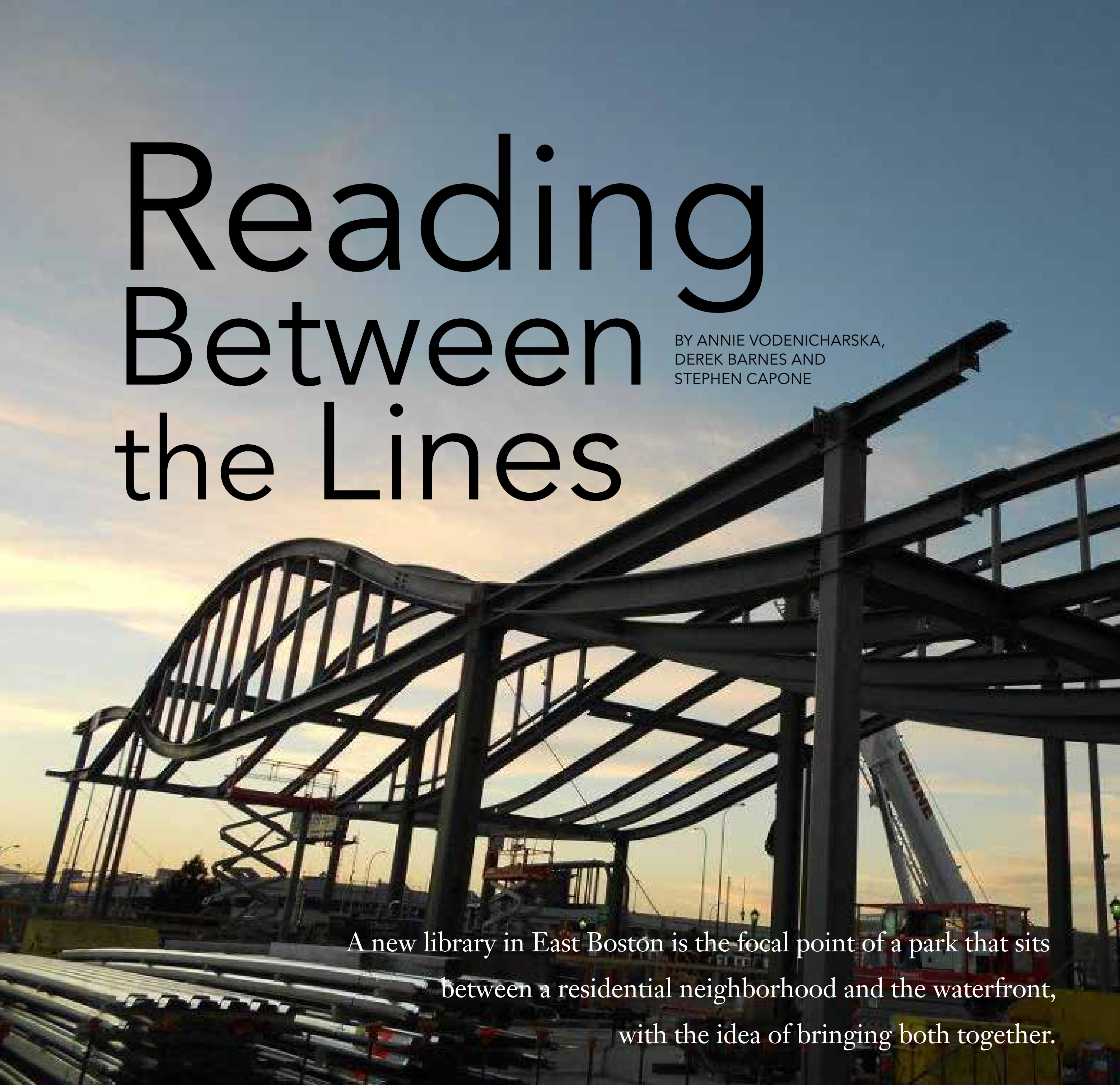
# Reading Between the Lines

BY ANNIE VODENICHARSKA, DEREK BARNES AND STEPHEN CAPONE



A new library in East Boston is the focal point of a park that sits between a residential neighborhood and the waterfront, with the idea of bringing both together.

**DRIVING SOUTH** on the elevated Highway 1A toward Logan Airport, the urban landscape of East Boston transitions from industrial to residential.

On the horizon across the harbor stands the city of Boston, which appears urbane and somewhat distant from this hard-working neighborhood that over the years has been home to shipyards, rail yards and now the airport.

Since 2007, the Bremen Street Park has acted as a modest greenway between residential East Boston and the highway that runs through this historic transportation hub. New plans to realize the full potential of this greenway will enhance the civic and visual relationships between the park and East Boston and will complement the work that East Boston has done to reclaim its waterfront for recreational use. Sited at the north end of the Bremen Street Park, the new 14,800-sq.-ft East Boston Public Library will create a strong sense of visual identity both from the highway above and from the park below.

From above, the one-story library's roofs rise and fall in gentle curves, like a rolling landscape amidst the semi-industrial scene. From below, families in Bremen Street Park will experience these same roofs as floating surfaces, ribbon-like in their thinness and in the way they seem to hover above the library's reading room, which is the building's centerpiece. The front roof cantilevers 12 ft continuously over the building's glass façade, providing a canopy and a reference to the horizontality of the park. The Douglas Fir planks that face the ceiling transition seamlessly from the outside overhang into the reading room, giving the ceiling a warmth and sense of scale even as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▲ Fabricating a curved section at Capone's shop.

◄ Curved steel is featured prominently in the new library.

▼ A 3D model of the framing system.


LeMessurier Consultants

**Annie Vodenicharska** (avodenicharska@lemessurier.com) was the project engineer for the East Boston Public Library and **Derek Barnes** (dbarnes@lemessurier.com), *not pictured*, was involved with design development. Both are structural engineers with LeMessurier Consultants. **Stephen Capone** (s.capone@caponeiron.com) is the president of Capone Iron Corporation.

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One of the signature lens-shaped clerestories.

Another 3D perspective of the steel framing system.

A rendering of the completed project.

William Rawn Associates

LeMessurier Consultants

The nexus of multiple members.

they enhance the dramatic interplay of interior and exterior surfaces. Projecting 24 ft into the reading room, the first arching ribbon meets with its counterpart curving in the opposite direction. This happens once more between the second and third ribbons. Between these first three roofs, lens-shaped clerestories open up to allow natural light into the library's reading room, offering a view of the sky and emphasizing the independence of each ribbon.

Spanning up to 60 ft between columns, the structural system supporting these ribbons is a tightly integrated plane of 12-in.-deep moment-connected steel members that form variations on a lenticular truss between each roof. These long spans carry uniform loads as an arch in the top span that reacts against a stress ribbon in the bottom span. These two spans are connected only by clerestory mullions that act as struts to resolve unbalanced tensions and compressions between the top and bottom spans. Shear forces resulting from unbalanced loads along the spans are carried by the W12 members themselves, obviating the need for diagonal truss bracing between the top and bottom spans. Roof beams are curved to create the ribbon forms and are moment connected at all ends to enhance stiffness. Steel connections were carefully detailed for each unique joint where the roofs intersect and where they are supported.

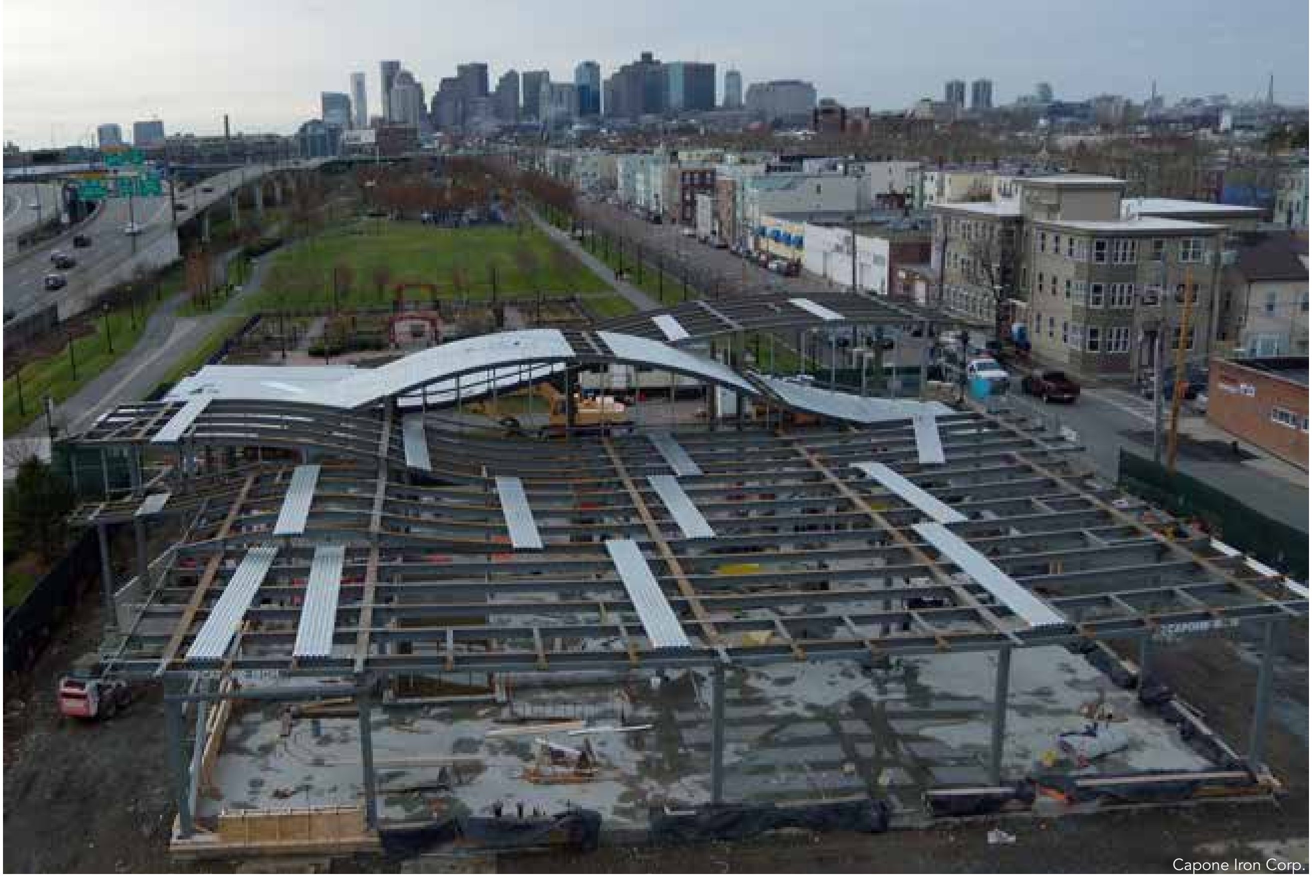
The structural engineer, LeMessurier Consultants, developed the complex roof geometry in a 3D Revit model during schematic design under exacting time constraints; 2D CAD files were received from architect William Rawn Associates on a Monday and the conceptual structural design was finalized on that Thursday. LeMessurier traced the essential curves into Revit and extruded shapes in 3D after estimating sizes based on hand calculations. Essential to the architecture of the ribbons and the logic of the structural system, all roof members were defined to have a uniform depth of 12 in. LeMessurier imported the Revit model into STAAD and analyzed the entire structure for gravity, unbalanced snow loads and lateral stability. Final sizes were determined based on a series of analytical iterations, and the Revit model was updated. Once the model with final sizes was assembled in Revit, each joint was checked by hand in order to identify the discontinuities that naturally occurred in the translation process between software packages. For instance, curving members with abutting ends required special attention, and each individual beam was rotated about its longitudinal axis by hand in order to ensure that its top flange was tangent to the top flange surface of the supporting lenticular truss. On Thursday morning, LeMessurier assembled the final Revit model in its entirety and developed a series of renderings of the framing for the architect.


The final constructed roof forms maintained a high degree of fidelity to the product of this original four-day design charrette, testifying to the importance of intensive communication between architect and engineer during conceptual design. Furthermore, the efficiency of this early work hinged not only on the correct use of all available computational tools but also the prudent engagement of these tools in the context of preliminary hand calculations. Several innovative workarounds were required for cases where the tools themselves were unable to handle complex details and shapes with a sufficient degree of generality.

Intensive use of the Revit model continued into the construction documentation phase, as roof steel connections were conceived and vetted in three dimensions. In order to facilitate the work of the detailer, LeMessurier supplied reactions for a range of unique connections. Using a single platform to communicate with the detailer, fabricator and architect, LeMessurier was able to ensure that the technical viability of several difficult connections did not compromise their visual quality.

The exposed architectural steel members, as well as each unique connection, were carefully detailed and precisely fabricated by Capone Iron Corporation. The steel frame weighs approximately 209 tons and required some 2,262 fabricating hours of labor. All of the main member assemblies were rolled by Chicago Metal Rolled Products to stringent tolerances, and many of the rolled pieces were assembled in the shop to minimize field welding and streamline the erection process. The contract documents specified certain locations along the roof edges for confirming survey work to be performed before the erected steel frame would be accepted by the owner. The erection process included the survey of the varied cantilevered edges, with certain adjustments made after initial alignment, to ensure a clean, crisp edge condition when the architectural finishes were installed.

The frame uses 209 tons of steel in all.




The library, with downtown Boston in the background.

Site demolition commenced in February 2012, the structure was set in place by January 2013 and the building was scheduled to open in June. Appearing as a dynamic landscape from the highway above and as a welcoming public space from the park below, this new library will speak to both residents and passersby about the true character of this beloved neighborhood fronting Boston Harbor. MSC

**Owner**
City of Boston

**Architect**
William Rawn Associates, Boston

**Structural Engineer**
LeMessurier Consultants, Boston

**General Contractor**
Deiulis Brothers Co., Lynn, Mass.

**Steel Team**

**Fabricator**
Capone Iron Corporation, Rowley, Mass. (AISC Member/ AISC Certified Fabricator)

**Bender-Roller**
Chicago Metal Rolled Products, Chicago (AISC Member)