 2m [6.56'] above the rim, which was very different from preceding wheels with trusses. The slewing bearing supports this and allows each cabin to rotate in this singular, tubular containment while keeping the floor level."

"The single tubular rim is segmented—as opposed to curved," says Randy Printz. "The rim is connected to the hub and spindle with one hundred twelve 3" locked coil cables that act as the spokes of the wheel."

The cabins were computer-modeled at what Hettema calls "rocket science level" to fine-tune design and sizing of all components, finishes, and systems, mocked up at the Grand Junction, Colorado shop of Leitner-Poma of America Inc. (LPOA), design/build and engineer of record for the cabins, and sourced worldwide. Steelwork was provided by Laron Inc. in Kingman, Arizona; exterior fiber-reinforced plastic (FRP) components were done by Sigma (a sister company to LPOA) in France. Interior FRP was done by MFG in Adelanto, California. Parts were shipped to Arizona, integrated into the framework, then trucked to Leitner-Poma's Las Vegas facility for assembly. The curved, tinted, double-glazed curtain walls, crafted by Sunglass in Italy, were likewise sent to Las Vegas, then installed in the cabins' steel structure.

Lighting the wheel

"There are no positions to throw light from that high in the air," says Hettema. "But if you put the lights on the wheel itself, what are you pointing at? Light doesn't travel in curved lines. The solution was about 2,000 very focused, programmable small fixtures that light the entire wheel in aggregate and gave Abbey a canvas to paint on. To create a new icon on the Strip, the most visually busy line of architecture anywhere in the world, the solution was to be clean and simple. Abbey nailed it."

There are 896 Martin Professional Tripix 300 LED strips

and 1,008 Martin Tripix Wash units with 240 Pathway Connectivity E-Din CMX/RDM splitters (four-way), and 16 Pathway Connectivity Pathport E-Din DMX nodes.

"Not every lighting designer gets to be part of changing the Las Vegas skyline," says Holmes. "We initially covered every prospect on how to treat it. We hauled out and tested lights on roofs of Las Vegas to see how something looks from 500' away. An important requirement was that both the system and the programming be successful from a variety of viewing distances: up close for riders, mid-distance from the top of The LINQ, and the very far distance from across the valley, the airport, etc."

The process included a full-scale wooden mockup of one segment of the wheel at Los Angeles-based Lexington Design & Fabrication. The actual wheel, made of steel and shipped in huge sections from China, "was not something where you could take another look and move something over a foot or two," says Holmes.

"Once it left the factory, it could not be modified. In addition to the mockup, quite a few 3-D drawings were generated," says Buddy Pope, senior project manager for system integrator 4Wall Entertainment.

Holmes' lighting team included senior designer Emanuel Treeson, also of NYXdesign, who collaborated on the specification of the lighting system; Troy Shackelton, lead for the electrical contractor Bombard Electric Inc.; and programmer Jason A. Badger. 4Wall project technicians were Heather Martinez, Shane Stine, David Foley, James Leblanc, and Shaun Ballew.

"The wheel itself is the star and we were helping show it off," Holmes says. "The lighting intent was to be kinetic and exciting but in a sophisticated way, and emphasize the very clean, modern structure. Programming sequences change over a lengthy period and the programming patterns were conceived to add dimensionality, to emphasize the curved shape. Using a three-color LED system, we were able to get a lot of variety. The lighting frequently returns to white to reveal the pure object. The lighting is intended to appear integral to the wheel itself. Fixtures were given a custom finish to match the wheel, and, where possible, an eyebrow designed by the architects was included to partially mask fixtures."

Lighting control for the wheel comes from an Alcorn McBride V4 Pro show controller, two Alcorn McBride IO64 parallel I/O controllers, two MA Lighting NPUs (Network Processing Units), and two MA Lighting grandMA2 replay units in the control tower on the dock. The wheel lights spring into action at sunset every day, starting with about 20 minutes of sequences compatible with sunset conditions, transitioning to exploit full darkness, and punctuated by a special sequence every hour on the hour. Other pre-programmed sequences were created for holidays and events. Additional programming was created to allow an operator to enter custom colors for special



Night view of the High Roller. The wheel and its lighting system draw power from a copper rail. The "cake" lighting feature atop the building at the right is programmed to echo the wheel lighting.

events and occasions.

One challenge was to keep the shows oriented on a rotating object. "The top-of-the-hour show, for instance, starts at the 12 o'clock position and then goes down each side," says Pope. "To accomplish this, the V16 takes a signal from the IRC to know which cabin is on top and then communicate that to the grandMA."

Most of the Pathway Connectivity opto-splitters are in custom-made enclosures spread out around the wheel. "The easiest way to cable it was to provide each individual fixture with a DMX home run to an opto-splitter, to divide up the DMX data," says Pope. "The enclosures are in each 'knuckle'—where a cable attaches to a rim section. For such a simple-looking design, it was a complex system."

A Millennial guest experience

Guests obtain tickets online, from the ticket office or ATM-like machines in The LINQ, then enter the five-story wheelhouse, which complements the neo-futurism of the wheel with its colors, fixtures, and circular motifs. (This building

also contains support offices, an equipment room on the fourth floor, and special event space on the top floor.)

"The experience is there to foster interactions between people: those you arrived with and those you meet," says Hettema. "Millennials, the target audience, are wary of anything too clichéd or 'theme park-y,' but they also want to know they're being paid attention to. Caesars brought on accesso, the ticketing contractor, to realize the crowd-flow scenarios we planned in a way that can be adjusted over time as needed."

After the first-floor security queue, you board an escalator for the second floor and emerge into a mood-lit room offering two options: Continue upstairs to board, or kick back first in the bar and lounge. The next escalators brings you to the third-floor departure concourse—a near-circular theatre for stand-up viewing of six Vegas-themed videos executive produced by THG. Walls painted with Screen Goo form a 232° viewing screen (billed as 270°) that is 13' tall by 120' long/1200 pixels by 9970 pixels. The 12.1 audio system uses six JBL AM7212 main screen

speakers, six JBL AC28/26 rear speakers, and two JBL ASB7118 subwoofers. On a platform overhead are seven Christie Digital WU7K-M projectors and four Martin MAC Vipers. Content is delivered by 7th Sense Delta and Delta Nano media servers in the fourth-floor rack room.

Equipment racks and PCs in the fourth-floor equipment room are part of the AV and show control system designed and engineered under the direction of Kevin Ruud. The audio DSP is all BSS London with Crown power using DCi8 600N, I-T5000HD, CTs2000blu and CTs3000blu amplifiers. Audio distribution throughout is mostly Blu-Link transmission, with AES digital on other pathways. Video distribution uses Extron PowerCages and Foxbox receivers. A video editing area features a MOTU HD Express interface and Alcorn Pro-TraXX for prerecorded messaging. There are two Alcorn ShowTouch touch-screens: one for overriding the automated wake-up and shutdown of the systems as well as service access to all systems, and the other indicating the current location of all cabins on the wheel.

Proceeding from the departure concourse along the loading path lined with stainless-steel railing—composed of a Banker Wire frame and woven wire mesh and a handrail by R & B Wagner, fabricated by Southwest Architectural Metals—you board your High Roller cabin through the open doors as it slowly comes into position (or is brought to a brief stop for disabled access or special event loading).

“Platform height and building configuration were informed by several factors, including the need to be able to drive emergency vehicles under it,” says Kasperowicz, “We went through a submittal process, concerning flight paths, to get the maximum height of 550' established. Then we worked our way down, setting the platform height, the wheelhouse building, floor levels, and loading platform. We had to keep a certain distance from the monorail, which cuts through the building. We needed two ways in—one for the general public and another for tour groups, and to let VIPs skip parts of the regular sequence. Everyone exits through retail and back out to The LINQ.”

Lighting the building

Illuminating Concepts (IC) was contracted to Klai Juba Wald at the conclusion of the concept and schematic phases for most of the architectural and effects lighting and control for the wheel house. The IC team included Kelly Stechschulte (project director), Josh Fisher (senior designer), Bruce Culver (designer), Scott Lempert (field project manager), Brandon Youells (content design/programming), and Dawn Shepherd (procurement).

“We provided a peer review to value-engineer design and complete documentation for construction, construction administration, and on-site integration of the lighting systems,” says Stechschulte. “The Philips Color

Kinetics Flex LMX customized for our application was one of the key modifications, first tested for intensity of effect and controllability through multiple mockups. There was a lot of preprogramming and animation time to reach the vision of Caesars and THG.”

The key equipment includes Philips Color Kinetics ColorFuse Powercore (66 pieces), Color Kinetics iColorflex LMX Gen 2 (custom application nodes 4" on center, 45 strands), Beta Calco Bubble RGB pendants in three diameters: (two 24" pieces, three 40" pieces, one 70" piece), an ETC Unison Mosaic control system and ETC Sensor 3 dimming racks, and two ELTS (Emergency Lighting Transfer Systems).

The four Martin Mac Vipers, which share space on the projector platform in the departure concourse to accent the videos shown there, were handled differently: “THG scoped the fixtures, and Caesars bought them and arranged their installation. Abbey Rosen-Holmes and 4Wall programmed them,” says Printz.

“Each of the kinetic fixtures/features was critical in the overall vision of the space,” says Stechschulte. “Through color and slowly changing lighting features and effects, and a sense of direction via the content of the portals, the intent is to guide visitors through the building. The Bubble pendants greet them at points of entry and the Flex nodes located within each of the portals create energy and direction to draw them along and up. It was important to the client that we synch kinetic portals to time with the various video segments.” The lighting palette was coordinated with artist Chris Reccardi’s colorful murals throughout the pre-show spaces that tell the story of a couple meeting on the High Roller.

No-button control

The mainstay of the Windows-based control system designed by Ruud is the network of Alcorn McBride V16 Pros (two in the wheelhouse, one on the platform in the control tower, one in each of the 28 cabins) that communicate with the control tower. A cabin reaching the zero position at the loading platform signals the tower, which relays back to all the others.

The networked V16s are tied to the AV and lighting systems. This internal clock system automatically turns itself on in the morning and runs through a half-hour start-up and diagnostics procedure, then carries on throughout the day until self-shutdown time.

“The V16Pro and Digital Binloop HD were a natural fit for the control and synchronous video playback needs of the High Roller cabins,” says Scott Harkless, director of sales, Alcorn McBride. “Since the gear is installed in the floor of the cabin, access to it is extremely limited. It had to be compact and ultra-reliable.”

The passengers’ trip to the top is punctuated with information, music, and entertaining commentary. The V16s

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On The LINQ.

control 28 Alcorn McBride four-channel Digital Binloops playing AV in the cabins (one per cabin) on Samsung MD32C 32" monitors. Each cabin has eight monitors, six full-range custom Leon PR-400 speakers located between monitors, and one Innovox subwoofer under one of the

two seats. Each cabin also has an Alcorn AM4 audio player, and Crown CT8150 eight-channel, convection-cooled power amp, emergency intercom, and surveillance camera. Under the floor are the AV rack, two storage cabinets of emergency supplies and backup HVAC.

Samsung monitors are used in the wheelhouse public spaces. All are 32", except five 55" units in the first-floor security queue and five 40" units at the photo redemption area near the gift shop. Two Alcorn-McBride Binloops, in the fourth-floor rack room, drive them along with three other monitors in the bar and one at the departure concourse. Another Binloop in the control tower drives a monitor on the platform.

The control tower houses audio processing and amplification for the platform and the intercom exchange station. It accommodates two live operators to do such things as slow down or stop the wheel for special loading situa-

tions, respond to emergency calls, adjust cabin volume, or override programming. Gear includes the Alcorn ShowTouch touch-screen interface for V16 Pro, BSS BLU-10 BLK programmable touch-screen Controller, BSS BLU-800 networked signal processor, four Crown CTs600BLU amplifiers, one Alcorn-McBride 8-TraXX with Ethernet audio playback unit, one Alcorn McBride Digital Binloop, one Alcorn McBride LightCue Pro, three Extron MTP RL 15HD receivers, TOA intercom interface gear, and one Behringer TRUTH B3030A monitor speaker.

"All cabin and wheel components communicate to the control room over a network that is part of the IRCs and consists of both wired and wireless elements," says Printz. "Wherever possible, the path is wired (including fiber). However, at the points where the system crosses sides of moving elements (cabin slewing ring and wheel hub and spindle), the connection is wireless."

"Bandwidth had to be allocated among ride control, lighting, AV show control, and the intercoms in each cabin," says Ruud. "Connections run up through the wheel's four support legs to the wheel hub—which holds a set of wireless network transceivers—and from the hub to the rim on



The LINQ as seen from the Strip.

fiber, with networked distribution points around the rim. Between every two cabins is another set of wireless transceivers. Originally, the system was set up to send each wireless command three times, but we lost info packets. Now, to ensure receipt, it goes 120 times, which still takes less than a minute.”

The tower will send cue commands to keep the video segments synchronized in each cabin according to its progress along the circuit. The cabin control system provided by LPOA provides position updates to all cabins. This information is updated each time a cabin passes through a fixed point on the platform.

Drive systems, safety, and seeing it through

Arup’s brief included designing the High Roller for a 50-year lifespan and satisfying Clark County building codes. “This involved identifying every possible failure mode and making sure they were either statistically improbable or

similar to electrical bus bars—with a copper rail distributing power around the rim. Power is transferred to the copper rail by a fully redundant set of electrical shoes that articulate with the rim as it turns. Power is similarly fed to the cabins, distributed from the rim via transformers that step down the power.

Should there be no power available, the wheel is evacuable via manual mode recovery drive, a self-functioning, stand-alone diesel-powered mechanism with hydraulic arms that can reach out, grab the rim, and turn the wheel.

There are multiple ways for maintenance workers or rescuers to traverse the structure. Each leg has ladders and platforms, stabilized by dampers to keep them from vibrating in the wind. There are attachment locations for cables.

Arup’s team, drawn from its San Francisco and London offices, included Krolicki, Michael Willford, Rob Smith, Adrian Crowther, Mary Ferguson, Brandon Sullivan, Nicholas Christie, Brandon Kluzniak, Ibbi Almufti, Alexej Goehring,

“There are no positions to throw light from that high in the air. But if you put the lights on the wheel itself, what are you pointing at? Light doesn’t travel in curved lines. The solution was about 2,000 very focused, programmable small fixtures that light the entire wheel in aggregate and gave Abbey a canvas to paint on. To create a new icon on the Strip, the most visually busy line of architecture anywhere in the world, the solution was to be clean and simple. Abbey nailed it.” — Hettema

designed out, and testing all components of backup systems as well,” says Krolicki.

The drive system was provided under a design/build contract by Schwager-Davis Inc. Arup handled concept design and SDI was in charge of detail design and fabrication. The wheel rotates at the platform level via a total of eight drive units, each consisting of four Michelin truck tires, 3’ in diameter, that are pinched around the drive rail and hydraulically linked to push together in one direction. “The whole drive system is 100% redundant from the power source through to the truck tires,” says Krolicki. Under contract to Schwager-Davis Inc., who fabricated all the electrical components for the system, Heywood Engineering designed and programmed the PLC-based IRC system that runs the wheel.

Electrical systems are fully redundant, to disallow any single point of failure. The wheel’s main power comes from the Nevada grid. A backup generator has the capacity to run the systems, and a crossover switch at the platform level can engage either of two distinct electrical rooms that feed a ConduTix-Wampfler collector system on the wheel—

Shaun Landman, John Lyle, Pat Dallard, Simon Cardwell, Chris Murgatroyd, Hugo Mulder, and Andrew Allsop.

As lead contractor on the wheel, American Bridge Co. played a design assist role in completing contract documents, giving input on construction and erection, and directing fabrication by ZMPC and Japan Steel Works. The wheel drive systems contractor was Schwager Davis Inc. and the systems are housed in a structure on the loading platform and run from the control tower.

Arup did the reference design for all engineering of the wheel, proved the concept, then stayed on as engineer of record for structural and geotechnical engineering, and as owner’s engineer for the drives and cabins. “The original intent was to hand it over completely to design/build,” says Krolicki. “But American Bridge asked us to continue, because we knew the design better than anyone and had a good relationship with the owner. I think there was great benefit in terms of the project schedule, and the ability to make sure others were delivering. Having our people there to see the initial design and concepts through was good for quality.”