John F. Kennedy International Airport Terminal 4

This spread Twelve V-columns support the new terminal's soaring atrium and the security screening checkpoint above.

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The new terminal complex consolidates Delta's operations at JFK with a structural steel design that fulfills the original master plan for the terminal and improves the experience of the more than 11 million passengers who will pass through it each year.

TO GAIN AN UPPER HAND in the competitive air travel market, carriers must adapt or die at the speed of sound. Whereas American Airlines and US Airways are merging, Delta Air Lines is betting on ground facilities to set it apart. The Atlanta-based corporation recently completed a $1.2 billion redevelopment of Terminal 4 at John F. Kennedy International Airport, one of eight domestic hubs. "New York is the most competitive market in the world; we can never stop investing in the customer," Gail Grimmett, Delta's senior vice president in New York, recently stated.

The project is a joint venture of architecture firm SOM and engineer Arup and dates to master planning that began in 2007. SOM associate director Mark Leininger explains that that process originally identified 19 sites where Delta could increase its gates, to service Latin America and other destinations. He adds, "Living up to the hub designation also means minimal transfer times."

Those criteria precluded reusing Pan Am Worldport, the 1960 pavilion that Leininger deems "too antiquated to ever put Delta on par with other carriers." Instead they favored Terminal 4, which boasted room to grow in flanking parking lots, as well as U.S. Customs and Border Protection facilities that could expand for quicker rechecks and transfers.

Yet even in Terminal 4, the ArupSOM team confronted obsolescence. The SOM design, completed

Above Check-in kiosks are located on the uppermost floor of the Terminal 4 headhouse.
Below The building's structural steel design creates open, daylit spaces.

Opposite One of eight domestic hubs, the terminal design aims to reduce transfer times with an efficient layout.

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in 2001, represented the first time a foreign airport operator—a private consortium led by Schiphol Group—constructed an airport terminal in the United States. The developer had looked to its namesake departures and arrivals building in Amsterdam for precedent. Because the public could freely access retail at the headhouse at Schiphol, for Terminal 4's equivalent SOM had routed passengers through a double-height retail hall before they reached security screening checkpoints (SSCPs) at the thresholds of Concourse A and Concourse B.

That configuration could not foresee current security protocols. More important, it offered few amenities to passengers who were now rushing to the airport, only to wait for long stretches after passing through the SSCPs. To best accommodate new behavior, ArupSOM revised the entry sequence to place a single SSCP immediately after check-in, located on the uppermost floor of the Terminal 4 headhouse. To do so, the joint venture also had to expand the floor area directly into the soaring atrium of the retail hall below. The new SSCP measures 280 by 70 feet.

"Steel was chosen for the SSCP construction to keep the structural depth to an absolute minimum and maintain an inviting retail interior," says Arup associate Jenny Buckley. "It was the obvious choice, as other structural systems could not compete on constructability, minimizing disruption, and aesthetic compatibility."

Buckley explains that a study of existing columns supporting the retail hall showed additional capacity for this insertion, but that analysis of the beams of the check-in floor, which ring the atrium, indicated little reserve. Consequently, 12 V-columns support the SSCP floor structure. Each is a pair of HSS 10.75-diameter pipe columns splaying from a custom pin connection just above the top of the finished retail floor; a gusset plate extends from the base plate. Among other things, the V-columns reduce the span of the girders above, stiffen those girders against lateral loads, and visually lighten the SSCP structure. Leininger likens its geometry to a forest, while Buckley points out that the V shapes mirror the arrangement of 14-inch-diameter pipes in the existing roof. Both columns and pin connections are detailed as Architecturally Exposed Structural Steel (AESS).

Directly underneath the retail floor, existing columns in the east–west direction are spaced on every other gridline. So W27-section primary girders were laid atop the V-columns in parallel—56 feet on center. The secondary structure then runs north–south with a middle span of 30 feet and approximately 16-foot cantilever lengths, which vary according to the curvature of the check-in floor. To minimize disruption to airport operations, the project team and building operator eschewed casting this intermediate structure in situ for a system of prefabricated steel-and-concrete planks. The typical plank cross-section comprises two W8x40 beams spaced at 2 feet on center, which structural steel fabricator Cives Steel Company welded to a 48-inch-wide Grade-50 steel plate that measures ⅜ inches thick.

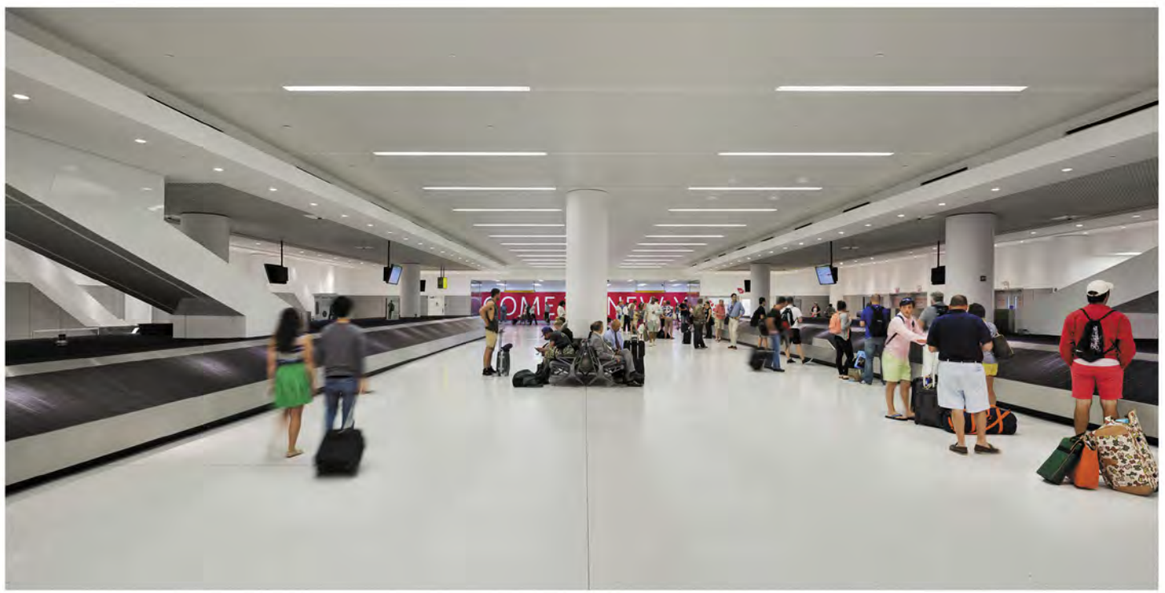
A lightweight concrete slab completes the SSCP structure, and is secured to the intermediate plate via shear studs welded to its top face. The 4-foot gap between the girder line and the check-in floor is spanned by a structural glass panel, which rests on the end of the cantilever and the edge of the existing slab, minimizing additional load on the older structure. These finishing touches also improve the functionality of the headhouse: Raceways within the topping slab contain power distribution conduits and cabling, data cable tray and cabling, public address conduits and cabling, and fire alarm conduits and cabling, allowing for easy reconfiguration in case of new security procedures. Meanwhile, lighting installed on the underside of the structural glass both illuminates the retail forest and elegantly demarcates wayfinding from check-in to SSCP.

Echoing the rationale for the plank system, the method for constructing the entire SSCP within the Terminal 4 headhouse required sensitivity to ongoing airport operations. So that passengers could have best access to circulation, construction manager Lend Lease worked on the SSCP from east to west, first erecting support-structure columns and then utilizing a gantry crane to maneuver the planks into place.

Right Construction of the new terminal was carefully choreographed to minimize disruptions on Delta's operations. **Below** Throughout the new building, raceways within the structure will allow conduits, such as those for power and sprinkler systems, to be reconfigured in case of new technology or security procedures.

"Steel was the obvious choice, as other structural systems could not compete on constructability, minimizing disruption, and aesthetic compatibility."

Jenny Buckley, Arup



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Introducing the gantry crane into the headhouse required removing and reinstalling IGUs from the south elevation of the 955,000-square-foot building.

Expanding Delta's presence at Concourse B required little such daintiness. Because the carrier's nine new gates were to be located post-security, the joint venture could "cordon off the expansion site like the Berlin Wall," Leininger says. The extended concourse comprises composite steel floor framing combined with transverse and longitudinal braced frames in four independent structures isolated by expansion joints; steel frames run 44 feet on center, and the typical floor beam sizes are W24x84 longitudinally with W12x35 intermediate beams.

In the less fastidious vein, for Concourse B the project team also could replicate structure that was already there. Passenger boarding bridges are modeled after existing gates, for example, with each bridge formed from a composite steel gravity system and braced and moment-frame lateral systems.

And it may replicate them again, considering that its property strategy has taken off. Among other recent initiatives, Delta is expanding recharging stations at 13 airports, and the company recently announced a $229 million investment to upgrade Terminal 5 at Los Angeles International Airport as well.

JOHN F. KENNEDY INTERNATIONAL AIRPORT TERMINAL 4

Location: **John F. Kennedy International Airport Terminal 4, Jamaica, New York, NY**
Owner: **Port Authority of New York and New Jersey**, *New York, NY*
Architect: **ArupSOM**, *New York, NY*
Structural Engineer: **Arup**, *New York, NY*
Mechanical Engineer: **Arup**, *New York, NY*
Construction Managers: **Turner–Peter Scalamandre & Sons, A Joint Venture**, *New York, NY* (Concourse B); **Lend Lease**, *New York, NY* (Headhouse)
Structural Steel Fabricator: **Cives Steel Company**, *Gouverneur, NY*
Structural Steel Erector: **Stonebridge Steel Erection**, *South Plainfield, NJ*