

# ONE SHELL OF A STRUCTURE

In the United Arab Emirates, it's not enough for a shopping mall to have, well, nice stores. The Mall of the Emirates in Dubai has all that and an indoor ski resort, to boot. So, in the land of can-you-top-this, is anyone really surprised that the new Yas Hotel in Abu Dhabi has a Formula 1 racetrack running through it? Game over, right? There's nothing that Aldar Properties, the hotel developers, could do to beat that. Guess again—to top it all off, they have *topped it all off* with an illuminated steel and glass gridshell that can be seen for miles around.

There's much more sandwiched between the racetrack below and the gridshell above. The complex, situated half on land and half on water and overlooking a marina, houses 850,000 sq ft

of built space, including 500 rooms and suites, 14 restaurants and lounges, and a host of spa treatment rooms, exercise facilities and rooftop swimming pools. Without question, though, the architectural centerpiece is the gridshell, a sweeping 217-meter, curvilinear structure that mimics the throw of a fishing net. The hotel design and gridshell was the brainchild of Asymptote Architecture, New York. Arup Lighting provided the lighting design for the exterior and gridshell. The Arup team included roughly 20 people from four different offices led by Brian Stacy from the New York office.

The gridshell drapes the two hotel towers that straddle the racetrack. It's composed of steel forms and approximately 5,000 diamond-

An illuminated veil of steel and glass draped over a mega-hotel punctuates the Abu Dhabi skyline

BY PAUL TARRICONE



The gridshell covers the two towers of the Yas Hotel that straddle the Formula 1 racetrack. It's composed of steel forms and approximately 5,000 diamond-shaped glass panels.



The Abu Dhabi Grand Prix began at dusk and finished at night, allowing the hotel to show off its shell.

Photos: Arup



Mock-ups of the glass panel were tested after the original plan to include load-bearing crossbars in the panels (inset) was abandoned.

shaped glass panels, which vary in size from 450 millimeters to about 5 meters. The glass panels are fixed to the steel but rotated 30 deg from the structure. The panels also have a carefully selected low-e coating and frit pattern that “works to balance the visual transparency, with properties that respond according to the different daytime and nighttime lighting conditions,” says Stacy.

The steel and glass are illuminated by nearly 5,000 custom LED luminaires mounted to connection nodes on the glass and perpendicular to the gridshell normal. The luminaires include a custom optic for the desired per pixel fadeout light distribution. The luminaire was designed to have an asymmetrical light distribution, dependent on the size of the panels. One luminaire per panel was used (with the exception of about 99 panels, which have no lights).

The programmed color-changing lighting and media sequences have transformed the gridshell into “a vibrant shroud” over the two hotel towers, says Stacy. “It plays against the surrounding sky, sea and desert landscape.”

#### PANEL DISCUSSION

A high level of durability and craftsmanship were obvious criteria for the luminaire, but the fixture also had to include an optical assembly that worked with the curvilinear form of the gridshell. “As the project design evolved, so did the luminaire design, and vice versa,” says Stacy.

At the start of the project, the luminaire was expected to have a downward central point and outward distribution. During the schematic phase of the project, crossed tie-lines within the glass panels were investigated as a way to better distribute the structural load of the entire gridshell. The lighting was tested against this design, but the tests showed that shadows formed on the glass panels when these bars were placed across them. In a rare victory for lighting designers over structural engineers, the crossbars were ultimately removed, allowing each glass panel to become a shadow-free pixel again.

A section of the gridshell without the crossbars was then mocked-up to review different types of glass, dichroic coatings and luminaire options. The mock-ups verified the position of the luminaire on the front (exterior) of the gridshell.

Subsequent prototype luminaire mock-ups tested for light distribution, thermal management, constructability and proof of concept. The luminaire eventually specified was an aluminum IP65 cylinder incorporating a four-channel LED array and beam angle diffuser. UK-based Enfis supplied the LED drivers and arrays, and the UK’s Cooper Lighting & Safety performed pre-manufacturing engineering and built the luminaires.

#### COOL AND UNDER CONTROL

The design also had to consider the sizzling desert climate, as summer temperatures in Abu Dhabi can reach 120 deg F during the day. Gavin Smith, managing director of Cooper Lighting, says his company knew from the start that the ambient temperature “would be a major challenge considering the inherent performance limitations for LED components and driver technology.” The company tested a number of LED products, but “the Enfis array/driver systems were the only ones that passed our rigorous environmental chamber trials.”

At the core of the lighting design at Yas is a “cutting-edge control system,” says Stacy. E:cue (a Traxon Technologies company) supplied the system. Each luminaire is independently controlled by a control server through a DMX Remote-Device Management protocol. The system provides bi-directional communication between the LED lighting on the gridshell and the control server; sends status reports to building management; and automatically adjusts the intensity of the LEDs to prevent overheating. Two-way communi-

**Gridshell lighting required nearly 5,000 aluminum cylinder luminaires housing a four-channel LED array and beam angle diffuser.**

cation with each driver/array combination provides real-time monitoring of fixture temperature, CCT and energy consumption.

The e:cue software also creates the color-changing lighting sequences and plays customized three-dimensional low-resolution video content on the gridshell. The lighting sequences and media files can be uploaded remotely through the Internet, and the content is triggered by programmed automation based on a matrix of settings tied to the astronomical clock, daylight sensors and a touch-screen user interface.

Finally, solar analysis was another critical component of the project and addressed “concern about reflections off the glass panels of the gridshell, and the solar shading provided by the gridshell structure on the enclosed hotel towers below,” Stacy explains. The analysis helped determine the glass panel positions and their rotation angle.

**PEDAL TO THE METAL**

The project team followed an accelerated schedule, completing the gridshell in less than two years and in time for the Abu Dhabi Grand Prix, which took place October 30-November 1, 2009. The Formula 1 cars and drivers even had to share top billing with the gridshell. Indeed, the start of the race was rescheduled to begin at dusk and finish in the dark in order to show spectators the building in all its illuminated glory. 🏎️



Photo: Cooper Lighting & Safety



**Race to the Finish**

- January 2008:** First project charrettes for the architectural and lighting concept.
- April 2008:** First gridshell mock-ups in Vienna, including preliminary lighting experimentation.
- May 2008:** Refined gridshell mock-ups.
- June 2008:** First phase of working drawings for contractor use.
- July 2008:** On-site mock-ups in Abu Dhabi with final prototype luminaires.
- August 2008:** Luminaire manufacturing underway.
- September 2008–March 2009:** Various exterior site and bridge lighting design projects and packages.
- Early 2009:** Construction underway (laying of cables and luminaire installation).
- June 2009:** Topping off of steel with last gridshell “ladder.”
- April – July 2009:** Content-creation process generates the media to be used on the gridshell.
- August 2009:** Major gridshell content presented to owner.
- September 2009:** Gridshell content finalized.
- October 2009:** Site work and calibration of content for gridshell.
- October 30–November 1, 2009:** Abu Dhabi Grand Prix.

**METRICS THAT MATTER**

**Yas Hotel**

**Glass Panels:** approximately 5,000, varying in size from 450 mm to 3 m

**Total Fixtures:** approximately 5,000 custom LED luminaires



**About the Designer:** Brian Stacy, Member IES (2002), LEED AP, IALD, leads the New York Arup Lighting office for the multidisciplinary architectural consulting and engineering firm. He has extensive experience designing lighting and related systems for a range of exterior and interior environments in the cul-

tural, civic, entertainment and corporate sectors. Prior to joining Arup, Mr. Stacy was the resident lighting designer at The Field Museum in Chicago. Projects since joining Arup include the Institute of Contemporary Art, Boston; the Seattle Art Museum Expansion; the Case Library expansion for Colgate University and the Fulton Street Transit Center in New York.