DENVER INTERNATIONAL AIRPORT HOTEL AND TRANSIT CENTER

BEST BUILDING PROJECT - GENERAL CONTRACTOR OVER $70 MILLION

MORTENSON
HUNT • 2015
SAUNDERS
A TRI-VENTURE

BUILDING THE DENVER INTERNATIONAL AIRPORT HOTEL AND TRANSIT CENTER

Forget for a moment the fact that Denver International Airport (DEN) is the 15th-busiest airport in the world and the fifth-busiest airport in the United States. Forget that it had to remain open with no disruption to 24x7 operations during construction of a $579 million project. Forget for a moment the number of stakeholders and the high-profile nature of the development. And also forget the required myriad security and FAA clearances and other logistical challenges of building at an active airport.

One look at the design and resulting product proves the delivery execution of this swooping form of steel and glass is without a doubt a true engineering and construction marvel.

A realization of part of DEN's original 1989 master plan, DEN's new Hotel and Transit Center (HTC) project includes three key elements: a 519-key Westin hotel and conference center; a 82,000 square foot plaza; and a public transit center that connects the new RTD commuter rail line to the airport. These elements comprise a single, integrated, iconic addition to DEN's Jeppesen Terminal.

The sustainably-designed (LEED-Gold) Hotel and Transit Center connects travelers from the airport to downtown and the hotel provides unparalleled views of the Rocky Mountains and the original Jeppesen terminal. The HTC offers amenities to other visitors and residents alike, with a welcoming, outdoor plaza that is the site of many activities and community events.

A unique tri-venture was exclusively and specifically assembled to build this very challenging project. The tri-venture builder, MHS, was comprised of Mortenson Construction, Hunt Construction and Saunders Construction. In addition to MHS, there were nearly 200 different trade partners involved with the construction of the HTC, which was designed by a team led by Gensler.

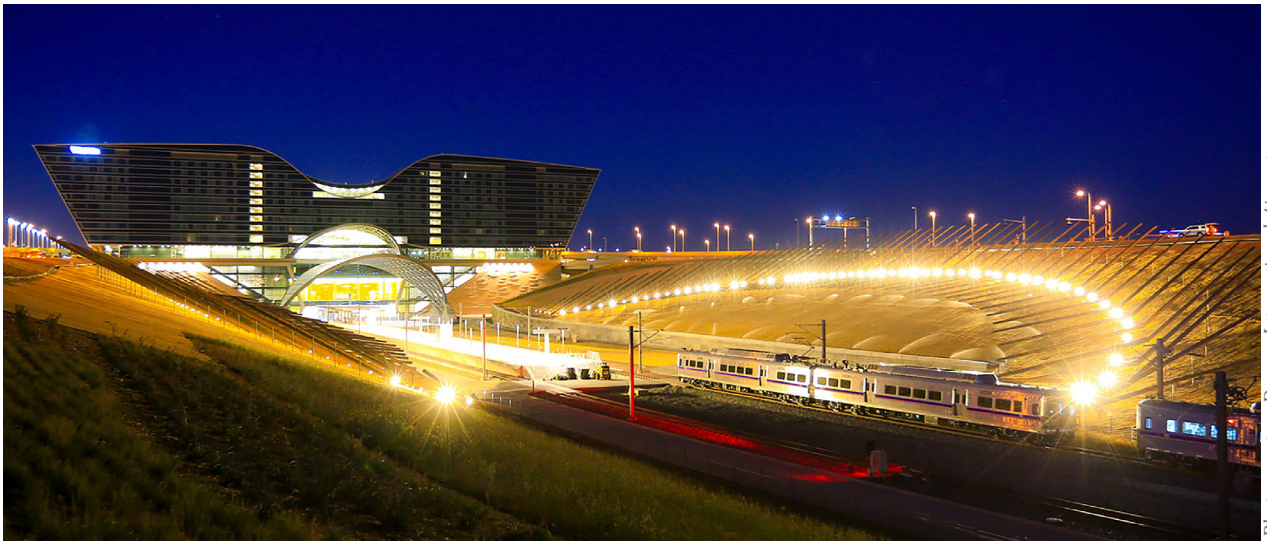
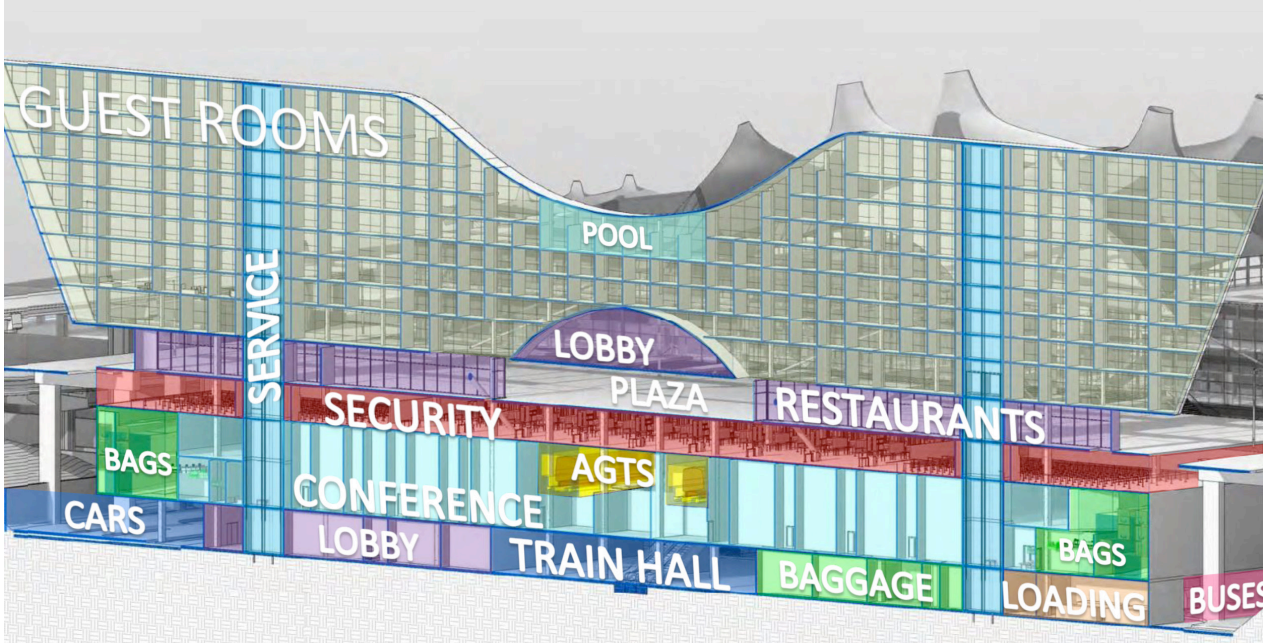


Photo courtesy Denver International Airport

SETTING THE PROJECT UP FOR SUCCESS

Long before any mobilization, the MHS team got to work on a plan to address the numerous challenges that lay ahead. Beyond all the players on the design and construction team, coordination with the owner also required clear communications and planning as there was a large group of stakeholders within DEN.

Though the project is owned by DEN, the hotel operator (Starwood) and the transit station operator (the Regional Transportation District) were also major stakeholders in the project, requiring detailed coordination among all three groups. By enlisting a team of key personnel to speak for the larger group, the MHS team was able to create a smaller, nimble, group where cost options could be presented and decisions made in a more timely and effective manner.



A section of the hotel and transit center demonstrates the complex nature of the project and its program.

GETTING TO WORK

Site access was limited, so the project required parking and laydown areas to be offsite. Material delivery required close coordination with DEN Airport Operations, Parking and Security to coordinate closures of traffic lanes or airside operations and any interface with public areas. Every closure was reviewed and agreed upon prior to submission, taking into account each stakeholder's need.

The work on the HTC also required coordination with other contractors working on adjacent and enabling projects. For instance, DEN was already constructing a new parking structure that shared the east border of the HTC project and another contractor was responsible for the utilities relocation package to within five feet of the hotel, as well as the delivery the enabling bridges right where traffic comes in and out of the airport. Weekly coordination meetings ensured that all contractors were successful and minimized impacts to each schedule.

Photo courtesy Denver International Airport

Careful coordination with other structures was required in numerous instances, such as constructing the HTC to within five inches of adjacent bridges.

With a deliverable date looming, and a newly formed design team and a unique, consolidated construction entity, the design and preconstruction phase of the DEN HTC project had to be an integrated and unified process that incorporated real-time cost estimating and constructability reviews along with an accelerated design process that packaged construction documents for strategic procurement. The solution called for co-location of the design, preconstruction and program management teams in an easily accessible, centrally-located space. Access to shared data streams was implemented so construction team members could provide design team members cost and constructability information in real time. This was accomplished with an integrated model that displayed cost-trending information in step with design evolution. Specialty contractors such as mechanical, structural glazing and electrical specialists were brought on board early enough to provide assistance and input into design decisions.

Photo courtesy Denver International Airport

DIGGING IN TO BUILD UP

Excavation of over 20 feet below existing grade was required to connect the new structure to the existing terminal – including the addition of 30 feet to the existing tent support. To facilitate construction, a tangent-pile concrete caisson system was implemented to allow for the mass excavation and stabilization of the existing terminal foundation and bridge abutments. As the project was completed, support for the existing tent of the Jeppesen Terminal was then anchored to the Level 5 deck of the new open-air plaza.

The project's structure is primarily cast-in-place concrete elements and contains a variety of typical framing techniques as well as several innovative structural solutions. One of the most notable and challenging features of the project are the diagrid steel and glass canopies that provide a covered transition from train to plane. The canopies were structurally independent of the hotel and cantilever 135' over the hotel plaza. They are constructed using diagrid technology, which is not unlike an eggshell, and which transfers the load across the surface of the canopy down to the massive abutments.

One canopy is free standing over the train platform and the other extends under the hotel itself, cantilevering out on both the north and south side of the hotel. The train canopy cantilever on the north side is a staggering 135', and 70' 4" on the south side. This canopy is supported solely by two massive concrete abutments. These banana-shaped abutments are 150' long and consist of multiple layers of reinforcing cages, and were constructed with more than 100 truckloads of concrete.

Photo courtesy Denver International Airport

The MHS team chose to use a self-consolidating concrete mix due to the amount of reinforcing present in the abutments. Personnel doors were engineered to allow entry to the inner rebar cages to provide access during construction. A secondary architecturally-aesthetic pour was performed after the primary abutment was completed.

The building's foundations consist of concrete grade beams, pier caps, mats and caissons that support the super structure. Cast-in-place shear walls make up the building's lateral force resisting system and span the entire height of the building. The MHS team chose to slip-form two of the four cores and platform-frame the others in an innovative approach to maintain the compressed schedule. At only 10' wide, two of the cores are relatively slender for the 15-story building height and provide an extremely economic solution using 10" thick, 5000 psi, concrete walls. One of the shear walls was cast with large triangular portions removed to facilitate natural light entering the area. Cast-in-place concrete columns, ranging from 5000 to 8000 psi, support the gravity loads of the building. Several of the columns required special forming techniques to provide outstanding architecturally exposed finishes.

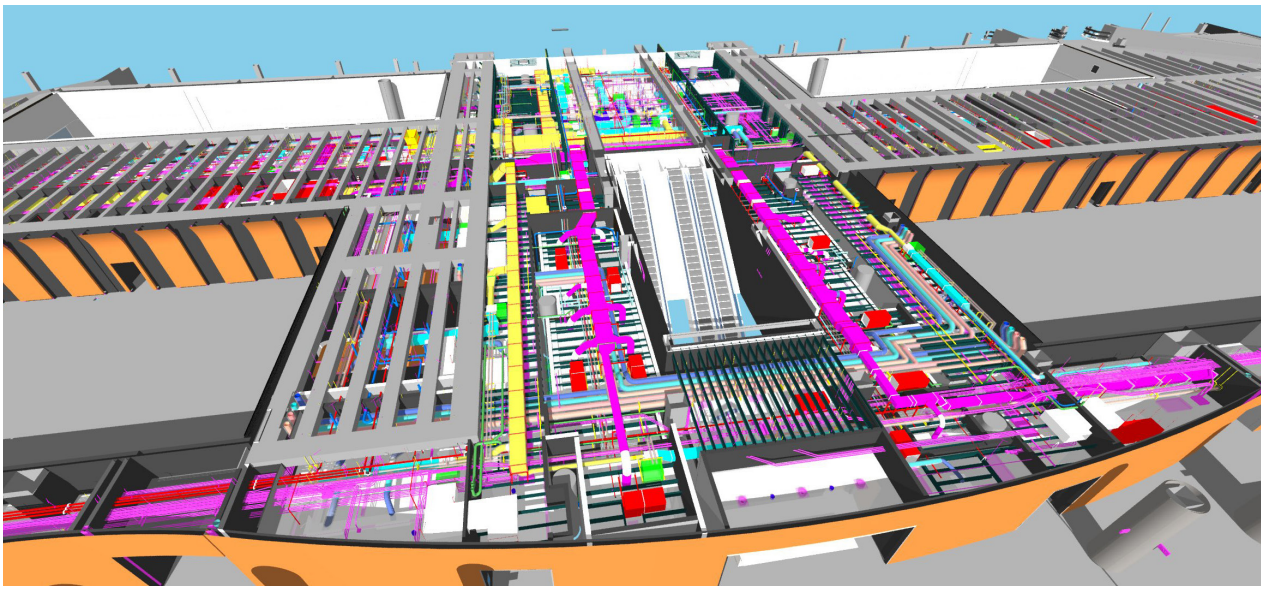
Photo courtesy Denver International Airport

A view of the progress in March of 2014. Special FAA clearances were needed to employ tower cranes on the site.

In addition to the difficult execution of the canopies themselves, the airport's existing Automated Guideway Transit System (AGTS) was extended into the new building in this area and is supported by an isolated structural system separate from the remainder of the building. The AGTS framing consists of cantilevered columns supporting 36"-x-104" wide mildly-reinforced concrete beams.

The MHS team essentially cut through the perimeter of the terminal building to extend the AGTS tunnels south into the hotel space, as well as provide baggage system and baggage cart access from the restricted area of the terminal into the hotel. We met regularly with DEN security personnel to develop plans for breaching the security perimeter and to provide temporary security procedures for craft personnel.

The project's design also included a five-story escalator, the tallest in Colorado, to help transport train travelers to the terminal. The "cave" as it is commonly referred to, proved to be one of the more complex work sequencing areas on the project. With the concrete structure enclosed, large escalator trusses (10,000 lbs) had to be set using a complex engineered rigging system enabling the section to be set just inches over a sloped membrane roofing system.



An image from the model showing the coordination required to accommodate the extension of the automated guideway transit system adjacent to the five-story escalator.

TOPPING IT ALL OFF

Suspended above the 11th floor pool and fitness area is an 80-foot clear span steel catenary roof that is supported by massive concrete anchorages on either side. This tension load from these anchorages is resolved with a combination of column bending and connection to the floor diaphragm. The roof of the building is comprised of a 2 ½" thick lightweight concrete-filled metal deck supported by steel beams. The concrete placement was very challenging as the roof slope varies with a maximum 45-degree angle creating a huge concern of concrete avalanching. That, plus an 850-foot pumping distance and a strict on-site slump variance requirement, was difficult to overcome. In the end, the roof was placed in strips up the slope using bucket drops.

Photo courtesy Denver International Airport

QUALITY CONSTRUCTION AIDED BY TECHNOLOGY

The quality and craftsmanship of the work at the DEN HTC is evident. The MHS team developed processes to mitigate risk and ensure design and construction work conformed to the unique project requirements and regulations that come with building a world-class facility at an active airport.

Integrated design and delivery through Building Information Modeling (BIM) provided the design and construction teams with instant input and feedback through the entirety of the project. The model was used to ensure constructability of the unique shapes and forms of the design and was fully coordinated before crews began installing in the field.

THE END RESULT - A PROJECT THAT ENHANCES DEN'S STATUS

The completion of the Hotel and Transit Center at Denver International Airport signals the completion a longtime vision for an airport hotel and rail service to Denver International Airport, making it one of the world's best connected airports. The entire project team is proud of its part in helping DEN deliver its intergovernmental agreement with the Regional Transportation District. DEN's geographic location mid-country, coupled with the stunning, new, Westin hotel and outdoor plaza, furthers DEN's reputation as one of the world's premiere international hubs.

Photo courtesy Denver International Airport

For a timelapse video of the DIA HTC progress please visit:
https://www.youtube.com/watch?v=WUWelowXflw