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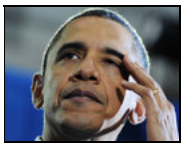

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Theodore Zoli: Bridge Engineer

There is poetry in a bridge, an economy of effort. Ted Zoli finds it.

By Tom Chiarella

Photo Credit: Courtesy Of John D. & Catherine T. MacArthur Foundation

Down wall, from girder into street night leaks, a rip-tooth of the sky's acetylene, all along this rusty, unfailing viaduct, from Jamaica out toward Flatbush in Brooklyn, city of poets, this is Saturday, and once again it is time to hoist the span.

Twenty-four tons of preassembled railroad bed, strapped and lifted on two simple bands, hanging above the street, soon to be nudged into position on its columns by two tradesmen using plain rope and steel rods no thicker than a bamboo switch. Nearby, a young engineer gives too much credit to awe when he says it reminds him of ballet. Sure, the hoisting of the span is quiet. You can hear someone beating a rug on a roof. Dancehall music throbs from the open window of a Scion. Old men mutely gaze from the doors of Chinese restaurants at this, the spectacle of the boulevard. This is no ballet. It's bridge work. Public works. This raising of the span is the lifting of a whale.

Ted Zoli, bridge builder, ringmaster, lead engineer of the whole shebang, takes it in. The platform sidles in the air above. Three seagulls turn in the sky. Be it the sight of the gulls or the silent rocking of the behemoth platform before it is seated, something makes Zoli point upward to conjure a poet. "Hart Crane," he says, "would have loved this."

Theodore Zoli, P.E. — Z is what contractors call him, and he sometimes refers to himself that way in a cell-phone message — a forty-four-year-old award-winning long-span bridge builder, is the engineer of the moment. The moment being now: our age, our time, after that crash, from the guts of our arguable recovery; when the investment of public works must outlast the stimulus, when function trumps form and cost outweighs vision. The era of the engineer begins as the era of the architect winks out. The engineer of this moment must find his satisfaction inside

public backlash are also setting in.

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By Kate Shapiro

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Pierce on the Michigan Primary War

By Charles P. Pierce

This isn't a presidential campaign anymore. Conservatives have forgotten how to, you know, conserve.

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his small solutions, in rebuilding and retrofitting what came before, and retooling the ancient precepts of his profession in order to save money, to build more, to use less. It helps that he likes it that way.

It is a pun, this engineer-of-the-moment thing. In engineering, a moment is the tendency of a force to cause a rotation about a point or axis from a distance that in turn produces bending stresses. Less exotic than it sounds, since a moment occurs pretty much any time one object exerts force on another. Post and lintel. Beam and pier. Arch and cable. Any number of connections in a structure might carry "moment." It's not uncommon for Zoli to put his hand on a rusty connection, a bearing maybe, and say something like, "See, this still makes a good moment." He means it will hold. He means it can be built upon. Zoli means it as a compliment to the work of those who came before him.

So, bridge building. Very male stuff. Bridges conquer — distance, time, gravity. This sometimes makes long-span bridge engineers build like male porn stars: bigger, longer, harder, sometimes only because they can. Their best work is almost always the product of public-works initiatives, the culmination of years spent studying the world's most difficult engineering puzzles — deep-water pilings, long-span spreads, minimal redundancy opportunities. Projects that must outlive their time. Think of the G. W., the Golden Gate, the Chesapeake Bay. People give these things nicknames. Long spans are built for the ages. Books are written about them. They inspire songs, sunsets, public television, and poetry.

Bob Kerrey Pedestrian Bridge
Nebraska to Iowa

The rare Zoli bridge that's iconic, the 3,000-foot Bob Kerrey Bridge — opened in 2008, connecting Council Bluffs, Iowa, to Omaha — is best known for its characteristic S shape spanning the Missouri River. "I never knew it as the Bob Kerrey Bridge," Zoli says. "They renamed it later. I tend to refer to these things more simply. Bridges tend to leave you once they're out of your control. I think of this as something like 'My time in Omaha.' I like that just fine."

We can only presume what the engineer sees in the bones of a city. Earlier, en route to Brooklyn, in the subway scuttle of Penn Station, Zoli's gaze rested on the multiple ceiling vaults, like redundant church ribs bracing the weight of the city. "When they built this," he said, "no one could have seen what the city would become, the volume this would have to support."

On the moving train, Zoli peered into the dark twist of tunnels and assessed. "It's overbuilt," he said of the 106-year-old transit system. "But that is its strength. It can take a lot of damage and still operate beautifully. The future is always ten times what you'd think it will be. The reflex has always been to build more with less" — the engineer's creed — "but things have less margin now. I've begun to think that maybe we've sacrificed damageability. Maybe damage is something we should trade on."

Damage?

"Think about short bridges. Limited-use bridges. Rural bridges. Why should we build them to last 100, 150 years? What if we could build a bridge that would last twenty years, that would rot safely and employ a controlled collapse? A bridge that could be replaced in a week instead of a year? Wouldn't it make sense to do less instead of more?"

Zoli on a good bridge, the George Washington: "That's a piece of engineering: two lines. Before they built the lower deck, it was just a ribbon with two towers. They were thinking about this massive engineering event in a new way, a spare way. Strong tower, light deck. Great bridge."

Zoli on a bad bridge, the Queensboro: "It's just a crap bridge. There's no sense of clarity of form. And it's an audacious problem in terms of maintenance. When you look at how many moments you have to worry about, it becomes a nasty problem. In terms of the engineering itself, it's heavier visually and more complex in its construction and design than it need be. There's nothing nice about it. When they built it, it must have seemed like: strong. But throwing a lot of steel at the problem is the worst sort of engineering. The more I look at it, the more it pisses me off."

Zoli on a so-so bridge, the Manhattan: "Ah, let's just say, following the Brooklyn Bridge, the Manhattan Bridge didn't up the ante in any significant way."

Atlantic Avenue Viaduct Rehabilitation
Brooklyn

"It's not high in the air," Zoli says of the project that's currently under way in Brooklyn. "But it's a true long-span project, and the space under it — the city itself, the people — it's a pretty important part of what the bridge represents. More important, really." When this part of the viaduct was built around 1901, the neighborhood below was a mix of business and residential — as it is today.

A supremely industrial evening, this smoke-cindered summer dimmet, this Saturday in Brooklyn, where Zoli is standing beneath the hulking, ancient Atlantic Avenue Viaduct, built in 1901. In all, 199 spans must be replaced in an operation that can occur only on Saturdays starting at 5:00 P.M. and ending at 11:00 P.M. Sundays. The plan calls for two spans to be replaced every week.

The signature of Zoli's system is that it is modest: He keeps the spans short, as in the original century-old design, allowing for a retrofit of the original network of

support columns rather than calling for their complete replacement. Using Zoli's stripped-down set of repeatable assembly processes, the contracting company can now do ten spans in a weekend, each the size of a modest Taco Bell. On a big job, Zoli always works smaller. "The shorter spans are more expensive, so it would seem not to make sense to use them," he acknowledges. "But they're simpler to install, making the work significantly faster. In the end, the construction process itself saves the money that goes into the quality of the material assembly."

Bridge engineers systematically delimit gravity, making them something like magicians. They work to understand the extreme limits of issues like load capacity and dynamic response, making them a little like actuaries. Their designs must factor in the effect of years, wind, water temperature, ocean currents, vibration patterns of traffic, the weight of footfalls, the last report of earth tremors. They envision wear, damage, and vulnerability in a world that doesn't yet exist, making them more like prophets. When you know enough, when you can calculate every variable multiple times from a laptop computer in a trailer at a work site, they find you can lift just about anything, making them more like strongmen at the circus.

The process of bridge assembly can typically be whittled into a series of discrete events, so that each stage is a component in a process of doing as much as you

can with as little as possible. This is Zoli's specialty, entering into the building process. His father was a concrete contractor who built roads in the Adirondacks; Zoli ran mixers, worked with dynamite, rebuilt engines from the time he was ten. He lost the tips of three fingers on one hand in a site accident when he was fourteen. It was nobody's fault, he says. He tripped.

The viaduct project is ahead of schedule, and there are dollars associated with that. Millions. This is the signature that matters now: time and money. That's why Zoli was chosen, and it's about the only way Zoli's willing to stick his name on a project. "This whole idea that a 'signature' bridge has to make a visual statement is borrowed from architecture at a particular scale," he says. "And it doesn't feel at home within functional forms like bridges. It doesn't seem right to me. Signature is something I want to take off these things. Especially the sense that the signature is me."

Lake Champlain Bridge Replacement
New York to Vermont

The original bridge connecting New York and Vermont closed when inspections revealed irreparable cracks. Zoli's firm engineered a 2,220-foot replacement similar to the original's continuous truss design, and it worked on an accelerated schedule (ten weeks) to protect fragile local economies. "It's not a high-volume bridge," Zoli says, "but its prominence as a structure was inarguable. You can't remove an eighty-year-old bridge without devastating a way of life. We moved fast."

In 1924, Hart Crane, the supremely gay, doomed modernist poet, lived in Brooklyn Heights, not all that far from the viaduct as the gulls fly, though a thousand miles in spirit. Crane would, as Zoli pointed out, love this lamplit scene along the viaduct, the hulking track in the sky, the way the workers stop everything when the commuter train out to Flatbush rattles past on the open track.

"Crane was a funny, muddled figure," Zoli had said as we rode the A train. "A really difficult guy. 'The Bridge' is not my favorite of his poems, and I think it's regarded as his best work. It's a large, ambitious thing, and Crane certainly got what a bridge is. But I like the more invisible poems better. The idea of the building project that disappears interests me in the same way. You try to say much with few words, so few words in poetry, that the space in between the words is huge. It feels both incomplete and austere. Bridge engineering should have the same goal, to do a lot with a little. I'm not interested in embellishments or some of the things that you might see on bridges that are not purely necessary."

He doubles back, more poetry: "With Crane, in that poem, the bridge is the center of things, yet it gets pretty invisible against the city — which is what bridges ought to do, a measure of their practical function."

The raising of each span of the viaduct demonstrates something about the engineer behind it. It is the technique of the form. The largeness of it — "This is a 1.5-mile bridge, there's no way around that," Zoli says — is undone by the modesty of each step. He simply makes it easier to build, gets a certain satisfaction from that, which is why this elevated urban railroad bed is what Zoli — MacArthur-grant winner, chief engineer of iconic bridges from Boston to Omaha to Mumbai — calls his best work.

"I'm just as proud of this viaduct as I am that S-shaped pedestrian bridge in Omaha — you know, a project that has a real presence," he says. "It's the wealth

of small decisions that went into this one. Right now, engineering innovation is really in construction. That's where evolution is measured. If you can make the construction easy, you can make the bridge cost-effective and realize all sorts of efficiencies that are truly efficiencies and not mirages."

Zoli is small — smallish guy physically, tucked in and trim — and his work is small in its presumptions. With some of the MacArthur money, he's developing a pedestrian rope bridge that's small enough to fit in a backpack, for use in rural regions where roads are few. He's undertaken remote and somewhat unglamorous projects with vigor, like using a highly accelerated engineering schedule — we're talking two years of engineering in about ten weeks — in replacing a bridge across Lake Champlain, taking into account the small and creaky economic truths of rural America. "The old bridge was dead," he says. "My inspection revealed the need to take it down. That's a part of the world where people were facing a two-hour detour, each way. That can kill a guy who's delivering truck parts." Picturing the life of one person, imagining his gain, his peril, crossing the bridge that you built? Small, private, empathetic. It's the way a poet works.

Those three bridges he mentioned earlier — the G. W., the Queensboro, the Manhattan — may, in fact, be the very bridges for which Zoli has developed retrofitting strategies to protect structures from terrorist attacks. Impossible to say, because Zoli can't name the bridges, or even indicate the cities he's worked in. National-security priorities suit a lack of ego.

Zoli regards the future — any future, that of a terrorist attack or a guy trying to deliver truck parts — as a series of large engineering questions accompanied by small engineering responses. "There are substances you can get at a hobby shop, pour in a wine bottle, and leave on a bridge railing that would do the damage necessary to bring down a structure that doesn't feature enough redundancy. There are tools a welder uses that burn hotter than almost any known substance. It's not even much of a trick imagining how they'd be used."

He developed a blast- and impact-resistant material to shield vulnerabilities of long-span bridge work, drawing inspiration from the way tanks are built. "In some fashion, the solutions go beyond what's calculable — to human behavior, human problem solving. Maybe one part of protection is we limit access — just take pedestrians off the bridge. But it's really difficult to reengineer a bridge in a way that deals with every contingency, so also we've learned to protect the bridge by assessing damageability. A good bridge can take some damage."

He watches the work on the Brooklyn viaduct, leaning against a concrete bridge footing. "I wish you could have seen the cutting of the piers," he said. "They were using a thermic lance. That's really something to see." A thermic lance is lengths of iron oxidized in the center of a steel tube by force-fed purified oxygen, creating something like 7,000-degree heat that cuts through almost anything. "Everyone gathers round to see them work the lance," Zoli says.

What about the hoisting of the span? Aren't we gathered round that?

"Oh, it's great," he says. "Raising a bridge span is a culmination of a great communal effort. It's far more ambitious to build something than it is to bring down. But a thermic lance — one person can use that. These guys are artists in their own way. I've always said that bridge building is technology, not art. Or if it is art, it's not like Western art — by the few, for the few. It's more like folk art — by the many, for the many."

Up on its columns now, just before the bolts are set in place, the span is nudged. Zoli watches without comment as the men work. With one small lift from the crane, just enough to push tension on the lifting straps, the whole event is umphed a few inches to the north, and the platform finds its seat. Just like that, it is an event no longer. Just like that, it assumes the seat of the invisible. This is Zoli's moment, when function takes over, and everyone else looks away.

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