

Blazing an orange trail

DART closes in on completion of the 14-mile Orange Line light rail

The operator of the largest light-rail system in the U.S., Dallas Area Rapid Transit (DART) is a robust multimodal transit system covering some 700 square miles and comprising 13 cities.

DART is responsible for more than 120 bus routes and 12,000 bus stops, paratransit services and HOV lanes. Additionally, the agency operates a 35-mile commuter rail line to Fort Worth jointly with the Fort Worth T and operates a 21-mile commuter rail to Denton for the Denton County Transportation Authority.

The light-rail system represents a real cultural shift in a region known for “car culture” and an extensive (if congested) freeway system. Comprising 90 miles of light-rail transit (LRT), the system is still growing. In 2012, DART opened the first two of three phases of the 14-mile Orange Line; the final phase, which will connect the DART system to DFW International Airport, is scheduled to open in 2014.

DART previously has constructed its light-rail system along existing railroad corridors that the agency owns. The Orange Line, however, forges a new right-of-way on its path through the suburban city of Irving. Fortunately, there were very few property owners along the new alignment. Property

acquisition was a joint effort between the public entities involved and required especially close coordination between DART and the Texas Department of Transportation (TxDOT).

A defining characteristic of the project has been its aggressive schedule. The design-build model—new to DART—allowed the agency to meet ambitious construction milestones. The delivery model heralded a cultural change within the agency and required understanding of new roles for design management, contract administration and quality oversight.

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freeway under construction; laying an embedded track section through an urban setting; and constructing a rail alignment on an airport at the end of active runways.

Threading the needle

Crossing the Elm Fork meant implementing the U.S. Army Corps of Engineers' post-Katrina rules for construction on or around levees. The bridge substructure had to be at least 50 ft from the wet and dry toe of slope of the levee. As a result, the bridge span is 260 ft. To add to DART's challenges, a 357-kW overhead transmission line could not be relocated; at the same time, the bridge had to provide at least 7 ft of clearance over the future top of the levee to provide maintenance access. This portion of the project became known as "Thread the Needle," and it required an innovative approach.

The key to success: Designing a bridge structure with minimal depth and maximum resistance to unloaded natural frequency of vibration. The design-builder developed a five-segment, post-tensioned, precast-concrete-girder structure totaling 550 ft long (145-ft flanking spans and a 260-ft main span). This type of long bridge span was unique for a light-rail bridge structure.

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DART secured the services of a long-bridge expert to help review the proposed structure. The final configuration for the main span comprised six girders varying in depth from 11 ft at the pier to 7 ft at midspan. The main span was constructed with a drop-in segment 160 ft long. This was the longest precast concrete girder ever made in



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Texas. This special bridge section was part of a 7,555-ft-long aerial structure crossing major arterial roadways, I-35E and the Elm Fork of the Trinity River.

Each of the six drop-in girders weighed 225,000 lb. A 900-ton crane, one of the largest in Texas, was erected to set them. Assembling the crane involved transporting it—in pieces—with 60 trailer trucks and bringing in

a smaller, 350-ton crane to assemble it. The 900-ton crane carried 400,000 lb of counterweight, and an additional 600,000 lb of counterweight was immediately adjacent to the crane to use when the boom reached a certain point while setting the drop-in girders. After the girders were in place, the post-tensioning took place and the cables were grouted.

Pushing the "envelope"

Another challenge involved designing and constructing a 1.25-mile section within Texas State Highway 114. TxDOT was reconstructing and widening the highway, and the new LRT alignment was to be placed in an envelope between the new frontage road and the reconstructed main lanes.

The design-builder had to rely on the proposed plans for the highway rather than "as-built" conditions when developing the final design for the Orange Line. The design also had to account for future improvements to an adjacent section of SH 114 at the Loop 12 interchange—improvements that were barely in the planning phase.

Once the design was far enough along for construction to start, the design-builder had to coordinate access with TxDOT's contractor. Franchise utility relocations under the TxDOT contract caused the DART access date to slip—a major challenge for DART and the design-builder, who had to develop a work-around for the envelope section while still meeting the established deadline for

revenue service. The work involved constructing drilled-shaft retaining walls connecting to mechanically stabilized earth walls built by TxDOT; tying into the newly constructed drainage system; and building the roadbed for the new rail line.

TxDOT constructed the shell of a pedestrian underpass below the frontage road so that access would be provided to the station's bus-transfer area. The design-builder had to complete the finish-out of the shell during the construction of the station in the envelope—which was conducted concurrently with TxDOT's construction of the frontage road and main lanes. At one location near the Cistercian Abbey, the alignment of the frontage road and the LRT swapped positions. The frontage road and the LRT aerial structure were braided to accomplish the position swap. From there the LRT alignment left the highway



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envelope and entered into the Las Colinas Urban District.

A host of stakeholders

Design and construction in the Urban District brought its own challenges, including the urban design requirements for the district. The alignment was in the median of an existing four-lane, divided roadway, with embedded track and pavers instead of ballasted track. One station was constructed to connect to the future extension of the Las Colinas People Mover. The finish-out of the two stations included city of Irving branding elements in addition to DART's own branding and station art. Early coordination through a series of stakeholder meetings was a key success factor.

This portion of the alignment is highly urbanized, and the sound from gates and flashers at the intersections was a concern. Ultimately, it was determined that the intersections should be controlled with city-operated traffic signals; owing to the surrounding density, the light-rail vehicles would operate at a maximum speed of 25 mph. Traffic-signal timing was monitored and adjusted to minimize the effect on traffic while maintaining train schedules.

Another challenge for the project was stabilizing the soils to accommodate the requirements of LRT track construction. The track area was encapsulated in a geomembrane to assure that the moisture content remained constant. This required the careful coordination of the relocation activities of franchise and public utilities. In addition, the city of Irving augmented its permitting requirements so that DART must review and approve new utility requests to ensure that the geomembrane is not penetrated, which could put the moisture conditioning at risk.

The last section of the project, which falls wholly on the DFW Airport property, had to be reviewed and approved by both DFW Airport and the FAA. Revisions to the alignment require those approvals as well.

The design-builder developed a

revision to the 10% alignment that relocated the LRT alignment to the south—adjacent to North Airfield Drive at an area known as the “Pinch Point.” This innovation would require relocating a section of North Airfield Drive, but it meant that DART would not need to acquire right-of-way from TxDOT.

The remaining challenge for the Orange Line is to complete the track and related system elements within the station being constructed by DFW International Airport. DFW Airport Station is adjacent to International Parkway, the North Service Road and Terminal A, making for a very constricted work space. Coordinating the installation of track and other system elements began during the design phase of the station—a full year before the design-builder contract was awarded for the last phase of the Orange Line.

DFW Airport Station has elements specific to the branding of the airport, including a signature canopy above the track. The canopy added some difficulty to coordinating the clearances from the overhead catenary system. The station design-review process took DART's criteria into account while meeting the scope and vision of DFW Airport.

The Orange Line involved a host of stakeholders with vested interests in the project's outcome. Partners who contributed to the project's success include the city of Irving; Las Colinas Association; Dallas County Reclamation District; DFW International Airport; Kiewit, Stacy and Witbeck, Reyes, Parsons (the joint venture that was DART's design-build team); TxDOT; and the city of Dallas.

Their coordination efforts have resulted in the first two phases of the project opening on time and within budget. The final phase of the project, including the station, is on schedule and within budget. In approximately a year and a half, DART will be one of the elite American transit properties with a direct connection to a major airport.

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