THE VIRTUE OF NECESSITY

Regarding Engineers, Taxes, and Getting What You Pay For

EARLY IN MY EXPLORATION OF INFRASTRUCTURE, I took a side tunnel off the main culvert channeling the Pigeon House Branch beneath central Raleigh. Bent low in a 5-foot concrete tunnel, I splashed my way upstream in the trickly flow until I saw something odd—daylight. I quickly reached what turned out to be a hole of some kind, with dirt, broken pipe, and pieces of asphalt jumbled together where the culvert had collapsed. I crept forward and stuck my head out for a better look only to hear the *beep . . . beep* of a reversing piece of heavy equipment and find myself staring at an approaching backhoe. I scuttled back, and in a moment I heard the backhoe engine stop. I slowly stuck my head out again and shouted, "Don't dig me!" The engineer, backhoe driver, and other workers presented satisfactorily openmouthed expressions as I popped up in their construction site like a Whac-a-Mole.

What had happened, I learned, was that a track hoe sent to excavate a patch of sinking pavement a few days before had itself caused further collapse and fallen into the hole. The track hoe had been fished out, and the current crew, watched by a city engineer, was using a lighter backhoe, picking its way into the collapse to investigate. Since I came from underground, the engineer asked if I would mind going back down and shooting a couple of pictures inside the culvert, especially of a crossing

water main under which I had ducked to get to the hole. That afternoon gave me my first sense of how truly intertwined all these systems are. The engineer asked me to take pictures because, GIS or no, maps and records or no, he wasn't at all sure what lay under that collapsing street. And the next city engineer I spoke with, Veronica High, explained what the city would have to move in order to fix the hole.

"For this one?" she said. "I think telephone, cable, electricity, fiber optics, gas, water, and sewer." A blithe smile. "And even moving a pole isn't simple, because you have to wait to find out who owns it, and then for everybody to do their work." Whoever owned the pole (the electric or telephone company) would have to work with the city to choose a place for the new pole, then install it. Then one by one the utilities would have to reroute their lines; that could be a week right there. "At least," High said.

And the systems aren't complex just because they hang from the same poles or lie in buried conduits next to each other, or because they require one another's assistance to work (try generating electricity without water to cool the generator, or treating water without electric pumps; try doing either without fiber-optic communications). No, they're becoming more complex every day just in what they do. And what they do, we can no longer do without. Everybody knows somebody who's proudly going "off the grid," right? With wind generator plans downloaded from the Internet and building supplies delivered by trucks over paved roads and a pipe bought at Home Depot to channel water that's potable because of modern upstream sewage treatment and stormwater management. You can't go off the grid anymore; we're all on the grid. We *are* the grid. And it's marvelous—it's miraculous. It's the eighth wonder of the modern world. Maybe it's the first seven, too.

That also presents a problem. Raleigh sewer collection superintendent Gene Stanley, who grew up on a farm, sees something scary in the way people depend on an infrastructure they don't understand and don't know how to live without. "You go to the grocery store," he says, "and they can't even count the change," much less grow tomatoes and corn or shoot a squirrel ("You put him over rice, you got you a good meal"). But

cut off the electricity or wreck the trucking routes and the processed food goes with them, along with the fuel we use to cook. Striking closer to his job, every year his family used to dig a new hole, move the outhouse, and use the dirt from the fresh hole to cover the old one. He doubts that one family in a hundred would know to do as much if the system he maintains failed. "It'll be the downfall of America," he told me.

I couldn't shoot a squirrel to save my life, and I utterly depend on my freshwater and electricity and sewage treatment as much as anybody else. And now that I've spent a lot of time with those systems, I still only just understand them. I naively hoped that by the end of this project I'd be able to walk down the street and answer any question about any wire hanging above my head, about any mysterious iron disk in the pavement, about every road and rail design. Of course, I can do nothing of the sort, and I've decided that's just fine. With systems this complex, this intertwined, this miraculous, you could spend all day every day thinking about them and you'd still be behind—unless you work for a utility company or one of the relevant government agencies, you just can't worry full-time about power, or water, or sewage, or cable, or trash, or roads. But that's okay: You deal with enough of the people who unclog your sewer pipes and clean your water, who interrupt their vacations to call power companies when they notice something that looks funny, and you develop a sort of awe for them.

On the other hand, you do have to know a little, because as a citizen you have decisions to make: How much to allocate in taxes? Which projects to support? Which rate increases are reasonable? You can't just ignore the infrastructure; you can't not know a thing about it. Ignorance is irresponsible, even indecent. Something that important, that central, requires your awareness and your conscious assessment. You have to have an opinion about the infrastructure.

Now I do. In fact, I have three opinions.

MY FIRST OPINION IS, THANK GOD FOR ENGINEERS. Whenever anyone claims that they yearn to live in some pre-20th-century Good Olde Days,

I have always had an easy answer. "Two things," I say. "Antibiotics and modern dentistry." People who pretend they would be just as happy without them are fools.

But to those two essentials I now add every stream of infrastructure I traced for these pages and the people who make them go. I have drunk water probably 5 or 10 times per day every day of my life—call it 150,000 drinks of water and you're in the neighborhood. And the next time I get some sort of waterborne illness from my drinking water will be the first. That's nothing short of a miracle, especially when you consider that at least a sixth of the world's population lacks access to safe drinking water. This is an unimaginable luxury, worth—well, ask one of those people without access what they'd pay to get clean water for their kids. Yet we not only take it for granted but actively complain about it, especially if the people managing the water systems wish to charge us for that life-giving, lifesaving service. We'll protest the cost of our freshwater going from a third of a penny to a half-penny per gallon—all the while sucking like infants from the dollar-a-pint plastic bottles of water we seemingly can no longer leave our houses without.

On and on. I don't go over the river and through the woods to get to Grandmother's house for Thanksgiving. I get in my car, which is in my driveway, and climb out in a parking lot 15 steps from her door, three states away, without ever having to do anything more onerous than change radio channels or pee in a public restroom whose cleanliness may not reach my lofty standards. If I'm in a hurry, I can jump on an airplane and get to Grandmother's house in a couple of hours. Either way I go, chances are I'll complain pretty much full-time about the high cost of fuel, or the capacity or quality of the roadways, or the capacity or quality of the waiting area, or the capacity or quality of the aircraft. If you think that's complaining, though, ask me for tax money to improve any of it—then you'll hear some complaining.

Nietzsche called architecture "triumph over gravitation," but really it's the engineers who fight not only gravity but all the forces of the physical world—the reality that heavy trucks destroy roads, that steel stresses, that lines sag, that water and sewage flow downhill. In our fresh-from-the-dryer, central-heated, smooth-paved, bright-lit, 10-gigabyte-per-second

lives, we never need spend a moment thinking about the trouble those physical forces will cause if we're not on guard every second. We have engineers to do that for us, and planners and guys with 16-foot-long shovels and guys who throw rubber blankets over energized power lines and guys who push around spewing water and sewer pipes in the middle of the night with mist freezing on their eyelashes. I've talked to a lot of those people, and I've decided I trust them.

Mind you, nobody wants to blindly trust engineers, or industry, or regulators, or government, or anybody else (including environmentalists, or me). I liked seeing the guards at my nuclear plant carrying machine guns; local publications, however, have run stories about lax security and propped-open fire doors. In 2007 disgruntled employees of the Peach Bottom plant in Pennsylvania leaked video of guards sleeping on the job. Most observers painted the Nuclear Regulatory Commission itself as dangerously complicit in the problems that caused the 1979 partial core meltdown at Three Mile Island, and whether utilities begin building new plants or not, the current plants are aging and will require significant oversight as utilities determine whether and how to extend their lives. I hate mountaintop removal coal mining as much as the next guy, and I holler about it and want it stopped. Just the same, like most people, I leave my computer and my lights on all day and enjoy a nice hot shower. The real way to make change in energy policy is to change energy use. We could stop mountaintop removal mining in a minute if we were willing to get along on the power generated by nuclear, hydro, and gas and oil plants. And if that means rolling blackouts, maybe rolling blackouts are good for the soul.

The point isn't that I know the solution to safe and responsible power generation; I manifestly do not. The point is that we bring the problems to the engineers and the engineers solve those problems: We say we want abundant power available to every customer every minute of every day, and we appear to place a higher value on that than on our West Virginia mountaintops, and so we end up with what we've got now. I trust my energy company to try to do well by its investors and its customers and the environment, but I trust it a whole lot more if regulators and utility commissions and the EPA are on the job. There are only so many hours

in the day for worry, and worrying doesn't solve problems. I'm deciding to trust the engineers. I may blame us for demanding too much, but I don't blame the engineers for bringing us the infrastructure we demand.

Every industry faces the same issues. As I write, the Raleigh wastewater treatment plant is fighting a fine levied on it for groundwater contamination. Local environmental groups actually support the plant's request for a diminished fine, but you probably don't want to ignore it when a government agency has made a mistake—and this mistake was caused not by incompetence but by actual malfeasance. We need journalists to dig and regulators to poke around opening folders and locked cabinets.

But first we need engineers. And what the engineers need is citizens who understand the basics of what they do. Do you know the difference between an amp and a volt, between a kilowatt and a kilowatt-hour? Do your teenage kids? We should. Should you be using your garbage disposal? Should water cost more than it does now? How safe is the soil treatment products the wastewater plant makes from your poop? Where does your water come from, and where does your trash go? We need to know these things—our kids need to know these things. We need these issues on our minds because in the next years and decades engineers are certainly going to present us with scary trade-offs, and we're going to have to make very tough choices. What happens to the planet if we keep burning coal? If we create more piles of nuclear waste? If we cover entire deserts with solar cells? Neither Ayn Rand laissez-faire true belief nor touch-nothing environmental idealism answers the questions.

AND SO MY SECOND OPINION IS, GET OUT YOUR WALLET—and be glad for the opportunity. "Infrastructure is destiny" is the catchphrase of the moment among the infrastructurati, but I got to using instead the phrase "our infrastructure, ourselves," which I think comes closer to the point. Since the end of the Roman Empire, allowing your infrastructure to rot has been a fine way to speed societal collapse. Nothing new there, yet we've chosen that road and seem to be sticking to it. Back in 1981, the authors of *America in Ruins,* which suddenly got everybody

talking about infrastructure, estimated that we were behind in our infrastructure investment by about $842 billion, and they figured *that* put us in crisis. Every couple of years the American Society of Civil Engineers (ASCE) puts out another report card, and we get another spate of Ds. In 2009, recall, they said it would take $2.2 trillion to get us back up to speed. In 2008 the Urban Land Institute estimated that we run an annual infrastructure funding deficit of at least $170 billion.

People actually can take action to shore up the infrastructure. Atlanta, which was losing 20 percent of its drinking water to leaky pipes and fouling its rivers and creeks with combined sewer overflows, in 2001 elected mayor Shirley Franklin, who passed a 1¢ sales tax increase and an increase in water rates; she called herself the sewer mayor. "If we don't protect water, we will be without water," she told the ASCE. "It's a question of who's going to pay, how much are you going to be willing to pay in order to insure that your children live the kind of life that we as Americans have promised them?" Atlanta has so far been willing to pay $4 billion. But most of us, like indulgent parents of lazy children, shake our heads at those Ds and exact a promise to try harder next time, or maybe we even start another study or another plan. Then we wipe our hands and move on.

And by "we" I don't mean "you"—I mean me, too. The original ham-handed Raleigh pogrom against garbage disposals, poorly managed though it was, had genuine value, and we all know that small steps add up: Raleigh has a fabulously low sanitary sewer overflow rate because it simply flushes its sewer pipes according to a schedule. So the very least I could do would be to stop using our garbage disposal—but I haven't. We have a baby, and he loves to go spelunking in the garbage, so our kitchen trash can is near the back door, on the other side of a baby gate. Leaning over the gate, trying to use an elbow to push open the spring-loaded can lid and somehow scrape food scraps into the trash? When I can just stand over the sink and stuff it all into the magic hole before I toss the plate in the dishwasher? Garbage disposal 1, best and well-informed intentions 0. I mean to do better, I honestly do, but . . . I'll just keep my fingers crossed that regular pipe maintenance will keep my zucchini fragments from clogging our neighborhood sewers, and that the treatment plant keeps on scooping them out.

No matter how often someone reminds us that these systems are important and need our attention, we don't change. China spends 9 percent of its gross domestic product on infrastructure; Europe spends 5 percent; the United States spends about 2.4 percent, and that's *down* from 3 percent 50 years ago. Vehicle miles traveled in the United States have doubled since 1980, but we've built just 4 percent more roads to handle the extra traffic. The Federal Highway Trust Fund is running out of money, but the 18.4¢-per-gallon tax that funds it hasn't gone up since the 1980s. Meanwhile, your tires—and the tires of the trucks carrying new iPhones to malls—are shaking the highways to pieces. So the North Carolina Turnpike Authority wants to put a toll on new highways it plans to construct in Wake County, and instead of saying, "Gosh, a nice new road—and for once at least we know how it will be paid for," people start brandishing pitchforks. If you still haven't had your fill of outrage, ask people for tax money for public transportation.

The Urban Land Institute advises the increased use of direct user fees for roads using wireless transponders that will do everything from automatically paying tolls to actually tracking road use mile by mile, making it possible to charge drivers far more specifically for actual road use. People balk, of course—as they balk at the tiered Internet fees some service providers talk about instituting. Then again, the water and telephone systems mostly started with simple hookup fees and unlimited use; now you have to pay for what you get. And right here in Raleigh the Public Utilities Department plans to institute tiered rates for water use (the more you use, the more each unit costs). Drought or no drought, citizens don't like it.

David Mohler, chief technology officer of Duke Energy, described the complex position of an investor-owned utility: obligated by regulation to provide power to every customer in its territory as cheaply as possible, but obligated as a business to satisfy investors. Now that utilities, which make their living selling power, are supposed to encourage conservation, he said, the problem becomes almost unsolvable. He told me he measures whether people are paying what power ought to cost by the furious calls his company gets when a storm knocks out power. "When the power goes out," he said, "the meter stops turning." So people don't have

power, but they're also not paying for it, which would seem like a break-even situation, but it obviously is not. "What that tells me," he said, "is that people value it much more than they pay for it."

Nobody likes to pay taxes; nobody's looking for more taxes to pay. But everything costs money, from paving roads to regulating power and telephone systems to cleaning and delivering water. I've seen people doing those things, and I like the results of their work. I say let's pay for it.

MY THIRD OPINION IS, LET'S LEARN TO LOVE OUR INFRASTRUCTURE. Beyond knowing just enough to help the engineers maintain it, and beyond digging out the funds to pay for it, we should appreciate it. Pliny and Herodotus called the sewers and aqueducts the crowning achievements of Greece and Rome; the 4th Dynasty Egyptians in 2700 BC left behind a sculpture of an official bearing the title "Superintendent of Works," and the 5th Dynasty did them one better, actually building a monument tomb for someone named Ti (or Tih) who held the same title under the pharaohs Neferirkare Kakai and Nyuserre Ini. By comparison, the I ♥ PUBLIC WORKS sticker on the office door of Raleigh's public works director lacks a certain multimillennial permanence.

But I don't suggest celebrating public administrators—I suggest celebrating the works themselves. One day I visited an electrical transmission line of 500 kilovolts—three long, drooping parallel arcs of wire held up by steel latticework pylons thousands of feet apart along a 100-foot-wide right-of-way that, mowed only often enough to keep trees from interfering with service, had reverted to meadow. In 15 minutes out there I saw five different species of butterfly and uncounted types of bug and fly. The thunderlike snap of the current overhead, caused by static as the air in the huge current around the wire ionizes and recombines, harmonized with the whirring and clicking of hoppers, bees, and beetles in the underbrush. The solemn march of those giant towers away from me in either direction struck me as almost indescribably beautiful: They're like the Cyclopes in Greek mythology, giants who did the enormous tasks for which mankind lacked the strength.

And as much as I was awed by the power lines they carried, I was

absolutely taken by the pylons themselves: four skeletal legs narrowing to a waist, atop which a sort of skirt spread, holding double strands of insulators that supported and stabilized two of the wires. Above that was an almost lyrical steel hexagon encircling the angle of insulators holding the final wire. The pylons reminded me of ballet dancers spinning, arms above their heads, and I couldn't help wondering: If the Eiffel Tower is beautiful, how on earth is this not beautiful? Why are we not laying trails along the right-of-way so that we can ride our bicycles beneath these pylons? Why do we not hire artists to paint them in celebratory colors? Festoon them with colored lights and garlands? I look at transmission pylons wherever I travel now. The pylons along the road leading into Raleigh from the west have three gently arching limbs on each side, growing smaller as they climb—I can never decide whether these pylons look like the masts of square-riggers under full sail or like a row of Southern belles hitching up their skirts and flouncing into town. When we drove across the country when I was a kid, my brother was reading *The War of the Worlds* and, developed a complex taxonomy of the different types of transmission pylons based on the machines the Martians created. Somehow, since then I—we—have forgotten to even see these things, much less appreciate them.

Clevelanders love the panoply of bridges across the Cuyahoga River; Philadelphians have no less love for the Ben Franklin Bridge and San Franciscans for the Golden Gate. Places like Raleigh, newer to city status, missed out on much of that burly industrial construction. But we've got poles and tubes, pipes and wires, and people need to begin seeing that those too merit celebration.

Creative types sometimes take over Raleigh's abandoned old water plant; its rotting innards have provided the perfect setting for an art installation about water and a moody backdrop for posy band portraits. But nobody takes pictures of the new plant. In downtown Raleigh, Randy Clifton, my guide to the electrical distribution system, pointed out the powerhouse, built in 1910, that had once held Raleigh's original coal-fired steam turbines and has since held a series of failed restaurants, but across the street from that he also pointed out one of Raleigh's few

industrial thrills: the nondescript downtown substation. Thanks to Clifton and a few of his co-workers, the transformers, switches, and the crisscrossing steel and aluminum framework of the substation are surrounded by evergreen plantings and lit at night by pale purple spotlights, in plain celebration of this little piece of infrastructure that the burgeoning entertainment district couldn't move out of its way. "We decided to do it just for the area," Clifton told me. "Just to enhance." He and his fellow linemen, that is, saw past the necessity to the virtue. They should do the same thing with the cooling tower at the nuclear plant.

The taxpayers see less clearly. In the median of one of the main roads into downtown stands a public sculpture, installed in 1995, that I think of as Raleigh's first piece of infrastructure art. Called the Light + Time Tower, the 40-foot galvanized steel tower is covered by glass panels backed by diffraction grating. Hit by the sun from different angles at different times, the panels glow in colors from a fluorescent orange to brilliant purple, changing as drivers throttle past at 45 mph. Whoever decided that drivers slogging their way through traffic during rush hour deserve a piece of artwork to look at should get an infrastructure medal, but instead critics immediately attacked it as looking like a broadcast antenna or cell phone tower. *Precisely.* Could there be any more perfect response to those fatuous cell phone towers dressed up to look like a tree drawn by a young child who has never seen a tree? I claim we need to start loving our infrastructure and celebrating it. Dale Eldred, the artist of the Light + Time Tower, agreed. Although in 1995 the people of Raleigh disagreed profoundly, I hope they'll eventually come around.

"MONEY AND POLITICAL WILL," transportation engineer Eric Lamb told me, are the two ingredients defining every roads question. In system after system, person after person told me the same thing: The technical problems the systems face aren't even close to unsolvable. Smart grid? A few hurdles, but we'll get there; it probably won't be cheap, though. get the bridges back up to snuff? We've had that technology since the 19th century. Stop pouring freshwater out through leaks, start shoring up the

pipes, plus build new aqueducts and reservoirs where we need them? Sure, we can do that. All we have to do is pony up. People persist in believing that these systems will somehow maintain themselves, expand themselves, improve themselves without anybody having to put anything in. But we can keep this remarkable infrastructure, this eighth wonder of the world, only if we're willing to work together for it. It's that simple.

When I'm out riding the streets with a highway engineer or running pipes with a sewer guy or inspecting conductors with a lineman, I can be an optimist and an epicure of industrial magic, but once I'm at home watching the news or reading the newspaper I lose hope. I haven't seen much in my infrastructure-rich neighborhood that makes me believe taxpayers are suddenly going to start asking to fund the projects that will keep our systems from falling down on our heads. I feel like a late-empire Roman, just hoping things hold out long enough for my kids to stay relatively safe. I'm left with the melancholy belief that we're going to stand around bickering while the pipes clog and the wires fall and the roads crumble. And it doesn't help that once again it's stopped raining—when last I checked, Raleigh's rainfall was 8 inches low for the year, and our reservoir, Falls Lake, was 4 feet low already. Isn't this where I came in?

And then, finally, I got a mailing from a candidate for the City Council who was campaigning to "reward households for their conservation and not punish them with water rate increases for doing what was asked of them." Atlanta raised its taxes twice to address its water problems, and in Raleigh we still think our rates are too high because in the middle of a drought we had to stop watering our lawns. Shortly before the election, the Raleigh region won another best-of accolade: The Web site The Daily Beast called us America's Smartest City. Maybe, but the cheap-water candidate won. During the campaign, everyone who went to his Web site and registered was entered in a drawing. The grand prize?

A new garbage disposal.