SUPERLIGHT, SUPERSTRONG, AND SUPERLARGE

Polymer structures give life to unusual conceptual designs.

by C.C. Sullivan

The design for a 40-foot bear structure originated in a 3-D digital model (top) that was later translated into a stereolithographic file to control a CNC miller cutting EPS piecemolds to be covered with foil and gel (middle). The fabricator laid glass fiber and resin over the numerous molds, and assembled them into six final pieces (bottom) for site erection on a foundation.

COURTESY KREYSLER & ASSOCIATES

Wonder materials can blow open the design phase. One oft-derided class of materials that offers potential design breakthroughs is fiber-reinforced polymers, or **FRPs**, which can be fabricated for a wide range of tensile, flexural, and impact properties. They're superlight—FRPs deliver more strength per unit of weight than any unreinforced plastic and most metals—and, at $35 to $70 per square foot installed, their costs for ornamental applications are comparable to those for glass-fiber-reinforced concrete, or **GFRC**.

Think of it: Design any conceivable shape—and get the strength to support it under any load or condition. Plus, get integral color and building parts that never rust.

Perhaps that's why the Melbourne-bred artist Lawrence Argent, head of the sculpture department at the University of Denver, worked with FRPs to produce a 40-foot-tall blue bear that will soon be peering inside the expansion of Denver's Colorado Convention Center, a 584,000-square-foot building designed by local firm Fentress Bradburn Architects. Called *I See What You Mean*, this odd commission will at least enliven the rather plain countenance of the building's main entrance on 14th Street when complete next April. Made of blue, faceted composite, the ursine form appears to press its nose and paws against the glass façade. Argent's goal? "To break down the hierarchical environment of what people believe about art."

TECHNOLOGY AND PERCEPTION

This artistic approach is about shock, in a way, while focusing on "how technology affects perception and can also be a tool of abstraction," says Argent, who is now working on another commission, an 8-foot bronze pacifier. "I scan works and manipulate them."

In this case, Argent worked toward condensing the amount of information needed to depict a bear. First, he scanned an original sculpted model using Cyberware (www.cyberware.com) to create a **digital 3-D model**, and by using the animation programs Maya (www.alias.com) and Lightwave 3D (www.newtek.com), adjusted the figure's posture and stance. He then returned the form to Cyberware and "decimated" it—that is, reduced the number of data points describing it, giving the bear a geometry comprising 4,000 discrete elements rather than its original 500,000. This "low-res" version was used to generate a rapid prototype made on a Stratysys **fused-deposition modeler**, or FDM, using a blue ABS plastic that inspired the bear's final hue.

Argent then partnered with West Coast composites guru William Kreysler (www.kreysler.com), whom he had worked with previously, to build the FRP structure. The digital file was transferred to a **stereolithography file**—also called STL, a standard format for sharing complicated object shapes—to create a tool path for milling on a large computer-numeric-controlled (CNC) machine. To cut expanded-polystyrene (EPS) foam blocks to be the negative, or male mold, of the form, the program Rhino (www.rhino3d.com) optimized the block sizes for the minimum number of sections and seam lines, as well as to fashion a membrane support system of composite members and **steel I beams** fashioned into an H-frame.

In the shop, Kreysler employs what is essentially fiberglass boatbuilding technology: The EPS piecemolds are covered with aluminum foil and a gel coat (because the FRP's resin melts the EPS on contact), followed by the structural laminate of **glass fiber and resin**, creating the outer skin. After curing, the seams are sharpened with a razor to minimize visibility. (While the composites are extremely durable, says Kreysler, a soluble acrylic finish by Rohm and Haas is often shop-applied to improve resistance to graffiti and soot.) For the bear, six final sections, each made up of about 40 pieces, were shipped to the jobsite and butted together in situ by means of a **flange system** that limits the seam variations, and then fixed to a foundation designed by the building's structural engineer. The fully self-supporting sculpture is designed to deflect by no more than 6 inches, so that it will not touch the adjacent window walls.

DISPLACED BEHEMOTH

When done, the sculpture might overpower the ubiquitous figures of sculptor Jonathan Borofsky's *Dancers* nearby, but not by mere scale or shock value. Argent's representational public art creates instant connections for viewers. He brings the area's fauna—or, perhaps, a kitschy chainsaw bear—down from the Rocky Mountains and into the realm of human commerce. The displaced behemoth also displaces our perception of what a convention center is, and how a public sculpture should be construed in such a context.

"Part of the prerequisite was piquing someone's interest," Argent explains.

"I wanted to make it accessible, not menacing."

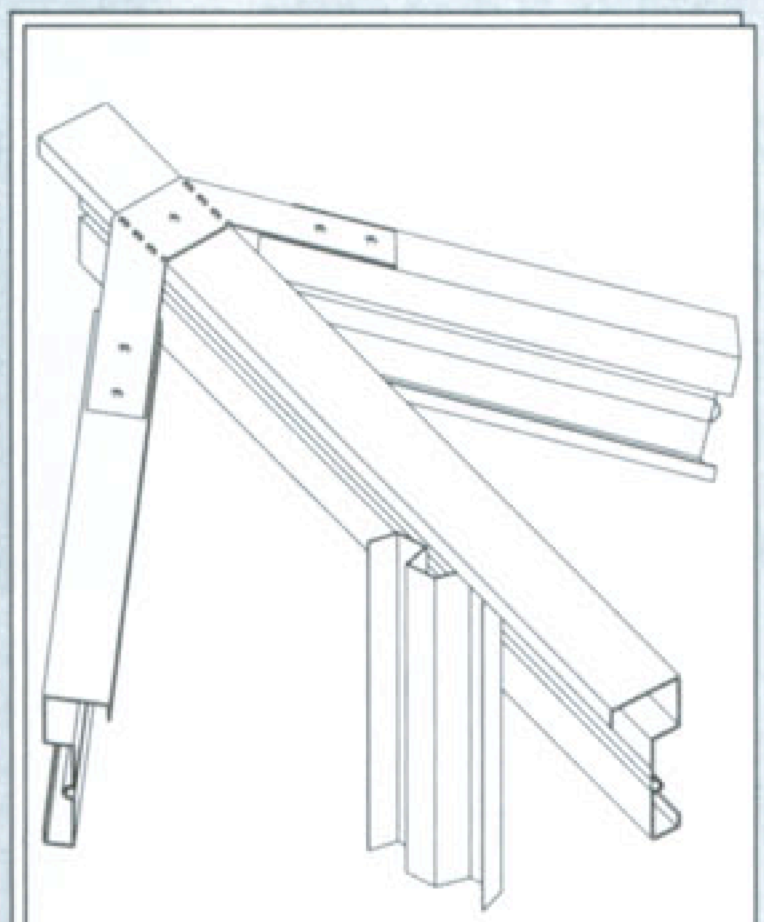
THE COLD, HARD FACTS ON COLD-FORMED STEEL

In 1992, a mere 500 houses were built with light-gauge steel frames; this year, as many as 500,000 new homes and additions will stand on steel studs and trusses. That quantum leap relates to more than steel's better **tensile and bending strength** over equivalent timber members, according to Bruce W. Bateman, who teaches construction science at Texas A&M University: This industry has evolved to produce uniform member shapes and sizes, and new construction standards and code adoptions make it easier to design and permit residential and light commercial structures. Finally, one no longer needs an engineer to design a house.

"There are new standards for steel framing, and more are coming out soon" for truss headers, **steel shearwalls**, and lateral load resistance, says Don Allen, executive director of the Light Gauge Steel Engineers Association, Washington, D.C. Engineer Timothy J. Waite, who wrote *Steel Frame House Construction* (Craftsman Book, 2000), adds that entirely new steel-frame approaches are emerging, including R-value-boosting "**slit-web studs**," corrosion-resistant galvanized members, and **single L-shaped headers**.

In fact, prescriptive methods for designing all-steel buildings are often out of date before they're printed, as manufacturers patent new connection designs and other ways to reduce materials and labor needed for equivalent details. Recent innovations include Ultra-Span Deluxe from St. Louis–based Aegis Metal Framing (www.aegismetalframing.com) and an improved TrusSteel by Alpine Engineered Products (www.trussteel.com). Both products reduce the amount of bracing material (and erection time) needed to attach a jack truss to a girder truss on a **hipped roof**—ideal for the growing institutional markets for non-combustible materials and homey, sloped-roof appeal, such as schools and nursing homes (see caption below).

While cold-formed steel is almost entirely **recycled**, it is rarely thought of as a green product. As its growth has shown, it is speed, cost, and versatility—and, in many cases, fire resistance—that have made light-gauge steel framing so attractive.



corner-truss detail 5"

For a new classroom building at United Services, a school for handicapped children near St. Louis, the old-line architecture firm LePique & Orne designed a hybrid structure of split-face concrete masonry and a metal-truss roof (left). Project architect Michael Baalman says a tight construction schedule and the economy and fire rating of steel frames swayed his choice. "And the sloped and peaked roof fits in with its residential neighborhood," he adds.

COURTESY AEGIS METAL FRAMING