
BUROHAPPOLD
ENGINEERING
WHERE DO YOU EXPERIENCE BOTH
THE JOURNEY AND THE DESTINATION?
ANAHEIM REGIONAL TRANSPORTATION INTERMODAL CENTER
9:28am
Bus Information
BUS TICKETS &
To Trains
Restaurants
Bus Bays 6-10
Restrooms
Bus Bays 11-13
Bus Bays 1-5

SMARTER FASTER

INTEGRATED SOLUTIONS FOR CIVIC ARCHITECTURE

VISION

To catalyze transit-oriented growth, Orange County envisioned a world-class gateway linking regional transportation systems, providing convenient access to the area's renowned destinations, and offering distinctive restaurants, shops and events. The iconic, LEED Platinum landmark embodies the region's commitment to a vital, sustainable future.

CHALLENGE

As a modern multi-modal transportation hub designed to connect eight existing public and private transportation systems as well as future streetcar and high-speed rail lines, ARTIC involved extensive coordination of complex infrastructure. When combined with aggressive sustainability targets—including 30% reduction of both energy and water use—and the desire for a landmark design, the project demanded a fully integrated design solution to achieve project goals within budget tolerances.

SOLUTION

Taking a holistic design approach using BIM and advanced computational design and analysis tools allowed the design team to propose a complex catenary-shaped enclosure employing lightweight ETFE panels. In addition to optimizing the design for energy performance and constructability, the models facilitated cost estimating, construction sequencing, just-in-time ordering, and digital fabrication.

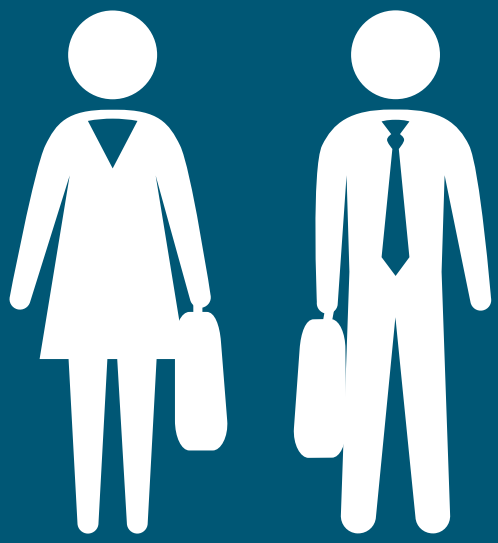
VALUE

The integrated solution leveraged the ETFE enclosure to address multiple goals. The translucent and insulating panels with varied frit patterns maximized daylight while reducing solar heat gain. Equally important, at just one-tenth the weight of glass, these lightweight panels required a less costly steel support structure. The modeling also enabled strategies for natural ventilation and water recycling that will reduce resource consumption and operating costs over time.


ANAHEIM REGIONAL TRANSPORTATION INTERMODAL
BAGGAGE CHECK
TAXI
California Yellow Cab

$188 MILLION
PROJECTED COST

40 MILLION
ANNUAL ORANGE COUNTY VISITORS



5,000
JOBS CREATED

EXPECTED DAILY BOARDINGS

CATALYZING A BETTER ANAHEIM

The Anaheim Regional Transportation Intermodal Center (ARTIC) is a world-class transportation gateway rooted in the tradition of grand rail stations yet embodying Orange County's vision for a sustainable, transit-centered future. ARTIC will serve the transportation needs of more than three million people across 34 cities and 40 million annual visitors to Orange County, including 20 million alone to Anaheim thanks to popular attractions such as the Disneyland Resort, two major sports venues, and a convention center.

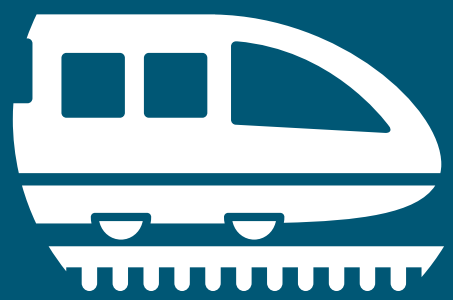
In addition to linking the region's rail, bus, taxi, and roadway systems—as well as bicycle and pedestrian pathways—in one central location, ARTIC will anchor the Anaheim Rapid Connection (ARC), a new streetcar system currently undergoing approvals, and mark the southern terminus of California's future high-speed rail line connecting the state's growing urban centers. With retail, restaurants and an expansive main hall, ARTIC also will serve as a community destination and event venue.

By enhancing local and regional transit options, ARTIC will spur future development within Anaheim's Platinum Triangle, a mixed-use district slated for millions of square feet of new office, commercial, and residential development. Development-related revenue from public-private partnerships, job growth, expanded tax base and other sources will further strengthen the region's economy.

10
TRANSPORTATION MODES

200,000
ETFE SQUARE FEET

1,082
PARKING SPACES



540,000
ANNUAL METROLINK RIDERS

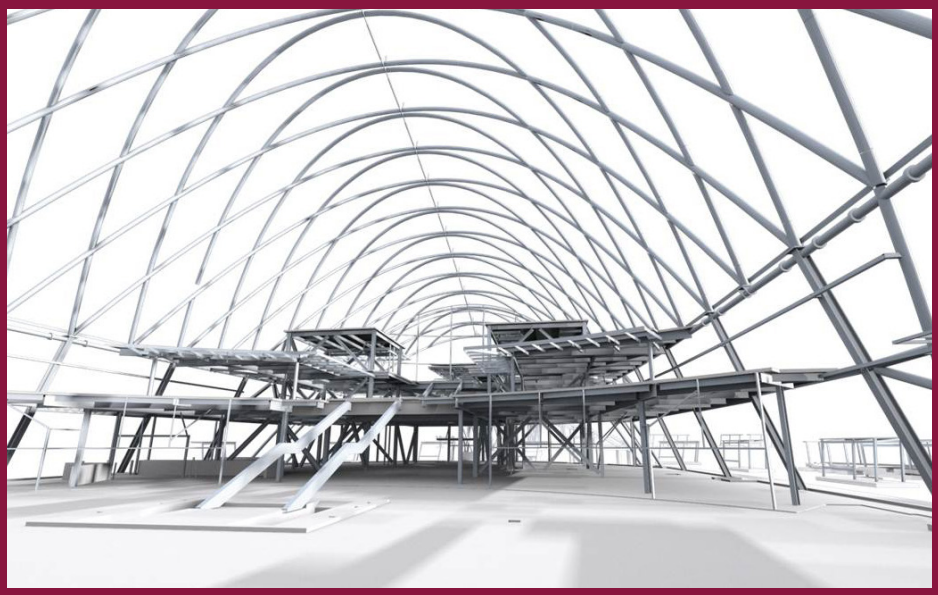
16 ACRES
OF SITE SPACE

67,880
SQUARE FEET OF TERMINAL

Image © Tom Fox, SWA

ACHIEVING MORE WITH LESS

TECHNOLOGY ENABLED DESIGN AND DELIVERY



While ARTIC's dramatic form establishes the facility's civic presence, it also composes a large percentage of the construction cost. Achieving project goals for design, cost, schedule, constructability and environmental performance, therefore, demanded a highly efficient design employing advanced materials systems and a level of accuracy not possible with conventional design and construction methods.

Taking a highly integrated team approach, BuroHappold worked closely with the design team led by HOK and Parsons Brinckerhoff, as well as Clark Construction, collaborating in a virtual environment to meet project goals.

BuroHappold's engineers, computational modeling experts and building physics analysts led the development of computational models for energy simulation, daylight simulation, lighting simulation, geometric rationalization, building systems coordination, cost estimation, fabrication, and construction sequencing.

Early 3D modeling of details and components helped stakeholders visualize the aesthetics of proposed systems, materials and technologies. Using virtual design and construction with BIM also facilitated construction sequencing, just-in-time ordering and delivery, and other time-saving processes.

THE ARTIC TEAM STRUCTURE

ARCHITECT
authors design model for coordination

STRUCTURAL ENGINEER
authors design model;
reviews coordination model

MEP ENGINEER
authors design model;
reviews coordination model

ENCLOSURE ENGINEER
authors design model and geometry model;
reviews coordination model

CONSTRUCTION MANAGER
manages BIM coordination; performs model-based estimating

PLUMBING SUBCONTRACTOR
authors coordination and fabrication model

HVAC SUBCONTRACTOR
authors coordination and fabrication model

ELECTRICAL SUBCONTRACTOR
authors coordination and fabrication model

STEEL SUBCONTRACTOR
authors coordination and fabrication model

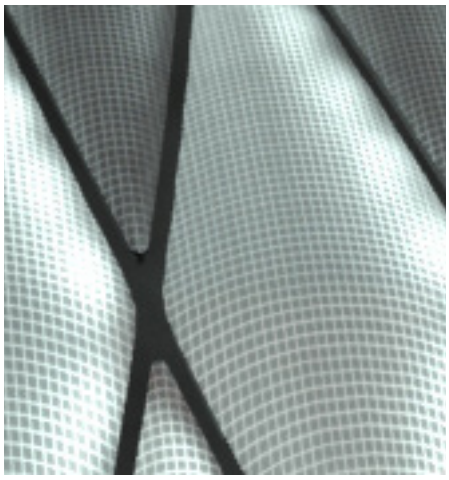
CURTAIN WALL AND METAL PANELS SUBCONTRACTOR
authors coordination and fabrication model

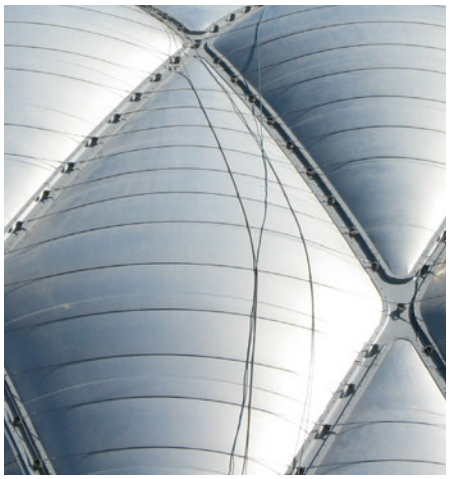
CONCRETE SUBCONTRACTOR
authors coordination and fabrication model

THE FUTURE IS LIGHT

ETFE

ETHYLENE TETRA FLUORO ETHYLENE
ONE-TENTH THE WEIGHT OF GLASS



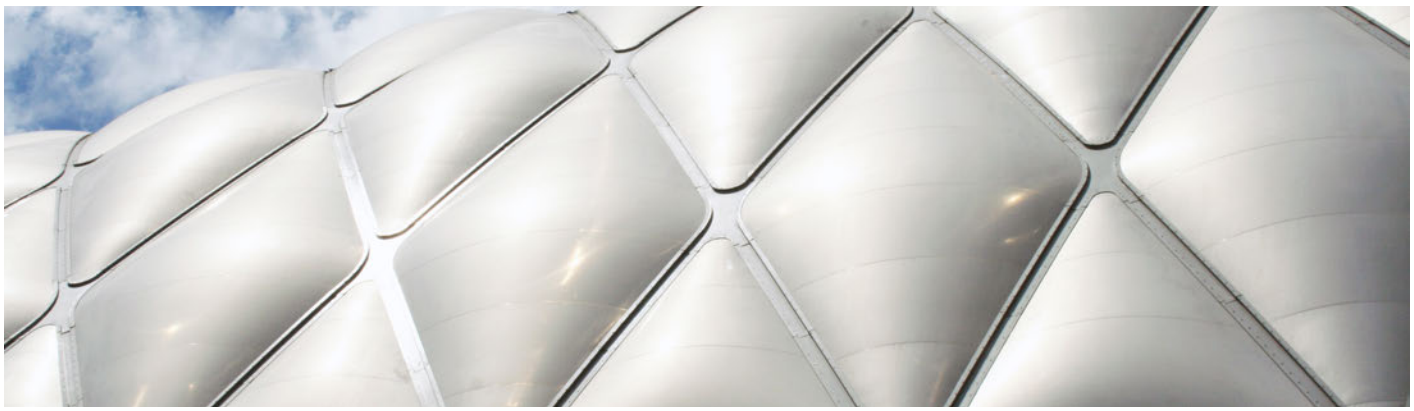


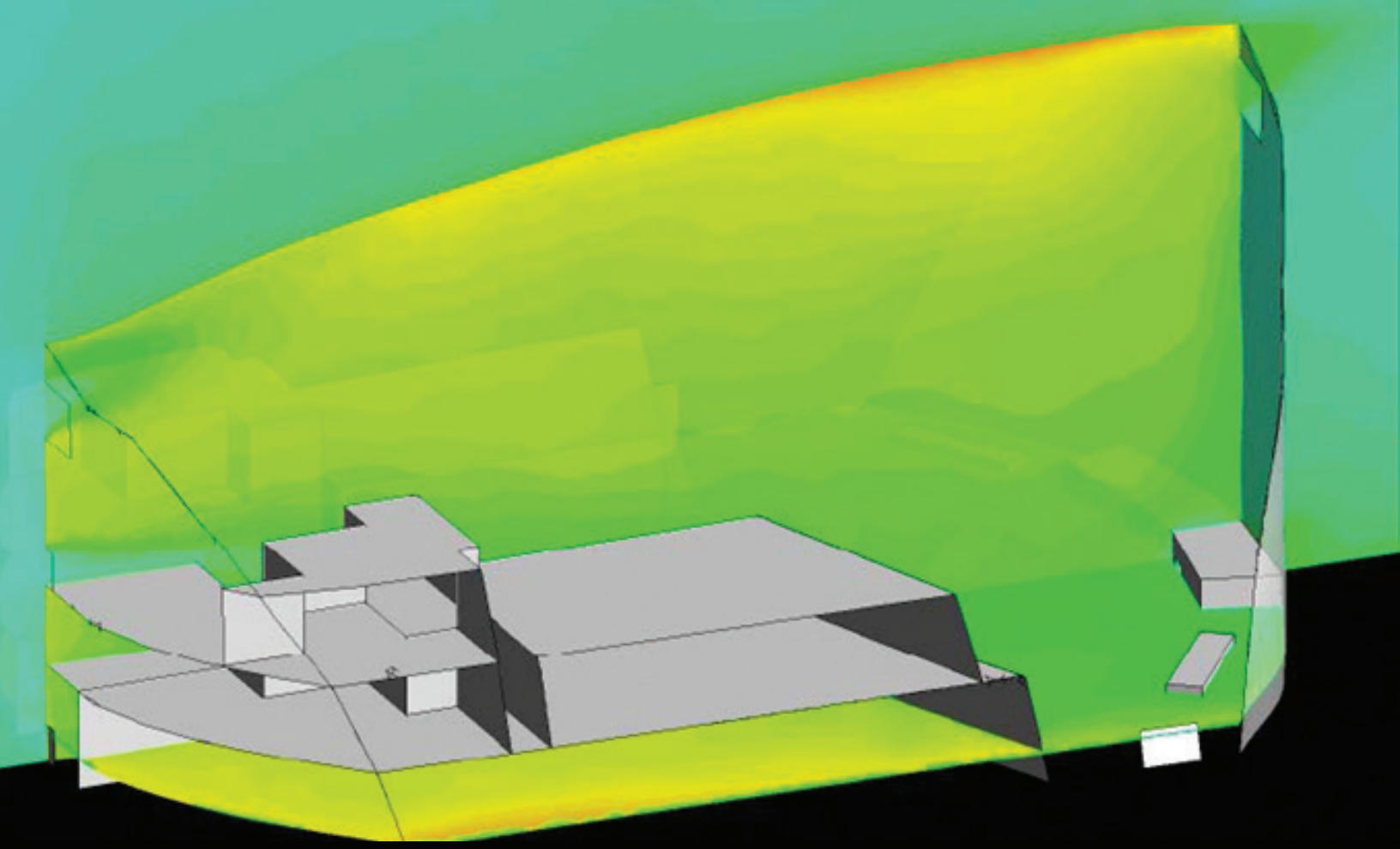
Based on initial analyses, the design team zeroed in on a three-part enclosure system comprising structural glass curtain walls, a metal rainscreen system, and what is currently the largest application of an ETFE (Ethylene Tetra Fluoro Ethylene) roof cladding system in North America. At one-tenth the weight of glass, the ETFE system generated substantially lighter loads on the supporting diagrid steel structure, thus significantly reducing the enclosure's cost while contributing to its streamlined aesthetic.

The ETFE cushions are composed of three layers of foil with varied frit patterns to reduce solar heat gain while maximizing daylight within the center. Because ETFE's thermal performance as well as structural performance relies on air pressure within the pillows, BuroHappold conducted detailed structural analysis of wind loads, deflections of the diagrid structure, and related stresses on the pillows. The connection systems and details also were designed to accommodate high temperature variations in the naturally ventilated building.

THE GEOGRID

Refining and rationalizing the shell's complex geometry required the development of multiple unique scripts and routines to enable smooth workflow between software programs such as Catia, Rhino, Revit and Robot analysis tools. The modeling proved critical to gaining required approvals for the ETFE system, which remains relatively uncommon in North America, and essential to its construction. For design control and precise coordination, all components associated with the complex shell form were coded into a software-agnostic "geogrid" that reduced the design to its simplest geometric elements—points and arcs—in order to convey exact design dimensions to all team members.

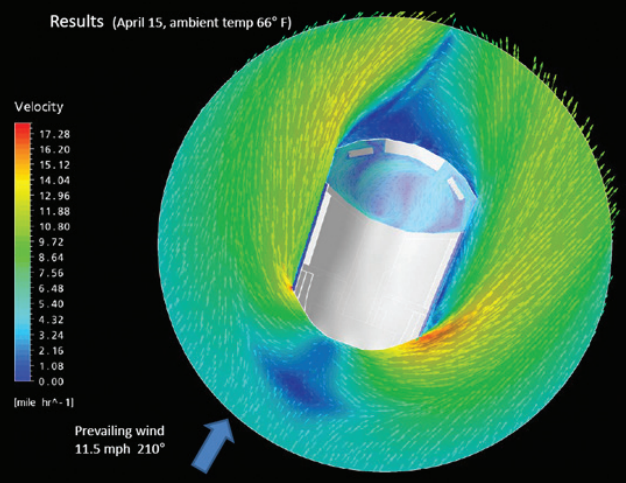




KEEPING ARTIC COMFORTABLE

High-transparency glass curtain walls enclose the north and south ends of ARTIC's ETFE shell. The curtain walls, which rise to 120 feet tall on the main north face, are hung from the roof by cables and supported laterally by rolled-steel wind girts and custom-cut armatures. The walls feature operable glass louvers controlled by a central building management system to provide natural ventilation for the center's dramatic main hall.

The team used computational fluid dynamics analysis to confirm that radiant heating and cooling—combined with natural ventilation—would maintain comfortable temperatures within the occupied stratum of the main hall.



Wind speed contours and vectors at pedestrian level (2m above ground)

120 FEET TALL

CURTAIN WALLS

GLASS LOUVERS

TO PROVIDE NATURAL VENTILATION

FLUID DYNAMICS

TO MAINTAIN COMFORTABLE TEMPERATURES

TOWARDS ZERO NET WATER

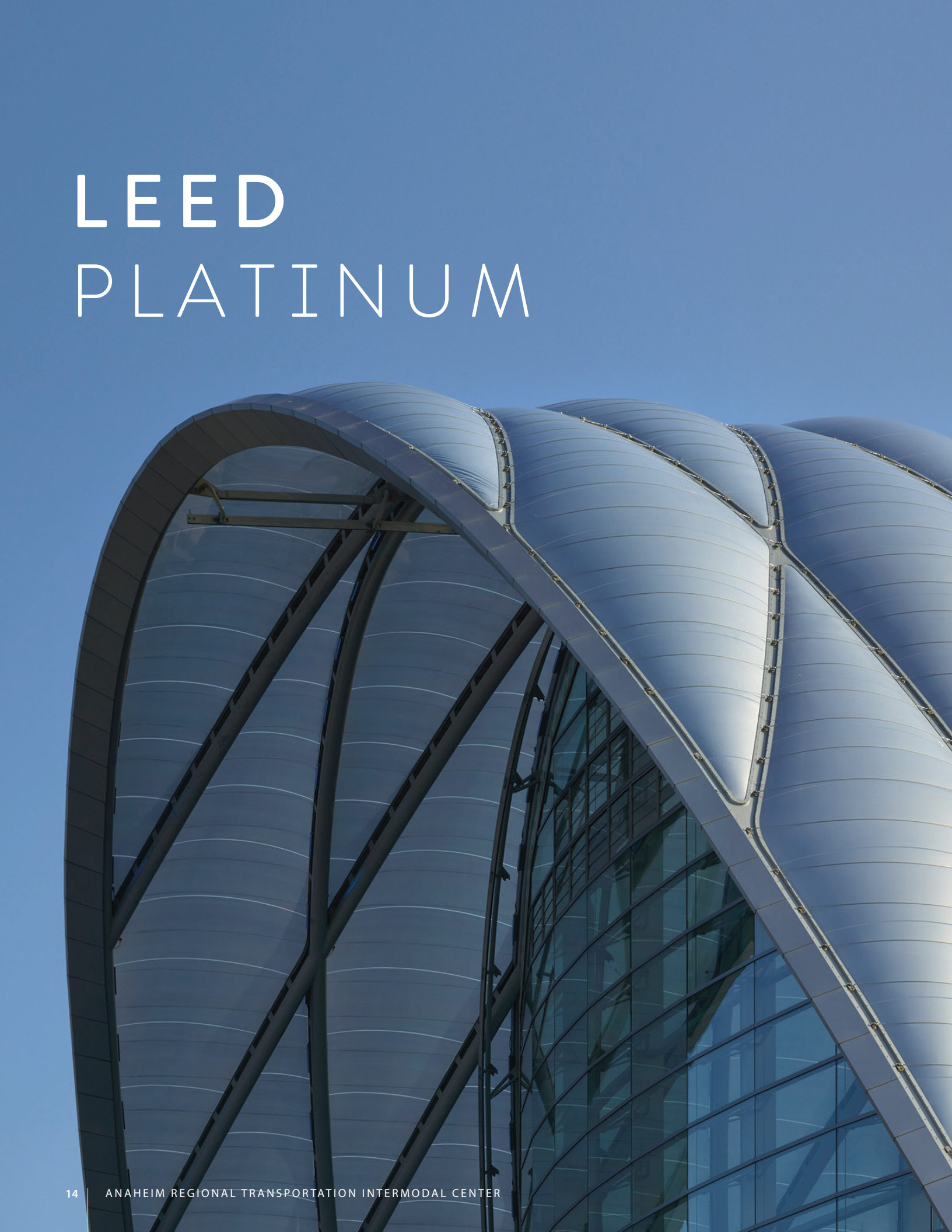
44%

REDUCTION IN WATER DEMAND

With a target of LEED Platinum achieved, the design team took an aggressive approach to water conservation and reuse from the outset. In addition to a 44% reduction in water demand through the use of low-flow fixtures and dual-flush toilets, ARTIC incorporates a recycled water system for toilet flushing, irrigation and cooling towers.

The comprehensive strategy reflects close collaboration with the Orange County Water District; the partnership allows ARTIC to use water from their Groundwater Replenishment System (GWRS) within the ARTIC site while also providing additional groundwater recharging basins for the county.

LEED PLATINUM



100%

OF COOLING TOWER AND IRRIGATION NEEDS MET WITH NON-POTABLE RECLAIMED WATER

33%

ENERGY COST SAVINGS OVER ASHRAE 90.1 2007

44%

REDUCTION IN BUILDING WATER DEMAND THROUGH LOW-FLOW FIXTURES

28.6%

ENERGY SAVINGS OVER ASHRAE 90.1 2007

As the centerpiece for Anaheim's long-term plan for sustainable urban growth, ARTIC also establishes a high bar for environmentally responsive design. The center achieved LEED Platinum certification, the highest rating possible from the U.S. Green Building Council, thanks to its integrated design.

Key components include the following:

WATER EFFICIENCY

- 44% reduction in building water demand through low-flow fixtures
- 80% of building non-process water needs met by reclaimed water
- 100% of cooling tower and irrigation needs met with non-potable reclaimed water
- Capture of stormwater runoff with site infiltration system and underground vaults
- Drought-tolerant native plant species incorporated into landscaping

ENERGY & ATMOSPHERE

- 28.6% energy savings over ASHRAE 90.1 2007
- 33% energy cost savings over ASHRAE 90.1 2007
- 150 kW DC photovoltaic arrays on parking shade structures meet 20% of the building's electrical needs
- High-performance ETFE roofing membrane
- Radiant flooring system

MATERIALS & RESOURCES

- Goal: +95% of construction waste diverted from landfills
- Goal: +20% recycled content, such as steel
- Forest Stewardship Council (FSC) certified wood

INDOOR ENVIRONMENTAL QUALITY

- Increased ventilation
- Low-emitting materials

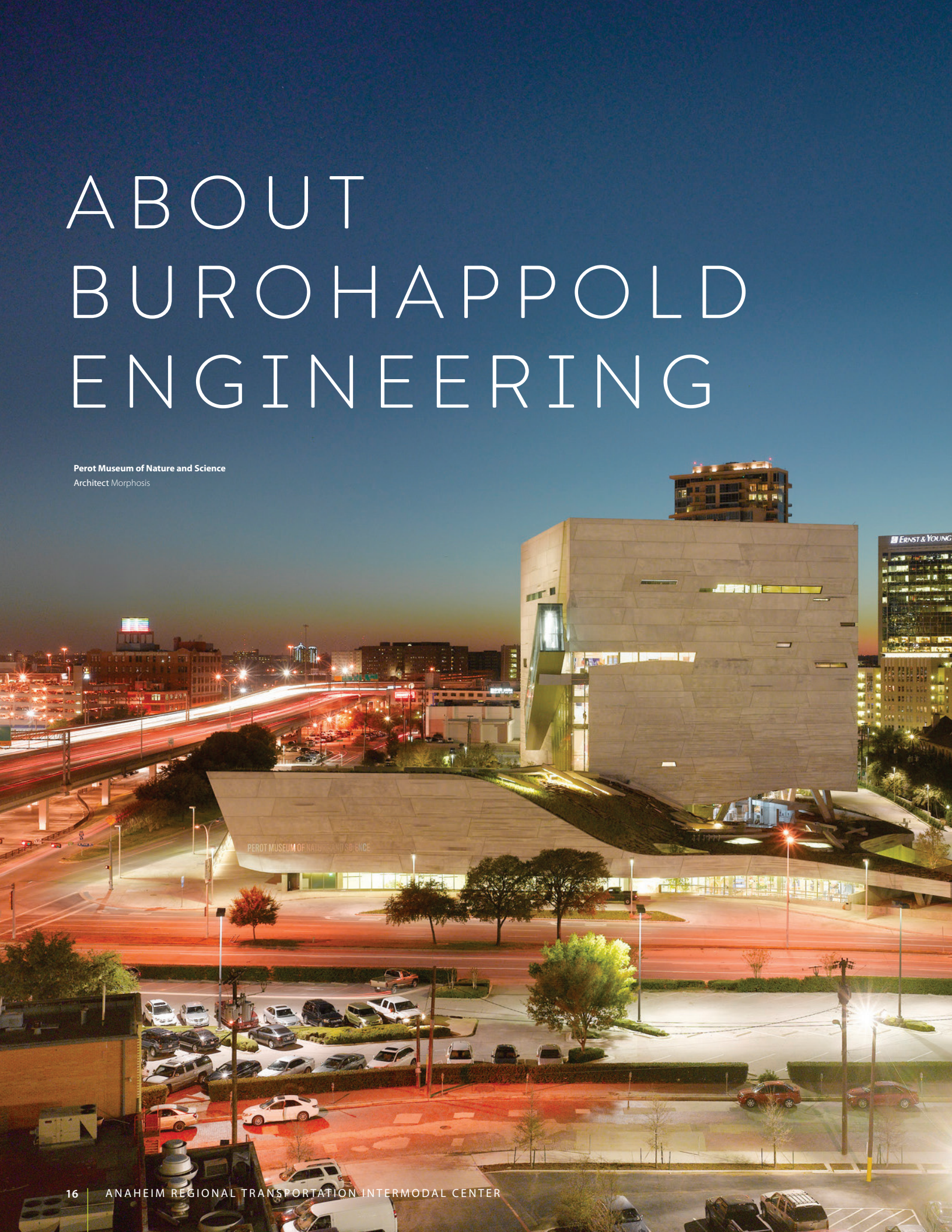
SUSTAINABLE SITES

- Electric vehicle charging stations

INNOVATION IN DESIGN

- City of Anaheim green cleaning program
- City of Anaheim green power program anticipated

ABOUT BUROHAPPOLD ENGINEERING



Perot Museum of Nature and Science
Architect Morphosis

FACTS

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OFFICES IN
NORTH AMERICA

BOSTON
CHICAGO
LOS ANGELES
NEW YORK
SAN FRANCISCO

Projects from top right

The Tower at PNC Plaza
Architect Gensler

Pinnacle Bank Arena
Architect DLR Group

Yale University School of Management
Architect Foster + Partners

Hall Winery
Architect Signum Architecture

Described by our clients as 'passionate', 'innovative', 'collaborative': BuroHappold Engineering is an independent, international engineering practice that over the last 40 years has become synonymous with the delivery of creative, value led building and city solutions for an ever changing world. Having worked on every continent, our clients include more than 90% of the world's leading architectural practices and we have collaborated with global organizations such as the United Nations, The World Bank and UNESCO. Through our global community of driven, world leading engineering professionals we deliver elegant solutions for buildings and cities that seek to address the major problems facing societies today.

Our North America practice, which includes offices in New York, Boston, Chicago, Los Angeles and San Francisco has completed a broad range of work—from high-performance renovations to advanced facade design for higher education, cultural, commercial and health-science clients—garnering over 100 awards for design and engineering.

Images (clockwise from top right) Gensler, Lawrence Anderson Photography, Chuck Choi Architectural Photography, Adrian Gregorutti, Roland Halbe

Anaheim Regional Transportation Intermodal Center
Anaheim, California
City of Anaheim and the Orange County Transportation Authority (OCTA)

HOK/Parsons Brinckerhoff
Architecture, Project Management and Civil Engineering

BuroHappold
MEP Engineering, Sustainability & LEED Consultancy, Facades Engineering, Enclosure 3D Modeling, Energy Modeling, Water & Renewable Energy Analysis, Shadow & Daylight Studies, Lighting Simulation

Clark Construction
General Contractor


13
ART
Route
14 & 15

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