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How Santiago Calatrava's Buildings Marry Engineering With Biology

By [Linda Tischler](#)

Two decades ago, Tom Fisher, now dean of the University of Minnesota College of Design, visited Spanish architect Santiago Calatrava in Zurich, where he has a staff of 40 and a lakeside villa.

As he was ushered into the architect's office, Fisher noticed an odd artifact hanging above the desk: the skeleton of a dog. "I thought it was his long-lost pet," he says.

It was, in fact, a gift from a veterinary student in Zurich, whom Calatrava had befriended. "He was living with me in the same house when I was doing my PhD," Calatrava says, "and I helped by doing the drawings for his thesis -- and he gave me a skeleton."

It's been said that the mechanical perfection of that skeleton inspired Calatrava's first big civic commission, the design for a train station in Zurich, whose corridors resemble an animal's rib cage. But Calatrava vacillates when asked about the source of his ideas. "Does nature inspire your buildings?" I ask, when we meet in his elegant town house on Park Avenue in New York. We've just paged through stacks of his watercolor sketches of figures in motion, landscapes, sea creatures, and birds. "No," he says, firmly. A pause. Then, "Sometimes I say yes," he confesses with a mischievous little smile. "Sometimes I say the human skeleton, because it's true that there's something essential in the construction of our body." He splays his hand, wiggling his thumb by way of illustration. "In my hands, there is a little bit of architecture and engineering. What architecture does is what a coat does for our body. It wraps us."

Anyone familiar with Calatrava's work is immediately struck by its biomorphic suggestiveness. His first skyscraper -- dubbed the Turning Torso -- in Malmö, Sweden, which is 54 stories high, with a 90-degree twist, was based on his sketches of the human spine. His art museum in Milwaukee has wings that open to the sky. A train station in Lisbon has columns that look like a forest of palm trees. A planetarium in Valencia, Spain, began with the sketch of a human eyeball.

"A biomimetic infrastructure is what's inherent in Calatrava's work," says Fisher. "He has this insight that natural processes create efficiencies. I've had arguments with people who think his work is extravagant and overly expressive, but I think the idea behind it is really profound. Nature and evolution take things down to their most elegant form, no more material than absolutely necessary, but also build in redundancy. If every architect took Calatrava's lessons to heart -- that evolution is the best engineer and nature is the best designer -- and acted with that in mind, it would be transformative."

Calatrava's understanding of natural engineering has allowed him to build radically innovative structures, some of which seem to defy gravity. "There's no question that he will go down as one of the great artistically oriented engineers in history," Fisher says.

Calatrava's best-known work in the United States is a project yet to be built, the transportation center at ground zero in lower Manhattan. Apart from the Temple Mount in Jerusalem, that site may be the most emotionally fraught parcel of real estate in the world. Calatrava's initial design was inspired by the idea of a child releasing a dove, with 200-foot-tall canopies mimicking ribbed wings that would open every year on September 11, letting sunlight enter the subterranean spaces.

When the plan was unveiled, critics were generally rapturous, comparing it to the secular cathedrals of Grand Central or the old Penn Station, and to Eero Saarinen's TWA terminal at JFK. Others thought it was an appropriate in-your-face gesture to the man who made the rebuilding necessary. "We wanted this to be 'Up yours, bin Laden,' " one construction worker told me.

The project has since become tangled in a world-class battle of egos and political posturing, the budget has ballooned, and the internecine finger pointing is played out in the city's tabloids. Calatrava, in the middle, has repeatedly revised his project, and has done so with a stoicism borne of long experience. After nearly three decades of working for municipalities, he knows that part of doing public-works projects is the inevitable squabbling over costs and the not-infrequent calls for his head.

"You must understand the difference between being an architect and a politician," he says resignedly. "Architecture is a profession of perseverance. You have to come through. The politician is there to blame someone. I don't have the vocation of the martyr. So you have to develop a kind of deafness. They can say what they want; I just work and work and work."

Like his fellow starchitects, Calatrava has seen some high-profile projects crash along with the economy. The Chicago Spire, a twirly 150-story pillar with a tapering point, intended to be the country's tallest building, is nothing but an excavation as developers try to jump-start financing. Eighty South Street, a Manhattan tower of 12 condos stacked like a stairway to heaven, fell victim to a dip in the supply of hedge-fund moguls willing to pony up \$30 million for an apartment.

But Calatrava isn't suffering quite as much as his peers. Indeed, having recently inaugurated a spectacular \$446 million train station in Liège, Belgium; overseen the groundbreaking of a new bridge in Dallas; unveiled a master plan for the University of South Florida Polytechnic in Lakeland; and put the finishing touches on the massive City of Arts and Sciences complex in Valencia, he continues to have a robust practice.

Overall, Calatrava was less invested in the kinds of projects that bloated the portfolios of his colleagues in the architectural firmament. And, with both engineering and architecture degrees, he has a technical range that enables him to tackle commissions beyond the scope of many of his peers. For all that versatility, however, he says he has devoted a surprising 90% of his work to civil-engineering projects. "I started one day, when I was 31 or 32, working in public projects, and I'm 58 and keep doing that," he says.

Public-works projects are rarely thought of as the glam side of the business. Too often, they are saddled with miserly budgets, subject to small-minded political agendas, and susceptible to ham-handed tinkering by bureaucrats eager to flex their muscles -- not exactly the kind of visionary clients that might let you wrap their buildings in titanium.

Despite these odds, Calatrava has managed, over the course of a 30-year career, not only to build some 40 bridges and 10 train stations but also to create a body of work that is among the most lyrical and inspiring of any working architect.

"Americans seem to believe that infrastructure should be as invisible and utilitarian as possible," says Fisher. "The idea that you could actually love infrastructure and find symbolic and expressive meaning in it is a huge contribution that Calatrava's made."

Indeed, in the current climate, when the U.S. could use a boost to its infrastructure and a jolt to its leaden mood, Calatrava may be the man for the times. In 2009, the American Society of Civil Engineers (ASCE) gave the United States' infrastructure a grade of D. "We've relaxed our consciousness about our infrastructure," says ASCE president Blaine Leonard. "We've grown beyond the capacity we've designed for and reduced the amount spent on it, relative to GDP. A quarter of our bridges are functionally obsolete or structurally deficient."

The Obama administration's commitment to rebuilding our infrastructure, the \$787 billion American Recovery and Reinvestment Act of 2009, briefly raised hopes that government would finally put enough money behind projects to reverse a shameful decline. But only about 10% was allotted for infrastructure, and thus far the bulk of that money has been targeted to shovel-ready projects -- mostly highway repaving.

Back in the 1920s, the national-infrastructure conversation was about pride and building for the ages, says Fisher. "The current idea that government involvement is evil is completely debilitating in the global economy. You need infrastructure to compete. We're acting like a third world country, while other places like Europe and China are investing." According to the ASCE, Europe invests 5% of its GDP in infrastructure, China invests 9%, and the U.S. invests a paltry 2.4%.

"We built the Hoover Dam when we were flat-ass broke in the middle of the Depression," says Reed Kroloff, director of the Cranbrook Academy of Art. "And completed the D.C. subway system when Jimmy Carter was president and there were gas lines around the corner. What we do now is the cheapest, fastest solution to every problem, not thinking you can be both expedient and expressive. It's terrible, sad, and inexcusably meek and meager. It's appalling to me that Americans have come to accept the suburban strip mall as our national architecture."

Precisely, says Calatrava. "There's a great opportunity to go back and learn from when great works were done in this country," he says. The building of Grand Central Terminal, he points out, led to the development of the skyscrapers of Midtown Manhattan and the growth of the surrounding area, including the very avenue on which his office and town house sit. "Bridges and stations are very strongly related to the development of a city. Public works are substantial; they're for the next generation."

He is a true believer in the power of architecture to define a place, pointing to the onion domes of Saint Petersburg, the bell towers of San Gimignano, and the minarets of Istanbul as examples of how the built environment can characterize a city. His affection for New York borders on the spiritual: "I remember, many years ago, coming over the Brooklyn Bridge in the night and seeing the skyline of Manhattan, with the Twin Towers. This was, for me, a kind of religious experience."

Calatrava's redefined another skyline -- Milwaukee's -- with his addition to the Saarinen-designed art museum. The roof-line, comprised of wings that open to a span equivalent to a Boeing 747's, has become

a symbol of the city and changed Milwaukee's perception of itself. "This is the single image, the lapel pin, that people from the city wear when they're boosters," says Rick Bell, New York director of the American Institute of Architects.

Not surprisingly, this architectural tour de force didn't come cheap. The final tally amounted to about \$130 million, underwritten by the city's philanthropists. The museum's director says the money was well spent, lending the museum a stature it might not have attained with a more modest addition. That's a compelling rationale for a privately funded venture; it's harder to argue when taxpayers are footing the bill. "His buildings have a reputation for being expensive," says Kroloff. "And it's difficult to resolve that structural derring-do with budgetary constraints."

So the question becomes: Where is the line separating a flight of fancy from the solution to a problem? How do you prevent architectural audacity from becoming mere extravagance? Calatrava counters that his buildings have a bigger purpose. His undulating train station in Liège, he says, was designed not simply to serve as one of the major rail hubs in northern Europe but also to transform the entire area surrounding the station, by connecting it to the river with a sparkling new avenue and plaza.

As often happens, the Liège station was plagued with budget problems and the blame got pinned on Calatrava. It's a topic that makes him lose his courtly, diplomatic mien. "If these costs were not justifiable, we would all be in prison," Calatrava says, his voice rising, his Spanish accent getting thicker. "I repeat. We would all be in prison!"

He knows how to bring a project in on budget, he says, and his track record makes that clear. "Because they are done by public officials, under strict surveillance of the accountants, there is not a cent that is not approved," he says, becoming still more agitated. "So even though journalists may say they are over budget, they are not over budget. It's just an illusion!"

He has, he says, done work in 17 countries, often for repeat clients, in such inbred networks as the European railway industry. "If you make a mistake with one, then everyone will know it immediately," he says. "But they are satisfied." He already has new projects lined up in Portugal and Spain to prove it. Calatrava says he could do the same in the U.S. without breaking the bank. "Basically, the buildings I construct have to be built for a very low budget," he says. "The only luxury has been the space and the light that I have to give them."

"Low," of course, is a relative term.

Five thousand miles from the turmoil in Liège, one of Calatrava's dazzling bridges is already rising in Dallas. To the west of downtown, the Margaret Hunt Hill Bridge is taking form over the Trinity River, and another Calatrava span, the Margaret McDermott Bridge, is on track to be built in three years. Calatrava's Dallas project embodies his most passionately held views about the potential for architecture to rehabilitate an area and bring a better life to even the most disadvantaged citizens; here, his bridge looks to be the catalyst to right some serious civil engineering mistakes of the past.

After the devastating Trinity River flood of 1908, Dallas's city fathers enlisted the Army Corps of Engineers to reroute the river a mile to the southwest and to straighten it out. The idea sounded good at the time, but as with many well-intentioned schemes, the result was disastrous. Newly straightened, the river became little more than a polluted drainage ditch. Worse, it cut off the city from the river, destroying a priceless aesthetic and recreational resource, and leaving the far bank beyond reach of the

economic development that has made Dallas the eighth-largest city in the U.S.

Dallas approved a \$246 million bond program in 1998 to reclaim the Trinity River Corridor. Four years later, since Dallas is a place that collects starchitecture like other cities collect World Series trophies, city officials naturally called Calatrava. He was charged with designing a bridge linking downtown Dallas to West Dallas, a poor, largely Hispanic neighborhood of heavy industry, gun shops, and small houses.

Calatrava was intrigued. It reminded him of his project in Valencia, where he took a blighted industrial zone known for its polluted soil, hookers, and drug dealers, and turned it into a major arts complex.

"I immediately got the feeling that this was the backyard of the city," he says. "What a pity that this river is the corridor for traffic and high tension lines, and buildings that nobody wants -- like neighborhood jails. I wanted to show people what a wonderful opportunity they had."

Rather than producing a simple mock-up of a bridge, Calatrava created a 12-foot-long model, with five bridges crossing the river at various points, showing how the area could be transformed into a less-manicured version of Central Park, with forests and floodplains.

City leaders were impressed. "This enormous project started with the bridges," says Gail Thomas, president and CEO of the Trinity Trust Foundation, a private fund-raising group. "The people in Dallas had turned their backs to the river, and we knew it would take something beautiful to capture the hearts of the people to return."

Not only would the \$2.2 billion project -- one of the nation's largest -- include lakes, a nature center, a white-water course, and equestrian trails along the river, but Thomas also hopes the bridges will encourage traffic to the opposite bank, where the city is looking to spur cottage industries and markets for everything from crafts to fresh produce. When the economy comes back, she hopes, developers will follow.

As with many of the public projects Calatrava undertakes, a period of fighting involving toll roads, levees, budgets, and environmental-impact statements quickly ensued. It's taken seven years, but girders for the first bridge are in place, and its 440-foot-tall arch is going up.

"Beauty is an ideal that inspires and helps us chart a new course and gives us hope," says Thomas, who has been at the heart of the fray to see the plan realized. "Dallas aspires to greatness. And why not? Why choose the opposite?"

That's a relatively easy stance in a city like Dallas that can tap a resident population of oil heiresses. The question remains whether Calatrava's brand of architecture can work in less-prosperous locales -- and whether he has the will or interest to adapt to more-modest projects. Kroloff, for one, thinks he does. "With Calatrava," he says, "you have to know going in that he's only going to be interested in a project if it allows him to explore. He has a very restless mind, in all the right ways. He'd do a Costco if he could figure out a way to hang it from one column."
