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AlgoRhythms by Milgo/Lalvani

**A Brooklyn Metalworking Company May Hold
the Key to 21st Century Shapemaking**



BEND

THE RULES OF STRUCTURE

By Peter Hall

Photography by Robert Polidori for *Metropolis*

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A Brooklyn metalworking shop with an unlikely name may hold the key to 21st-century shapemaking.

As company names go, Milgo/Bufkin sounds almost Dickensian. Pushing open the hefty rust-coated steel door of the company headquarters, I half expect to be greeted by a scrawny Mr. Milgo and a plump Mr. Bufkin, with polished bald heads and prominent nose hairs. The truth is almost as good. The Milgo/Bufkin factory, founded in 1916 in a toxic corner of industrial Brooklyn, is where the drawings and doodles of designers and sculptors are turned into palpable reality. It is the art-and-architecture world's little secret.

The chief of this family-owned business is not a Milgo or a Bufkin, but Bruce Gitlin, who offers a hearty handshake and speaks in an accelerated voluminous manner as if someone might be about to interrupt him. "The name never meant anything to me," he says, adding that Milgo/Bufkin is a fabrication (appropriately enough), a conflation of an off-the-shelf company name Milgo Industrial and Bufkin Enterprises, named after all the first initials of his children, nephews, and nieces. In the last 40 years the firm has built work for the whole canon of art sculptors: Donald Judd, Claes Oldenberg, Jeff Koons, Richard Serra, Robert Indiana, and Matthew Barney. It has fabricated the metalwork in some of New York's best-known lobbies, entrance doors, and facades—including Tiffany's, Bloomingdales, Lever House, Trump Tower, the Ford Foundation—and that large number "9" outside 9 West 57th Street. And this is only the beginning of the tour.

Gitlin is about to show me a project that he believes will "change all manufacturing in the world." The brain behind the manufacturer's bravado waits in the company boardroom—a scholarly figure with a salt-and-pepper beard and a scrutinizing bespectacled gaze. Haresh Lalvani is a professor of architecture at Pratt Institute and a self-described "architect-morphologist." Together Lalvani and Gitlin have invented AlgoRhythms, a bad pun but a unique initiative involving some large bending machines, a grand theory, and, well, the future of architecture.

AlgoRhythms describes a method for folding a single sheet of metal into complex and elaborate forms, based on Lalvani's calculations. By way of introduction, Lalvani borrows a sheet of paper from my notebook. The structural engineer Robert Le Ricolais, he explains, established that "by crushing structures we reveal what they want to become." Lalvani rolls the sheet of paper into a cylinder and then strikes it sharply at the top with the heel of his hand. The cylinder crumples at the center, creating several apparently random folds. To Lalvani these are not random, but the key to the underlying deep nature of structure. "Any skin under some sort of force wants to take on a natural pattern," he says. "These patterns have some morphological laws. We are working with that idea and applying it to metal."

The first AlgoRhythms prototypes are arranged around the table and propped against the walls of the studio. There is a ceiling panel of rippling steel, an undulating wall panel, and a series of steel maquettes of column covers that curve and flow in waves. Though the twisting metal might remind one of the by now near merchandised signature of Frank Gehry, they're not derived from one man's intuitive sense of proportion or aesthetics but generated from algoRhythms based on Lalvani's architectural "genetic code."

For more than 30 years Lalvani has located his career at the intersection of architecture, nature, and higher mathematics, where, he says, he is working to "decode the architectural genome" and discover the elemental principles underlying natural and artificial form. In other words, DNA, nature's building blocks, has a counterpart in the artificial world that can be used to generate structures. Thrust across the meeting table is one of Lalvani's many diagrams of these structures, showing progressive variations—in several dimensions—of the Buckyball, the 60-atom carbon molecule shaped like a soccer ball (named by scientists after R. Buckminster

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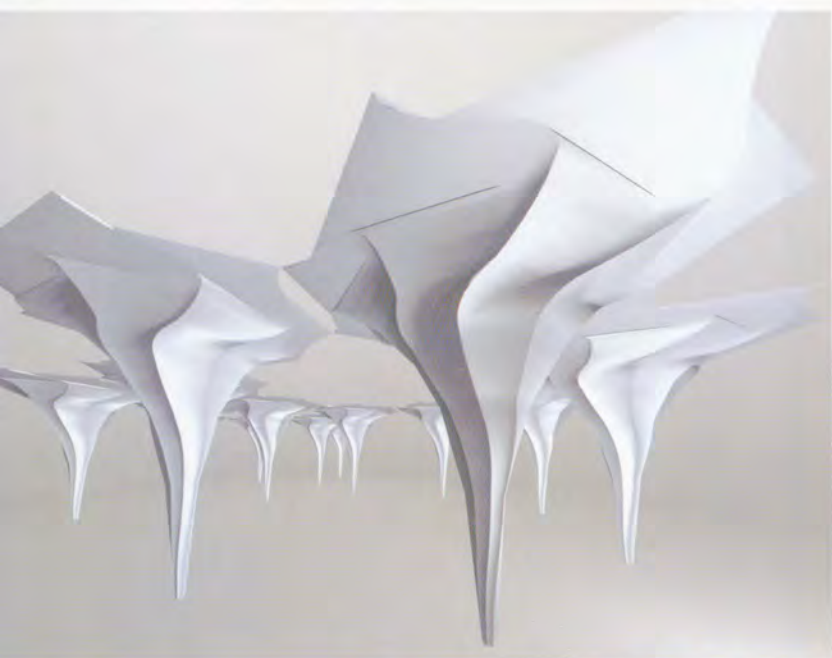
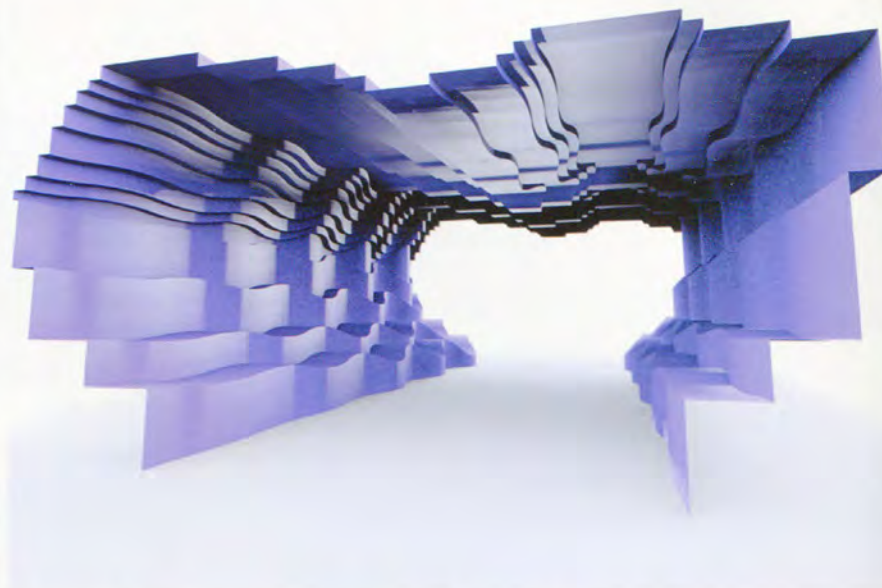
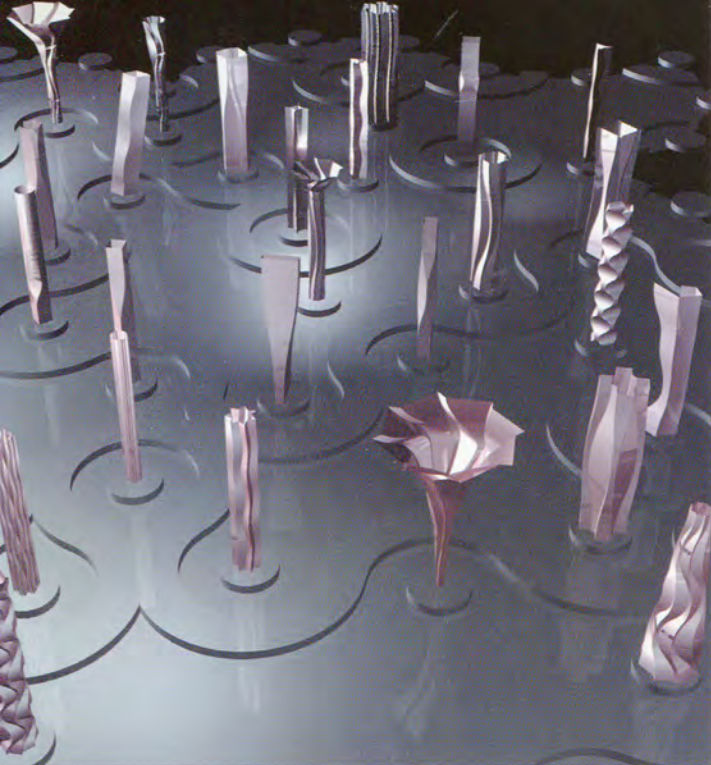
Using Lalvani's advanced surface mathematics, Milgo/Bufkin is able to manufacture complex forms, such as these column covers, without using expensive tooling and machinery.

Fuller's geodesic domes). Lalvani began identifying such variations on a theme at Pratt in the early 1970s, and in the early '80s he developed a code for generating variations of Islamic motifs. At Milgo/Bufkin he has applied automatic shape making to metal manufacturing. Setting out to modulate a stiff metal surface into several rigid curved surfaces without weakening the material, Lalvani developed a series of algorithmically generated geometries. These were then translated (by a former student, Neil Katz) into computer models and fed into computer-controlled machinery that marks and laser cuts sheet metal and readies it for folding (which is currently done manually).

Gitlin holds up a large piece of metal with corrugated curves. "I can only do this with the formulas that Hareh gives me," he says. "There's a whole new body of shapes and forms that have come out of his work that allows us to do things that have never been seen before. It's opened up the design palette enormously."

Lalvani does not stop there. He argues that if his artificial genetic code were to be combined with biological or physical building processes, buildings could eventually be "grown" into any desired shape. Architecture would be able to design itself. Lalvani is not the first theorist to propose self-generating buildings. His Pratt colleague William Katavolos introduced the idea of growing architecture more than 40 years ago in his book *Organics*, and more recently architect John Johansen has proposed that with molecular engineering atoms can be encoded with shape information that would permit controlled self-production. But Lalvani appears to be the first to provide a systematic means for this to happen, by borrowing from biology the conceptual model of the genome. This presumptuous adaptation would strike some scientists as audacious, pointless, or even insane. Mathematicians would not be troubled by using algorithms to generate forms, but might balk at the idea of Lalvani's "hyperuniverse of form," where all patterns are indexed within a unified database. Indeed wading through one of Lalvani's papers, replete with his idiosyncratic phrases—his "architectural genome" and "morphological universe"—can be a bewildering experience. But Lalvani has done some homework. Loren Day, a virologist and research professor at New York University School of Medicine, met Lalvani recently and was surprised by the extent of his understanding of molecular biology. "I must say Hareh is very familiar with much of the work being done in viruses," Day says, adding that Lalvani's knowledge of the morphology of viruses, most of which are structured like Buckyballs, led him to the concept. As for the validity of applying the genome to artificial forms, Day offers cautious confidence. "I wouldn't say it's valid, but it's very useful as a broad concept—the idea that one can break down forms into their elemental components, which are the building blocks. If I understand it correctly, you apply simple rules to these building blocks and generate remarkably diverse structures. And Hareh is doing just that."

Whether or not Lalvani's AlgoRhythms are the first pillars of a self-constructing citadel, they have immediate potential to structural engineers like Vincent DeSimone, whose firm has worked on a number of Gehry buildings. "If you take a piece of steel and bend it, it gets an inherent strength out of the geometry of the bend," DeSimone says. "A lot of times when you want to make a warped surface in metal you literally have to stretch it. Lalvani's algorithms have given you a method where, by folding along perforations, the metal is never stretched." The distinction between AlgoRhythms and the sculptural steel surfaces of Gehry's building, DeSimone says, is that "Gehry's is a free-form surface; Hareh's is a 3-D solids model." At Gehry's new Fisher Center for the Performing Arts, at Bard College, for example, the undulating stainless-steel roof functions as a rain and snow shield, but the load is carried by a series of ribs under-



MILGO PROJECTS

AlgoRhythms—Haresh Lalvani's system for efficiently bending sheets of metal into complex forms. The Column Museum (top left) is a virtual record of the column covers possible using AlgoRhythms. These variations show how the system lends itself to mass-customization. The continuous surface of Milgo Gallery 1 (top right)—a proposed gallery space for the factory—forms a ceiling and walls; the bends serve as shelves for display objects. Milgo Gallery 2 (bottom right) is another potential gallery. Each Umbrella (middle left) shows how a column can transition into a ceiling. Waveknot (middle right) is a continuous-winding space with a rippled surface. This aerial view of the Transitions space (bottom left) shows how regular walls (left side) morph into irregular ones (right side).



Courtesy Haresh Lalvani. Computer images by: top right, Neil Katz and Ajmal Akash; bottom right, Neil Katz; all others, Neil Katz and Mohammed Al-Khayr



Lalvani (below, on the left) stands with Milgo/Bufkin chairman Bruce Gitlin in front of AlgoRhythms forms. While traditional metal fabrication requires expensive equipment, such as the press brake (bottom right), to bend flat sheets into 3D shapes, AlgoRhythms forms are made strictly in the hands-on finishing area (below left). The computerized water jet cutter (bottom left) is one of the factory's sophisticated finishing tools.

neath—the “real roof,” as DeSimone puts it. With Lalvani's technique, in theory an entire building could be made of load-bearing folded metal.

The difficulty with using metal for structure is that it has a tendency to perform badly in the intense heat of a fire. DeSimone proposes filling the folded metal forms with concrete. “The panel would be an external form of reinforcing,” he says. “You could come up with a designer's dream, which would be an exposed structural-steel metal building.” He adds, “I can see walking into a building where the lowest structural columns are magnificently folded pieces of titanium and they're real: the titanium is not just an appliqué but integral to the strength of the concrete.”

Gitlin drives me in his Range Rover toward the Milgo/Bufkin “art shop,” where the AlgoRhythms are fabricated. Through the car windows are the bleak industrial hinterlands of Brooklyn, which have been stamped out of once fecund farmland by a succession of manufacturing industries. Shipbuilding gave way to printing, pottery, glass, ironworks, and finally, oil. When a refinery opened in Greenpoint in 1867 and began draining its refuse into the nearby creeks, the local fish and blue crabs promptly expired, as did most traces of organic life. It seems ironic that the molecular structure of nature might now provide the key to the future of the built environment.

Gitlin's Russian immigrant grandfather founded the company as a wooden carriage-making shop in 1916. That business dwindled, and the firm, then named Biltwell, turned to making horse-drawn wagons, which were shortly thereafter eclipsed by the motor car. After the depression the firm switched to making truck bodies, another tough business. Gitlin says his grandfather would collect overdue payment armed with a crowbar. When his father took over, most truck buyers were Italian-Americans, and many of his customers seemed to have Mafia connections. In 1963 Gitlin walked in, age 21, armed with a metallurgical engineering degree, and told his father to dump the lot and move into high-end architectural metalwork and art fabrication. “I had no customers—no work—but my father believed in me,” Gitlin recalls. “I didn't know what the hell I was doing, but we changed the whole business.”

We arrive at an intersection outside the art shop, an area Rem Koolhaas might call “junkspace.” Across the street is Gotcha Auto Salvage and Acme Steel Doors. The art shop is a nondescript brick warehouse building with a giant billboard on its roof, positioned for the benefit of drivers on the Brooklyn Queens Expressway, which roars overhead. The word *Milgo* is daubed crudely in paint above the door.

Stepping through the door, however, is like entering a fantastical grotto



of shining steel, bronze, and oxyacetylene. A technician is filing a small bronze sculpture. Sparks fly from the dark corners of the shop. Shoved against a grille-covered window is a steel tree with perfect shining petals. A packing crate lying casually on the floor bears the stenciled letters “JUDD—RED COPPER PROGRESSION 1985.” As we move toward the back of the shop Gitlin points out a 15-foot-high John Raimondi piece named *Pyre*, and introduces me to the head of the art shop, a looming figure with an iron handshake. Alex Kveton showed up at Milgo/Bufkin's door one day in 1983, according to Gitlin, and said, “I'm here to work for Milgo.” A renowned sculptor in Czechoslovakia, Kveton and his wife had fled the country and come to Greenpoint with only one goal: a job at Milgo/Bufkin. Gitlin asked how he knew about the firm. “Everybody knows about Milgo,” Kveton said. “I read the art magazines.”

Kveton continues to work as a sculptor (a metal headless horseman currently sits in the shop waiting to be shipped to its client, the town of Sleepy Hollow) but is also responsible for turning Lalvani's research ideas into metal. I ask him what was the biggest challenge of the AlgoRhythms project. “Figuring out how to make it,” he says bluntly.

Lined up side by side, the full-size 12-foot-high AlgoRhythms columns begin to reveal their power as mutable forms. They make a curious platoon, twisting and rippling like some sort of dramatized baroque rebuttal of the machine age's claim to a rectilinear world. But I am struck by how easily Lalvani and Gitlin's grand project might be limited by this array of curving steel, how Milgo/Bufkin might be pigeonholed as providers of fancy metal coverings, the stamped tin ceiling of the twenty-first century.

Lalvani is anxious that his work not be portrayed as the development of trendy shapes; this is an entire system for generating infinitely variable form. Like Fuller before him, he cleaves to the idea that when science begins to mimic nature at a molecular level, it moves into a realm outside of fashion. When I raise the possibility that AlgoRhythms might be a victim of architecture's fickle aesthetics, he protests: “How can you say that life will become outdated?” He concedes that “there's a danger that if we

It's encouraging to think that pure research has met a real-world partner

restrict ourselves to metal it will have a certain life span—and that's purely circumstantial." He adds, "This is just one case study."

Lalvani and Gitlin are already at work on another project they refer to as "universal skin." Though reluctant to divulge details, they hint at a technique whereby any sheet material can be morphed and expanded into any shape following Lalvani's algorithyms. At the more speculative end of his design work, Lalvani has rendered entire virtual environments of morphologically encoded structures. A Column Museum proposes a space filled with a sampling of all possible architectural columns past, present, and future, arranged as physical display or in virtual space with numerous entrance and exit points. The dazzling Waveknot proposes opaque corrugated glass-and-metal modules forming an undulating surface defined by a simple knot, such that the surface becomes both inside and out.

In five years, Lalvani says, enough of the morphological genome will be mapped and the project will have a strong enough scientific foundation to make it publicly available to other researchers to help advance. "First I want to make sure it has a foundation," he says. "When it's grounded in mathematics, you're not just giving an opinion."

The project certainly won't fail for lack of conviction. When Gitlin was first introduced to Lalvani by his friend and colleague John Lobell in 1996, Gitlin listened to Lalvani for "about five minutes," he says, and knew he was ready to collaborate. Gitlin's next hurdle, however, is to finance the manufacture of machinery that can mass-produce—or mass-customize, rather—the AlgoRhythms. So far most of the project has been funded out of Milgo/Bufkin's coffers. One scheme received additional support from Pratt and a two-year grant from NYSTAR (New York State Office of Science, Technology and Academic Research). Gitlin is discussing partnerships with two research-heavy universities. The result, he imagines, would be a giant "organic machine" capable of producing sections, seats, cars, even tunnels.

Lobell adds that mass customization will present designers with the ultimate ideal: "The designer logs in, sees an image on-screen, starts pulling and distorting it with the mouse to get exactly what he wants, clicks, and

the design goes straight to a laser cutter. It's FedExed to him the next day." As for the fashionable nature of the project's implied themes, Lobell—an architect—has no qualms. "The current demand of the profession is for curves," he says ironically.

Alicia Imperiale, an architectural theorist and author of *New Flatness: Surface Tension in Digital Architecture*, believes there is a link between Lalvani's work at Milgo and the architecture of Herzog and de Meuron, Greg Lynn, and Foreign Office Architecture (notably their Yokohama Terminal project). Lalvani, she notes, has arrived on similar terrain from a different starting place. "He has found a logic between morphological change—the way something looks—and how it performs," Imperiale says. "Because of his

understanding of the fluid dynamics of surface, he's able to manipulate that and use the forces to let it support and sustain itself. I find that compelling and efficient. I would love to see how an environment would be made with these forms."

The distinction between Lalvani and his more celebrated peers in the realm of commercial architecture is that he did not set out to translate post-modern ideas into headline-grabbing buildings. His goal was simply to continue his graduate studies. The incentive to put theory into practice came from more practical considerations. According to Gitlin, Lalvani wanted to send his son to private school and couldn't afford to. Gitlin says this with the affable swagger of a Brooklyn businessman. The more measured but beguiling delivery of Lalvani, the academic immigrant from India, makes a striking contrast. They're an odd pair. But it's encouraging to think that pure research has met a real-world partner in the form of a family-owned metalworking shop in Brooklyn.

Toward the end of my visit Lalvani takes me out to get coffee from a stainless-steel canteen truck parked under the expressway to serve local factory workers. He tells me, with a gleam of delight in his eye, that he thinks of Milgo/Bufkin as "romantic." For a theorist immersed in one field for decades to suddenly see his ideas made manifest must be a rewarding experience. As for Milgo/Bufkin, it's a collaboration that could take the venerable Greenpoint firm well into the twenty-first century. www.metropolismag.com

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