Bridginess

More of the Civil Engineering Life

Brian Brenner, P.E.

ASCE PRESS

Bridginess

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The morning sun glints off
Freshly tempered steel
As a new bridge sees its first sunrise
It stands proudly for
All to watch as they
Gaze in wide wonder
At its vastness

The gates are opened
For the first time
Letting some uncaring,
Some attentive persons
Try out the bridge
And see if the engineers
Succeeded in their
Job well done

Days, months, years, pass
Until that morning sun no longer
Glints off its shiny surface
But instead is
Swallowed in its cloudy depths
Then the engineers are called back
To fix the weathered bridge
So a new generation
Can pass through its gates
And travel to the waiting side

Rachel Brenner

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Foreword

Brian Brenner follows in the footsteps of Mark Twain in his entertaining, enjoyable collection of witty essays. Brenner's enthusiasms—civil engineering, bridges, life in general, sports, special occasions—are artfully matched with a Twain-like love for poking fun at popular culture, self-important specialists, and his own foibles. Civil engineers like Brenner are known for taking future wives on "bridge dates" and stopping the car on family vacations to photograph notable bridge crossings. Just as important, however, Brenner is a credible, knowledgeable engineer whose passion for bridges has led him to study them carefully and to think deeply about how and what they span.

Brenner can be linked to another bridge engineer, Thomas Telford. Telford supervised the design and construction of more than 1,000 bridges and roads in Scotland and England; he was also the first president of the Institution of Civil Engineers, the British equivalent of ASCE. Similarly, Brenner has been involved in the engineering of dozens of bridges, has visited many more, and teaches bridge design. He is also active in ASCE, serving on technical committees and as editor (successively) of two ASCE journals.

In this appreciation volume about bridges, I am very glad to read a discussion of bridge history. Brenner's travels take us to covered bridges across New England and a rest-home park for retired truss bridges. In many of these essays, you will read about beautiful old bridges that grace the landscape and serve as silent sentinels of our past. In Brenner's optimistic and often funny take on the bridge future, the glow of the bridge past is always present. This is how it should be—we engineers stand on the shoulders of giants.

I hope you enjoy *Bridginess*. And now I must go—I am late for a bridge date. I'll take my camera, and I won't leave it on top of the car.

—Jerry R. Rogers, Ph.D., P.E., D.WRE, Dist.M.ASCE

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Marina Bay in Summer

The best outdoor palm trees around Boston, and maybe the only outdoor palm trees around Boston, can be found at Marina Bay in Quincy. Marina Bay is a recently constructed planned development on Boston Harbor just south of the city. The development features condominiums, offices, support facilities for the boats in the marina, and a waterfront boardwalk lined with restaurants and shops. Adjacent to the boardwalk is an outdoor music nightclub, where the palm trees are planted at the entrance gate. The palm trees are guests only for the warm season. They pack up and migrate south soon after the arrival of the first fall nip.

On a warm summer night, Marina Bay is the place to be around Boston. Calypso music and "Dirty Water" play at the nightclub. The sound echoes off the buildings and the bay, all the way to Spectacle Island. A party is going on at the docks. Boat owners pass around cheese platters and sip white wine while lounging on their aft decks. The boardwalk is busy with strollers of all ages who come to see the scene and feel the cool breeze off the harbor. Once it's warm enough, the restaurants open their outdoor seating areas on the boardwalk, and the places are packed. Strollers, boaters, and diners gawk at the boats, the bay, and each other.

One of the bars has large TV screens facing the boardwalk deck, where everyone participates in the essential Boston summer ritual of watching the Red Sox. Members of Red Sox Nation congregate around the screen during the late innings. It's still in the hopeful phase of the season when all things are possible. Even after the two recent World Series victories, Red Sox fans expect once again to live through the tragic arc of their fandom: hope in spring, glory in summer, utter heartbreak

and despair in fall. But heartbreak is far from the bay tonight. By the eighth inning, the Sox still have the lead. Everyone feels good and when "Sweet Caroline" plays at Fenway Pahk, everyone joins in to sing ("Sweet Caroline, wah wah wah, good times never felt so good!"). Diners who have completed the main course at the restaurants are ready for some ice cream. The coffee shop at the end of the walk doubles as a good creamery and serves cold, extra-thick frappes.

Marina Bay is a nice place, but it wasn't always so. That anyone would visit the bay at all is a testament to several recent civil engineering successes. The darkened twin knolls of mysterious Spectacle Island poke dimly above the waterline in the backdrop. Today, the knolls are part of a beautifully landscaped park. But they are actually two mounds of garbage. The mounds contain residue of the island's days as host to a horse rendering plant and garbage dump. Thanks to the placement of three million cubic yards of excavation from the Central Artery/Tunnel project, the dump was capped, and now the island is pristine.

The harbor water itself was at one time a garbage dump. Raw sewage used to be pumped directly into the bay. Boston Harbor's nadir came back in the late 20th century, when the first President Bush took a boat ride on the grimy bay during election season to embarrass the Democratic candidate, former Massachusetts Governor Michael Dukakis. Pictures of Bush in a boat and Dukakis in a tank are the two enduring images from that campaign. Today, thanks to the Boston Harbor cleanup project, the water quality has been greatly improved. Up and down the harbor waterfront, people swim at beaches that previously were shunned. You can look down into the water at Marina Bay and see live jellyfish. That interesting fragrance in the air comes from sizzling food in the restaurants, not decaying items floating in the water.

Marina Bay's development includes some nice applications of Smart Growth and new urbanism. Many of the new street grids have townhomes built close to the boulevards, with front porches and nicely detailed streetscapes. Traffic is calmed by strategically placed rotaries and speed bumps. The traffic control details work well enough, although it helps that the site is out on a peninsula, not really on the way to anything. So it's comparatively easy to calm the traffic because there's not much of it and it's not really going anywhere.

Unfortunately, recent construction at Marina Bay has reverted to the more standard suburban pattern. For example, newer buildings are set back from the boulevards with wide lawns and parking lots. It seems like the developers lost confidence in the original construction model, and this is too bad, because much of Marina Bay's charm is generated by the placement and proximity of the shops, condominium, and townhomes. The original designs led to construction of some excellent public spaces. Many of the new buildings are far less charming, because they are spread out with little association to one another and connected only by parking lots and driveways.

Back at the boardwalk, if you sit and look out across the harbor, you get the impression that Boston's infrastructure is well-ordered. From this summertime view, the often-turbulent city seems to fulfill its self-image as a shining City on the Hill and the Athens of America. Jets follow the southern glide way in a regular pattern of descent to Logan Airport. Vehicles that are usually stalled on the Expressway stream peacefully at a rapid clip. The new IBEW windmill, floodlit in blue to mimic the lighting pattern of the Zakim Bridge, lazily flaps its blades in the breeze, a hopeful sign of good things to come. To the north, the downtown skyline soars, with sparkling towers poking up amid cow path streets and old brownstone blocks.

Viewed on a summer night from the boardwalk at Marina Bay, Boston looks like a well-designed place: a fortunate aggregation of its natural harbor and islands, its winding history, and some smart, nicely built, recent projects. The calypso music bounces, glasses full of Sam Adams clink, the Red Sox score, and the tribulations of the cold season are remote. Maybe at some time in the distant future, December or worse will arrive again. Then the palm trees will be packed away and a bitter Canadian wind will swoop down from Quebec to froth and freeze the tranquil bay. But sitting on the boardwalk at Marina Bay on a warm summer evening, it doesn't seem like a possibility, at least for now. So it's time to party.

My Name

When I'm having an existential moment, I think about why I'm named "Brian." Why not "Fred" or "Wilma"? (Well, not "Wilma.") Or, for that matter, why not "mongoose" or "cable-stayed bridge"?

Our names seem arbitrary, but they have a big impact on our lives. Some studies show that people with cool names end up being cool, and people with less cool names end up being dorky. I think the studies use other phrases besides "cool" and "dorky," but this terminology is good enough for our purposes. To illustrate the point, I was going to list cool names and less cool names, but then the less cool people would end up being insulted. Clearly they know who they are, having received less cool names and then having grown up that way. Since they have enough problems in life, it's not necessary to add to them here.

I think "Brian" is a name of average coolness, not really on the A list, but not a loser name either. Trying to optimize on coolness, I came up with a list of cool names for my future children. It wasn't that hard to do, seeing that there were many cool names to choose from. It was obvious what they were, and all we had to do was pick a cool name and the kid would be largely set for life. I presented my list to the other party involved, but surprisingly she didn't completely agree. Lauren had her own ideas of names that were cool. I thought that her selections were moderately cool but not nearly as cool as mine. It seemed that we had a slight disagreement. So after some thoughtful engineering analysis, I came up with a rational procedure to resolve it. When Lauren was in labor, I proposed that we play "baby backgammon." We both wrote two lists of potential names, five for boys and five for girls. During each round of baby backgammon, the winner could cross off a name from

the loser's list. In the case of a gammon (a double win), two names could be deleted, and likewise for a backgammon, three names. I thought that this plan was exceedingly clever. Not only would playing backgammon distract Lauren from being in labor, but I am a better player (she won't admit it, but it's true). So unless she rolled all double sixes, all the time, the child's name would be selected from my cool list and not Lauren's less cool list. Everyone would be happy, and the child would have a successful life.

In practice, there was a significant gap between the design intent and the actual construction. Baby backgammon lasted only a few rounds. Then as things got more intense, Lauren was no longer interested in the game. I don't remember now how we decided on my son's name, but it definitely wasn't by playing backgammon.

Engineers have an ambivalent relationship with names. I'm guessing that no one played backgammon when trying to name a bridge. But the process is often not straightforward. The naming of prominent bridges can attract a lot of attention. For example, the Zakim Bridge replaced an ugly, anonymous truss bridge in Boston. The full name of the Zakim Bridge is actually the Leonard P. Zakim Bunker Hill Bridge. Although most people use the shorter name, the awkward official name reflects the long, convoluted, and somewhat bitter process involved in its selection. The first part of the name honors the late Leonard P. Zakim, former head of the Anti-Defamation League in Boston and a man renowned for bringing disparate communities together—for "building bridges" between them. The second part of the name recognizes an area landmark, and it was championed in response (in part) to a feeling that the local turf was being disparaged by the naming process. The compromise, instead of picking one or the other, was to include both. But even with the eventual compromise, some unfortunate darker undertones rumbled during the debate, ironic considering the nature of Mr. Zakim's work and the graceful beauty of the bridge.

The names of more modest bridges are more modest. For run-of-the-mill highway bridges, most people probably don't know what the names are or that they even have names. But bridges cannot remain nameless. They must be identified on drawings, in legal notices for contracts and bidding, and for later maintenance. They have to be called something, not just "Hey, you—bridge!"

For these average bridges, which avoid the emotional and irrational naming approaches of the big bridges, the engineers get to take over. A sample naming convention can be found at the Oregon Department of Transportation website.* The naming convention is based on a series of rules. The Basic Rule states: "Keep the name simple, preferably less than 38 characters, always less than 50 characters."

The Basic Rule is applied with a series of Primary and Secondary rules that cover all types of bridges. When a bridge in Oregon is named, what crosses over comes before what crosses under, as in "Empire Ave over Hwy 4." Water rules, connectivity rules, ramp rules, and a slew of secondary rules act as tie breakers.

The advantage of the Basic Rule and all of its corollaries is that the resulting bridge name will fit in the standard drawing title block without reduction of font size. But a disadvantage is that some subjective decisions are needed to decide what to keep in the name and what to leave out. Therefore, the bridge carrying Terwilliger Boulevard over Highway One, for example, can properly be named "SW Terwilliger Blvd over Hwy 1 & Ramps" and not "SW Terwilliger Blvd over Hwy 1 & SB Hwy 1 Ramp to SW Barbur Blvd & SW Bertha Blvd Ramp to NB Hwy 1 & SW Canby St."

Does a bridge's name have any bearing on its existence, like a person's name? If a bridge receives a cool name, does it grow up cool? Without a cool name, will it end up demoralized, broken and then demolished? For example, suppose that "SW Terwilliger Blvd over Hwy 1 & Ramps" is found to have serious structural problems. A decision is needed to rebuild or demolish it. Probably the bridge name would have no positive bearing on that decision. After all, who would miss a bridge named "SW Terwilliger Blvd over Hwy 1 & Ramps"? But, what if the bridge were named "God's Gift to Mankind Bridge"? Maybe that would affect the demolition debate.

Some bridge names are inherently cool, like the Sunshine Skyway Bridge and the Golden Gate Bridge. Both of these spectacular structures are cool bridges. But we may have a cause-and-effect issue here. It's not obvious that the bridges are cool because of their names. They may be cool because they are cool, and they just happen to have cool names. Clearly the Golden Gate Bridge would be cool even if it were named

* http://www.oregon.gov/ODOT/HWY/BRIDGE/docs/BrNaming.pdf (accessed May 28, 2008).

the Futz Bridge. In the case of the Sunshine Skyway Bridge, the opposite argument can be made. The current Sunshine Skyway is a dramatic, sleek cable-stayed bridge across Tampa Bay. Its predecessor consisted of twin hulking, cantilever truss spans that did not exactly grace the bay. The previous Sunshine Skyway bit the dust, or more accurately, visited Davy Jones's locker, when a barge rammed into a pier supporting one of the two spans, leading to a catastrophic collapse and 35 fatalities. After the accident, nobody talked much about keeping the intact structure and rebuilding the damaged one. Both were scrapped and replaced by the new structure. They kept the name but ditched the old bridges.

In Massachusetts, you come across small roadside signs along the right-of-way, posted on bridge railings and at the abutments. These signs list names for bridges in memory of soldiers fallen in combat. The bridges are not spectacular suspension bridges, but mostly standard beam bridge overpasses. The bridges are nondescript, and memories of the fallen have receded with time. Somehow though, both are lifted out of anonymity by these poignant little signs. The names make the memorial bridges become something more than what they were. A rose by any other name might still smell as sweet, but still we are reminded of the power of a name.

The MRS Degree

The movie *Diner* takes place in 1959. It's about five male friends in their early 20s who mostly have nothing to do, so they sit around and talk at a diner. This helps to explain the movie's title. The five characters are young and immature. One of them is a football fanatic engaged to be married. He decides that his future wife needs to be as dedicated to the appreciation of football as he is. To verify this, he prepares a special written exam about football that his fiancée has to take and pass in order to get married. Several scenes in the movie dwell on the five friends hovering around, discussing the fiancée's progress taking the test. Since the wedding invitations have been mailed and the arrangements made, a lot is riding on the outcome. The five friends are pretty serious about this test. They want her to pass, sort of, but it isn't clear that the marriage would proceed if she doesn't.

I'm not fanatical about football, and I would never dream about subjecting my fiancée to a football exam. On the other hand, tests to determine relationship compatibility make sense, and I am fanatical about bridges. So when I became engaged, I prepared the Bridge Exam, offered in the Commonwealth of Massachusetts for partial fulfillment of the requirements of the MRS degree. The Bridge Exam was offered in May 1985, with the wedding scheduled for the following month. The Bridge Exam originally had two parts. The first part, shown in figure 1, was a series of questions. The second part was to be a field trip, during which the candidate would be driven around New York City and asked to identify different types of bridges.

Unfortunately, scheduling precluded administration of part two. Fortunately, the examiner was suitably impressed by the results from

The Commonwealth of Massachusetts
Bridge Exam

In Partial Fulfillment of the Requirements for the MRS Degree

May 18, 1985

1. What state is the longest span arch bridge in?
2. What was originally planned for the towers of the George Washington Bridge but never built?
3. Name the Washington State suspension bridge that collapsed in the wind and was rebuilt.
4. What two continents does the Bosporus Bridge connect?
5. What is the longest span in New York City?
6. In which city can you find a large, double suspension bridge?
7. Who designed the Brooklyn Bridge?
8. In which state did a highway bridge recently collapse, killing three people and prompting a massive bridge inspection?
9. The longest bridge span in the world is in which country?
10. What type of bridge has the longest span?
11. In which country was the first metal bridge built?
12. What company designed the Newport Bridge?
13. The Rainbow Bridge is a large arch bridge near what famous waterfall?
14. Name two types of movable bridge spans.
15. What is the difference between a cable-stayed bridge and a suspension bridge?

Figure 1. The Bridge Exam.

part one, so the follow-up part was cancelled. The candidate didn't get a perfect score on part one, having burst out laughing before she finished it. But you will agree that a score of over 90% is excellent for this type of test. Clearly, the candidate was qualified to live a life appreciating bridges.

You might imagine that the exam process was arduous, but the candidate received a lot of training in the subject matter ahead of time. It turns out that you can go on a really cheap date by visiting bridges. When we were dating, Lauren must have thought it was strange that we often got lost and ended up, by coincidence, at all the good bridges. We didn't get lost, of course. I would get out of the car, scope out the bridge (from different angles, above and below), and share with Lauren the finer points of what we found. Sometimes we would visit bridges that I had designed. I would walk with Lauren and show her the bridge beams and piers, not as an inanimate objects but as if I were introducing an old and favored friend.

After a while, Lauren got used to these dates. At least she had some good stories to tell her friends, who didn't get taken out on bridge dates. Fast forwarding to the present, these getting-lost-at-a-bridge dates have become more expensive than they used to be, because dinner or some other nonbridge thing is now involved as well.

If I had done a detailed, rational analysis (which I should have done because I'm an engineer), it's not certain that I would have married Lauren. This is because our personalities are very different. One time I took a personality test in which the results were summarized by four letters that relate to four different categories of personality. The letters and the personality categories were:

1. Extraversion (E) – Introversion (I)

2. Sensing (S) – Intuition (N)

3. Thinking (T) – Feeling (F)

4. Judging (J) – Perceiving (P)

Extraverts derive their energy from the external world, while introverts derive theirs from an internal world. Sensing people tend to collect their information from the external or objective world, and intuitive people

get theirs from an internal or imaginative world. Thinking people use logic to make decisions, whereas feeling people rely on emotions. And, in the last category, judging people are organizers and planners, versus perceiving people who improvise and seek alternatives.

Together, these four categories represent a spectrum of conditions for a particular personality type. For example, you could be an extravert or an introvert. Within the categories are grades of variation, between, say, an extreme extravert and extreme introvert. To determine the category you fit in, you answer a series of questions. The questions would be something like: "On a date, do you prefer to visit with people or go see a bridge?" If the response is to see people, then you tend to be extraverted. If you prefer to see a bridge (and who wouldn't?), then you are probably introverted. By responding to dozens of such questions, your personality profile is built. Somehow, questions are designed to determine gradations of personality and not just the extremes. After your responses have been evaluated, you receive a relative numerical score for each of the four personality categories, from zero to 100. A score of 50 in any one category places your personality square in the middle, not too introverted and not too extraverted. But if you receive scores closer to zero or 100, then you are out on the edge of that particular category. The scores help you determine which letters represent your personality.

Several studies have shown that the most common engineering personality profile is ISTJ, representing the traits of introversion, sensing, thinking, and judging. I scored close to the edges on all these categories, but Lauren, the human resources professional, received pretty much the opposite scores. So our relationship was based on three separate clichés: my standard engineering personality, her outgoing HR personality, and the idea that opposites attract.

Actually, this last idea is probably a good thing. What if we had the same personality type? What if Lauren were an engineer? I wonder what it's like for two civil engineers to be married. Would you get home from work and start fighting about rebar spacing and $f'c$?

Twenty years later, the Bridge Exam turned out to be a great introduction for my bridge design class at Tufts University. I prepared a full lecture using the old exam as a template, but with some wandering off into different class themes, such as aesthetics, analysis methods then and now, and constructability. The students were suitably interested in

the lecture. They were even more interested to know how well Lauren did when she took the test.

My presentation has a cross-generational translation problem. This being the 21st century, most of my students had not heard of *Diner*. But they thought that the Bridge Exam is a viable concept. Even better, I am pleased to introduce a whole new generation of future fiancées and (with luck) spouses to this unique civil engineering approach to relationship quality control.

Niche Knowledge

I found a new way to waste time by playing a game called Reversi. Reversi is the computer version of Othello, a board game that predates the computer by hundreds of years. To play Othello, opponents place white or black pieces called stones on a square board containing 64 spaces. When you place a stone on the playing field, all of your opponent's stones in a line between your stones change color and become yours. As stones are sequentially added, the black and white stones change back and forth. Eventually, when all the spaces are filled, the player with the most stones wins.

Othello is deceptively easy. You can learn how to play in about five minutes. Unlike a typical video game, there is no virtual world with thousands of different rules and conditions. In Othello, each playing piece can only do one thing, unlike chess (where you have to remember the peculiar movement of the horse) or checkers (where the pieces move, jump, or get regally promoted if they survive long enough). Othello, with its dearth of rules and low-tech approach, is my kind of game. If *Othello for Dummies* were a real book, it would be very short. Or so you would think.

But if you thought so, you would be wrong. Othello is very complex. Playing the game at the entry skill level only exposes the tip of the complexity iceberg. I got a hint of this when the computer asked what ability level I wanted to play at: beginner, intermediate, or expert. Given that I thought it was a second-grade game at best, I didn't take the question seriously and selected "expert." The computer searched the Internet and found a series of advanced players from China and the Far East. These players proceeded to clean my clock.

After playing a bit more, I learned that Othello requires a lot of strategy, with many different combinations of plays involving good and bad sequences. As I continued to burn otherwise productive hours, I understood some of the tricks and strategy. I learned certain opening moves to avoid getting trapped, whether leading off or playing second. I learned how to go for the diagonals on the board and not get clumped. I picked up a clever squeeze play on the back board that leads to capture of an all-important corner square. I mastered another clever maneuver, an endgame defensive play to capture the crucial corner squares after all else has failed.

So, *Othello for Dummies* would have a few more pages than I originally thought. When I searched, I found entire Web sites and societies dedicated to Othello. The Web site for the British Othello Federation* contains guidelines, club meeting dates and locations, a store, and even details about tournaments. A talented player could even make a living on the professional Othello circuit. Maybe I'll never bend it like Beckham, but as an Othello pro, I could travel from tournament to tournament, rack up the big bucks, maybe snag a few Othello sneaker endorsements, and all the while attract groupies and attention like a movie star or rock god. The ancient game of Othello had spawned a modern self-contained subworld with all the typical trappings of human microsocieties: skill levels, status, riches, fame, and pecking order. Although not as easy to see, a dark side to this subworld probably exists as well, with silent gatherings of the broken former champions who suffered Othello wrist injuries or lost their minds. One day they were at the head of the Othello pack, but then fate took a nasty turn and they suffered a Reversi.

The blossoming of Othello society is yet another manifestation of the explosion of knowledge of everything. In our computer-enabled society, where our analysis, data storage, and management capabilities have been magnified by a factor of 16 trillion, no area of life is too simple or too remote to avoid being made more complex. There is a niche of knowledge for everything, along with societies and expertise to administer the niches.

I was hoping to play a simple game where I didn't have to think so much. I just wanted to place my stones on the board, win a few, lose

* http://www.britishothello.org.uk/ (accessed May 28, 2008).

a few less. That the game was so complicated led to stress—I needed a break. So, I decided to go for a bike ride.

I put on layers of low-tech gray sweats and started off on my treasured low-tech road bike. A few months ago, my technological friend had given me a present of a speedometer/odometer/weather forecaster/garage door opener device that I had attached to the handlebars. Unfortunately, the device could not yet do any of these functions, because many more parts remained to be assembled. In one complex installation procedure, I was supposed to attach the radio connection to the spoke, or something like that. I never completed the installation, but I did have a useless but fancy-looking monitor attached to the handlebars.

It was a beautiful, cool fall day with puffy gray fair-weather clouds and a deep blue sky. I pedaled into town, content with a lazy ride on my usual route around the lake. But it was not to be. That morning, the A-team bikers had assembled in the town square. Unlike us B-team riders, with our low-fashion attire and Walmart bikes, the A-team had taken biking to a whole new level. They envisioned themselves as riders in the Tour de France—if not in the lead peloton, then at least with the support staff. Members of the A-team did not dress in layers of floppy gray sweats. They wore stylish, butt-hugging spandex outfits emblazoned with logos and announcements. A-teamers had sleek, aerodynamic helmets and special riding gloves. Their bikes were not from Walmart, or any other mart, but had lightweight high-strength frames made from special, hybrid composite material so that the bikes actually had negative weight. These special machines cost multiple thousands of dollars and were so light that they had to be tethered to the ground when not being ridden, lest they float away like helium-filled balloons.

I tried to slouch by the A-team congregation, but they saw me. I was friends with several members in real life, and they shamed me into joining their posse. Unlike the pleasant jaunt I had planned, I was off on a furious full-speed race, featuring something called drafting, where different bikers took turns in the lead, like the head goose in an airborne V formation. When I rode with my B-team friends, with our motley assembly of clothes and bikes, we would chat, lazily pedal, and then meet for an elaborate buffet where we undid many of the benefits of the previous exercise. The A-team did not chat. They pedaled furiously for tens of miles in studied silence, in a rush of cold air as birds maneuvered

to avoid getting trampled. Afterwards, when the rims and spokes finally cooled, coffee was permitted, but not a luxurious buffet.

My technological friend rode with the B-team but he had A-team pretensions. He had what seemed like dozens of devices on his handlebars. He proudly wore butt-hugging spandex and had special bike shoes that attached themselves to the pedals. He had two bikes, a "comfort" bike with fatter tires and a sleek, composite-material roadster with microthin tires. My technological friend explained to me the subculture of biking. For example, there was a proper way to train. Pedaling was not to be done all at once, but by switching gears in a certain sequence like Lance Armstrong (my friend knew this because he had read the book). There was special biking food and a biking store that sold the special food, the attachments, and the butt-hugging accessories. One time when we were pedaling together, I was peacefully plodding in high gear. My technological friend explained how I was doing it all wrong and how I could advance if I changed gears and followed the proper sequence. I smiled politely and spat off to the other side.

What does it take to decomplicate? Could we return to a simpler, less complex time, without all of the subworlds, knowledge overflows, and spandex? We are constantly faced with this challenge: how deep do we want to go? Today, every endeavor is like an onion, with infinite layers hiding the core of ultimate knowledge at the center. It's like that episode of the original *Star Trek* series (actually, if you're a nerd of a certain age, everything is like an episode of the original *Star Trek* series). In the onion episode, the starship *Enterprise* gets caught in a black vortex of nonspace, which turns out to be caused by a giant, energy-sucking amoeba. At the center of the blackness is the amoeba. At the center of that is the nucleus, which Mr. Spock destroys with the shuttle craft. So the lesson is that there are always layers upon layers of knowledge, until you get to the center, and then you have to blow it up with the shuttle craft. I longed for the good old days without onions when life was simple.

So after the bike ride, I did some editing. I had a stack of articles and papers to go through. Because I help edit a journal, my in-box is often full of things to edit. I thought I would turn the PC on for a few minutes and race through the stack, but it was not to be. None of the writers could write. They got it all wrong. Their clauses were clueless. Their punctuation chopped up sentences incorrectly. They used semicolons

in desperation, when they couldn't think of words to connect their sentence fragments. It was a massacre instead of a mastering of the English language.

If only these people had taken a little more time. Clearly they were interested, having taken pen to paper and fingers to keyboard. They wanted to write. They just hadn't bothered to learn the details.

Convention Crashers

My new office in the suburbs is next door to a hotel. I joined the hotel's health club so I could work out at lunch. The club has a nice indoor pool, some free weights, and a room full of exercise bikes and equipment. To get to the club, I cross the parking lot between buildings and enter the hotel side door, near the grand ballroom and conference meeting rooms. For a few moments, I join the crowds of conventioneers.

The conferences frequently change, so I get to see a different one each day. Sometimes I mingle for a few minutes on the way to the gym, chat with some attendees, and help myself to conference snacks. Nobody can tell that I am an uninvited guest. It was a little bit like the movie *Wedding Crashers,* where two men pretended to be wedding guests at receptions they weren't invited to so they could meet women. But this was different. As a convention crasher, I am cruising for hors d'oeuvres, not women.

Some conferences feature fairly standard topics—technical meetings, corporate instructional classes, and the like. Since the surrounding area is home to many high-tech firms and startups, however, many conferences have extreme technology themes, with computers and gizmos at the display booths, and a lexicon of jabberwocky in the PowerPoint presentations. Even the conference names, like Aonix and Gozingo, are taken from a language that someone probably knows how to speak, but not the average human being. The participants of these meetings walk around dazed and bemused, in tune with the gadgets and techno-talk but otherwise not completely connected to the rest of us.

Some conferences are not so techie but have themes that are just plain nice, like a day-long auxiliary gardening convention where I hung

around. Here, the booths had displays with advice on how to grow ferns and the successful use of environmentally friendly manure. Attendants at the booths gave away a lot of samples, so that day I got some seeds and complimentary garden toys in addition to the delicious organic snacks. But I didn't get any samples of manure.

In the mix are some conferences that seem strange to me, even off-putting. A few corporate award-type meetings are held in the main ballroom, where the CEO or some other company big shot stands at the podium and hands out service awards. At Nubico's* award luncheon, a slideshow had been set up as a backdrop to the proceedings taking place on the stage. The show flashed slides describing Nubico's corporate values. The values emphasized teamwork, because "there is no 'I' in 'TEAM'." Everyone sat around the tables nibbling on carrots as the CEO introduced the award winners and invited them to the stage. When it came time to introduce John, one of the award winners, the CEO said: "Here is John. John has won the award for best corporate spirit. John exemplifies the values and principles of Nubico. He is a paragon. Let us praise John."

John walked up to the stage dressed in the uniform of Nubico, a conservative gray suit with an open collar and no tie. He had a beaming, bright, toothy smile. Everyone applauded for John with moderate, polite enthusiasm as he shook the CEO's hand. I think John won a plaque that day instead of a new car. As in any company, I'm sure the proceedings all made perfect sense to the insiders. To the inhabitants of Nubico's self-contained corporate culture, the behavior was expected and conventional. But as an outsider standing at the door of the ballroom watching the ceremony, it seemed to me that John was a suck-up and the PowerPoint slides displaying corporate values were taken straight out of *Dilbert,* if not *1984*.

One of the odder conferences featured a regional beauty pageant for young teenage girls. The contestants were inappropriately and tartishly dressed to look many years older than they were, dolled up with eyeliner and too much face paint. They were accompanied by fretting mothers with stern, stressed-out expressions, almost the opposite of the loopy grin worn by John. The grand ballroom that day had the young girls

* I made this name up, but it sounded like that.

up on the stage strutting and performing. They had to answer beauty-pageant-type questions, like "How should the world be saved?" and "What is your favorite pet?"

Another convention was a local gathering of science-fiction types. This was Nerdfest 2007, a gathering of intense, socially awkward young men and women who had fierce debates about gamma rays and neutron beams. Actually, since I'm also a nerd, I felt completely at home at this one. I slid up to one of the groups where an animated debate was in progress about the future of borons in the galaxy. At least I think that's what they were talking about. Maybe it was positrons or neurotrons, or maybe it was the Neutral Zone where the positrons were. Anyway, uninvited conference crasher that I was, I still wanted to be a part of it all, at least for a few minutes. I grabbed some energy protein space bars from the galactic buffet, and then I asked the group, "But what about the impact of Quasar 7?" They glared at me, in that socially awkward way that nerds glare. There were two problems with my question. One was that the planet, Quasar 7, even if there was such a thing, had no impact on the borons. The other problem was that I had my gym bag with me and was obviously going to work out at the health club. None of the participants in the boron group looked like they had worked out. Ever. So I had to be an alien of a different type invading their group, and I was not welcome.

After a while, I had become quite at home at the hotel. Some of the staff were confused when they saw me every morning—most guests checked out after a week or so, but I kept on coming back. I told them that I was an engineer from the building next door, stopping by for coffee. The lobby coffee bar serves some good cappuccino, which unfortunately I have to pay for. I made friends with the barista. She filled me in about some of the really, *really* unusual conferences the hotel had had in the past, the ones that I didn't have the chance to attend. For example, I missed the transgendered convention. This meeting occupied the hotel's conference facilities for the weekend. Not that there's anything wrong with that. Keep in mind that the suburbs, even in the year 2007, even around ultraprogressive Boston, still tended to be a 1950s kind of place. So I tried to picture how this conference fit in. Were the other hotel guests notified in advance? Were there any other functions scheduled

that Saturday evening, like maybe a wedding or a 25th anniversary party? Maybe a meeting of the Loyal Order of Water Buffaloes?*

People who go to conferences expect a particular type of infrastructure to support the conference meetings, an infrastructure convention for conventions. For example, this hotel has a ballroom and break-out meeting rooms. Using flexible dividers supported by ceiling tracks, the rooms can be configured in many shapes and sizes to facilitate a wide variety of meetings. Rooms are internally ventilated and windowless. By avoiding sunshine, the hotels, like casinos, seem to think that meetings won't suffer from the distraction of the outside world. (Also, if the hotel has the chance to book a conference of vampires, they are all set, at least in the breakout rooms.) Food can be served in many different formats: buffet service in the front hall,† sit-down service in the ballroom, and so on.

The hotel next door hosts relatively small conferences. For large conferences with thousands of attendees, the new infrastructure form of convention centers has evolved. Convention centers contain many of the same facilities as hotels, but on a much bigger scale. Convention centers around the United States fiercely compete with each other to book the biggest conferences. These megaconventions, which produce enormous revenues, are believed to generate millions of dollars for surrounding restaurants, hotels, and support facilities as well. The argument of lucrative secondary revenue is often used in political debates to support the spending of public funds to build the big convention centers. Unlike the privately built and owned hotel, with its modest meeting facilities, the argument goes that convention centers need to be built with public funding, because they are too big and complicated to finance and build otherwise. Then, if a city fails to build a credible conference center, millions of dollars will be diverted to more welcoming metropolises. The degree of support can include direct financing and management of construction, or it can be more roundabout, such as providing for the surrounding infrastructure and land use improvements in support of the new facility.

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* The Loyal Order of Water Buffaloes is a reference from the Flintstones cartoon, but apparently some real life spin-offs actually exist. See, for example http://lowb.org/lowb/.

†For a convention crasher, this is the best setup—easy access to the food.

Convention centers tend to be big, windowless, and boxy. Often the buildings are not very good neighbors in the cities where they're plopped. At best, a convention center is detailed to blend unobtrusively into the urban fabric, like the one in Seattle that looks much smaller than it actually is. The Washington State Convention and Trade Center in downtown Seattle is designed to cover a portion of Interstate 5 downtown, providing a series of parks on a deck over the highway, with cascading waterfalls to mask the traffic noise.

At the other end of the spectrum are facilities that bear little spatial relationship to the place they inhabit. The giant Anaheim Convention Center in California is representative of this group. It consists of several massive buildings, set back from the overall city. In defense of that convention center, though, it can be argued that most of Anaheim doesn't have much spatial coordination or urbanism either.

Boston was the site of a fierce convention center debate for many years. The city had its publicly financed Hines Convention Center, centrally located in the middle of the Back Bay but dowdy and small by megaconference standards. Over the years, a private meeting site, the Bayside Exposition Center, opened near the harbor in South Boston. The Exposition Center was a success, hosting moderate-sized, regional meetings. But still, the Boston area couldn't compete for the biggest conferences. Eventually, the city decided to build a megacenter to compete on the circuit. As a result, the Boston Convention and Exhibition Center was constructed in the vast, underutilized swath of land in the northern section of South Boston. After a rocky start with few bookings, this center took off and is considered a financial success. Large meetings that used to bypass Boston now come to the city. But although the center is a success in getting meetings, the facility is not a good example of city building. It is a behemoth structure that looks like it fell from space onto its vast acreage among former factory buildings and parking lots. The facility has barren exterior walls and seems out of place considering the overall layout of historic Boston, with its quirky mix of human-scaled old and new structures.

Because convention centers are relatively new, over time it's likely the form and design approach will improve. Designers will do a better job of integrating them into cities instead of separating them. Maybe meetings of the future will discover the benefits of natural light, fresh

air, and windows. Anaheim's Convention Center, for example, was retrofitted a few years ago. The blank exteriors walls were replaced with soaring glass facades and more pedestrian-friendly gardens and paths. Unfortunately, the rest of Anaheim still needs to be retrofitted.

Back at the hotel next door, I was excited to learn that a new conference was in town: Zucchini-Con, a meeting of the Squash Growers Association of America (SGAA, pronounced "Sgaa").* I was glad that Zucchini-Con was on the schedule. I like zucchini bread, and I figured there would be lots of free samples. So I grabbed my gym bag and ambled over to the hotel at lunch time, where a breakout session was under way. For a few minutes, I joined the conversation in one the groups. The hotel's pleasant staff circulated with trays of warm zucchini bread, and my new colleagues and I debated our different approaches for growing really big zucchinis.

* I made this up, too. But somewhere in the United States, zucchini growers must be having a convention. I am betting that they will be serving warm zucchini bread. Count me in.

Back at the Olive Garden

We visited Raleigh, North Carolina, and went out to dinner at the Olive Garden, north of downtown. The Olive Garden is a pleasant Italian restaurant with massive portions and an unlimited supply of breadsticks. Apparently the price was right and the food was good, because much of Raleigh seemed to be waiting outside for a table. Prospective diners received a disk that would ring once a table was ready. Most waited in the small lobby or outside in front of the building. There wasn't really enough space for all the people waiting, the architects perhaps underestimating the restaurant's popularity. Also, once outside the doors, the quality of the surroundings dropped off considerably. Inside the space was comfortable and human-scaled. But outdoors on this property and apparently in the rest of Raleigh, the intention of the design was to provide a way to go from cars to the private realm. The Olive Garden has a bench or two, a little plaza and walkway, some trees, and that was it.

The maître d' estimated a wait of 30 minutes for our table. We decided to be efficient and visit the drugstore during our wait. With no drugstore in walking distance, we got in the car and navigated down the wide arterial and subarterial roads surrounding the restaurant. Each of the arterials and subarterials collided at monumental intersections, with hundreds of feet of blacktop and cars queued in all directions. The traffic signals were timed for complex phases: through traffic, left turns, parts of left turns, multiple-lane left turns. The surrounding turf featured either vast parking lots with stores and offices or, a bit further back, some housing developments cordoned off from the noise and dust of the arterial roads. So the place we were in was defined by acres of

asphalt intermittently interrupted by isolated structures. These features constituted the built environment of northern Raleigh.

We arrived at a road called the "Falls of Neuse." For some reason, I thought this road was the "Eyes of Newt." The native North Carolinians we traveled with did not think this was funny. En route to the drugstore, the reservation disk activated and started beeping. It was much less than 30 minutes, and we were pleased that our table was ready so soon. We doubled back to the restaurant. Unfortunately, it wasn't simple to get there. We had to drive along several direction-separated arterials and through the complex networks of signalized intersections. Eventually we made it back to the restaurant only to learn that our table wasn't ready after all. The disk activated because we were out of disk range. The devices were programmed to whine at a certain distance from the restaurant, thus reminding guests not to take them home. Otherwise you would be stuck with a continuously whining reservation disk, and who would want that?

So we had a few more minutes to see the sights of northern Raleigh on another loop to the drugstore. There wasn't much to see. Most areas had sidewalks, but no one was walking. This seemed to be true at all hours of the day, not just in the evening. In this area, one could drive for miles and not encounter a semblance of public space: no promenades, no urbane city streets, no river walks, nothing that resembled a downtown. Square miles of terrain had been transformed into a depressing, formless, placeless sprawl of arterial boulevards, football-field-sized intersections, parking lots, and glopscapes in between. Much of this infrastructure had been recently built, within the last decade or two. As with the restaurant, the private interior spaces were uniformly excellent. Interiors of housing, offices, and stores were comfortable, luxurious, and well-designed.

The exterior, public spaces were a different story. What would it have taken to create a place, or some semblance of place, in the public spaces outside? The area around our hotel was quite nice, with some trees, a few fountains, and an attractive outdoor pool. The architects had cleverly wrapped the building structure around the pool deck on two sides. With landscaping on the open end of the triangular plan, a nice outdoor room was formed. Unfortunately, on the open edge of the triangle, the deck extended to the property line. Next door was a strip

mall. A restaurant occupied the space immediately adjacent to the pool, and it also had an outdoor patio. This patio could have been placed next to the pool. Then the diners could watch the swimmers, and vice versa. Instead, the restaurant patio was placed next to the parking lot, and the hotel's pool deck ended at a blank back wall of the strip mall building, overlooking air conditioning ducts and utility wiring. With some simple changes, a mini-oasis of public space could have been created—no real change in cost, just some forethought and design sense. Instead, the two properties had no continuity and no design relationship. It was a lost opportunity: al fresco diners overlooked the sterile, steaming parking lot, and swimmers had to pretend that the third wall of the outside room, with its air conditioners and industrial ducts, wasn't an eyesore. This small example of dysfunctional public space design had been repeated on a grand scale, consuming much of newly built Raleigh.

If you looked carefully along the arterials, you could find vestiges of the traditional North Carolina countryside in pockets: areas of woods, expansive fields for grazing horses, rolling piedmont. This terrain was being transformed into suburbia. It struck me as a real life but bad episode of *Star Trek,* where the Borg had decided to subsume all landscapes. Resistance was futile. We would become one of them. We would exist in a homogenized, formless, hellish, ugly landscape of endless driving, isolated in car cocoons. Village streets? Promenades? Walking? Interaction? These were things of distant memory, plowed over en route to Walmart.

Back at the Olive Garden, we consumed our fill of the endless buttered breadsticks. The dessert menu featured very large concoctions, presented on UFO-sized plates. We hadn't eaten the entire main course, so we decided to pass. What we needed was a nice walk to work off some of that pasta, but there was nowhere to walk to. The property did have a little trellised walkway alongside the restaurant to the parking lot. But it was a short walk, maybe enough to burn off one scoop of rigatoni and some sauce. We climbed back into the car and drove down the massive arterials, through sophisticated multilane, multiphased traffic signals, past acres of paved plazas, strip malls, office parks, and finally back to the hotel. Some kids were splashing in the pool. The sound of the water blended with the humming of the air conditioners posted on the blank utility wall next door.

Airport Inspection

In the fall of 2006, I was waiting in the airport security checkpoint line. For this overnight trip to Chicago, I had booked an early morning flight, quickly packed some stuff in my gym bag, and raced down the Expressway to the airport. I thought I could cleverly save time by carrying everything onto the plane instead of checking my bag. Perhaps I hadn't been paying enough attention to world events.

The passenger security checkpoints represent a path of transition from comfortable civilian life to a much different place. As I entered the long and winding line, I was gradually sucked into this new culture. I had many warnings that I was leaving the normal realm. At first I ignored the warnings: passengers were not permitted to have weapons, sharp things, untoward language, untoward glances, or irony. None of this applied to me, of course, except for the part about irony. But as I marched on, the warnings became both more dire and more peculiar. No fluids were allowed. Prospective passengers were permitted one clear plastic baggie to display a limited number of fluid containers. The airport didn't provide baggies—you had to bring your own. This assumed that you had paid attention to world events before coming to the airport.

I made it past the first check for ID and boarding pass, but then I started to worry. I had fluids! In my overnight bag, I had shampoo, and a container of liquid soap, and stick deodorant, and shaving cream. I had toothpaste, which technically wasn't a fluid, but could be considered fluid-like. What would happen when I reached the screening station? My fluids were buried in the overnight bag. Would they find my fluids? Maybe they wouldn't be smart enough to find my fluids.

As if directing cattle to the chute, a neatly dressed attendant barked orders to walk to an inspection gate. The no-irony rule was strictly enforced. Candidate passengers soberly went about their business, emptying pockets of coins, keys, and any other metal object that could trigger an objection at the electronic portal. Because previous harm had been attempted using weaponized shoes, all the passengers had to remove their shoes. This by itself was a spectacle: nervous civilians rushing to their in-flight destiny, forced to disrobe their feet. It was all very smelly, but the stern-faced inspectors and the meekly compliant passengers pretended otherwise. Laptop computers were subject to special treatment, even more so than the shoes. Laptops were to be removed and separated from their comfortable packing. Some of the devices were inspected via a device featuring a wand that looked like a giant Q-tip. Maybe the inspectors were looking for computer ear wax.

It was pretty impressive that most people made it through without losing a wallet or keys. The inspection process required intense concentration to keep track of personal belongings, since most participants were in a rush and had to unpack things that had been carefully packed. All this had to be done while shoeless. Adding to the confusion, the entire inspection area was under construction. The terminal was relatively new, having been completely rebuilt about 15 years ago. But even so, significant rebuilding work was under way, and this added noise, dust, and uncertainty to an already frenetic environment.

After about a half an hour, I made it to the head of the line and stepped up for inspection. I placed my bag on the X-ray conveyor belt, disrobed my feet, and hoped for the best. I made it through the metal detector without any buzzing, but my bag was having troubles on the belt. The attendants looked over the X-ray screen grimly and moved the conveyor belt back and forth a few times to provide additional views. Other attendants were called over for consultation. Finally, the bag was expelled from the X-ray chamber, but before I could grab it and escape, a natty attendant motioned to me:

"Sir, is this your bag?"

"Yes," I replied with lowered eyes.

"Sir, would you object if I inspected your bag?"

I thought: "Yes, I would object if you inspected my bag. I'm an American citizen in good standing who has never been a terrorist and

supports all things patriotic. My bag has an assortment of clothes and personal grooming devices and products, none of which are a threat or could affect aviation in anyway. Yes, I would object. I had to wake up at four in the morning to make it to this 6:30 a.m. flight. I have paid hundreds of dollars for the privilege of being here. I should be respected and treated with dignity as a person and not like a cow."

I said, with eyes lowered, "Yes, please. Go right ahead."

We walked over to the special inspection pit, where my gym bag was unceremoniously plopped. All the while, passengers who had successfully made the transition to purgatory streamed by, glancing for a moment at those unfortunate souls trapped in the pit.

My Inspector donned white rubber gloves that snapped when he put them on. My Inspector wore a pleasant, mild smirk, which communicated a certain sense of enjoyment of the proceedings. His expression violated the no-irony rule.

My Inspector zipped open the gym bag, exposing its guts to the harsh fluorescent glare of the terminal lights. Looking at those white rubber gloves, I had a flashback to being at the doctor's office, with the gym bag at the receiving end of the prostate check. After shifting things around a bit, My Inspector said with an implied tsk-tsk, "What have we here?" He proceeded to remove offending items. Each item was neatly lined on the table: the liquid soap, the large container of shampoo, about a dozen smaller containers of shampoo from previous trips, and the deodorant.

My Inspector said, "You know, if you had packed these smaller items in clear plastic bags, they would be acceptable."

"Do you have any bags I can use?" I asked.

"Oh, no," said My Inspector. "You have to bring the bags with you. We certainly don't provide them."

So if I had put the little containers in a plastic bag, they would be OK. Why aren't they OK now? Can we pretend that there's a virtual plastic bag? But I didn't say anything and kept my eyes lowered.

"Now this item," My Inspector said with some disappointment, pointing to the large shampoo container. "This item is much too big, even with a clear plastic bag. I'm afraid it's not going to make it."

The inspection continued for a few more minutes until every nook and cranny of my gym bag had been exposed and properly evaluated. At

the completion of the review, I had lost the big shampoo, the little shampoos, the liquid soap, and just about everything else except the deodorant. The stick deodorant, for some reason, was considered acceptable. My Inspector offered some kind of explanation why this was so, but I didn't really hear the gist of it. I was mourning the loss of my shampoos and soap.

My Inspector said: "You know, you can check this bag at the airline counter. I can get you a special pass so you can go to the front of the line." But even with the special pass, there was no way I would make the plane in time. I would need a special special pass to go to the head of the other two lines, along with a half-hour flight delay.

Reluctantly I zipped up a now-lighter gym bag. An assortment of formerly useful personal grooming products stood in a line, at attention like soldiers on the table. They were not going to accompany me to Chicago. My Inspector wished me a safe journey, and then I was released to go to the gate with my fluidless bag.

Finding the gate was not so easy, because the entire area was a construction site. As I walked to the gate, I dodged bollards and maneuvered through temporary passageways, and I realized what was being constructed. The needs for security checkpoints and airport inspection stations have led to a whole new series of architectural and infrastructure requirements. Space is needed for passengers to take off shoes, to put them back on, to empty pockets into containers, and so on. Vast space is needed for lines to store and sort passengers as they wade through the inspection process. Infrastructure planning tends to be relatively slow, deliberate, and reactive, but airports are being challenged by changing space requirements and needs at a pace faster than they can address them. Almost overnight, thoughtfully and carefully planned areas at airports—which worked just fine a few weeks ago—are awkward, inefficient, and out of date. So, for example, it is possible to design an effective facility where large numbers of people can take off their shoes and put them back on under stress, but this consideration was not a blip on the planning screen until relatively recently. The terminal buildings don't have space where people can comfortably congregate, sit, take their shoes off, sort their items, go through the metal detector, and then reverse the process. Terminals must be rebuilt.

For infrastructure planners and constructors, the new requirements pose big challenges. It is necessary to consider almost-real-time design adjustment and reaction to requirements that continue to change as adjustments are made. It's akin to dealing with the decision to have a six-lane highway bridge made on the day the four-lane bridge is complete. The resulting construction at airport terminals must satisfy the needs to protect the facilities, protect the people using them, and support inspection processes that can be done both comprehensively and quickly. Speed and comfort are what most people react to—this is the "cattle at the chute" factor. But really, how well the inspection job is done is what counts most here. Despite the discomfort, most people are willing to trade some discomfort for the understanding that they're safe.

In Chicago, I found a drugstore and refilled my bag with fluids. On the way back home, I learned my lesson and checked my bag. Unfortunately this story is not finished. We can expect future dislocations and changes to the process, although we don't know what. It will probably be difficult, but engineers will learn to deal with new, rapidly changing infrastructure design requirements, with new components required even before the ink is dry on the old designs.

Mass General, without the M

Returning from Worcester one evening, we drove on Route 9 past Massachusetts General Hospital. The hospital complex includes a tower with a large, illuminated rooftop sign that says "MassGeneral." Or at least that's what it is supposed to say. Unfortunately, the "M" had malfunctioned that evening. So the large, brightly lit sign high up over the landscape projected a different message.

About a mile down the road, across the border in Shrewsbury, we stopped for coffee and books at a big bookstore. The parking lot is up on a hill, and from there you can take in the full spectacle of the nighttime glopscape spread out to Lake Quinsigamond to the west. Overrun by sprawl, Route 9 in this area is a dysfunctional landscape of vast, windswept parking lots, towering signs, and wide intersections: in short, a place about as far as you can get from the iconic New England countryside of quaint human-scaled villages, sweeping greens, and rock walls. So in a sense, the broken hospital sign's message, although not intended, was accurate.

Before today's high-speed highways, roadside signs were simpler, smaller, and less intimidating. The first ones were milestones, marking the distance to Rome. These early road signs were not illuminated and did not deface the landscape. In the old days, you could only go so fast on a horse. Thus the visual horizon and perspective for a sign didn't require towering dimensions. Now, though, roadside businesses are erecting ever-larger highway signs to advertise their wares. The development of automobiles and faster highways led to the creation of this supersized form of infrastructure, designed to attract the attention of speeding motorists.

At first, roadside signs were novel and inventive. Many people affectionately remember the Burma-Shave grouping of signs, in which each message was presented in a clever sequence of four or five signs like these:

School ahead
Take it slow
Let the little
Shavers grow
Burma-Shave

Don't stick
Your elbow
Out too far
It might go home
In another car
Burma-Shave

A peach looks good
With lots of fuzz
But man's no peach
And never was
Burma-Shave

These signs were placed all over highways in the 1920s and '30s, greeting the first generation of drivers who answered the call to freedom on the American road—and who presumably shaved with Burma-Shave.

With faster roads and electricity, bigger signs were built that didn't just provide information but dominated the surrounding landscapes. Today's business highway signs are not just informative. The signs and billboards are often towering and disorganized. They form a key visual component of the discordant, cluttered landscape of sprawl.

Some towns with successfully restrictive design codes have managed to rein in their signs. For example, Route 9 suddenly changes character if you drive eastbound from Natick to Wellesley. Once in Wellesley, the landscape is pleasantly organized and tamed. Signs for stores are more modestly constructed, done up in a faux Colonial style, advertising the availability of dry cleaning or pedicures. The signs are made of

wood and decorated in such a way as to give the impression of the way dry cleaning was advertised to the Patriots in 1776. But in the areas that aren't as successful in defining and defending their zoning, the signs are a mishmash. Drive down any generic suburban strip, and your eyes are feasted (or more accurately, roasted) by the mismatched, misplaced signs that glare over the streetscape. To attract attention amid all that clutter, businesses need their signs to be tall and robustly proportioned. Figure 1 shows a signed landscape with only signs and no landscape. Note the sign for the Waffle House restaurant chain in the upper right corner of the illustration.

In the aftermath of Hurricane Katrina, the cartoon came uncomfortably close to reality (figure 2). At this Waffle House location in Biloxi, Mississippi, the sign was well designed to handle hurricane force winds. Unfortunately, the restaurant structure wasn't, and all that remained was the sign.

As with other aspects of sprawl, the bedlam of discordant and ugly roadside signs is not easy to manage, because doing so butts into the realm of personal property rights and free commerce. A few years back, blue service signs were placed on interstate highways. These signs instructed drivers regarding the different types of services available at interchanges. Local businesses could place advertisements on them. But unlike the free-for-all at the exits, the presentation was in neat, orderly categories (gas, food, lodging), with a modest size and uniform style.

Even with this improvement, in most areas towering billboards are still permitted just beyond the interstate right-of-way. While the interstate corridors themselves are better organized, the ugliness begins just off the expressway, where disorder and clutter rule the arteries at the interchanges.

As garish as they are, ugly roadside signs provide useful and needed information to motorists. If you're driving down the freeway on fumes, it's good news to see a 200-foot-tall spire promising gasoline salvation in the distance. But what if the needed information could be provided without wrecking the landscape? GPS systems are now available for use in automobiles. It is technically feasible for your onboard system to tell you where the roadside services are and even plot the route to get there. You can say "Chinese food" to the console, and the car starts telling you where to drive for your meal. Conceptually, this information could be

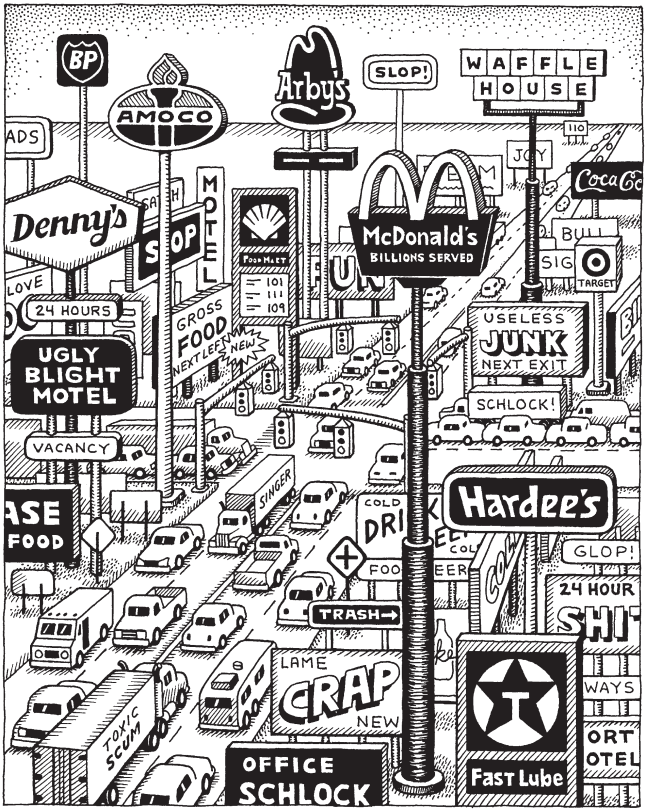

Figure 1.
Modern landscape with signs.

Source: Andy Singer.
Reprinted with permission.

Figure 2.
Landscape in Biloxi, Mississippi, following Hurricane Katrina.

Source: Ric Feld/AP Photo.
Reprinted with permission.

offered in place of the ugly roadside signs. But successfully replacing the signs and reclaiming the landscape require an organized, planned approach. Businesses would have to buy into the concept of advertising over the web, with more modest and better coordinated roadside signage. Property owners would have to agree to guidelines to coordinate their properties and not think that their individual freedoms have been trampled on if they can't hoist behemoth lighted signs.

One night, while I was driving in suburban New York, I exited the interstate. Not surprisingly, a generic, garish landscape sprawled along the exit way. It was a moonless night, but the area was brightly lit by the unnatural glow of huge roadside signs hawking the usual bric-a-brac. The signs were visible for miles down the highway, so motorists would have enough time to exit and find their gas, donuts, and motels. One towering sign advertised a Shell gas station. This sign consisted of a sequence of black letters placed in illuminated yellow squares, similar in shape to the "Waffle House" sign, but much, much, much bigger. The sign was huge and awesome, rising maybe a hundred and fifty feet off the ground. That night, the "S" had malfunctioned. So, rising over the sprawl, motorists were greeted by a gigantic Shell sign without the "S." It wasn't what the sign was supposed to say, but the description was about right.

Postscript

Recently, Route 9 has been reconstructed near Lake Quinsigamond. The design does a good job of introducing some order and format to the otherwise discordant landscape. It includes pavers, landscaping, and improved lanes and markings for the highway. This type of design in general is a challenge, as it seeks to reconcile the conflicting requirements of highway traffic, urbanity, and suburban sprawl glopscape. Probably the retrofitting of suburban sprawl will be a growth industry in the decades to come, as we seek to recover from some of the infrastructure design mistakes of the late 20th century.

Horse Management and Suspension Bridge Design

My student Julia was studying the analysis of suspension bridges. She referred to the classic text, *A Practical Treatise on Suspension Bridges: Their Design, Construction, and Erection* by D. B. Steinman, published by John Wiley and Sons in 1929. This old but great reference develops analytical procedures based on the deflection theory and provides pages of charts and graphs for practical design. At least, it was practical by 1929 standards, when civil engineers were analyzing and designing modern suspension bridges without PCs sitting on the desk top. The book's basic approach is to painstakingly develop pages and pages of analytic theory and then to present the results in somewhat more digestible graphs and tables that can be conveniently applied via slide rule. The approach is emblematic of how engineering used to be done. It is amazing to think that engineers could design a suspension bridge without computerized analysis and data management tools, but they did, and Steinman's book illustrates how.

The book was not available from our local university library, but we were able to find a loaner from Worcester. Julia worked on her analysis for several weeks using this copy. Unfortunately the book was due for return, and Julia still needed it. In order to check the book out again, Julia had to return it first. The good news was that there wasn't a huge demand for 1929 books on suspension bridge deflection theory analysis. The bad news was that this was the only copy of the book we could find. If it had to be shipped back to Worcester, checked in, checked out, and then shipped back again, Julia would be bookless for at least a week.

After spending many long nights engrossed in the text, Julia was not ready to part with it. But soon the overdue fees would start to pile

up, not at a level comparable to her graduate student tuition fees, but still of concern. Being good engineers, we decided to seek an alternate design. What if we could Google a copy of the text and purchase it? The book was out of print for decades, but maybe some copies were floating around in the electronosphere.

Our Google and Amazon searches identified nothing, so then we tried eBay, which is known to have everything. We typed in the data, clicked on the search button and then—success! eBay identified several hits for us to examine. Strangely, the choices had some of the initial identifying search words crossed off, but this didn't seem to be a problem. We were just happy to find a match. We clicked on the first selection and the Web site described text that matched our query: "Horses & Hounds, Practical Treatise on their Management."

This was not exactly what we had in mind.

After rolling on the floor in laughter for about five minutes (and the next five eBay hits didn't help, either), we thought about the implications of this new relationship between horses and suspension bridge design. eBay, through some algorithm, had evaluated millions of references and focused on the terms "practical treatise." Through this tenuous connection, the computer decided that "practical treatise" was what we were looking for. Algorithms used by the other search engines apparently are more discriminating. Amazon and other search sites correctly realized that they didn't have what we sought, and they avoided the distraction of listing marginal, false matches.

Interestingly enough, the newly identified equine–suspension bridge relationship has some implications for both infrastructure design and engineering analysis. The item that we searched for was a printed book, but in the age of electronic everything, what is to become of printed books? Students nowadays are used to conducting research via the Web. In the past, the gold standard for generic research was the *Encyclopaedia Britannica*. Nowadays, students are very familiar with the Web-based Wikipedia, the informal, democratic, online encyclopedia. Probably few current students have heard of or opened the *Encyclopaedia Britannica*. The idea that you would have to physically go someplace to find information is passé. Tufts students, for example, have access from their laptops via the library to electronic journals. With wireless Internet, they can study and research anywhere, and they do. So there's

less motivation for going to the library because you don't need to anymore. This poses a challenge in figuring out what to do with the physical library space. All research is becoming virtual.

Many libraries address this challenge by rethinking what the space should be. They have added cafés, computer rooms, media rooms, and all sorts of peripheral spaces. None of these rooms or uses fits the old library definition of volumes of dusty books on shelves, with Dewey Decimal card catalogues and librarians patrolling the stacks and shushing the talkers. The old draw of a library, its primary function as the source for all information, is being supplanted by the diffusion of the information. So it's not clear what a library will be needed for in the future. If a central storage space for books is no longer required because you can just Google the information, do you really need a location for cafés, reading rooms, and the like?

The elegant charts in Steinman's book likewise seem to be an anachronism. Today numbers are easily managed by Mathcad. Number crunching that used to take months can be completed in minutes. Whatever you don't know is a click away.

But in the old days, the physical difficulty of accessing the data and managing it required a much more elaborate and careful treatment. In order to design a suspension bridge in 1929, you had to be deeply involved in the analysis process. There were no black boxes to put the garbage in and take the garbage out of. Less obviously, the old process required collaboration among a group of colleagues, who pored over the nitty-gritty and carefully checked and rechecked the work. Steinman's treatise was used and applied by collaborative groups, not by individuals holed up with their laptop screens. With this collaboration came the give and take of multiple views and the application of checks and balances.

Likewise for the library. While the Web makes analysis and data management possible in dispersed settings, perhaps the central function of a library is more than just storing books. Maybe the notion of a library as a physical place should not be so easily discarded. This is because, ultimately, humans are social beings who analyze and solve problems best in collaboration, not individually. Maybe in the future, all of the common space for collaboration will be provided by Starbucks. But it's probably better for libraries to be the place to go when it's time

to think and collaborate, even if you are no longer compelled to visit for the books.

When it came time to return the text to Worcester, Julia received some good news: a second New England copy of Steinman had been found in Rhode Island. So she continued her studies of the deflection theory with no down time, and at least for now, we had no further need to consider the implications of horse management.

Back to School

Wrentham Village is a village of sorts, but not a real village. It doesn't have schools, or churches, or greens, or even a town hall. It only has stores. Wrentham Village is a relatively new shopping center in Wrentham, Massachusetts. It is advertised as a collection of factory-direct stores, in which different brands offer their merchandise directly to consumers at discount prices. Unlike a large department store with everything under one roof, the center has dozens of smaller stores situated in shopping pods. The pods are sited at the middle of a vast parking lagoon, with easy access to I-495, the Boston area's über beltway. The lagoon with its shopping pod nucleus is close enough to the freeway that you can see signs for it as you approach. The Wrentham Village sign towers over the trees in the adjacent woods and lights up the sky at night.

Inside the village, shoppers walk along modestly pleasant, nondescript pedestrian lanes lined with the stores. The pedestrian lanes are all outdoors, exposed to the weather. Use of open-air public spaces is one innovation of this type of discount shopping center, in contrast to an enclosed, environmentally controlled mall. The costs of maintaining the space must be considerably less, because there are no heating and cooling bills for the walkways and plazas. The shopping pods are arranged in hollow squares, with the interiors of the squares reserved for trucking and supplies. Access to the supply areas is via small alleys, off-limits to shoppers, that are connected to the main parking lagoon. The supply areas with their loading docks and garbage bins, while not directly in the pedestrian paths, are not exactly hidden from view either. The theory behind the architecture seems to be that because it's a

discount center, shoppers should expect some degree of less-than-Grade-A accommodations.

I needed stuff, so I trekked to the village in September. This is the back-to-school period when, for the annual clothing resupply, kids are lugged by their parents. The place was packed. It was not possible to get a spot in the parking lagoon close to the stores, although many drivers trolled and circled for openings. I didn't have the patience, so I parked at the outskirts about a quarter of a mile away, and made the 10-minute hike across the asphalt to the edge of the shopping pods. As with the rest of the infrastructure, the parking lot design was functional and adequate—good enough to park your car, with a few trees and some throwaway landscaping, but a sad replacement for the vast expanse of woodlands that had been mowed down to provide the space.

Once in the village, I joined the hundreds of glazed shoppers scurrying from store to store. (I thought of a scene from the movie *Dawn of the Dead,* where the zombies mill about in a shopping mall, buying merchandise and chewing on flesh.) In keeping with the discount theme, the public spaces of the factory stores had few amenities. There were not many benches or water fountains. The intersection of the pedestrian lanes presented a confusing jumble of pathways and shrub landscaping, as if the designers couldn't decide whether it was more important to make the space look nice or to funnel the shoppers away from the center and closer to the edges. The edges were where the stores were, and the object was to get the patrons to shop and spend. At one pedestrian lane intersection, there was a small overhead trellis that had no discernible function. No grape vines grew on it, and it didn't provide shade or cover from the rain. It was a functionless structure not even in keeping with the discount layout of the rest of the village.

The part of the infrastructure that seemed best developed was the signs. At any one place in the village, you could see signs showing you where you were and where the other stores were. There weren't many benches to sit on to read the signs, but at least you could easily make your way from store to store.

It's interesting to compare the new shopping village to its traditional New England counterpart. Historically, New England has small towns dotting the landscape between Boston and the smaller cities. The traditional village layout includes a grassy public common and a defined

commercial center, with surrounding residential areas. The real Wrentham Village is not too far away from the shopping center, and it typifies this tradition. However, the real village does not offer the efficiencies for mass consumption that the new shopping village does. The few stores are mid-20th century and don't have the space and easy access for supply. Their floor plans are too small by today's big-box standards and the stores can compete only as boutique shops, small restaurants, or niche suppliers. In the real village, space is provided for pedestrians but not for thousands of cars in giant parking lots. Wrentham Village, the new shopping version, is representative of the shopping infrastructure that is being built all over the United States. These new facilities have easy access, are designed for suppliers and customers to get into and out of as efficiently as possible, and have minimal, low-cost public spaces.

What makes the example in Wrentham more jarring than elsewhere is its proximity to traditional New England villages, many of which are a stone's throw away. In much of the rest of the United States, the surrounding sprawl of infrastructure is not that much different from the new shopping villages. But in New England, infrastructure in the traditional towns tends to be human-scaled and of a layout and design that fits into the landscape, instead of overwhelming it. In the Wrentham Village shopping center, the merchandise is a bargain, but the design of public space and the center's connection to its surroundings are also offered at a discount.

Aqua Teen Hunger Force Attacks I-93!

In the "we have more things to worry about than this" department, a strange story unfolded in Boston on January 31, 2007. A cable TV network unleashed a guerilla advertising campaign upon the citizens of the metropolitan area. The network was advertising one of its late-night cartoons, *Aqua Teen Hunger Force*. This is a show about talking French fries and a meatball. The advertisements consisted of small electronic signs that lit up at night. The lights formed the shape of one of the TV show characters. The concept behind the unconventional advertising campaign was that it would bypass traditional, older outlets and methods (with their older customers). The ads were directed at hard-to-reach young men, who apparently don't read much but like to buy things. The little signs were posted all over the city, and several were placed on bridge columns.

At night, the little signs looked like something made out of Lite-Brite toys—not very threatening. During the day, it was different. The signs had wires poking out of the back, with circuitry and batteries. They looked like bombs. For several weeks, the signs weren't noticed (and that is another issue worth contemplating). Then, a transit worker saw one attached to a steel column supporting the double-deck structure of I-93 just north of the Zakim Bridge. Not knowing what it was or why it was there, the worker called in an alarm, and forces quickly mobilized to detach and destroy the threatening device. More signs were found, setting off a chain reaction of hysteria paralyzing half the city. I-93 was closed, along with the Mass. Ave. Bridge and Storrow Drive. A hospital was temporarily evacuated. Sapper squads were called in to disarm more signs as they were located. The signs were blasted and disabled by

water cannons. Eventually word got around that the devices were harmless. After many hours of massive traffic jams and dislocation that some thought rivaled the *War of the Worlds* radio broadcast of 1938, things eventually quieted down, and the incident moved into the recrimination phase.

Bridges are prime targets for guerrilla advertisers because of their high visibility and low clutter. A sign can really stand out on a bridge, because the structures are designed to be just bridges and not billboards. Bridges also provide a built-in audience of thousands who drive across and under them. Sometimes this audience is held captive in traffic jams, and then what better place to provide a diversion? Bridge structures are not usually designed for advertisements, because engineers envision sleek superstructures with graceful lines and smooth surfaces. Lite-Brite advertisement panels are not included in the construction bid documents. But the jarring discord of the ads is part of the appeal for underground advertisers, who get an effective, low-cost product that really sticks out. In the case of the cartoon campaign in Boston, though, the ads also shut down the city.

Recently, bridges are being used for a lot more applications than just crossing roads and rivers. Banners are hung from bridge decks and pedestrian fencing. Some have messages of a personal nature (figure 1). Other banners are large sheets welcoming soldiers home from tours of duty abroad. In 2005, an English bridge unwittingly served as the canvas for a nasty divorce battle.* The participants hung up dueling banners. He said: "Wendy, I want a divorce. JBS." She said: "No way. You are the cheat! Wendy." Documentation is not available on whether JBS or Wendy prevailed, but apparently the bridge made it through OK.

Some banners have been used to protest, for and against. The Web site for a design studio in Manchester, U.K., provides helpful, practical instructions for how to hang a protest banner from a bridge.† For example, protesters should attach milk jugs full of water with ropes to the top of the banner (to anchor the banner on the bridge) and water-filled plastic bags to the bottom of the banner (to weigh down the banner

* http://www.usatoday.com/news/offbeat/2005-10-14-bridge-couple_x.htm (accessed June 28, 2008).

† http://www.uhc.org.uk/webpages/toolbox/attack/subvertising/banner_drop.htm (accessed June 28, 2008).

Figure 1. Banner over Interstate 80 East in Morris County, New Jersey.
Source: http://www.flickr.com/photos/nicholas_t/220090264/, courtesy of Nicholas T.

itself). The instructions do not include asking for permission to hang the banners ahead of time, but they did suggest that participants should take photographs to document the event. This way, the protest and message could live on through the Internet and blogs.

A lot of energy goes into hanging up the banners. Not much goes into taking them down. Drive around now and you can see decaying banners, frayed sheets with faded, running lettering. However virtuous the original message, torn and tattered banners become no better than graffiti, defacing the bridge and its surroundings. Sometimes the message is unintentionally sad, like when a soldier is being welcomed home, but the sheet is ripped and you can't read all the letters. At that point, it's not much of a welcome.

In the end, bric-a-brac hung on bridges is jarring because it violates the fundamental principal of form following function. Some can argue that beauty is in the eye of the beholder, but most texts on bridge aesthetics counter by teaching that good aesthetics can be achieved by proper dimensioning of a bridge structure and by thoughtful treatment of details. This engineer-friendly approach stipulates that aesthetics can be quantified to an extent. Engineers don't have to be artists to design

good-looking bridges. Guidelines can be followed so the design ends up in the right ballpark. For example, piers should be in proportion to beams, not too wide and not too thin. Bridges should appear and be proportioned with dimensions that properly reflect the structural function. To an extent, this is clear to nonengineers, although they probably don't have the vocabulary to explain or the training to understand why a particular structure is ugly. But they do sense it when they see it.

With the basic form and shape of a bridge properly determined, other treatments can be thought of as add-ons. Context-sensitive design stipulates that structures should be in harmony with the surroundings. The Federal Highway Administration defines context-sensitive solutions (CSS) in this way:

> CSS is a collaborative, interdisciplinary approach that involves all stakeholders to develop a transportation facility that fits its physical setting and preserves scenic, aesthetic, historic and environmental resources, while maintaining safety and mobility. CSS is an approach that considers the total context within which a transportation improvement project will exist.*

This is an admirable (and you would think, somewhat obvious) design goal. A corollary of CSS states that the appropriate context can be achieved for bridges by improving surface, texture, and color. Sometimes the argument for a context-sensitive design supports a false architectural façade in front of the actual structure. For example, a beam bridge may have masonry arch panels stapled in front to make it look like an arch bridge. When the Broadway over Boulder Creek Bridge in Boulder, Colorado, was reconstructed, the original, historic masonry structure was replaced by a concrete beam bridge. The new bridge has arch-shaped fascia panels.

This approach to bridge aesthetics can work if the underlying structure is properly dimensioned to begin with. City of Boulder Transportation Project Manager Alex May commented:

> A lot of bridges, such as this one with its false arch facade, are very utilitarian in their design … Often in a bridge

* http://www.fhwa.dot.gov/context/what.cfm (accessed May 28, 2008).

> rehabilitation, the architect will cover the bridge up to look like something it isn't. One of the things that we stressed in the design was that we wanted it to be elegant and pure in form.*

So, if the underlying structure is not properly dimensioned, the results may not be as satisfying as the Broadway Bridge. To paraphrase Dick Cheney, who paraphrased someone else, "You can put lipstick on a pig, but it's still a pig."

A long-standing debated has focused on whether we should have a squeaky clean, ordered infrastructure or a free-wheeling, laissez-faire approach. Some argue that graffiti is art, and others argue that it defaces the environment. Boston's Aqua Teen bridge assault is not likely to resolve things or make a constructive contribution to this discussion. The company that conceived the advertising campaign was widely denounced for its lack of common sense: in the year 2007, was it really a good idea to advertise with devices that looked like bombs? The parent company ended up forking over millions of dollars to Boston agencies to pay for overtime and emergency services provided during the height of the hysteria, and the head of the cartoon company resigned. However, the payout was only a fraction of the total cost of the event, since you would have to also figure in thousands of hours of lost time for those stuck in the traffic jams, as well as the ensuing lost business. The offending company could have easily paid ten times as much and not gotten the quality of exposure and buzz that advertisers crave. Even with the black eye, the multimillion-dollar payout, and a top executive falling on his sword, the campaign was probably determined (behind closed, hermetically sealed doors) to be a whopping success.

So, with built-in motivation for future guerilla marketing approaches of this type, we can probably expect more of them—maybe not as brazen as the Lite-Brites and with luck not as disruptive. In these future campaigns, bridges may be not just bridges but giant spanning billboards, ripe for the next huckster to use to sell his wares.

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* Carter & Burgess. (2003). "Function and Beauty: The Aesthetics of Bridge Design." *Carter & Burgess Quarterly,* Issue 3. Also http://www.c-b.com/information%20center/transportation/ic.asp?tID=23&pID=216 (accessed May 28, 2008).

Highways to Nowhere

Many cities around the country have highways to nowhere. These structures were constructed for later connecting roads that were never built. In New York City, a massive interchange looms above the Staten Island Expressway. This interchange was built to connect to a subsequent north–south expressway running to the Outerbridge Crossing. The last segment of the expressway was never built, so the interchange looms, rusting and unused, above the busy highway. Downtown Baltimore also has a prominent highway to nowhere, with Jersey barriers and temporary fences blocking access. The temporary fences have become permanent. In Boston, you can see vestiges of connections to ghost expressways: the infamous Inner Belt, the extension of Route 95 from Route 128, and the completion of the Northeast Expressway north through Revere and Saugus.

Highways to nowhere are monuments to the imperfection of the construction planning process. When the interstate highway program was formulated and enacted decades ago, everyone understood that it was impossible to build everything simultaneously. Only bits and pieces could be built at a time. Later, the pieces would be stitched together to form the great interstate corridors. The highway designers did their best to design and package the pieces. In an era when no highway went unbuilt, it made sense to plan and build the connections for the later pieces. In this way, the later segments could be built with fewer impacts on the expressways already open.

Unfortunately, the best highway designers couldn't design for changing fashions and policies. As a result, we have dotting the landscape these looming edifices to policies of the past.

As a boy, I thought that things would get better when the highway was finished. This is a short definition of "progress." For example, to go to grandma's house, we used to take Interstate 84, which stopped at the Taconic Parkway exit eastbound towards Connecticut. A mile or so before the end of the highway, big red warning signs shouted "Expressway Ends!" The road became more forbidding, with cones and warning stripes. At the edge of the traveled way, at the final exit, a barrier blocked further travel. The pavement and roadwork of the interstate continued off a few hundred feet up a hill before halting at a row of trees. I was convinced that if we could take that road, we'd get to grandma's house much faster.

Eventually, Interstate 84 was finished and became a highway to somewhere, but I was disappointed. Even with the new part of the road open, we still took the same old exit, so we didn't get to grandma's house any faster after all.

Creative reuse of highways to nowhere is a challenge. In Boston, part of the exit from I-93 to the defunct Inner Belt has been rebuilt. The double-deck viaduct north of the city has unused stub ramps, some of which have been connected to a new exit and bridge across the Charles River. A ghost highway has been brought back from the dead. Other parts of the ramp connection branch off into space and dead-end in midair. Before the downtown Central Artery viaduct was replaced by a tunnel and then demolished, some artists proposed keeping sections of the viaduct standing, so pieces of the old bridge could serve as a link to the past. In the end, one green metal column from the viaduct underpinning was not removed and remains in place, poking out of the sidewalk adjacent to Faneuil Hall. The column is labeled with the numeral 38, which stands for Bent 38, one of the dozens of support bents that held up the expressway viaduct. Today you can watch tourists stop and puzzle over the incongruous column and its mysterious, abstract number.*

Elsewhere, because of tight construction budgets, the remnants of the highways to nowhere are likely to remain, undisturbed and unused. We can look at these unfinished interchanges and roads that come to a stop, and ponder what would have been, and where they would have led.

* For example, see http://www.flickr.com/photos/55226641@N00/1675620592/ (accessed March 23, 2009).

Everyone Wants One

Planners came up with an unusual bridge design in Europe, where they built the Passerelle du Jardin des Deux Rives for pedestrians and bicyclists (figure 1). The structure is a double-tower cable-stayed bridge. The towers stand on concrete piers shaped like boats and tilt with the cables flying backward to the curving bridge deck. The overall effect is two sailboats racing each other. This conceptual design is very showy and dramatic, in part because its shapes and angles are unexpected and not normally seen in bridges. The design is not necessarily optimized, but it does go out of its way to startle.

The Sundial Bridge at Turtle Bay is another cable-stayed pedestrian bridge, this one crossing the Sacramento River in Redding, California (figure 2). The single pylon leans back against the unbalanced loads from the main span. While the bridge structure is slender, the pylon is massive and almost overwrought. Again, it is perhaps not the most efficient of designs, but the structure definitely grabs your attention, in part by being so out of the ordinary, and in this case, with an appearance that seems a little bit unstable.

Both of these structures are somewhat extreme examples of a relatively new type of bridge design. Instead of "form follows function," these bridges aspire to be viewed as structural art. The semblance of art is achieved by surprising, unexpected load paths: the pylons lean back to handle loads; the cables seem twisted up in knots; and the arches are playfully varied, featuring interruptions and load transfers at peculiar points and sometimes leaning over to one side.

For some structures, the startling effect is accentuated by a feeling of danger, as if the bridge were going to tip over or worse. The first

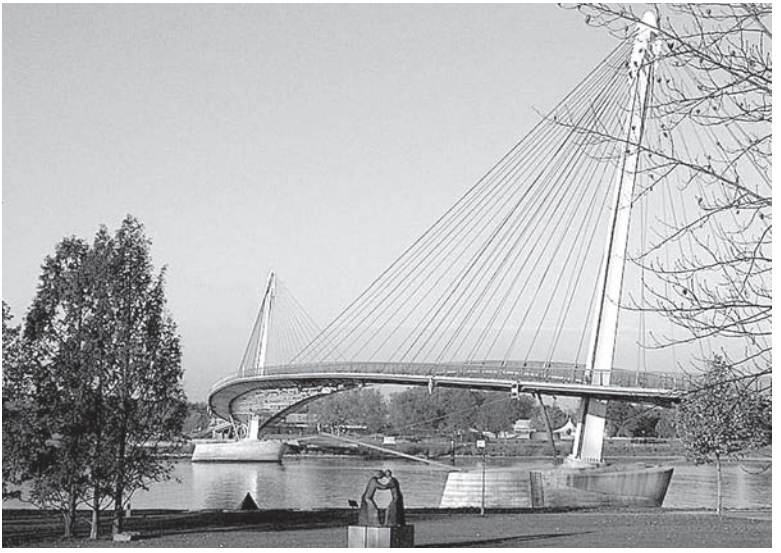

Figure 1. The Passerelle du Jardin des Deux Rives is a bicycle and pedestrian bridge between Kehl in Germany and Strasbourg in France.

Source: http://en.wikipedia.org/wiki/File:071105-094558.jpg (accessed May 6, 2009). Courtesy of JRMW.

Figure 2. Sundial Bridge over Turtle Bay near Redding, California.

Source: ©iStockphoto.com/Michael Brake.

Tacoma Narrows Bridge also conveyed the effect of impending collapse by its undulating, roller-coaster deck. In its brief life, the bridge was a tourist attraction because of the sense of danger in crossing. However, for the first Tacoma Narrows Bridge, the hint of danger was not intended and eventually turned into reality.

Among the most showy of these new bridges is the Juscelino Kubitschek Bridge, known as the JK Bridge, over Lake Paranoá in Brasília, Brazil (figure 3). This bridge features a group of three arches placed out of the bridge deck plane, with cables and stays to pull everything back into place. The high startle effect is achieved by the arches being out of line with the roadway. They seem to pop out of the water like serpents. There is no good structural reason to place arches in this way, so the effect of the bridge is whimsical and unexpected. Unfortunately, because the arches are not where they normally and efficiently would be, substantial additional piers were needed to hold up the deck, and the combination of arch bases and piers clutters up the water. Some complex engineering thought went into the challenge of keeping the whole thing upright and not collapsing into the lake. The bridge has won several awards. It's interesting that an architect, Alexandre Chan, is often cited for the work, not the structural engineer, Mario Vila Verde.

Complex structural designs have been enabled by computers. Today, architects and engineers can plan structures that perhaps could have been imagined in the past, but were not possible in any practical

Figure 3. JK Bridge over Lake Paranoá, Brasília, Brazil
Source: Courtesy of Mario Roberto Duran Ortiz.

way. For example, suspension bridge analysis in the early and mid-20th century was a monumental task without computer-aided analysis and design software. Automation has freed designers from many of the computational constraints, not just in the analysis, but in the extremely complicated requirements for depiction and documentation of the structures. So, instead of a plain vanilla suspension bridge, engineers today can design bridge cables and towers with all sorts of unusual curves and angles. For a particular bridge, if each cable, beam, and connection detail must be fabricated in unique angles and shapes, then success or failure will be determined to a large degree by how well the shop drawings are managed. You need a computer for structural details and fabrication if every beam, every connector, and every cable has different dimensions, different curves, and connections at unusual, out-of-plane angles.

The prominence of showy bridges has led to a phenomenon that I think of as "everyone wants one." Consider the Arthur DiTommaso Bridge, which is also known as the Fifth Street Bridge (figure 4). This cable-stayed bridge in Fitchburg, Massachusetts, has a center span of 358 feet. It opened in 2003 and replaced an older truss bridge that had

Figure 4. Arthur DiTommaso Bridge, also known as the Fifth Street Bridge, in Fitchburg, Massachusetts.
Source: Courtesy of Randy Jollimore, photographer.

been closed to traffic in 1995. An earlier design for the replacement bridge featured one taller pylon and a longer main span. During the public review process, shorter towers emerged as the preference, so the resulting structure was built.

As cable-stayed bridges go, the Fifth Street Bridge is a tad small. Cable-stayed bridges are not usually chosen for spans of 350 feet. But the community viewed the bridge replacement as an opportunity not just to replace the decaying truss bridge, but to build a landmark signature structure, an iconic bridge that could revitalize the community and function as a visual rallying point. In Fitchburg, when people looked at the railroad tracks at Fifth Street, some didn't see railroad tracks. They saw the Golden Gate.

In general, a focus on the symbolic and artistic merits of bridges is a good thing. The U.S. landscape is cluttered with serviceable but clunky bridges. These gawky structures are safe and get the job done, but with a little imagination and focus they could have graced their surroundings instead of soiling them. Part of the engineer's design job is understanding the fundamental proportioning for aesthetics. Even nonengineers intuitively understand when a beam is too deep or a pier too slender. They may not be able to do the calculations, but they know that something just doesn't look right.

On the other hand, the new crop of showy, artistic bridges can be too much of a good thing. A properly proportioned bridge shouldn't cost any more than an ill-proportioned bridge. Adhering to "form follows function" leads to attractive, aesthetic structures. When load paths and structural forms are selected for startle-value instead of structural value, an increased budget may be needed. The examples shown here are perhaps not the most cost-effective solutions. So we may end up with an expectation that aesthetic structures must cost more. There's nothing wrong with paying more for showmanship, if that's what particular communities and organizations want to do. But that doesn't justify ill-proportioned designs for other structures. If the trend of "everyone wants one" gets out of hand with a widespread belief that you have to spend a lot of money for beautiful bridges, we may end up going back to the ugly, utilitarian designs of 1950s. This would be a shame, because although not every bridge can cross the Golden Gate, every bridge can be well-proportioned and attractive in its own way.

The Canopy

A drive through the woods can be astonishing because of the contrast. You don't normally think of driving through a forest. Roads are a manifestation of civilization, and the woods are the primeval and uncivilized. You wouldn't think that the two would mix.

In the United States, where mass ownership of automobiles was invented, road construction is an expression of our ability to conquer and tame the frontier. In the New World, civilization, at least the western European version of it, landed on the Atlantic coast and spread west. The settlers first rode on horses, then on barges in canals, then on the railroads, and finally on automobiles and trucks. The interstate highway program capped the construction of vast road networks across the United States. Some consider the interstate program as humankind's greatest infrastructure project.* It was perhaps the last act in taming the American frontier. After the interstates were done, there wasn't much frontier left. All that remained were vestiges of the really wild wilderness, little bits and pieces tucked away far from the exit ramps. When you drive on highways surrounded by woods, you can imagine that the forest is again primeval and boundless, with miles of wooded terrain untouched by man. But it's an illusion. There's a McDonald's waiting a short distance on the other side.

I like driving on roads in the woods, sometimes just to imagine what the frontier was like. It's a bit silly, of course, to think of the frontier

* Lester A. Hoel and Andrew J. Short. (2006). "The Engineering of the Interstate Highway System: A 50-Year Retrospective of Advances and Contributions." *Transportation Research News,* 244 (May–June), 24–29. Also http://onlinepubs.trb.org/onlinepubs/trnews/trnews244retro.pdf (accessed June 28, 2008).

in this way. Driving on a carefully engineered blacktop in a plush, climate-controlled vehicle with surround sound and woofers is pretty distant from a frontier experience. The wilderness was wild, in part, because it lacked creature comforts and conveniences, such as rapid transportation. Unlike modern life, the frontier was a difficult place. But all the same, I like the illusion of wildness from my safe, modern vantage point. The trees hug the sides of the road and branches form a canopy, greening the sunlight and making the place seem much more wild than it actually is.

Some roads in my suburban hometown provide a brief wilderness experience of this type. For example, Edgehill Road has a stretch of a quarter-mile or so where the houses stop and the woods take over. This length of road is bordered by a golf course on one side and a cemetery on the other. The edge of the active part of the cemetery stops up a hill away from the road, with the remaining area covered by woods. The golf course similarly has a buffer of trees between the fairways and the road. So for a short distance, because of a quirk of the land use pattern, it seems like you're driving in the forest.

Up on Moose Hill, you really do drive in the forest. This large land tract features upland woods preserved in a natural state by the Massachusetts Audubon Society. The few roads crossing through the reservation have a rural, untamed look, much different from most of the rest of the town. Civilization intrudes occasionally, in the form of old rock walls and meadows. These intrusions are more 18th century than 21st, because they are vestiges of old farms long since abandoned and grown over.

In town, we have another road named Mountain Street, which climbs a hill that is definitely not a mountain. Toward the top of the hill, the pavement ends for a short distance, the house lots recede, and you drive (slowly) through a remote, wild-looking, densely forested patch. This area is, temporarily, one of the last, large undeveloped sections of town, with privately owned, wooded land that is slated for construction of a nursing home. I like biking on this part of the road, at least until the woods are plowed and paved over. The treed canopy is evocative of a time when the town was rural, with far fewer houses and built areas.

Combining roads and woods tends not to result in a steady-state pattern of land use. Once new roads are built, the surrounding woods

become accessible for uses other than forest. Particularly when the roads offer easy access to utilities such as water lines and sewers, the adjacent land is assigned a new value in the development marketplace. So the surprising border between a newly constructed road and the adjoining forest land never remains that way for long, unless the forces at play interrupt the typical patterns of land development. In my town, which is largely built out, a wooded road can remain that way if the land is preserved, such as by a state park or Audubon Society reservation or through some quirk of private land use, such Edgehill Road.

One of the most interesting and unexpected roadways through the woods is the Palisades Parkway in New Jersey. The parkway is a limited-access highway that extends from I-95 at the George Washington Bridge in New Jersey north to Bear Mountain State Park in New York State. Palisades Parkway runs up the middle of one of the most urbanized corridors in the United States. Immediately to the west is densely built northern New Jersey. Immediately to the east, across the Hudson River, are urbanized areas of lower Westchester County in New York. But for a distance of 12 miles, the adjacent terrain is wooded and the right-of-way looks rural and remote. Although this appearance is an illusion, when you drive the parkway, surrounded by dense foliage and enveloped by the canopy of trees, you are treated to an experience of wilderness. The cool, green parkway is a welcome relief, particularly after leaving Manhattan, particularly on a hot, sticky New York summer day. For a few brief miles, you can imagine that woods extend in all directions, and that civilization's intrusion ends at the pavement edge.

Bridginess

A successful bridge design should result in a structure that expresses its function to span, related to the site it crosses. I think of this expression of spanning as "bridginess." It's not just a question of bridge aesthetics, such as the massing, shape of the towers, slenderness, and so on. It's about how the bridge expresses its spanning function, how it shows itself to the world that it's a bridge. A span with good bridginess looks right. It fits correctly into its landscape. It benefits from engineering decisions for pier placement, superstructure, and span that seem correct to the casual observer, even to nonengineers. A bridge with poor bridginess looks peculiar. Something is wrong, something doesn't make sense in the design. A pier is placed in shallow water where there shouldn't be one. The span is too long for the site. The superstructure is overwhelming and massive where small and subtle is called for. A bridge with bad bridginess may have an excellent aesthetic design. Its individual components may be correctly sized and detailed, and the whole package may be put together well. But when considered at its site, the structure doesn't span well.

It's exciting (well, at least for me) to drive across a structure with good bridginess. Some bridges are so well designed and situated that the drama of crossing them is heightened. Approaching the Verrazano-Narrows Bridge from the Belt Parkway in Brooklyn is an example of the start of a great bridge experience. You begin with just the hint of bridge—signs advising that the span is coming, then a glimpse of a tall tower in the distance. Around the bend in Coney Island, the majestic bridge makes its appearance, slowly materializing and massing on the horizon as you get closer. What a fierce, no-nonsense bridge it is, with its

formal towers and curving, slender deck that floats in a heroic, almost impossible leap over the water. To get to the Verrazano from the parkway, you follow a sequence that builds the bridge suspense, whetting your appetite for the experience yet to come. First you gradually drive to an approach causeway, then cross under the back span and around the back of it, next to the massive concrete abutments. This part of the drive is a great bridge-tease, a taste of the approaching glory.

To make it onto the deck, you drive up steep ramps, ascending as if to the sky. On a day with a particular cloud cover and light, it can seem like the towers are surrounded by halos. Finally, after all that effort and expectation, you are on the great bridge, first on the back span, then on the main center span, hanging in midair, high above the earth in bright sunshine. Driving on that grand ribbon, you are so high up and so far from the world that the buildings of lower Manhattan look tiny poking out of the harbor, and the massive barges and cruise ships on the open Atlantic seem like toys But you only get to stay in the sky for a few moments. It's a long bridge, but soon you reach the end. It's over. You pass the toll plaza on the other side, and you're deposited onto Staten Island to go smoke a cigarette.

Some bridges are artistic and beautiful, but not all bridges express bridginess. To expand the definition of bridginess, consider a few examples, good, bad, and in between. The Golden Gate Bridge is an example of a design with great bridginess. This is one of the world's most appreciated bridges, by both engineers and nonengineers, and for good reason. The structure has a great expression of its spanning function in relation to the site. Placement of the piers, dimensions, anchorages—all seem correct for the task of crossing the Golden Gate. You look at the bridge and immediately understand the enormity of the bridge requirements, the depth of the channel, the currents, the wind. Even the approach deck arch on the San Francisco side, which spans a historic fort, seems correct and whimsical as part of the entire package. The good bridginess of this design is complemented by an excellent aesthetic design as well. The towers are beautifully shaped and the natural grace of the suspended span is perfect and daring for the site. To get a feel for what other designs might have looked like, review sketches of earlier conceptual designs. One concept featured a hulking hybrid suspension-cantilever

truss span, a monstrosity that probably would have been tolerated but not beloved (figure 1).

Another crossing with excellent bridginess is the New River Gorge Bridge in Fayetteville, West Virginia (figure 2). With the world's second longest arch span, this heroic bridge with a steel arch leaps across the gorge. The spanning function is clear and easily understood by all observers. The bridge has become a landmark and icon for West Virginia. The expression of spanning seems correct: the walls of the gorge appear to hug and resist the thrusting force from the arch.

Some bridges lose their bridginess when they awkwardly juxtapose different types of structures. For example, consider the two-part Glacis Bridge in Ingolstadt, Germany, completed in 1999. Individual structural components of the highway and pedestrian crossings are crisply and attractively detailed. But it can't decide whether it's a beam bridge or a suspended span. Put together, this is one confused bridge. The undulating pedestrian crossing looks like it's about to fall off the side.

Then there's the combination of the Royal Albert Bridge and the Tamar Road Bridge near Plymouth, England (figure 3). The Royal Albert is a railroad bridge designed and constructed under chief engineer Isambard K. Brunel. It has a classic lenticular truss form, with spans of 580 feet. One pier is placed somewhat awkwardly in the center of the river. The adjacent Tamar suspension bridge opened in 1961. It has a 1,100-foot center span that clears most of the channel. Individually, each bridge is interesting and graceful in its own way. The railroad bridge has an antique, historic shape and is beautifully detailed. The suspension bridge is utilitarian, sleek, and modern, a smaller but effective representative of this bridge type. There's nothing particularly special about the design, but in terms of aesthetics it's hard to screw up a suspension bridge.

Together, however, the two bridges make an odd pair and collectively fail to express good bridginess. Because they are adjacent to one another, engineering conditions that apply to one should apply to the other. The problem is with the suspension bridge. If the river design conditions were such that a pier could be placed in the middle for the old truss bridge, why was the grand sweeping suspension span needed in the later bridge? Does the river bottom drop off immediately adjacent to the truss bridge, requiring a longer span at the road bridge site?

Figure 1. Early sketch for the Golden Gate Bridge.

Source: Derleth Collection, Water Resources Center Archives – University of California, Berkeley. Reproduced with permission.

Figure 2. New River Gorge Bridge in Fayetteville, West Virginia.

Source: Library of Congress, Prints & Photographs Division, HAER No. WV-41-5.

Figure 3. In the United Kingdom, the Tamar Road Bridge, a suspension bridge, was paired unfortunately with the Royal Albert Bridge, a lenticular truss railroad bridge designed by I. K. Brunel.

Source: http://commons.wikimedia.org/wiki/File:Royal_Albert_Bridge.jpg (accessed December 29, 2008). Courtesy of Richard Peat.

Figure 4. Twin spans of the Delaware Memorial Bridge were built 17 years apart.

Source: http://commons.wikimedia.org/wiki/File:DelawareMemorialBridgeFromSouth.jpg (accessed December 29, 2008). Courtesy of Waste Time R.

The suspension bridge looks strange at the site for this reason. It is an uncomfortable, peculiar-looking design.

Another less-than-successful pairing can be found at the southern end of Lake Huron, crossing the St. Clair River. The (first) Blue Water Bridge was built in 1932, and another span, the Second Blue Water Bridge, situated immediately to the south of the older one, opened in 1995. Separately, each bridge is nice. Both spans have a tied arch shape and proportions that are about right for the channel dimensions. The earlier bridge is a continuous truss shaped as an arch, whereas the sequel bridge is detailed as a true tied arch. The bridge approaches have reasonable pier spacings and span aspect ratios. So as individual bridges, they are handsome and convincing. But unfortunately they don't work as well immediately next to one another. The bridges have vastly different individual shapes and proportions, and very little space separates the two. Considering the design requirements, it's understandable that current methods would lead to new choices for the recent span. The new bridge has less truss and sleeker plate girders. But it somehow looks wrong next to the old bridge, and thus the two, side by side, express bad bridginess.

Placing a new span near an old one is always a challenge for good design. Decisions made for the old span are often not up to date and wouldn't be made for the new design. But still, there are ways of addressing the problem. Designers of the Delaware Memorial Bridge twins did so by designing a bookend new suspension bridge that opened in 1968 to go along with the older structure that originally opened for traffic in 1951 (figure 4). So, the shape can be closely mimicked, even as the design is updated to modern code requirements and geometrics. The new bridge, for example, has bolted connections instead of rivets.

Another choice would be to select a different bridge type altogether, while still respecting site conditions and needs. For example, the Second Blue Water Bridge could have been a cable-stayed structure with piers and approaches in about the same arrangement as the original tied-arch. This would have been a startling design, but if correctly detailed, it might have fit better than the current arrangement.

A third option would be to separate the two bridges with more distance. Because of approach and traffic requirements, this may not have been possible for the Blue Water structures, but if it were, the result would have been a more pleasing arrangement. The bridges would

have looked like separate structures spanning the strait, not unlike the way the Brooklyn, Manhattan, and Williamsburg Bridges appear in their crossing of the East River in New York. There, the three suspension bridges are suitably spaced so that they appear to be three separate bridges. Imagine the difference if they were sited within 100 feet or so of one another. Then the grandeur and spectacle of the Brooklyn Bridge might be lost.

In 2003, a new suspension bridge was built across the Carquinez Strait near San Francisco, California (figure 5). This, the third bridge at the site, was the first new suspension bridge built in the United States in many years, and it has a successful, attractive design. The concrete towers and superstructure are utilitarian and sleek, with no adornment. The suspension bridge form itself is a natural—again, it's hard to mess up the aesthetics of this bridge form, and the designers did a nice job. In terms of bridginess, however, the results are mixed. The new bridge was placed immediately to the west of the old cantilever span (finished in 1958). This is not a fatal flaw of bridginess, per se. In fact, the two bridges work well next to each other. The old cantilever truss bridge is a hulking span in the tradition of the Firth of Forth Rail Bridge in Scotland. The new Carquinez suspension bridge is sleek and optimized, not unlike

Figure 5. The newest Carquinez Strait Bridge, a suspension bridge, was completed in 2003, adjacent to the second Carquinez Strait Bridge, which was finished in 1958.

Source: http://commons.wikimedia.org/wiki/File:Carquinez_Bridge_9-1-2007_From_Northeast.jpg (accessed May 11, 2009). Courtesy of Leon Bacud.

the Forth Road Bridge. The bridginess problem is the same as with the Royal Albert/Tamar Road bridges. The old cantilever Carquinez bridge has a pier in the middle of the channel, while the new suspension bridge spans the strait with no pier. The two look strange next to each other: how to explain why one bridge needed a pier in the center, while the adjacent one did not? The bad bridginess in the Carquinez Strait may be modified with time. Eventually, the old cantilever truss will need to be replaced. Maybe the future designers will select a suspension bridge with concrete towers in similar proportion to the bridge just built.

Many factors influence bridge design decisions, and many have little to do with engineering. Political requirements can affect how a bridge is placed and massed. Construction staging can have a big impact on bridginess; a design could be perfectly placed and sited, but if you can't build it, the design remains on paper. Sometimes a bridge can be visually understood only through the history of how its construction was staged. These mysteries deepen with age, because staging requirements are soon forgotten, but the bridge structure itself remains as a monument.

To get to the eastern shore of Maryland from Washington, D.C., you cross the William Preston Lane Jr. Memorial Bay Bridge, known to locals as the Bay Bridge. This bridge, really a set of twin spans, are two of the world's great bridges. The structures span the Chesapeake Bay for more than four miles. The first bridge, carrying eastbound traffic, was constructed in 1952, and the accompanying span was built in 1973. The spans cross two separate shipping channels and thus have two long-span components: a suspension span and a truss span. The bridges are similar in form but are not twins, as the two Delaware Memorial bridges are. The older eastbound bridge has an above-deck stiffening truss that you drive through, while the newer westbound bridge has a below-deck truss. Likewise, both bridges have long-span trusses, but the older bridge has a more traditional cantilever form, while the new bridge has a rounded, above-deck arch shape.

Few bridges are more enjoyable to drive across than the Bay Bridges. The structures are a hodgepodge of bridge forms and types, gleefully laid out along sweeping curves so that you can see it all as you drive. You get the feeling that the engineers were having fun with this design: let's try a suspension bridge here, a deck truss there. It's like

something from a giant erector set, but full-scale and soaring over the wide, long bay.

By my own definition, I guess you could say that the Bay Bridges don't feature great bridginess. But in this case, I have to disagree with myself. Both bridges, the old and the new, respectfully reflect each other's bridgy point of view. The structures' pure celebration of nuts-and-bolts engineering—along with the amazing drama of the drive, featuring long over-water curves and the wide bay—puts these bridges way over the top. The Bay Bridges are worth going out of your way, just to drive across them for the sheer spectacle of it. Often I do.

The Gift

Dan was free at last. After 18 years of living under the watchful gaze of saddened but smiling parents, he was a freshman at college. It was the first day. His parents said their tearful good-byes and took off for the long, solitary return trip to New England. Dan watched the station wagon's exhaust fade away. All around him, students unpacked clothes, TVs, computers, and other essential bric-a-brac. Classes hadn't started yet so he had a few days to experience college fun with no responsibilities. He was free, free, free!! He relaxed in his new dorm room with his new roommate, a kid whose last name ended in "y." Out in the hall there were girls. Someone was tossing a football. The dorm room was neat and spotless, at least for now. The two moms had organized everything, with the clothes carefully folded and each item in its proper place. The floor was not yet piled with dirty laundry or half-eaten food. Dan and his new roommate smiled. That would change.

As he was checking out the new lay of the land (his land), Dan looked in his sock drawer. A small gift-wrapped bag was hidden below the socks.

The kid whose last name ended in "y" said, "Looks like you got a present."

"It's cookies," Dan said. "My parents made cookies." He said this in a neutral, play-my-cards-close-to-the-vest tone of voice. Probably he would share the cookies, but Dan was really hungry and he wasn't completely sure that he would share them.

The bag had an envelope attached with a card. Normally Dan would go straight for the cookies and ignore the card, but that didn't seem appropriate in this case. Even though his parents had only been

gone for an hour, this time they were really gone, so he decided that he should read the card first. That way, it would be more respectful of the gift.

The card said:

> Dear Dan: We love you. We are so proud that you're starting your college year. Best of luck. We are looking forward to being grandparents. Just not yet. Love, Mom and Dad.

Dan reread the last line several times and then opened the bag. It wasn't cookies. There was an assortment. Since mom and dad weren't sure exactly what type to get, they got everything.

The kid whose last name ended in "y" asked, "What kind of cookies did they make?"

Dan said, in a much different tone of voice, "It's not cookies."

It's probably not obvious, but this story is related to the performance of triaxial tests. These are loading tests performed by geotechnical engineers on soil samples. The samples are cut to be cylindrical in shape, about eight inches long or so, and they are placed in a testing device and exposed to different types of stress. The objective of the tests is to measure how the soil reacts under different loading conditions. By doing so, geotechnical engineers can determine soil properties and overall behavior, as well as model foundation and substrata performance during construction.

In order to run the test, the soil sample is placed in a chamber filled with water. Clearly, the soil sample must be contained, or the water will mix with the soil and the sample will turn to mud. The most common method to contain the soil is to place it in an impervious membrane. It is possible to purchase membranes specially designed for the triaxial tests, but most geotechnical engineers don't bother. Suitable membranes are conveniently available at the local drug store, in shapes and strengths satisfactory for the tests. To get proper results, however, only certain types of these commonly available membranes may be used, and they must be employed using correct procedures. For some reason, little documentation is available on the proper way to use the membranes for triaxial tests. The key information has been largely transmitted by geotechnical engineers via word of mouth, in a hushed tone of voice.

Should you need to run a triaxial test of, say, clay, note that when selecting a membrane you really want to use the basic product. You don't want or need accessories. In the old days, circa Summer of '42, membranes were available in pretty much one shape and type, but today, membranes come with an explosion of options. For geotechnical purposes, you do not want to select the membranes with projections. Ruffles and ridges will interfere with proper performance during the triaxial tests. Membranes of different colors may be aesthetically attractive, but the color is not really relevant for the success of your test. However, size does matter when it comes to membranes. A very large sheath may be too large for the soil sample and may fail to properly contain the material. Also, specially coated membranes are not appropriate for triaxial testing and should be avoided. The various coatings can interfere with the results.

It's helpful to have a large supply available, so when purchasing membranes, buy in bulk. Let the sales attendant know that you are a geotechnical engineer performing triaxial tests. All weekend.

Back in the lab, when it's time to fit the membranes onto the soil samples, most geotechnical engineers report that experience is key. After trial and error, novice triaxial testers will get the hang of it. It is important to use two membranes instead of one, because keeping water out of the sample is essential. Apparently membranes often have small nicks and cuts that can lead to infiltration.

Geotech professors comment (not in writing, of course) that triaxial test instruction has a unique component, with an aspect not present in many other civil engineering topics. In the old days (again, circa Summer of '42), virtually all civil engineering students were male, which was simultaneously easier and harder for triaxial test lessons. Nowadays, many more women are studying to become civil engineers. The best teaching method, therefore, is a studiously clinical approach, with an irony-free, straight-lipped delivery.

When Dan's freshmen year ended, we piled into the station wagon and drove back down to Maryland. It was sort of like the drop-off process, but in reverse. All of the students were deconstructing their dorm rooms and dragging the voluminous bric-a-brac to the street. Fortunately, we borrowed a rooftop carrier to fit all the extra stuff Dan had accumulated. This was where I stuffed his dirty laundry—all four weeks

of it. Dan had timed his last wash so that his clean clothes, or some semblance of them, would run out just as we arrived.

Dan had a great year and preparing to leave college was bittersweet. It took many trips from his dorm room to the street and many hours to empty out all his stuff. The loaded station wagon looked like the vehicle at the beginning of the *Beverly Hillbillies,* except that Granny wasn't riding in the back, and none of the college kids knew who the Beverly Hillbillies were anyway. The dorm room that had been home to the two boys during their first-year adventure was now forlorn and nearly bare. In the corner, with piles of refuse waiting to be tossed, was the empty gift bag.

The empty bag reminded me of engineering school and my days in the geotech lab. I said to Dan, "I remember Intro to Geotech. That was a great class."

Dan said, "Yes, Dad, I learned a lot in Intro to Geotech. I'm glad I took that course. I enjoyed it."

The kid whose last name ended in "y" was puzzled. He said, "Mr. Brenner, Dan didn't sign up for Introduction to Geotechnical Engineering."

When I Turned 16

For my 16th birthday present, my parents decided to take me out to dinner. They made reservations at a really nice restaurant in New Jersey, the Palisadium. The restaurant overlooked the Hudson River atop the Palisades cliffs. Unluckily for me, on the day of my birthday I got sick and started running a fever. I was home in bed, but my parents didn't want to miss going out. So they went out to celebrate my birthday dinner without me.

Years later, I was curious about what happened to the restaurant. I had never actually eaten dinner there, but I was told the food was good. The Palisadium used to feature American-style cuisine, but some time between then and now, it changed to a Korean/Japanese menu. The change actually tells you a bit about the recent history of that part of New Jersey. The lower Hudson Valley was home to many factories and wharves in the 1970s, but 30 years later, most of these have gone out of business. In their place is a less industrial, more cosmopolitan collection of stores, condominiums, and a cleaned riverfront.

My turning 16 was not the only thing that happened in 1976, although it seemed like it at the time. It was also the year of the American Bicentennial, and as part of the celebration, a festival of tall ships had been organized to sail up and down the Hudson River. The ships assembled for the parade in lower New York Harbor. This was quite a spectacle. Beautiful schooners and tall-masted ships from all over the world paraded up the river, providing a great visual contrast between the modern-day towers of Manhattan and the sailing ships from the past.

The tall-masted ships were impressive, but much of the condition of the Hudson River shoreline was not. In the late 1970s, the Hudson

was polluted by industrial waste from factories up and down the valley. The water quality was not good, and the banks of the lower Hudson in New Jersey and Manhattan were also in a sorry condition. The shore was lined by aging, decaying factories, rotting wharves, and parking lots. The waterfront then was largely treated as a garbage dump and not as an asset. For many people, the waterfront was not someplace to visit. Even crossing the river subtly reinforced the notion that the riverfront was a place to avoid. From the north, you crossed the Hudson by driving across the George Washington Bridge, a grand but formal and forbidding suspension bridge that towered over the river below. From the south, you drove beneath the river in one of the two tunnels. Either way, the riverfront with its greenish muck and decay was separated from contact and daily experience. Manhattan and most of the rest of New York City was on an island, but you never got that feeling being there.

During high school, I got a summer job at Lamont-Doherty, the geological observatory of Columbia University. The observatory is located on a beautiful, spacious campus on a bluff above the Hudson River in Palisades, New York. Apparently many of the scientists didn't get the memo about avoiding contact with the hazardous Hudson River. They had a much more active relationship with it than most people. They would go boating and sailing and would pursue other recreational activities on its shiny, oily surface, as if it were a normal body of water and not a toxic waste dump. Some of the scientists had sons who were also in high school, and they decided that I should go waterskiing with them. Going waterskiing on the river required direct contact with and in the water. I hemmed and hawed, but that was no match for adolescent peer pressure, so the fateful date for the trip was selected.

One of the goals of the trip was to ski around the Tappan Zee Bridge. Unlike the George Washington Bridge and most of the other spans across the lower Hudson, the TZ bridge imposed on drivers a more intimate relationship with the river. Most of the bridge crosses the river on trestles that rise only a few dozen feet or so above the water, not way up in space like the George Washington Bridge to the south or the Bear Mountain suspension bridge to the north. When you were driving high up on a suspended span, it was easier to ignore the presence of the toxic Hudson brew far below. But when you crossed the TZ bridge, you couldn't ignore the river. The bridge was so low to the water and the land

so far away at the wide Tappan Zee estuary crossing that you were one with the river when you crossed.

At least that's what it was like on top of the bridge. When waterskiing, I would have to ride on a boat and step off it into a murky green abyss before getting up on the water skis. As the boat left the dock, I tried to be cool about it with my friends (in a 16-year-old kind of way). But inside, it felt like the walk to the electric chair. They piloted out into the middle of the wide river, and it was my turn. I had the skis on and slid off the side of the boat into the "water." It felt cool, like water, maybe a little bit thicker than normal water, what with the chemicals and clumps. I waited to see if my legs would start to dissolve, but they remained attached. It wasn't so bad after all. They started the motor, and soon I was up on the skis. The sun was out, there were girls in the boat, it was kind of fun. I started getting comfortable, trying maneuvers across the boat wake to impress everyone.

But then after a few runs, my friends changed direction and headed straight for the low bridge trestles. They were going to steer the boat directly between the piers! I tried feebly calling out but there was too much noise and polluted salt spray. We were going in. I remember holding on for dear life as the boat narrowly missed the piers and I skied beneath the span. Safely on the other side, I lost my grip and fell, face first and mouth open, off the skis and into the river. I must have gulped down a good gallon or so of the refreshing Hudson brew. I made it back to the boat, and I don't think my swallowing the water ended up causing any permanent damage. Although over time, maybe my memory has been affected a bit. Although over time, maybe my memory has been affected a bit.

I survived waterskiing more or less intact. That July, hundreds of thousands of people lined the shore to watch the spectacle of the tall ship parade. The waterfront was temporarily cleaned up—some garbage and floating muck was swept away and viewing stands were constructed in the weed-strewn parking lots. In lower Manhattan, many spectators watched the parade from a high vantage point in the World Trade Center. Some photos taken from the event can be found on the Internet,*

* http://www.uwsp.edu/geo/projects/geoweb/participants/Dutch/WTC1976/WTC002.htm (accessed March 23, 2009).

which didn't exist in 1976. Now the Internet exists, but the World Trade Center doesn't.

As part of the celebration, viewers did their best to ignore the murky, smelly green water and surrounding decay. A few blocks inland on both the New Jersey and New York sides, the terrain was much different and much improved. On top of the Palisades cliffs, the area was residential. The Palisadium was located here, at the base of a high-rise apartment complex. The restaurant was still offering the upmarket American-style cuisine. At that time, not many Japanese and Korean restaurants served dinner in New Jersey.

Thirty years later, the factories, which had been holding on by a thread, have largely gone out of business. The Hudson waterfront, then considered a blight, is now prime yuppie real estate. A new light rail transit line opened in 2005 along the Jersey river shore. As the line moves inland from the shoreline, it rises through the cliffs via the old Weehawken tunnel. This former railroad tunnel is 4,156 feet long, constructed in the 1880s. It connects the lower Hudson shore with higher terrain behind the Palisades cliffs. For more than a hundred years, it carried rail freight trains until it was abandoned in 2002. As part of the Hudson–Bergen light rail project, the old tunnel was refurbished, and a new underground station was constructed. The new traffic demanding the tunnel was not generated by freight from riverfront factories. It came from commuters who lived in new condominiums built along the refurbished waterfront.

Even the old water in the Hudson River had been renewed by massive cleanup efforts. While not yet swimmable, the newly cleaned river has started to be reunited with its landscape. Today, one of the most interesting ways to cross the river is via the NY Waterway ferry. A new terminal was constructed in Weehawken, one of several ferry slips for the boats that regularly cross the channel. Unlike almost any other way of commuting in New York, the ferry ride is pleasant and stress free. At times, it can be astonishingly beautiful, such as when the crossing occurs around dawn with the sun poking through and illuminating the craggy Manhattan towers.

With progress in the landscape and water at the New York shorefront and in many locations around the United States, it may be that the period when we shunned the waterfront was a blip in time. All over the

United States and the industrial world, formerly soiled shorelines are being rediscovered and rescued. Today, I could be taken out to dinner high up on the Palisades and look out at a landscape much different and much improved from the past. I can only hope that this time I'll get to eat the meal.

Bridges at the Beach

To a nine-year-old future engineer's eyes, the beach is a giant construction site. Mounds of sand become arch bridges, soaring castles, and tall spires. Entire cities and civilizations rise and fall between the tides.

When I was a kid and we visited the beach, I would build from dawn until dusk. I would stake out a good patch of sand not too far from the edge of the water, but not so close that the waves would undo my creations. At a young age, I developed a rough feel for urban planning. I designated patches of sand for cities and for the farms and hinterlands in between. They were sand farms, but I imagined that the sand was covered with cornfields, farmhouses, and cattle. My sand cities had medieval walls and turrets. The streets were winding and mysterious, and the buildings had carefully crafted shapes formed by my collection of clam shells and plastic shovels.

The cities had to connect with each other, and they didn't have sand airports in those days, so I designed and constructed a vast network of expressways. You might think that walled, medieval cities and modern limited access highways don't mix, but this historical anachronism didn't bother me at the time. Later in life, I found that the juxtaposition of the two actually existed in real life. This combination is a common feature of the British countryside, where sleek 21st-century motorways designed for 80-mph-travel dead-end in thatch-covered villages with lanes barely wide enough for cows.

Beyond the city walls and surrounding moat, the sand expressways featured wide, smooth roads for the toy cars. My interchange designs were elaborate. I dug sand arch bridges for the grade separation, and learned roughly how to deal with cut-and-fill sections when connecting

the ramps. I wasn't using a computer or doing any calculations, but playing in the sand gave me plenty of opportunities to iterate different layouts and to get a feel for what worked and what didn't.

At some point, there was always a big river or some other obstacle that the expressway had to cross. I dug out giant pits with my clam shells and left a wall of sand in the middle of the pit. Carefully patting down and trimming the wall, I dug a series of arch shapes through the wall, and it became a bridge crossing the pit. These sand bridges were grand structures. They looked like miniature Roman aqueducts.

After a good 10 hours or so of continuous design and construction, my sand civilizations reached their apex. By then, I was fried to the color of lobster red, because those were the days when being out in the direct sun was thought to be good and people actually put cocoa butter on their skin to enhance the burn. As twilight approached, I would sit back and admire my creations. Except for the sounds of crashing waves and crying seagulls, the sand cities were deathly still. But I imagined that they were teeming with life. People streamed on the winding streets, trucks cruised on the expressways, plows tended to the green but sandy farms. In the distance I heard my name being called—a real call, not my imagination—and it was time for me to go. The sun set on my creations, and overnight another civilization was lost to antiquity.

Playing in the sand is thought to be an activity for children. But a sand sculptor can learn a lot of civil engineering basics while ostensibly playing. Sand is a great building material, but it has its limitations. When compacted and moist, sand can handle compression pretty well. But it can't handle tension at all. So sand bridges must have arch shapes, because beams made out of sand don't work so well. I became frustrated with this limitation, and one summer I brought a box of wood blocks along on our summer beach vacation. Then I built beam bridges for my expressways. When that worked, I got some twine and designed some suspension bridges as well. The combination of sand, wood blocks, and twine allowed me to build some nice, long bridges. I had built suspension bridges out of blocks at home, but the bridges were better at the beach. Unlike on my bedroom floor, I could dig out vast rivers and canyons to cross and use the blocks and sand to construct good anchorages.

Working with the different materials, I got a feel for the advantages and disadvantages of each. The wood blocks were best for all

applications, but I had a limited supply, so even though they held up better in compression than the sand, it made sense to use them only as beams and not columns. This is not unlike the limitations posed by the use of concrete and steel. Steel is much stronger than concrete, even in compression, but concrete ends up being the better choice for columns since it is much less expensive and easier to build with than steel. But like sand, concrete can't handle tension at all. At a minimum, it must be reinforced with steel to handle tension stresses from bending.

One of the best places to build is the stretch of sand right at the ocean's edge. Some beach days, instead of avoiding the ocean, I would challenge it. I would build sand castles with protective walls as close as possible to the pounding surf. These were high-maintenance castles because the protective walls had to be built and rebuilt to rebuff the attacking waves. If the tide were going out, the battle eventually would be won, and I would build supplemental walls closer to the surf to up the ante. Tides going in the opposite direction, though, were a problem. After a while, I couldn't place enough wet sand on the seawalls to keep out the charging ocean. The walls would be breached, and the castles were doomed.

Playing in the sand also provides an early lesson in soil mechanics. When I dug a hole near the water's edge, I quickly reached a point not too far down where water fills in the hole continuously. This is the phreatic surface. Later presentations in college about the water table and the principles of effective stress make a lot more sense when you have beach experience under your belt. Actually, playing with the water table and qualitatively experiencing its behavior is a terrific way to understand the analytical characterizations. So it may be a good idea for college classes introducing soil mechanics to take a field trip to the beach and dig in the sand.

An experienced nine-year-old knows that sand behaves differently when it's wet. If you fill a pail with dry sand, turn it upside down, and then pull the pail, you get a pile of dry sand, not a pail-shaped column. Mix in a bit of water, on the other hand, tamp it down, and then pull the pail, and the mix stands by itself and hardens into a nice architectural shape. Therefore, the mix and construction sequence are important for getting a strong, workable construction material. This is not unlike

building with concrete, although beach sand is a lot simpler to work with and has fewer additives.

Sand is an expressive material that is great for sculpture (figure 1). Some oceanside communities sponsor sand castle competitions. The entries in these contests feature traditional castles, but also all sorts of other sculptures and creations. These entries were constructed by participants a lot older than nine, so it looks like I'm not the only adult still playing with sand. One time as a kid I entered a sand castle contest. I built one of my specialties, a traditional castle with some elaborate sand drawbridges crossing the moat. The judges were impressed. I won a little trophy for this creation, which I treasured growing up. Later I realized that all the kids won a prize, but this didn't diminish my sense of achievement.

I'm no longer nine years old, but I still like to build castles at the beach and play with blocks. In fact, put me in a room full of blocks at the children's museum, and I'll spend an hour or two building giant cantilever structures and different bridge forms. When I go to the beach as an adult, it helps to have kids along with me. At times I become the chief engineer, managing the design and construction instead of doing it directly by myself. This is a change from when I was the kid

Figure 1. Sand castle creations near the Golden Gate Bridge.
Source: ©iStockphoto.com/Christopher Walker.

master-builder. Time and adulthood have led to other changes. In addition to being much taller, married, and having adult things like a car, a job, and my own children, now I see the world from my advanced, mature adult perspective (to a limited extent, some friends would argue). Unlike the child who developed an intuitive feel for the design and construction process, now I know, analytically, what I'm doing. I know about stress and strain, and I can prepare analyses to model the material behavior.

But otherwise, it's pretty much as it was. When I'm at the beach with a crew of kids, the infrastructure of vast civilizations rises from our handiwork. We engage in the process: conceptual design, iteration, implementation. As the sun sets, the junior engineers and I look out over what we've built. Shadows form on the turrets and spires. The imaginary people commute on the sand expressways to their waiting homes in their walled cities. In play, we kids have mimicked the act of creation. This is really what engineering is all about.

Meeting at the Summit

My house is sited atop a hill, and the driveway is a bit steep. The driveway slope is such that when you ascend to my house, you start in a tropical rain forest and end in tundra, crossing through all of Earth's climatic zones in a matter of seconds. Eagles and other birds of prey circle overhead and caw in the fierce thermal updrafts.

It was winter and we scheduled an evening meeting at my house. This was a problem. In the winter, unless you have a lot of experience, you can't drive up my driveway. Even those with experience can get into a lot of trouble because of the ice and snow. At times I've spun around 360 degrees going down the driveway, rolling over shrubs and the mailbox. One winter I had to be towed out of a snow rut three times in one week. This is what happens going down, which is relatively easy. Going up is a whole different story. On snowy days, to drive up I would position the car at my neighbor's driveway across the street to provide some running room. Then I would use the "Warp 7" approach, gunning the accelerator, calling out to Scotty to provide more power, and attempting to generate enough forward momentum to overcome the lack of traction and thus roll to the top of the slope. After five or six tries, enough of a rut would be worn in the pavement and ice to allow me to make it to the top. Then, triumphant, I would exit from my vehicle and breathe deeply the scent of the steaming bits of tire rubber left splattered on the pavement.

So for this winter meeting, no one was going to be driving up the slope. Guests had to park on the street and somehow walk up to my house. To further complicate things, a bitter northwest wind blew in from Canada that night, ruffling the needles on the shivering mugo pine

tree that dominates my front yard atop the precipice. As the meeting time approached, guests slipped and slid as they scaled the hill, trying to gain purchase on the icy driveway. For the younger guests this was hard enough, but we were particularly concerned about Bob. Bob is a distinguished, older gentleman who moves around well enough on normal, flat surfaces. But scaling a steep, icy glacier of a driveway would not be so easy. We had to come up with a plan to safely escort Bob to my front door.

A rescue plan for Bob would not have been necessary if my front yard had been designed differently. My house is part of a standard 1970s-style housing development. Each home is plopped down in a 20,000-square-foot yard carved out of former woods along the side of a hill. The hill slopes down to the northeast, bottoming out at the edge of a wetland and stream. In the housing development design, each lot has a separate driveway. My next-door neighbor shares the slope, and his driveway runs parallel to mine. His driveway grade is not quite as steep, but it's still a challenge in the winter.

A more logical design would be for the two homes to share a driveway. In the grading plan, this would have permitted a less steep driveway for both houses, more usable space, less pavement, more greenery, and fewer maintenance issues (such as plowing in the winter). A win–win design, for sure, except that the design code doesn't allow shared driveways.

Driving around town and in most of suburbia, you can see this zoning flaw everywhere. An extra driveway or two isn't such a big deal, but hundreds of thousands of extra driveways, in aggregate, represents a huge waste of space and resources. The same design function, providing home access, could have been achieved with dramatically fewer resources, both initially and over the design life of the structures. Shared driveways would still provide access to the homes and garages, but at less cost in terms of money and the environment.

The wastefulness of the existing rules becomes even more obvious when you come across a successful exception. At the center of my town, a plot of land was redeveloped for the construction of three houses. The homes were designed to be pleasant, upper-end dwellings. The developer made a case that three homes were needed to make the project financially viable at the site, and town planners were in favor

of redevelopment because existing conditions were decrepit. But three homes would not fit on the standard plot plan zoned with three separate driveways. So permission was granted for a shared, communal driveway. What was built was not only more efficient, but led to a better overall design for the site. Not only did the shared driveway provide access to the garages, but the three homeowners use it as a communal open space. The driveway became an outdoor room and playground for the kids.

Prior to Bob's arrival, we debated several schemes for getting him up the hill. One idea was to set up a modified sky lift, where a rope was tied to a chair and pulled up the driveway by a pulley system. Another scheme involved a relay approach, in which Bob would be passed off from person to person at different stations along the slope. Our chosen design, which was less elaborate but worked OK, was to have three gentlemen slowly escort Bob up the hillside, moving to the grassy area to the side of the pavement where there was better traction. After about 10 minutes, Bob was safely delivered to my living room, at which point the meeting could begin.

It would have made things easier if houses could share driveways. Multiple driveways on multiple plots of land are really symptoms of a larger design flaw built into the zoning laws, which overall tend to require separation of land uses. Again, this is illustrated by an exception to the zoning design rules. The three-house complex at the center of town doesn't benefit only from a shared driveway. In effect, the site conditions led to construction of larger yards and shared public space. Instead of isolated housing pods, a mini-village was built with more usable outdoor space.

Not far from this site, another developer wished to develop a small plot of land for three houses in a space where they wouldn't fit. The solution, another exception to the rules, was to design a small cul-de-sac that was landscaped and paved in such a way that it could be counted as part of the space for each of the three houses. The home owners quickly took advantage of this space, using it as a type of common village green and playground.

The logical extension of shared driveways and cul-de-sacs is the layout of private spaces to develop more efficient and usable shared, public spaces—goals of the Smart Growth and New Urbanism movements. Smart Growth calls for zoning that is more flexible and shared usage

instead of the rigorous separation of uses that characterizes present-day suburban zoning codes. With the general trend for increasing oil prices, Smart Growth may seem increasingly smart, and even required if we are to maintain our standard of living.

Fortunately, everyone made it safely up my driveway, and we had a successful meeting. The bitter Canadian wind scoured the ice and snow outside, but we laughed and mocked the weather. We were untouchable because there wasn't a blackout (at least yet) and we had heat and warm hors d'oeuvres. But even as we mocked Mother Nature, we remembered our dilemma. The meeting eventually ended and we had to figure out how to get Bob back down to the street.

Engineering with Elephants

For an engineering school, the obvious choice for university mascot is a beaver. The Massachusetts Institute of Technology debated its selection of mascots in the following article from *The Tech:**

> The beaver is perhaps the most conspicuous symbol of MIT. It appears on the "brass rat" class ring and a costumed beaver occasionally appears at sporting events and some student activities.
>
> The beaver was adopted as the MIT mascot in 1914. Lester D. Gardner 1898 presented the idea to MIT president Richard C. Maclaurin at the annual dinner of the Technology Club of New York. According to brass rat lore, Gardner's argument for choosing a beaver follows:
>
> "We first thought of the kangaroo, which, like Tech, goes forward by leaps and bounds. Then we considered the elephant. He is wise, patient, strong, hard working, and like all those who graduate from Tech, has a good tough hide. But neither of these were American animals. We turned to [William Temple] Hornaday's book on the animals of North America and instantly chose the beaver. The beaver not only typifies the Tech [student], but his habits are peculiarly our own. The

* Aaron D. Mihalik. (1999). "A Beaver, a Seal, and an Engineer." *The Tech* 119(26), May 11. Also http://www-tech.mit.edu/V119/N26/mascots.26f.html (accessed July 23, 2008).

beaver is noted for his engineering, mechanical skills, and industry. His habits are nocturnal. He does his best work in the dark."

Although MIT passed on elephants, other universities were up for the challenge. At Tufts University, the mascot is Jumbo, who was a real African elephant as opposed to a conceptual one. Jumbo's story is described in an article from *Tufts Journal*.* Even for an elephant, Jumbo was big, over 12 feet tall. He was born in 1861 and eventually owned by P. T. Barnum, of circus fame. Jumbo toured with the circus and lived the high life, for an elephant. Unfortunately, in 1885 Jumbo was killed in a tragic train collision. We know what happened to Jumbo, but there's no discussion about what happened to the train. Overall, it probably wasn't a pretty scene.

Mr. Barnum had the prize elephant's hide stuffed, and it was donated to Tufts and displayed on campus in the Barnum Museum. Several superstitions developed around the stuffed creature. Students visited the museum before sporting events and tugged on his tail for good luck. At one point, so many students tugged on the tail that it fell off. Tragedy struck again in 1975 when the museum burned down, and now all that remains of Jumbo are his ashes. A plaster and concrete model of Jumbo has been constructed in front of the Tufts biology building, and this is where tour guides stop to recite the legend to prospective students and their parents.

College mascots are most prominent at sporting events. The battle between mascot elephants and beavers is a bit of an anachronism, but it could be worse. For example, the University of Maryland has a turtle for a mascot. Along with slugs and paramecia, turtles are creatures even less heroic and fierce than beavers or elephants. So a turtle would not seem to be good mascot material. But at least it is a creature. One notch down on the mascot scale is the choice of such mascots as Native Americans, even more of an anachronism. Fighting braves with tomahawk chops are harder to root for than turtles, elephants, or beavers, and the symbolism is offensive to many.

* Tufts Journal. (2001). "The Story of Jumbo." *Tufts Journal* October. Also http://tuftsjournal.tufts.edu/archive/2001/october/tufts150/index.shtml (accessed July 23, 2008)

In the pantheon of articles about engineering applications of elephants comes this entry: "The Uselessness of Elephants in Compacting Fill."* This is a dead-serious paper (I think) about trying to use elephants to compact fill. The basic idea is that elephants can provide an effective, low-cost method for soil compaction, especially in areas where heavy equipment is not available and elephants are. This seems like a good idea. When elephants walk on soil, the soil gets squished. But in actual experiments with elephants, there were problems. It turns out that when elephants walk, they don't mind setting their feet down on soft material the first time. But the creatures are smart. By the second pass and thereafter, they prefer to walk in their own, compacted footsteps instead of fresh, soft material. The elephants quickly realize that there's less exertion walking on ground that's already been compressed. So the paper concludes that if you try to use elephants to compact fill over an area, you end up with some nicely compacted, localized footprints, and uncompacted fill everywhere else.

Fast forwarding a few decades, one of the strangest engineering requests in recent memory involved elephants. When the Zakim Bridge was completed in Boston, the opening ceremonies included elephants marching across the span (figure 1). This is not a typical loading condition, so calculations had to be prepared to evaluate the capacity of the bridge and deck for elephants. If a bridge is designed for HS 25 trucks, you would think, by extension, that the structure is OK for elephants. But this conclusion shouldn't be taken for granted. For one thing, maybe the weight applied by an elephant's foot is more concentrated than that of a truck tire.

Then there is the issue of elephant impact. Impact is a separate force that bridge designers must consider. It's caused by the tendency of vehicles to bounce up and down a bit as they move forward. This vertical motion imparts extra force that the bridge must resist. The U.S. Load and Resistance Factor bridge design code specifies an impact value of 33% of live load. However, elephants would tend to bounce a lot more than a truck. Also, a truck has rubber tires that cushion the blow, but

* Richard L. Meehan. (1967). "The Uselessness of Elephants in Compacting Fill." *Canadian Geotechnical Journal,* 4(3), September.

Figure 1. A parade of Ringling Bros. and Barnum & Bailey Circus elephants on the Leonard P. Zakim Bunker Hill Bridge in Boston, Tuesday, Oct. 15, 2002.
Source: AP Photo/Lisa Poole.

elephants have more rigid feet. Therefore the percentage of an elephant's weight that should be used for impact load would tend to be greater. Of course, this discussion is based on standard elephant operating conditions. If a mouse sauntered across the deck at the wrong moment, all of the elephants would scurry off in panic, and then perhaps an emergency elephant impact loading factor should be used in the calculations as well.

In addition to these literal questions about elephants, engineers should consider the figurative cases as well. Whether the question involves the naming of mascots or pachyderms marching across cable-stayed bridges, it's important to see the elephant in the living room. In our detail-oriented life, we can miss the bigger picture. But the elephant is sitting there, often in front of our noses, if only we would stop a minute to see him. Unfortunately, he's not helping with soil compaction.

The Show

Every year, we put on a show. It's a musical spoof in celebration of the Jewish holiday of Purim. All summer long, the writers pore over Broadway musicals and select the songs to be used for our performance. Then they rewrite the lyrics to tell the story of Purim, which concerns a fanatical Iranian (Persian) tyrant named Haman who tried and failed to wipe the Jews off the face of the earth centuries ago. Our show is not exactly a Broadway production, in part because we're all amateurs and most of us can't sing or dance. But the show's director, nicknamed the General, shares our delusions of grandeur. So for many weeks of practice, we belt Broadway show tunes slightly out of key (Randy: "It's a little bit pitchy for me") and learn rudimentary dance steps.

This year's production started out normally enough. The writers were particularly clever, adapting songs from many different shows. They even had us performing Abba's "Dancing Queen," which has a melody that you really can't sing unless you're young and Swedish. We received the scripts and were ready for practice. Then the General dropped a little bombshell. Our show's creative team decided that for this year, the men would perform the women's parts, and vice versa. As part of the festivities, the male performers would have to dress in drag.

We slogged through long, grueling rehearsals as opening day approached. The General was getting increasingly antsy, because time was short and we still couldn't sing or dance. Soon it was dress rehearsal day, and we were all dolled up (literally). I had the idea that I should look like Carmen Miranda for the show, and Evelyn, my exceptionally talented mother-in-law, made a fruit salad turban for me. The top of the hat included a bunch of grapes and a prominent banana. Knowing that

I'm barely capable of dressing in male clothing, Evelyn feared disaster. She carefully packed the turban in a box and provided detailed directions on how to wear it. A marker in the front said "front," to ensure that I wouldn't wear the hat backward. For the dress rehearsal, it took me several minutes to get all the stuff on. Eventually I figured out how to wear my blond wig and the fruit salad hat. I guess it could have been worse: some of my more creative colleagues in the chorus took their outfits a few steps further, wearing high heels and featuring displays of prominent cleavage. I drew the line at that. It was enough to try to sing and dance in a wig while wearing a fruit salad hat. No high heels for me—I wore sneakers.

Before we knew it, we were backstage on opening night. The General was onstage, introducing (warning?) the packed audience of 400 about our upcoming performance. The house lights dimmed. Our four-piece orchestra started up. The first number was "A Comedy Tonight" from *A Funny Thing Happened on the Way to the Forum,* but with the words changed. We all shared nervous glances: Break a leg! Tear a fishnet stocking! On with the show!

In terms of production quality, one step up (well, really, about 20 steps up) from the production values of our show could be experienced at a performance of *The Lion King*. This spectacular show features magnificent sets, amazing costumes, and a group of performers who can actually sing and dance. For its national tour stop in Boston, *The Lion King* was staged at the Opera House.

The Opera House was originally known as the B. F. Keith Theater. Built in 1928, it hosted vaudeville shows and motion pictures. The theater was designed in a style much different from today's sticky floored, multiscreen cinemas. It has only one auditorium, not ten, and the accommodations are opulent: fine wood paneling, chandeliers, artistic murals on the ceilings. The old theater had been a place to visit. Unfortunately, over time its opulence faded. Large, single-screen theaters couldn't compete with the flexible, multiscreen venues. As the movie-going experience degenerated from a fancy evening at the theater to what now more closely resembles a teenage boy's night out, the old Opera House became a dinosaur and a relic. In 1991, the building was damaged by fire, and the theater closed. The Opera House became an empty, decaying hulk

that remained unused for years, surrounded by a rough neighborhood charmingly known as the Combat Zone.

Then the neighborhood gentrified and the old theater's fortunes improved. After many battles and false starts, the facility was successfully reconstructed and renovated. The Opera House was back in business hosting live theater performances, and *The Lion King* opened there on July 14, 2004. We had tickets for a performance that following weekend. On the night of the show, we walked into the theater through its modest and somewhat deceptive Washington Street entrance. Inside, you could see what a spectacular job the renovators had done. The Opera House is now an astonishing place: beautifully detailed, opulent, lush. The entrance lobby was lavishly gilded. Magnificent ceiling paintings had been restored. The light from the brass and gold chandeliers reflected off polished marble floors. The auditorium was again a place for greatness, with a soaring vaulted ceiling and soft golden light everywhere. Befitting the grand environment, theatergoers dressed in gowns and evening attire. No one's shoes stuck to the floor.

Cinemas provide patrons a much different experience from the hushed grandeur and opulence of the renovated Opera House. Cinema lobbies are designed to facilitate crowd control. These lobbies are noisy, unpleasant places with winding lines that seem like cattle chutes. There are no glittering chandeliers, just gaudy harsh lights and front-lit movie posters. The refreshment stand with its junk food menu is arranged for quick movement of people. The whole operation is designed for rapid cleaning and turnover. Elegance is usually not one of the design criteria.

A movie theater can be so uncomfortable that patrons may decide to stay home. In addition to sticky floors, older cineplexes have low, uncomfortable seating where your view may be blocked by the person in front of you. In the past, this was not a problem for business. Movie theaters used to have a monopoly on the screening of films. It wasn't very long ago that there were no videocassettes or DVDs or access to movies through the Internet. If you wanted to see a movie, you had to go to the theater, no matter how uncomfortable the seats. But with increasingly sophisticated home entertainment systems and easy access to films, movies can be watched in comfort at home without someone's head blocking the view.

As a result, nowadays the public needs prodding to leave the comfort of the living room. Cinema designers have gotten the message. Recently built movie theaters feature stadium seating, in which the auditorium is sloped enough that you can see the movie unobstructed, even if the person in front is wearing a fruit salad hat. The seats in these new theaters are wider and have more leg room, keeping pace with the increasing American girth. The rows have more room for easy egress to the restroom and refreshment stand.

A movie theater near my house has made even more improvements. The theater offers something called the luxe level, which I guess is an abbreviation of "deluxe." For a significantly higher price, you can sit in the special luxe level screening room. You are served food and snacks at your seat, still movie-theater fare, but served at your seat. The seats themselves are arranged as sofas and loveseats, without restrictive arm rests in between. When you sit in the luxe level theater, the experience is designed to approximate a fairly comfortable living room, with food service. But it is still a long way from the opulence of the Opera House. I noticed also that the most violent and sophomoric movies are chosen for the special luxe-level screening. So, the experience is still targeted toward teenage boys, but with increased comfort and easy access to the snack foods that teenage boys get at home.

Theaters used to be an important part of the city. In Boston, all of the older live-performance venues congregate in an area now designated as the Theater District. Until recently, this area was also in the Combat Zone until planners came up with the better, high-brow designation. In the past, the way theater buildings were built enhanced the streetscape and city life. Theaters were part of the urban fabric. The facades with their marquee displays added visual excitement, and the throngs of theatergoers added energy before and after the show. The street scene was part of the theatergoing experience.

Today's movie theaters, mostly built in the suburbs, use a different approach. The cineplex near my house is not part of any city street, but set off in its own parking lagoon. The only way to get to the theater is by driving in and out of the lagoon, and this leads to significant traffic jams at the highway. A little strip mall was built in a neighboring lagoon. It houses some restaurants, providing a natural accompaniment for a night out at the movies. You would think that it would be easy to

get from the restaurants to the movie theater, but it isn't, at least not by design. After a meal, diners can try to walk next door to the theater. However, no walkway has been provided, so movie patrons must hike up a steep, muddy slope that has been worn down into an unofficial path by other pedestrians. By design, diners going to the movies next door are not supposed to walk there. They are supposed to drive out of the strip mall parking lagoon, onto the highway, and back up into the theater parking lot. This maneuver can take upwards of five minutes, in contrast to the 30-second hike through the mud.

Unlike theaters of the past, today's suburban cineplexes don't generate much street activity. They are mostly barren public spaces, with charmless, garish auditoriums plunked down in vast garbage-strewn parking lots. With time, maybe cinema design quality will improve further as the owners compete to attract viewers from their comfortable dens and increasingly sophisticated home theater systems. It's ironic that perhaps the key reason for going out to the cinema in the first place is to be part of the crowd. A group reaction, such as hundreds of viewers laughing at the same moment, makes for a better show. This is one experience you can't get in your living room, no matter how comfortable it is. Unfortunately, the quality of public space design in many movie theaters is still lagging.

We were in luck at the opening of our show. We made it through our lines and didn't trip or burst out laughing during the "Dancing Queen" number. Our audience loved the show, and they were ecstatic at the curtain call. They had never seen such a performance. Probably few people in the world had. The General was pleased and gratified that months of hard work had paid off. We basked in the adoration of our audience and thought about a possible future in the theater. Maybe some of us had contemplated fame, fortune, and a long run of the show. But opening night was also planned to be closing night—it was a one-performance show. After the music died and the audience departed, we hung up our fishnet stockings and cleared the pancake makeup from our faces. At the cast party, the General reminisced about our (recent) glory. It was time to look toward the future. Soon, the songwriters would start planning for next year's show. With any luck, I'll get to wear pants for that performance.

World's Ugliest Bike Trail

I visited St. Louis and stayed at a hotel a block away from the giant arch. The arch is the stupendous, exuberant, but otherwise functionless structure on the bank of the Mississippi River that towers above everything in the city. Even the great Mississippi River itself is no match for the silver-coated arch. The arch gleams and soars, while the river is maybe a quarter-mile wide and looks like a swollen, muddy creek.

I had a few hours in between meetings, and I noticed a bike trail leading north from the arch along the bank of the river. On trips to other cities, I had had good luck renting bikes and touring. It was a good way to both work out and enjoy the local terrain. One time, when visiting San Diego, I biked from the downtown to a bike path and boardwalk along the beach, ending at La Jolla. This was a spectacular, amazing ride. Along the way, I stopped to ride a roller coaster, sip smoothies, and watch the seals and beach volleyballers play. On a trip to Fort Collins, Colorado, I found the whole city to be very bike friendly, crossed with many trails. Here, too, for me was the site of a great bike ride. In St. Louis, a bike rental shop was conveniently open for business near the arch. The trail looked good, with the ride ending at a historic pedestrian bridge. It appeared that I found another winner.

Excited at the prospect of biking for a few hours, I bolted out of my lunch meeting, changed into shorts, and walked beneath the big arch, down the stairs to the bike shop. The shop, really a kiosk, wasn't very busy, but I figured that since it was a weekday, the other bikers were probably waiting for the weekend. It didn't occur to me that there could be another explanation. I picked out a hybrid bike and started toward the trail entrance, first biking on city streets. On the trail, the first few

hundred yards or so were nice enough. I passed beneath the beautiful old Eads Bridge and beside a new riverboat floating casino. But after that, things went downhill (figuratively, not literally).

The north St. Louis bike trail traversed some of the ugliest industrial landscape known to man. Near the start of the trail was an old, functioning, but dilapidated power station. The route proceeded on to decaying industrial plants, not one but two auto graveyards, several dumps, a few nondescript aged factories, and several sewage treatment plants. I was greeted with pungent aromas, alternating among the odors of lime, raw sewage, rotting garbage, and other harder-to-identify miasmas of industrial waste. Sometimes I was offered combination odors, such as dump/sewage or lime/mystery smell. On the bike map, the path was identified as a dedicated trail. But about two miles or so north of the arch, suddenly I was sharing the narrow road with assorted trucks and flatbeds that angrily honked me to the side as they moved steaming and dripping mounds from one place to another.

Occasionally the factories and industrial yards were walled off. Bike riders were granted a reprieve from the dump sites, with views only of the (relatively) unscathed waterfront. But even the Mississippi, for at least the first five miles or so, was not much to look at. The river bank was punctuated by decaying wharves and docks connected by conveyor belts to the factories. Every now and then, an abandoned, rotting barge poked its snout above the water line. The stretches of walled relief themselves were interrupted by places along the river where the landowners apparently did not give permission for the bike trail to run along the riverfront. At these sections, the trail turned inland, away from the relatively pleasant riverfront and into the heart of the wasteland. Here, riders threaded their way through the 19th-century industrial landscape.

In the postindustrial age (assuming that there is such a thing), what should an industrial landscape look like? The industrial infrastructure and environment never put great emphasis on aesthetics or in creating a pleasant landscape for human beings. You can see this clearly in the border areas between industrial and residential land. In adjacent residential neighborhoods, much more care and concern is taken on how the landscape is arranged. Where the industrial landscape is chaotic, the residential areas are neatly ordered, with rows of homes and delineated infrastructure. Where the industrial landscape is dirty and smelly,

the residential areas have trees and flowers, and any noxious substances are carefully managed. The industrial landscape is, in general, not fit for human habitation. The residential landscape is. But individuals who earn a living in the industrial landscape can end up spending a much greater percentage of their waking hours there than in the residential one.

It is not preordained that industrial landscapes must be obnoxious. Elements that make a landscape fit for human use—good order, organization between sites, management of noxious materials, aesthetic treatments—can be designed and built. The prevailing argument against doing so is that it would add unacceptable costs to industry. In the United States, where manufacturing can't compete in the global marketplace anyway, extra funds are not available to make the industrial places look nice. But a true accounting of all costs would prove this argument specious. Rendering landscapes unfit or barely fit for human use costs more overall, but the costs are hidden and not accounted for in any ledger book. The bill is paid by later generations. Just as a strip mine extracts short-term profits while not charging the mining companies the costs resulting from long-term degradation, the industrial landscape north of St. Louis imposes long-term costs that aren't accounted for. An infrastructure system that better manages long-term costs and impacts doesn't just result in nicer places, but leads to a better, fairer economy in which all the costs and benefits are taken into account. Civil engineers are grappling with this challenge now, in terms of designing for "sustainability." This challenge is profound because all of our training and methods have largely involved detailed analysis and reckoning of short-term impacts, while longer-term issues were evaluated subjectively, if at all.

The north St. Louis bike trail is part of the larger Mississippi River Trail that will eventually extend from Louisiana to Minnesota. The project's Web site describes an ambitious, forward-thinking plan:

> Since the establishment of the Mississippi River Trail Project in 1996, the general public's regard and desire for trails has mushroomed. Communities without trails are clamoring for them, communities with trails want more. The desire for long distance trails is steadily increasing. While their appeal to the adventuresome is important, the connectivity between

> rural areas, communities, and major metropolitan regions is something that is no longer "just desirable," it is necessary to the economies of scale that support alternate transportation and natural resource conservation. Beyond these key needs, improving opportunities for tourism, the nation's third most important and quickly growing industry, can be found in the development of trails and trail systems.*

Biking north along the Mississippi, then, I found a certain beauty in the trailblazing bike trail. Along with the waste dumps, car scrap lots, and bric-a-brac is the vision of a grand trail along the great river. To fulfill this vision, civil engineers are challenged to develop sustainable infrastructure and to build better places, even industrial lots, that work well in the present and will be appreciated in the future.

* http://www.mississippirivertrail.org/ (accessed June 20, 2008).

Buffalo on 495

In August 2006, drivers on Route 24 suffered through a horrendous traffic jam south of Boston. The incident occurred in the afternoon, when a car and a tanker truck collided. Unfortunately for the many drivers snared in the traffic jam, the tanker was filled with raw sewage pumped from restaurant septic systems. The tanker tipped over, and the sewage poured onto the freeway. All six lanes were closed at one point, leading to a multimile backup in which travelers were stuck in place for several hours, not moving at all. A few motorists abandoned their cars and walked away from the freeway. With the sight of abandoned cars, some compared the event to the benchmark of Boston traffic jams, the Blizzard of '78, when motorists were trapped by the sudden snowfall on Route 128 and abandoned their vehicles en masse. The sewage jam was not caused by drifting snow, but it did pose a different kind of problem: you couldn't plow the stuff off the roads, and the unfortunate traffic victims had to deal with the stench. Snow is cold and life-threatening in big enough quantities. But at least fresh snow has a pleasant color and doesn't stink.

Driving is our transportation mode of choice, even around Boston, which has above-average use of public transport. We imagine our drives to be free and unfettered by traffic, but they're not. Driving times are subject to wide variability. Mussolini could make the trains run on time, but no one has been able to properly schedule an auto commute. Some traffic jams are regularly expected during commuting hours and when they don't happen, it's a nice surprise. Many other jams are caused by accidents and unforeseen events. On any particular morning you don't know what's going to crash or fall on the road. Some days, for no rhyme

or reason, the traffic flow is completely clear, a gift from the commuting gods. Other days, the sh*t hits the fan … or pours onto the pavement.

I remember one period which I thought of as "building materials week." Each day, a different type of building material fell off a truck traveling on Route 128. On Monday, it was sheet rock. On Tuesday, masonry blocks. On Wednesday, nails, and so on. Wednesday, as you can imagine, was a particularly tough day. The initial accident was bad enough, resulting in expressway lane closures and miles of stop and go. But even after the accident was cleared, nails scattered on the pavement added to travelers' woes, causing many flat tires. I don't remember what landed on the highway on Thursday, but by the end of the week, you could have built an addition to your house by using the stuff dumped along the right-of-way.

Navigating the morning traffic takes skill, patience, and a careful deciphering of the clues from the radio reports. In Boston, the station with the most comprehensive report and the best traffic helicopter does a reasonably good job at describing the good, the bad, and the ugly each morning. But, unfortunately, this station has an annoying habit of switching the order of presentation from roads south to north and vice versa. You never know if they're going to start with traffic descriptions from the south or the north during any particular report. This can be a problem for me because I need to know the conditions of roads south of Boston and I don't care about the north. If I'm about to make a fateful turn (hopefully onto the road less traveled), and the report is describing north first, then I have to trust my gut instinct without any backup information.

In the past, my key decision in the morning was in choosing either Route 128 or the expressway. One time, as I was about to make my decision, the traffic report came on the radio, and as luck would have it, north was described first. Before the discussion continued to southern conditions, I made my decision to take the expressway. The views of the harbor are better, and all things being equal, the expressway saved me a few miles in comparison with Route 128. A few seconds later, conditions south of Boston were described. It turned out that Route 128 was a breeze. The expressway, however, had suffered from a historic accident leading to a two-hour backup.

Possibly one of the strangest moments in Boston commuting history occurred when the radio reports warned about buffalo on the

road. Apparently some buffalo were wandering on Interstate 495, and cars were plowing into them. I-495 is the outer beltway for Boston, and much of the surrounding terrain is wooded and wild by Massachusetts standards. But even considering the presence of forest, there are no native buffalo in Massachusetts to stray onto the road. I-495 is situated to the west, but not that far west, as in South Dakota. It turned out that the buffalo were being transported in a truck, and some had managed to flip a latch and escape onto the road. I'm not sure if the result of this was roadkill or carkill, since hitting a buffalo is not like hitting a skunk. But it's possible that if a BBQ truck tipped over in the vicinity, they could have set up a nice grill.

Wild fauna have adjusted to civilization with time and are migrating to urban areas. This results in more collisions and roadkill. Deer and even moose collisions have become problematic in Massachusetts, and not only because of dents in autos. A minor scandal erupted a few years ago when it was reported that the seemingly bucolic MassPike median in Stockbridge was used to dispose of dead carcasses. Over many decades, Turnpike officials collected the roadkill and dumped thousands of deer, beaver, and other animal remains between the lanes. Tony, charming Stockbridge, home of the Norman Rockwell museum and the beautiful Red Lion Inn, was thus potentially the site of a Stephen King novel. After word got out about the impromptu pet cemetery, dead animal bodies were no longer dumped in the median, but on the sides of the road where they could be more easily eaten and disposed of naturally.

When stuck in traffic, animal-induced or otherwise, drivers have many hours of free time on their hands. The options for effectively using the time are limited: you can't go to sleep or go bowling. Many just sit and stew. Some take the high road while stuck on the low road by listening to recorded books. Other commuters creatively save time by engaging in such personal grooming habits as shaving or shampooing. But for most, the only solace is to listen to the radio. The combination of hours of time to be occupied by people trapped in cars has resulted in the development of a new art form: the morning drive-by radio program. Drivers mired in traffic or swerving around buffalo and moose can while away the hours by listening to shock jocks and wannabes. The original pioneer shock jock offered up an intelligent but offensive mélange of cutting sarcasm, 7th-grade-boy humor, and just plain inappropriate

discussion. His program was driven off the airwaves by censorship, to be replaced by imitators doing essentially the same thing. The shock jock radio programs, while good for a laugh, have little or no redeeming social value. High-horse commentators point out that the programs are yet another sign of the impending end of Western Civilization. The commentators are probably part of the 1% of Americans who ride public transit to work. So these privileged commuters can read a good book en route to their jobs and not have to worry about hitting a buffalo.

Occasionally, I dream of the morning of sunshine. In the dream, I rev up my car cocoon, turn on the radio (probably something intelligent like classical music or NPR), and breeze to work at the legal speed limit, or maybe a tad more. The few drivers on the road that day are particularly friendly. Housing materials are not being transported by truck. The moose are hibernating and not around to be plowed into. When I wake up from the dream, there is still a moment when it's all possible, but then the cruel reality of reality sets in and the moment fades. I'm in my car listening to crud and watching the taillights that are not far in front of me and not moving very fast.

Postscript

I received a device for Father's Day known as an "iPod" (yes, and I know you all know what an iPod is, but keep in mind who is writing this). An iPod is a little device that can store hundreds of songs. Dan and Rachel were particularly eager to teach me the mysteries of operating the iPod. It looks simple, with a little wheel and control panel on the front. But as with all aspects of modern technology, there is so much more you can do with it than just turn it on and listen to music. After I was able to temper my kids' frustration, they relented and showed me only the basics, saving advanced lessons for another time. With some more tinkering and a little practice, now I am able to listen to glorious music of my own choosing. This morning I cruised (or more accurately, slogged) down Route 128 listening to U2. The reality was eight lanes of traffic, four lanes moving slow,* but for me, it was a City of Shimmering Lights.

* A paraphrase of "Telegraph Road," by Dire Straits.

The Night Shift

To make it in time for an 8:30 a.m. meeting on Long Island, my colleague and I had to catch a 6:00 a.m. ferry leaving from Bridgeport, Connecticut. I couldn't stay over the night before, and no other option got us there on time. To make the ferry, I had to leave my house at 3:00 a.m. and drive two and half hours to Bridgeport. At those hours, I experienced the world of infrastructure at night. It is a very different place.

Fortunately, the weather was OK as I left my driveway and headed toward the interstate. The center of town was deserted at three in the morning—any travelers from the day before were long since home, and traffic had yet to start for the morning commute. 3:00 a.m. is really the nadir of human activity. Alone, I drove down Main Street to the entrance to I-95, which had almost no cars, just me and the big trucks. At that hour, overnight truckers were still out on the freeway, making time when there was no congestion. But even the truck traffic was very light, and for long stretches of pavement, I was alone.

My colleague Wael and I planned to meet at the ferry slip. But he was coming from a different direction. Instead of driving down I-95, he would be crossing the wilds of central Connecticut. We thought it would be a good idea to call on the cell phone every half hour or so to make sure we were both still awake and not off the road, rolled over in a ditch and eaten by wolves.

I called Wael on my cell phone.

"Hello, Wael."

"Hello, Brian."

"Are you awake?"

Wael said, "Yes." This was good news. He was awake.

"Where are you now?"

Congestion on interstate highways has greatly increased during the last 10 years. Around Boston, almost every freeway is clogged in the morning and evening. The traffic reports talk about the regular, expected traffic jams, and the weary reporters only get excited when a truck tips over or something closes lanes. But America's dire traffic condition is not so apparent at night, when it's clear sailing. One of the solutions being bandied about is "congestion pricing," charging a premium for transportation services during the peak hours. The idea is to make the cost during prime time so high that enough traffic will be shifted to off-peak hours. If the prices are tinkered with enough, traffic should be jam-free all the time.

Congestion pricing as a concept makes sense. You can already see it in play at 3:30 a.m. on I-95 in Rhode Island. Instead of the highway being totally deserted, many trucking companies take advantage of the trafficless expressways to move shipments by night. They don't pay an official "price" for shipping during daytime rush hours. But the costs of lost or wasted time, labor, and fuel resulting from daytime gridlock provide a strong incentive for traveling in the wee hours of the morning.

Some congestion pricing arguments have taken on a liberal-versus-conservative edge. The debate focuses on what to do with high-occupancy vehicle, or HOV, lanes. The lanes were originally established to provide special access to buses and carpools. The socially responsible argument is that if you ride a bus or load extra passengers in your car, you should be rewarded with a less-congested freeway lane. The free-market approach takes a different tack: HOV lanes should accessible to all, but at a price. The lanes should be tolled, with the fee high enough to ensure no congestion. Today's tolling technology, with transponders and drive-through readers, makes this approach technically feasible. But whether it's socially feasible—and whether it would be widely applied—is still not clear. The idea is that if you have enough money, you can pay to avoid a traffic jam, unlike the rabble stuck in the stop-and-go. This argument is simultaneously very American in its free-market laissez-faire, and very un-American in its denial of the pursuit of commuting happiness for all.

I had driven another 30 miles or so down central Rhode Island. I thought it would be a good idea to check in with Wael:

I called Wael on my cell phone.

"Hello, Wael."

"Hello, Brian."

"Are you awake?"

Wael said, "Yes." This was good news. He was still awake.

"Where are you now?"

Because highways are so heavily traveled during the day, the only time to repair them is at night. As I was traveling down I-95, the Massachusetts segment was mostly quiet, but several projects were under way in Rhode Island. The landscape of overnight construction is a world unto itself. Each site is brilliantly lit with flood lamps. One of the bridge construction jobs I passed had a group of police cruisers flashing bright red and blue lights. From a distance, the glare from the floods and the cruiser lights looked unworldly, almost like the UFO spectacle in the movie *Close Encounters of the Third Kind*. The traffic control approaching the work zone was ominous. As dangerous as work zones are for workers and for drivers during the day, at night they are much worse, because the traffic can be flying by, drivers may be drowsy, and it's dark everywhere. The work zone approaches that I passed had many well-lit warning signs, flashing cones, and other devices to jolt potentially weary drivers to a higher state of alertness.

The work zones were all scenes of furious activity. Each one probably had time limitations for when work could start and when the crews had to pack up and get the road ready for morning rush hour. Between the setup and takedown, not a lot of time remains for getting the actual work done. So, overnight highway and bridge maintenance is probably the least efficient way to get the work done. Also, unlike a work zone that can be set up and remain in place, when it's necessary to route the traffic back on top of what's being built, provisions must be made. So, construction can be an agonizing, laborious process, with hours of setup, demobilization, and covering one's tracks, with only a little actual construction in the middle.

I was only a few miles outside of Bridgeport now. The early early rush was building. Some commuters joined the truckers on the road,

getting a head start on the drive to New York City. I pulled off the ferry exit and navigated to the dock. Downtown Bridgeport was deserted. Reds and greens from the traffic lights reflected off the bare pavement. At the ferry entrance, a small line had formed for the 6:00 a.m. trip. Everyone had extra-large cups of coffee.

Wael was sitting in the waiting room. "What took you so long?" he asked.

Wildlife Returns to Suburbia

The American Dream is based on taming the wild. Civilization meets the edge of the vast frontier, there is a battle, and the vast frontier loses. In terms of infrastructure, realization of the dream includes living in single-family homes—little individual castles for all the human inhabitants. When this vision joined up with the interstate highway program after World War II, the result was the new land-use pattern of suburbia. In humankind's centuries on earth, people had never lived in such a way, dispersed in private little castles, widely separated from where they worked and shopped, with office parks and shopping malls likewise spread over the landscape. Fulfillment of the American Dream takes a lot of space, and areas that used to be wilderness have been transformed into housing subdivisions. The previous wilderness residents were displaced, retreating to what remained of the wild. But the remnants are shrinking, and the animals have to go somewhere. So they are moving back, living with us and learning to adapt and thrive in their new suburban environment.

I don't have cable, and I've seen exactly one episode of *The Sopranos.* It featured a black bear hanging out by the backyard swimming pool of Tony's upscale suburban mobster house. I think other things happened in this episode, like the wife complaining about something and a waiter getting shot. But mostly I remember the bear. It was supposed to be ironic that a bear would wander into someone's backyard in suburban New Jersey. A lot of what transpired on this TV show was intended to be ironic, to temper the extreme violence of the mob members' killing each other. But a black bear in New Jersey is no longer ironic, so in that way the attempt to introduce irony into the script was itself ironic.

Black bears in the suburbs are not found only on TV. My mother reported that a bear visited her neighborhood supermarket in the New

York suburbs. Having the supermarket next to a national park is one thing, but this parking lot was in the middle of town, about as far as possible from anyplace where a bear would live, you would think. Where did it come from?

In my home town south of Boston, rarely do I go biking and not spot some deer. Last summer, my friend Steve and I went biking at sunrise. We saw a herd of deer in a field of tall grass, gracefully leaping in and out of the sunshine. It was a scene reminiscent of the Serengeti. Less graceful, but more common, is the sight of deer casually munching on hedges at a neighbor's house, in broad daylight. These deer have made themselves at home. Sometimes they run away when they spot you. Often, they just look up with that quizzical deer look and then continue dining on your hedges.

Deer sightings in the suburbs are now common and seeing a deer in your yard is no big surprise. The deer have been followed by moose. The Massachusetts Department of Fish and Game reports that moose are returning to the Bay State in increasing numbers,* especially in the north-central part of the state. Moose have no natural predators in Massachusetts, and they are protected from hunting. North-central Massachusetts is still pretty wild, but downtown Brookline is not. A few years ago, a moose sauntered through the middle of this very built-up section of the Boston metro area.

When moose wander back to their former haunts, they come in contact with a new feature in the landscape: express highways. Moose collisions are more frequent. A collision between a moose and car is not pretty, not for the moose and often not for the automobile. The problem seems to get worse during the mating season, when the moose attention span is further diverted.†

In addition to moose and squirrel, all sorts of creatures displaced by the initial construction of suburbia have learned to adapt and have moved back. Many Massachusetts towns are overrun by Canada geese. Flocks of these big, honking birds gracefully fly in formation and then less gracefully land to conquer whatever territory they see fit. Canada geese are not shy and will attack and nip at people who approach them.

* http://www.mass.gov/dfwele/dfw/wildlife/living/living_with_moose.htm (accessed July 22, 2008).
† Ibid.

A gaggle of geese started to hang out at the pond near my house. In the spring, the eggs hatch, and cute little ducklings waddle onto the road. The geese have a regular commute each morning, from one side of the street to the other. It is common in the spring for all traffic to stop for five minutes or so as a goose family crosses the street, with one parent in the front and the other in the back, and the adorable, awkward babies lined up in the middle. Accepting reality, the town recently posted some yellow goose warning signs at the crossing.

Nature abhors a vacuum. All of the critters that have moved back to the suburbs are potentially dinner for more voracious carnivores. It's only a matter of time before the carnivores learn to adapt and move to the suburbs as well. A significant problem is that the carnivores not only eat deer and skunk, but may attack household pets and human beings. Already, cats and small dogs are not safe outdoors in some areas inhabited by coyotes. In the western United States, mountain lion sightings have become more frequent. A mountain lion is a small lion—in other words, a creature on four paws with sharp teeth that roams the landscape looking for fresh meat. In 1991, a student was jogging near his high school in Idaho Springs, Colorado. He was mauled and killed by a mountain lion. Other cases have been reported of mountain lions attacking hikers in California. The attacks are mostly at parks and in rural areas, but more sightings have been reported in the suburbs as housing developments have edged up into the western foothills.

It is human nature to see the status of things mostly as a steady state, and not in transition. The view we see today we expect to see, more or less, tomorrow. This may be why the concept of global warming (whether caused by humanity or natural climatic cycles or both) is difficult for us to conceptualize on a daily, operating level. Should, for example, sea level rise to the point that many coastal areas are flooded, the landscape will be changed way beyond our notions of how it should be. The same concept is at work in our view of suburbia, I think. Our unspoken understanding is that the human space is for people. Pets are allowed, but not wild animals. The wild is supposed to live out at the frontier, far away from human beings. But now Wyoming is becoming paved and Cheyenne is no longer the wild west. The animals have nowhere to go, so they are coming back to live with us. Whether we like it or not, we have company.

Back to the Transit Future

I like to ride the Metro subway when visiting Washington, D.C. This transit system was conceived as a kind of transit utopia. The designers looked at contemporary transit systems and tried to develop a design that solved all previous problems. Whereas other U.S. subways were noisy, claustrophobic, graffiti-laden, and grimy, Metro was designed to be sleek, futuristic, airy, and clean. Patrons were to use a computerized farecard system, in which fares were prorated based on distance and time, not like the old systems that charged one fare for every ride. With this automatic system, human fare collectors weren't needed (as much). The underground stations featured soaring, cathedral-like plenums, with soft, indirect lighting. Walls and barriers were placed to discourage graffiti. The trains were quiet, cool, and carpeted—no jarring, screeching ride on the rails in this system.

Utopia is a place that's often more fun to think about than to try to actually visit. It's interesting to see how Washington Metro's transit utopia has weathered over the years. Overall, the system has kept up. The automatic farecards, which malfunctioned early on and were the butt of jokes, work well now. The stations tend to be well maintained and are still impressive, with the possible exception of the escalators, which seem to malfunction a lot. There is little or no graffiti. The bane of underground spaces, leaking water, appears to be mostly under control, although there are areas of seepage. Metro still operates my favorite detail, the flashing lights at the edge of the platform that let you know a train is approaching. When you board, the trains continue to be plush, air-conditioned, and comfortable. The ride is smooth and quiet.

All is not perfect in utopia of course. With increasing age has come more frequent breakdown of equipment and interruption of service. Metro funding has been problematic, especially during the more recent difficult economic times.

In particular, one aspect of the Metro has not kept up so well, I think. The system was planned with a unified architecture. Stations were designed to be almost identical. Each underground station has the same barrel vault, the same waffle slab liner with recessed lights, the same direction poles, and the same free-form floating mezzanine above the tracks. Even the above-grade stations have shapes and details that copy the underground spaces in an attempt to achieve uniformity. This architectural vision of uniformity hasn't changed much with time. The effect is a bit numbing after you get over the novelty of the design details. For regular commuters riding every day, it must get dull to see the same station over and over. You look for some changes in the pattern, but there aren't any.

Maybe a problem with planning for utopia is that the planners leave after the plan is finished. Most of the built places and structures that are considered to be the best have changed and improved over time. With a few exceptions, it's difficult to get it perfectly right in one shot. Over time, transit systems, cities, the built form are modified and evolve. The expression "Rome wasn't built in a day" sums it up. In planning for utopia, everything is expected to be immediately perfect. There is no need or desire for change, and thus no provision for it. However, experience indicates that the best things grow and change with time.

Unlike the designs by computer engineers that can be obsolete in six months, civil engineering designs can be still standing and in use for decades. This is both a great advantage and a disadvantage. The advantage is that the really good designs, like the Brooklyn Bridge, stick around and become beloved icons. The disadvantage is that the clunkers remain with us as well. If the resources were available, we would just as soon tear them down, but the reality is that they remain, peppering the landscape, rudely reminding us to do better next time. With luck, the ugly designs can be considered "historic," homely structures and facilities that grow on you after a while.

The lesson for designers is not to expect the design to be perfect. With few exceptions, the design won't be. The best approach, then, is

to include the capacity for change and growth in the original design. For design/build/operate contracts and for designs that feature review of life-cycle costs, the scope of work more directly recognizes the impact of time, and the opportunity for future change and growth.

What the Future Should Look Like

In the past, we all knew what the future should look like. Today, we're not so sure.

In the 1940s, '50s, and '60s, the vision of future infrastructure was one of shining progress. In those decades, the future was to feature speeding motorcars and spaceships, the taming of nature to human ends, and plenty of infrastructure and leisure for all. When you met George Jetson, you zoomed around in air cruisers that launched between mushroom-shaped sky palaces. There was a rush hour, sort of, where the cruisers all competed to fly on the air freeway. It was never really clear why they all needed to crowd together like that. Just a few feet away was open, blue sky without a cloud in sight.

The original *Star Trek* showcased this shiny new future. Many of us grew up with the *Star Trek* lexicon, from "fascinating" (spoken with arched eyebrows) to "beam me up." Although many *Star Trek*-type innovations, such as the cellular phone and the diagnostic hospital bed, have become reality faster than expected, "beaming up" still remains a concept for the distant future. In *The Physics of Star Trek*,* Lawrence M. Krauss suggests that this particular technology is perhaps the most difficult to build in reality. Although beaming up may be technically impossible, it certainly would have major implications for infrastructure. If you could really beam up, you wouldn't need smart automobiles on freeways. But even with *Star Trek*'s transporter moving people around, the futurists who imagined the show had a vision of infrastructure that

* Lawrence M. Krauss. *The Physics of Star Trek*. Originally published in 1996 by Harper Paperbacks, a revised edition was published by Basic Books in 2007.

was uniform and bright. Captain Kirk and his cohorts beamed up (and down) to planets with glass and concrete cities with modern architecture and nary a traffic jam in sight. A lot of the planets looked like southern California.

Maybe the ultimate past vision of the future was shown in the movie, *2001: A Space Odyssey*. In the year 2001 there were to be regular Pan Am flights to an orbiting space station. Everything on the space station and even the moon was to be 1960s modern but yet familiar. You could stay at an orbiting hotel chain and phone home via picture phone. The infrastructure of the future shown in 2001 was futuristic, but coherent, recognizable and expected.

In the past, then, it was clear what the future should look like. With that clarity of vision came a fairly uniform set of goals and decisions for building infrastructure. No one debated much about superhighways plowing through cities, urban redevelopment, or modern architecture sprouting glass towers on the ruins of ancient structures. This was what the future was supposed to be, and people set out to build it.

Unfortunately, like any other vision, this plan had some deficiencies. The future of shiny, speedy superhighways, two cars in every garage, and "form follows function" turned out to be a present of endless rush hours, more than two cars in every garage, and suburban sprawl. Past visions of the future are being discredited. At Disneyland, they've knocked down the old Tomorrowland. It's been replaced with a neoformless, theme park future. The old Tomorrowland had that spiffy architecture of tomorrow and a ride to Mars. Today's Tomorrowland replaces the ride to Mars with an "alien encounter" where a monster escapes into the audience and threatens to rip heads off.

Today's popular vision of tomorrow is confused. For example, the movie *Bicentennial Man* is about a 200-year-old robot that evolves into Robin Williams. The special effects department needed to show what a progression of 200 years would look like. The results are a mishmash. Infrastructure scenes include a view of an added double deck on the Golden Gate Bridge, and some type of peculiar overhead transit system on the hills of San Francisco. The people filming these scenes didn't have much vision of their own regarding what would happen to infrastructure over 200 years, and they didn't have any clear consensus to fall back on. The movie's final scenes are interesting. The large manor

house where much of the action takes place at the beginning of the film appears to be set in the country. At the end, the distant city is seen to have encroached on its grounds. The filmmakers seem to picture 200 years of future infrastructure growth as the city's envelopment of the once-isolated manor house. The city is idealized as an image of soaring glass towers. Strangely, there is no view of the strip malls, freeways, and burger palaces that surely must have filled the land in between.

Without a vision of what the future should look like, even a discredited one, there is no overarching goal for infrastructure. Maybe it is time for civil engineers to sit back and imagine what the future should look like. We can "plan the work and work the plan" on a bigger scale. Our vision of future infrastructure could have a comfortable meshing of the past and the present, with historic structures coexisting peacefully with human-scaled modern developments. Somehow urban sprawl would be tamed, with the right mix of transit and automobiles. In the United States, we would finally become comfortable with the end of the Wild Wild West and the closing of the frontier. In this era of final buildout, not every place would need to be a shopping mall or parking lot.

Envisioning what the future should look like is good for civil engineers to do, in part because no one else seems to be doing it today. A coherent vision of the future may make the present easier to live in. It provides an engineering environment that is not just good for planning but good for business as well. While many will (correctly) criticize elements of this infrastructure vision, surely it is better to have a dream of something, however blemished, than to have nothing at all. Today's plans for future infrastructure are based on no vision beyond the strip mall and office park. Driving around today, you can see what the future will look like if we continue building this way.

Gephyrophobia

> **Fear of bridges:** An abnormal and persistent fear of bridges, especially crossing bridges. Sufferers of this phobia experience undue anxiety even though they realize their fear is irrational. Their fear may result partly from the fear of enclosure (claustrophobia) or the fear of heights (acrophobia). Phobic drivers may worry about being in an accident in busy traffic or losing control of their vehicles. High bridges over waterways and gorges can be especially intimidating, as can be very long or very narrow bridges.
>
> Fear of bridges is a relatively common phobia although most people with it do not know they have something called "gephyrophobia." However, the derivation of the word "gephyrophobia" is perfectly straightforward (if you know Greek); it is derived from the Greek words "gephyra" (bridge) and "phobos" (fear).*

Fear of bridges? Gephyrophobia? How could anyone be afraid of a bridge?

Figure 1 shows a picture of the first Tacoma Narrows Bridge. Figure 2 shows a picture of the first Sunshine Skyway Bridge near Tampa, to the left of the second, brand-new span. The former, as we know, danced in the wind and provided a film loop for generations of engineering students that displays the dynamic effects of structures in the wind. The

* http://www.medterms.com/script/main/art.asp?articlekey=12355 (accessed June 20, 2008).

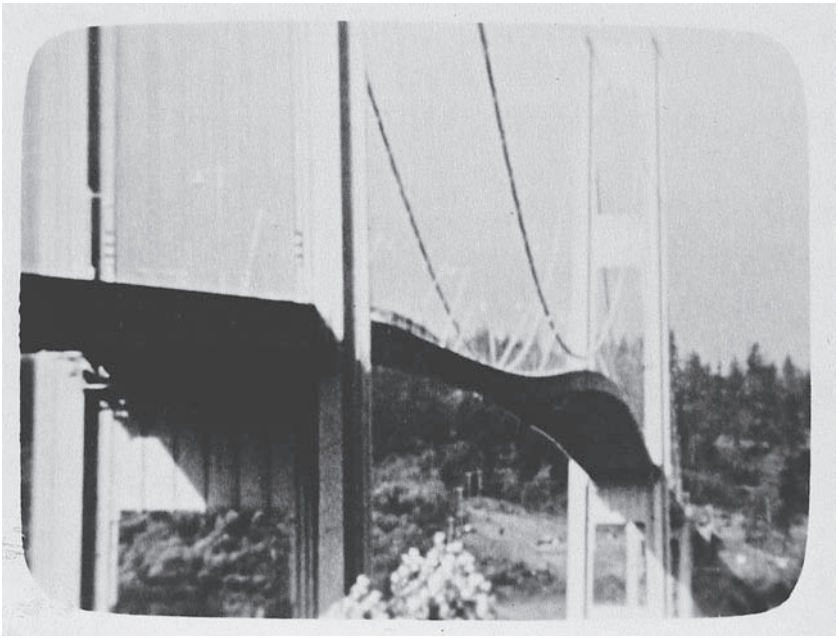

Figure 1. The first Tacoma Narrows Bridge.
Source: Library of Congress, Prints & Photographs Division, HAER WA-99, 32.

Figure 2. The Sunshine Skyway Bridge crosses Tampa Bay in Florida. The original bridge (left) is being dismantled; the new cable-stayed bridge (right) carries traffic.
Source: http://en.wikipedia.org/wiki/File:Skyway_Bridge_2.jpg (accessed May 11, 2009). Courtesy of Apelbaum.

latter tanked after being hit by a barge; in the photograph, you can see where some of the bridge is missing.

All right, maybe it's possible to be afraid of bridges. Although being afraid of pizza makes more sense. Overall, bridges are pretty safe. The odds are greater that you will choke on a piece of pizza than that you will drive off a bridge. A pizza with extra cheese can burn your tongue and throat. Even a really hot-looking bridge can't burn your tongue and throat.

The first time I visited Tampa, I went out of my way to drive across the new Sunshine Skyway (I tend to go out of my way to find bridges on trips). The Skyway is the spectacular, signature cable-stayed bridge that crosses Tampa Bay for five and a half miles, replacing the older demolished span. The bridge is so long that when you drive on it, after a while you can't see either shoreline. It feels like you're driving out on the ocean. Mile after mile, just you and your lonely automobile, lost atop the deep blue of the sea, with no land in sight. Then, way out in the middle of the bridge (where you are lost! lost!), you start upon a fearsome, steep climb, on narrow lanes with merely an insubstantial concrete rail parapet protecting you from a dismal plunge into the shark-infested bay. The slope flattens out, but then you're in the middle of the main span, suspended in midair, impossibly high above the infinite watery abyss. The single plane of golden cables are strong, but they look like twine, ready to snap at the slightest jerk or breeze. A fierce crosswind buffets your car. You grip the steering wheel in terror, knuckles turning white as the blood flow is constricted. You chart a straight path in the road lane, trying not to slip ever so slightly to the side, next to the flimsy rail and then over, in a screaming plummet into the anonymous brine.

OK, so maybe I felt a slight twinge of anxiety as I crossed the Sunshine Skyway—me, one of the world's great appreciators of bridges, and I was coming down with gephyrophobia! I couldn't develop a fear of bridges. What if people found out? I would have to nip the anxiety in the bud, and I would have to do it fast, or who knew would mental malady I would come down with next: Dementia? Schizophrenia? An insatiable desire to save old engineering reports?

I found a Web site that specializes in all types of anxieties. According to Change That's Right Now (CTRN), gephyrophobia can be more debilitating than you might think:

> If you are living with fear of bridges, what is the real cost to your health, your career or school, and to your family life? Avoiding the issue indefinitely would mean resigning yourself to living in fear, missing out on priceless life experiences big and small, living a life that is just a shadow of what it will be when the problem is gone.
>
> For anyone earning a living, the financial toll of this phobia is incalculable. Living with fear means you can never concentrate fully and give your best. Lost opportunities. Poor performance or grades. Promotions that pass you by. Your phobia could cost you tens, even hundreds of thousands of dollars over your lifetime, let alone the cost to your health and quality of life. Now fear of bridges can be gone for less than the price of a round-trip airline ticket.*

Apparently the fear of bridges is quite common, and hundreds if not thousands of people avoid a bridge by taking the tunnel instead. That is, until they develop a fear of tunnels, and then either they're stuck on the ferry or they have to stay home.

According to CTRN, there are hundreds of things to be afraid of (over 1,300, in fact). Most of the phobias are associated with issues which, in a rational sense, aren't really threatening—fear of public speaking, for example, in comparison to the fear of being eaten by a squid. Many people report that public speaking is their greatest fear of all. If they had a choice, they would probably choose to swim with killer squid instead of getting up in front of 300 people for a presentation. In that case, they would be eaten by a squid before the presentation and then they wouldn't have to worry about the speech.

The anxieties reported by CTRN are modern maladies. At the dawn of time, humankind didn't have to worry about gephyrophobia. There weren't many bridges and no one drove across them. Plenty of things were around to be afraid of, of course. For example, while you wouldn't be asked to present a PowerPoint show in the cave, you did have to worry about getting attacked by a carnivore. In the scheme of

* http://www.changethatsrightnow.com/fear-of-bridges.asp (accessed June 20, 2008).

things, being eaten by a carnivore is a more substantial fear then making a public presentation. With humankind's triumph over the carnivores, it seems like our psyches, which are probably naturally wired to be afraid, experienced a fear deficit. We have filled the fear gap with modern anxieties, including, sadly, the fear of bridges.

What to do? Hypnosis is one option. HypnosisDownloads.com offers downloadable MP3 files for self-hypnosis: "The thought of being relaxed while driving across a bridge probably feels impossible to you, but you will be amazed after listening to *Fear of Driving over Bridges*."* Your therapy begins with only a modest payment of $12.95 for the first download, with discounts for downloads to address other phobias. As an added bonus, after your self-hypnosis, when you wake up, you will think you are a chicken.†

Gephyrophobia is not a joke, although I've done my best to milk it for what it's worth. The fear of bridges is big business. You can shell out quite a bit for hypnosis tapes and therapy. If that doesn't work, you can actually hire people to drive your car across the intimidating bridge. The Bay Bridge in Maryland is a good candidate for this approach (figure 3). The bridge is so long, so high in the air, so exuberant, and so separated from the shore, that driving across it is not for everyone. In fact, the Maryland Transportation Authority provides information for "drive over" services, companies that will drive your car across the bridge for a modest fee. There is some demand for this service: some 4,000 people use it annually.‡ Hire a driver, add a little sleeping medication to the mix, and you can get from Annapolis to the Eastern Shore without seeing how close you came to swimming with the fishies.

One way of overcoming anxiety is to confront your fears. This is how I overcame my fear of public speaking, and this is how I have now overcome my slight, not-worth-mentioning case of gephyrophobia. By sharing my anxiety with you, by airing it out in public, I am freed from this mildly gripping fear. Now I can proceed with my life, and I don't have to shell out $12.95. Are you afraid of bridges? You can overcome it! Here's my program. Watch the videotape of the Tacoma Narrows Bridge

* http://www.hypnosisdownloads.com/downloads/phobias_fears/fear-bridges.html (accessed June 20, 2008).

† That is a cheap hypnosis joke.

‡ http://www.baybridge.com/cms/index.php?option=com_content&task=view&id=50 (accessed June 20, 2008).

Figure 3. Twin spans of the Bay Bridge over the Chesapeake Bay in Maryland.

Source: http://commons.wikimedia.org/wiki/File:Bay_bridges_shot_187609960.jpg (accessed March 26, 2009). Courtesy of Benjamin Graves.

collapsing for a few hours, and then find a nice, long, high, delicately supported bridge to drive across. Do this a few times on a windy, stormy day, until your confidence builds and the anxiety slowly drains. If you follow this program, you, too, can join the ranks of the bridge-fearless (I wish there were a Greek word for this). Do it because bridges should be appreciated and not feared. Do it now, and start to experience a life free of gephyrophobia.

Go Jump Off a Bridge

One day as I was driving, the Bee Gees came on the radio. It was the song "Staying Alive" (uh, uh, uh, uh, staying aliiiiiiive!). I don't think the disc jockey was doing a 1970s retrospective that day or had any desire to revive disco. It was just one of those random radio moments. But the song didn't remind me of my disco past, since I don't have a disco past. It reminded me of bridges.

The song was from the movie *Saturday Night Fever*. In the film, John Travolta plays a character named Tony Manero. Tony is a clerk in a dead-end job during the day, but he goes out dancing every night. He and his friends wear white polyester leisure suits and they dance to Donna Summer at the disco. Many decades later, Travolta was in the movie *Hairspray,* where he is not a hopeful teenage punk but someone's mother (really). He also sings and dances, this time in a dress. So in the arc of Travolta's movie career, there was a full circle and closure of sorts.

What I remember most about *Saturday Night Fever* is not the dancing or disco, but the bridges. The movie features some crude bridge symbolism to advance the plot. One bridge is symbolic of good, and another bridge represents evil. The Brooklyn Bridge was cast as the good bridge (figure 1). This is not a stretch since almost everyone loves the Brooklyn Bridge. In the movie, this bridge represents hope and a successful future. The Brooklyn Bridge is Tony's lifeline and a connection from his grubby, meaningless life in Brooklyn to glamorous, sophisticated Manhattan. The bridge is both a physical and symbolic connection.

If things don't quite work out, another bridge looms in the distance, a darker, sinister span. Playing the part of the evil bridge is the Verrazano-Narrows Bridge (figure 2). In the movie, this structure represents

Figure 1. Brooklyn Bridge, with the Brooklyn ferry slip in the foreground.
Source: Library of Congress, Prints & Photographs Division, HAER NY, 31-NEYO, 90-23. Photograph by Jet Lowe.

Figure 2. Verrazano-Narrows Bridge.
Source: Library of Congress, Prints & Photographs Division, HAER NY, 24-BROK, 57-11.

feelings of despair and hopelessness. At one low point, the characters are going to jump off it. Unlike the Brooklyn Bridge, the Verrazano doesn't have pedestrian walkways. The film writers get around this obstacle by having the characters park their cars and hang off the side.

Probably the two bridges weren't requested to audition for their roles. But in casting the bridges, the director chose the soulful, grandfatherly Brooklyn Bridge to represent life and wisdom. To symbolize death and despair, he chose a sleek, soulless modern span. This choice could have worked in reverse, I suppose, depending on the type of movie and the plot. If it was a horror movie, the sleek, modern Verrazano could have been the good bridge, representative of salvation and the triumph of modernity over feudalism. In contrast, the vaguely Frankensteinian Brooklyn Bridge, with its medieval Gothic towers, could have been the evil span. So when you're going symbolic with bridges, context is important.

In the movie, the poor Verrazano-Narrows Bridge (my personal all-time favorite bridge) suffered the indignity of being cast as a suicide bridge. In the real world, many bridges have attracted individuals attempting to commit suicide, and these structures have had the misfortune of becoming associated with the act. Some bridges are actually known by the name "Suicide Bridge." A bridge across the Choptank River on the eastern shore of the Chesapeake Bay is known by this name. It doesn't seem like a great selling point, but there is an eatery named the Suicide Bridge Restaurant next to the bridge. It's a seafood restaurant offering some good Eastern Shore fare. You can dine along the river and watch the boats and birds. The present Suicide Bridge, for which the restaurant is named, is the most recent of three spans crossing the river:

> The original bridge was a wooden structure built around 1888. The second bridge, also wooden and only one lane, was built around 1910. The third and current bridge, which is also wooden but covered with asphalt, was built in 1967 and dedicated in January 1968. Local residents apparently have always called it Suicide Bridge.*

* http://www.suicidebridge.com/legend.html (accessed June 20, 2008).

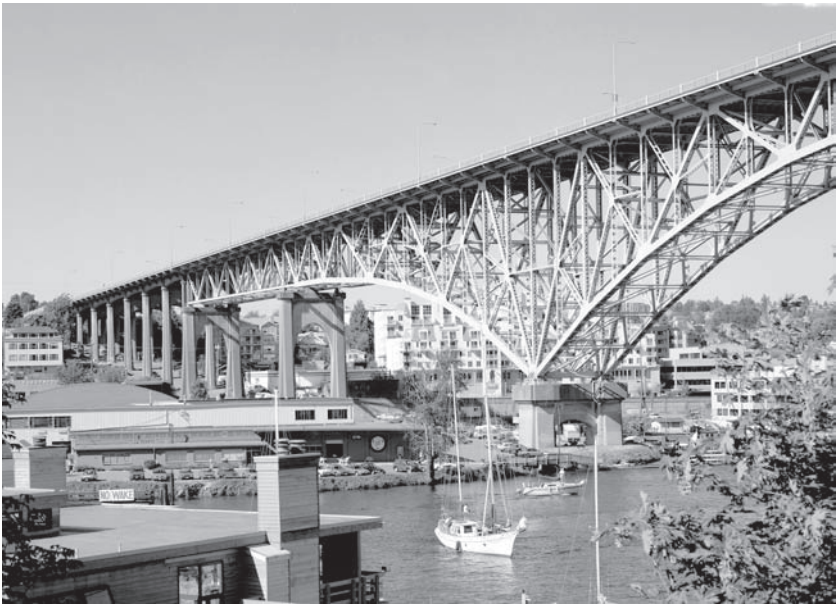

Figure 3. Aurora Bridge, Seattle.
Source: Library of Congress, Prints & Photographs Division, HAER WASH, 17-SEAT, 12-3.

Over the years, many residents have met their end at the bridge. Most of the cases were considered to be suicide, but the documentation suggests that some were due to foul play. The restaurant owners don't emphasize the less palatable aspects of the location and name. Their advertisements focus on the food, the pleasant scenery, and the surrounding tourist attractions. But even though it's not played up, a little notoriety doesn't hurt (as long as it's tastefully done, of course). Diners visit for the dramatically presented soft-shell crabs, but the unspoken implication is that they may experience drama of a different sort.

Many bridges have unfortunately become associated with suicide. In Seattle, office workers next to the Aurora Bridge (figure 3) suffer trauma from seeing so many people jump off it.* The Aurora Bridge is a hundred feet or so above ground, prominently crossing the canal connecting Lake Washington to Lake Union. The site is both highly visible

* http://www.msnbc.msn.com/id/16829300/ (accessed June 20, 2008).

Figure 4. Golden Gate Bridge.
Source: Library of Congress, Prints & Photographs Division, HAER CAL, 38-SANFRA, 140-2.

and anonymous, two features that seem to attract those desperately inclined.

After a while, some bridges become associated with suicide, for no reason other than their repeated selection in the past. The All-America Bridge (Y-Bridge) in Akron, Ohio, is well known in this way. "But perhaps the most reasonable explanation for the suicides is this: The bridge's reputation has become self-fulfilling. So many people have ended their lives here that it's almost become the purpose of the structure."* The landing point for the Y-Bridge is not in the woods, but a densely populated neighborhood. Over the years, residents have become resigned—but not accustomed—to the grisly events.

The Golden Gate Bridge is perhaps the world's most famous bridge for suicides (figure 4). It has walkways that provide a spectacular view for healthy pedestrians, but that unfortunately serve as a magnet for the emotionally disturbed. Interestingly, the Golden Gate's notoriety for suicides was one factor in the lack of pedestrian walkways on the Verrazano. Robert Moses, chairman of the Triborough Bridge and Tunnel

* http://www.clevescene.com/2005-06-08/news/suicide-bridge/1 (accessed June 20, 2008).

Authority, was determined to avoid suicides from New York's signature span. The pedestrian walkways that were originally included in the design were deleted.*

Currently, the Golden Gate Bridge is the subject of a project to reduce suicides.† The study is being conducted in phases and uses typical engineering terminology and methods. Phase 1, completed in 2007, was the "Wind Tunnel Testing of Generic Suicide Deterrent Concepts." The goal was to evaluate how modifications to bridge parapets and railings might affect the wind stability of the bridge. The conceptual designs included additions to the pedestrian railing, complete replacement of the railing, and nets extending over the sides of the bridge to catch people who jump off. The concepts were modeled in wind tunnel tests to ensure that additions to the structure wouldn't end up damaging the bridge. Subsequent phases of the work include preliminary design, eventual final design of the selected alternative, and then construction.

In this project, the use of terminology and methods from engineering work, so typical and commonplace, collides with the reality of what is being designed. An engineering project to prevent suicides requires rational procedures to address irrational behavior. This results in an uncomfortable mix. The bland, systematic engineering jargon can describe and depict "options" in a "study." But the design objective is not systematic and rational.

Some argue that those desperate enough to commit suicide will do it anyway. In that case, a nice, tall, exposed bridge provides a public service of sorts, since it focuses the activity and thus limits its extent. The counterargument is that by reducing the ease of the act at a person's most desperate moment, perhaps the behavior can be ultimately avoided and successfully treated.

Furthermore, heated discussion on the Golden Gate project has focused on the appearance of the end product. The bridge is one of the most beautiful structures in the world. Adding nets on the side will not be aesthetically pleasing. Maybe it is inappropriate to consider the bridge's appearance if lives can be saved. But on the other hand, marring

* http://www.transalt.org/bridges/verrazano.html (accessed June 20, 2008).
† http://www.ggbsuicidebarrier.org/studyoverview.asp (accessed June 20, 2008).

the beauty of the Golden Gate Bridge is something that should be avoided if possible.

If you're going to jump off a bridge, it's better to be attached to a giant rubber band, or at least wearing a parachute. This is what happens on Bridge Day at the New River Gorge Bridge in West Virginia. Thousands converge on the giant arch bridge in the autumn. The span crosses about 850 feet above the river, making it one of the world's highest bridges. The weekend-long festival includes pancake breakfasts, rappelling off the side of the bridge, whitewater rafting down the river, and parachute jumps from the span.

The Bridge Day festivities are a celebration of life. Even so, because the span is high and exposed, the New River Gorge Bridge is not immune to suicide attempts. Unfortunately, bridges will continue to be associated with this difficult illness. But for one day in West Virginia, after jumping off a bridge, you get to climb back up and do it again.

The Moral Infrastructure Equivalent of War

Engineers are used to dealing with the forces of nature as the adversary. A structural engineer's rulebook describes how to account for the forces of gravity, impact, and decay, with the objective of getting the bridge up and keeping it standing for its design life. Likewise, each civil engineering discipline has a set of rules and constraints that are essentially about finding ways to manage the laws of physics. So the design process is an exercise in counteracting the forces of nature.

The attacks on September 11 were not the first incidence of worldwide terrorism. Some countries have experienced attacks on a regular basis that, in aggregate, match or even exceed the horrors inflicted on 9/11. Yet the scale of the single assault, loss of life, and resulting infrastructure devastation has led to new engineering concerns. The aftermath of the September 11 tragedy requires that engineers consider not only forces of nature, but a new and very different kind of adversary. Engineers are now called upon to design against the whims of human evil as well. This is a frightening, confusing prospect. Engineers are suddenly on the front line of a new war, with civilization's infrastructure in the cross hairs. We engineers are good at quantifying physics, but engineering to resist the forces of evil is not something we've been trained for, and to an extent it renders many of our comfortable, time-honored processes obsolete. If one of the goals of terrorism, as expressed by the religious fanatics of September 11, is to destroy infrastructure on a grand scale (so that those who are left presumably can live in caves), then the response must be to build infrastructure back up on a grand scale, so that the terrorist's work is ultimately meaningless. To meet this

challenge, what is needed is an approach that can be characterized as the moral infrastructure equivalent of war.

Present construction methods don't meet the challenge. Our processes and project delivery methods have congealed, to an extent, in a comfortable but shopworn approach. The job gets done, but it involves a lot of time, coordination, and frustration. This is illustrated by the popular expression "They can send a man to the moon, but they can't … [fill in the blank]." For infrastructure projects, issues can drag on, the participating parties conflict, and the work doesn't get done the way it should. How many of us in the architecture/engineering/construction industry have sat around a conference table silently stewing as the work is diverted for some stupidity or triviality, or worse?

When a natural disaster strikes, we have seen flashes of a much different approach. After a southern California earthquake many years ago, the Santa Monica freeway was shut down after an overpass collapsed. If the usual project delivery method was employed, it would have taken six months or more to rebuild the bridge. But having an arterial freeway shut down for half a year in Los Angeles is not an option, so the bridge was rebuilt in weeks and the freeway was reopened. Now how could this be? If reconstruction could be done in six weeks instead of six months, why not always do it this way? Why did we have to wait for an earthquake?

We can all snicker about the answer to that question. It starts with the word "because," and doesn't get much farther than that. But now things are different. Natural disasters like earthquakes are, fortunately, infrequent enough so that the fabric of our lives, as enabled by the built environment, is not greatly torn up by them. So an infrequent, heroic reaction can be authorized, and after it's done, we all shake hands and go back to business as usual. What happened on September 11 changes the rules. If terrorism's goal is to destroy our infrastructure (and us), our only defense will be to render the terrorist's work meaningless. I disagree with those who propose other approaches, such as trying to understand the "root cause" of why terrorists behave the way they do and then somehow changing our behavior to accommodate it. This is a rationalist approach applied to irrational fanatics. The root cause is that they don't like our infrastructure and our existence and thus want to kill us. We need to render their work meaningless and let them go to their

deaths with as little impact on our way of life as possible. In other words, they are perfectly free to worship in caves and blow themselves up in nihilistic conflagrations. But let them do it in their own caves, alone.

Given the new realities, engineers and the A/E/C industry must be heroically "on call" all the time. The project delivery methods that brought the bridge up in California and rebuilt the site at Ground Zero so astonishingly fast will be needed not just for special occasions, but as standard operating procedure. Furthermore, our society at large must reconnect A/E/C work with a functioning built environment. In the past, society understood the relationship between successful engineering, better infrastructure, and an improved way of life. Today, functioning infrastructure is taken for granted, and only during rare moments when there are problems does the public take notice. Engineers really are more important than actors or baseball players, and society ought to recognize this. To meet the difficult and painful challenges of the threats to our well-being, engineers must be prepared to work differently and to speak out. We haven't volunteered for this role, but we have been placed on the front lines of the new war.

Bridges I Have Known

Over the years, I have found myself forming emotional attachments to the bridges I've worked on. Railroad over Burrill Street was one of my early favorites. This is a sleek, compact little bridge, three spans in fact. The middle span has a steel plate that both holds the railroad ballast and acts as a combined top flange for the stringer—an interesting arrangement. The piers are about right, not too stocky, not too lean. Burrill Street has an accompanying group of pedestrian ramps made of precast, prestressed concrete T-beam sections. The ramps zigzagged to connect to the nearby commuter rail station. All in all, Burrill Street was a hot little number.

Recently we were awarded a job to work on the Tobin Bridge. The assignment is to prepare a three-dimensional finite-element model of the structure. The Tobin Bridge is the largest bridge in Massachusetts. It is a double-decked structure more than two miles long, featuring a long-span cantilever truss over the Mystic River, a smaller Warren truss crossing the Little Mystic River, and dozens of steel-framed approach spans. In preparation for modeling, we had studied the vintage 1940s engineering drawings for the spans. In those days, an entire bridge could be depicted by a set of 80 or so drawings. Back then, without the benefit (or penalty, depending on your viewpoint) of CADD, engineers had to be very efficient in drawing their bridges. What could take 20 sheets today was shown in one drawing sheet in the original Tobin set.

While the drawing set may be small, the actual bridge isn't. The Tobin Bridge is so large that it has its own management office, situated high up on the structure right below the toll booths. We were invited to the office for our first presentation meeting, and what a thrill that was!

We parked in the lot at the base of the bridge, between the two massive truss spans. Once inside the entranceway, we rode the elevator up to the aerie office. This was in a small way like a ride up to heaven, although we were all still living and probably the symbolism of the moment was not on everyone else's mind. In the coffee room, a window looked out onto the truss structure to the north. We could see the underside of the bridge up close, with all the steel members presented for our view. There was floorbeam FB12! There was a 33″ deep steel stringer! During our meeting, the conference room swayed gently. Trucks were passing overhead, but it was as if the Tobin had a heartbeat that we could feel.

Forming emotional attachments to bridges is a bit nutty, I suspect. For one thing, bridges are inanimate objects, unlike people or even pets. In reaction to one's expressions of affection and admiration, a friend can express an emotional response. But bridges are more like trees or rocks. Still, at our meeting, the Tobin managers described one of their colleagues, who was responsible for maintenance of the bridge. This gentleman really knew the Tobin structure inside and out. When he walked on the bridge, he could tell if something was wrong just by listening to the structure's response. If a truck drove by and the ringing sound was somehow different, not only did he know it was different, but he had a good feel for what the issue was. Knowing a structure in this way is a great advantage for maintenance. It takes a combination of analytical smarts, construction experience, and time. I suspect there is an emotional component as well. When you get that close to the subject, you start to anthropomorphize it (or "her").

Like everything else in life, the basic concepts have already been described in the original *Star Trek* TV series. Scotty, the chief engineer of the Starship *Enterprise,* didn't design bridges. But he often expressed overt feelings for his ship. Scotty was a jealous, possessive suitor. He carefully protected the *Enterprise*'s honor, to the point that one time he got into a big fight when the Klingons insulted her. Scotty actually had some human relationships but I think they were shallow and secondary in his life. Scotty's human relationships never seemed to work out well. One time, a girl he was dating was attacked by the reincarnation of Jack the Ripper. Another time, his date was possessed by some sort of energy being. Yet even though Scotty's dates were never very successful, his relationship with the *Enterprise* endured.

The love of my life (well, in addition to the bridges) has encountered my quirky passion and over the years has learned to deal with it. When we first met, Lauren put up with the "bridge dates" where we would drive to one of my designs to go inspecting. By now, she knows that on a road trip we will always end up visiting at least one bridge. I will stop the car and climb out and look around while she patiently waits inside. Lauren has made peace with it. Also, over the years, I think I've been more successful than Scotty. Lauren has never felt threatened by my passion for bridges. Neither has she been attacked by an energy being or by the reincarnation of Jack the Ripper.

The nonemotional response of bridges is the subject of ongoing research. Engineers and academicians are at work developing structural health monitoring systems. The idea is that you can compare measured responses on a bridge to what is analytically expected and, from the difference, glean understanding of structural conditions. For example, a beam should deflect so much under a particular load. If a beam deflects twice as much, it may be that the beam has corroded, leading to reduced structural stiffness and more deflection than what the analytical model predicts. This basic approach has been known and understood for decades. But recently, the technology for analysis, structural instrumentation, and remote data collection has greatly improved, to the extent that what was once only theoretically feasible may now become practical and even necessary in all bridges. The automated structural health monitoring systems can provide a wealth of information to supplement physical bridge inspections. The intuition and understanding of our colleague at the Tobin Bridge remains invaluable and will not be replaced by automated systems. But structural health monitoring, when successfully employed, can provide a stream of regularly delivered, objective data to sharpen the picture of the bridge's condition.

The good news is that at no time in the history of humankind has there been so much infrastructure. The bad news is that it's all getting older, and much of the infrastructure needs repair or replacement. The accumulation of hundreds of thousands of aging bridges, along with the need to keep them functioning, has placed terrific strains on infrastructure maintenance. The solution to this problem is a combination of modern technology and old-fashioned maintenance and repair approaches. Analysis and remote sensing will go a long way towards

supplementing and improving structural inspection, maintenance, and repair approaches. But even with these excellent improvements, every bridge still needs an engineer like Scotty, a knowledgeable advocate who will fight her battles and ward off the Klingons.

Managing to Avoid Congestion

The plot of the movie *The Truman Show* concerns the life of a man who lives in a TV show but doesn't know it. The producers of the TV show constructed an imaginary village covered by a huge dome and populated this set with actors. Everyone except the star of the show, Truman, is a performer playing a scripted role. Truman lives his life not knowing that his wife, employer, and neighbors are all actors working from the producer's script. The proceedings are cleverly filmed and presented to the voyeuristic public, who watch the show to see each new development in the soap opera of Truman's life.

This is not a great movie to see if you're paranoid.

The village that Truman lives in, the "set," is supposed to be an idealized, sunny, perfectly built place. Gentle waves lap the shore of this seacoast village, which has cheerful, inviting architecture, palm trees, and friendly people. In the movie, the village is presented as someplace utopian. In reality, the village is not a set at all, but an actual place. *The Truman Show* was filmed at Seaside, Florida, a newly built town on the Gulf coast. This village is at the vanguard of the New Urbanism movement. Seaside has certain zoning and design features that can be summarized as follows:

- Stores and offices are permitted in some areas along with houses and apartments. The design allows for mixed use.
- The street grid has features that lead to pedestrian comfort, such as reduced street width, traffic calming devices, trees, sidewalks, and benches.

- Garages do not face the street, but are set back in alleys.
- The houses are built densely and designed to shape the public street space. This is accomplished with relatively small front yards, front porches and cupolas that lead to a transition from outside to inside, and building position and massing that help the street to feel like an outside room and not a speedway.

The New Urbanism design guidelines that were in place for the building of Seaside are illegal in much of the United States. Most towns and cities have strict zoning regulations that separate stores from offices from housing. Even the types of housing are strictly separated by area: apartments from townhouses from single-family homes from really exclusive single-family homes. Required lot sizes and setbacks lead to today's standard suburban housing developments, shopping malls, and office "parks." Today's dominant form of urban design is sprawl. One ramification of sprawl is traffic congestion. Because everything is widely separated, you have to drive large distances to go shopping, to go to work, to do anything. You can't walk, and usually there's not a subway or bus stop near the one-acre zoned lots.

Yet, the utopian world of *The Truman Show* wasn't filmed at Levittown or at a strip mall. When the movie producers needed an idealized place for their imaginary world, they selected a town that violates all of today's suburban development practices. It's ironic that at the end of the movie, Truman escapes from his fishbowl existence and chooses to live in the outside world. What the movie doesn't show is Truman's subsequent life in a housing subdivision with a 90-minute, one-way commute in heavy traffic.

Probably most people suspect that something is wrong with the present development scheme. They muse in bumper-to-bumper traffic and are uneasy cruising by dreary indoor shopping malls and the vast parking lots that define modern suburban spaces. They go to visit Main Street at Disney World and marvel at what a great place it is, not really understanding why they can't live near Main Street in real life.

The public at large may be uncomfortable and dissatisfied, not understanding why. Civil engineers have a greater responsibility. It is our business to design and shape the built environment. Therefore, we

need to better understand how the design pieces fit together and act on this knowledge. Part of congestion management is encouraging design that reduces congestion. Dealing with this problem requires the skills and participation of engineers as well as planners.

Providence

Note: **For readers outside the United States,** here is a quick primer for this essay. Providence is the capital of Rhode Island, the smallest of the 50 U.S. states. Rhode Island is situated just to the south of Massachusetts and has the nickname "The Ocean State," because tourism boards felt that "The Puny State" would send the wrong message. Proud residents of Massachusetts, of which I am one, have a history of making fun of tiny Rhode Island. PBS refers to the Public Broadcasting Service, renowned for its cerebral and sometimes highbrow programming.

I watched a TV show on Friday nights called *Providence*. It's about a family living in Providence, Rhode Island. It's a low brainpower TV show. The people are mostly nice and get into pat situations that they try to fix. The father is a veterinarian, so cute sick puppies and chimps are usually around. One of the main characters is dead and appears in dreams. This is a little bit strange, but it's OK because it's Friday night after a long week, and you don't want to have to deal with PBS. Also, the title of *Providence* is pleasant and comforting. It's better than a TV show named *Latrine* or *Waste Dump*.

Ever the engineer, I realized that one of the reasons I liked the show is the way it depicts infrastructure. The built environment of Providence practically glows on the screen. The city and neighborhoods are often shown in golden sunlight, in early October. The nighttime scenes sparkle. The city, with its buildings, bridges, and neighborhoods, is on the screen so often that it's almost another character. The show's basic theme is that the main character decides to return home from soulless Los Angeles to her family in homey Providence. The subtext here is that Los Angeles is not a real place where you can live and be happy, but "home"

is. In terms of the built environment, the way "home" is depicted by the show is interesting.

The real Providence has experienced a dramatic transformation in recent years. A lot of civil engineering work has gone into its rebuilding. The old Providence was sort of dumpy, a rundown, past-its-prime small northeastern U.S. city. The Providence River was polluted and buried in culverts. Today, the newly rebuilt Providence has a rescued downtown river and park along its banks. You can take a gondola ride on the river. The bridges crossing the river are sculptured and appealing. This downtown park is the site of something called WaterFire, where on Saturday nights during the warm season, giant bonfires are lit on river barges, and classical music is played along the banks. Most of the residents of Rhode Island attend these events, having traveled from the nether reaches of the Ocean State (traveling from the nether reaches of Rhode Island can take a few minutes). Overall, the small downtown has been rebuilt with a new shopping district, a terrific railroad station, hotels, and facilities. It is now someplace to visit.

The residential neighborhoods of Providence are, for the most part, well-kept and intact. You can walk around a lot of preserved historic areas with old Victorian houses. *Providence* chose a big old Providence house to be the home of the fictional TV family. Many neighborhoods really do look like the ones depicted on the show. As with everything else on film, the real Providence is not as wonderful and glowing and dramatic as the TV version. Rhode Island residents, while being nice, aren't that nice. But I think, overall, the city now has a lot going for it, and this is captured by the show.

For civil engineers, it's interesting to note that Providence has embarked on its own version of Boston's Central Artery Project. The plan is to relocate the junction of two highways, I-195 and I-95. These two interstates currently mash in a 1960s-style interchange too close to other expressway junctions on I-95, resulting in frequent traffic jams. Although the project's original motivation was traffic improvement, it is an opportunity for urban improvement as well. The rerouted highway crosses the Providence River on an elegant new tied-arch bridge (figure 1), replacing a gangling mass of steel beams and piers, further gracing the rebuilt river. The highway relocation will reconnect an older area of the city to downtown. This section, which had been cut off by the I-195

Figure 1. Providence River Bridge, a new tied-arch bridge in Providence, Rhode Island. Note the hurricane barriers.

Source: http://commons.wikimedia.org/wiki/File:Barrier-Providence.jpg (accessed March 26, 2009). Courtesy of Marcbela.

expressway, has seen much rebuilding activity already, with new shops, lofts, and the Providence Children's Museum. This being Rhode Island, with its perpetual inferiority complex, the scope of the project is still many factors smaller than the Central Artery. As usual, Rhode Islanders feel a bit overshadowed. Still, it's an impressive, big project in its own right. The redevelopment is a good example of the peripheral benefits that can be realized from a transportation rebuilding project.

The lack of engineers' presence in popular culture and thought makes me grateful for the little crumbs thrown to us. This is a reflection of engineers' status in the scheme of things. We civil engineers design and build the infrastructure that makes society itself possible, but we're taken for granted. Recently, there was a bidding war for a new Red Sox baseball player. His contract could almost fund the entire highway construction job in Providence. It would be better if there were some bidding wars over the really good structural engineers. But, since that's not

about to happen, I guess it's OK to sit back and watch the bridges and buildings of Providence on TV, at least on a Friday night.

Postscript

In 2007 and 2008, the first phases of the I-195 relocation project were opened. I-195 eastbound traffic from I-95 northbound now crosses the spectacular new tied-arch bridge gracing the mouth of the Providence River. The bridge was prefabricated, and its construction and placement were complex. The feat is documented in an excellent article by Brian Busch and Michael Culmo, "Pre-Assembly and Shipping of the New Providence River Bridge," in the Fall/Winter 2007 issue of *Civil Engineering Practice* (volume 22, number 5).

Ward's Berry Farm

Not far from my house is Ward's Berry Farm, an example of the new trend of "agritainment." This trend has farms adding all sorts of nonagricultural features and nontraditional uses to generate income. In some ways, it's a vision of the farm as more of a park and less of a place that produces food. In the case of Ward's Berry Farm, this idea is reinforced when you drive north up route I-95 from Providence. A blue sign at the exit lists the farm as an "attraction."

The farm property is very beautiful, with spacious cornfields surrounded by conservation land. The fields edge up to a wall of trees. On a sunny day in late August, my daughter Rachel and I went blueberry picking. We walked across the parking lot, past the new gourmet shop with its cheese counter and freshly made smoothies, past the little playground where birthday parties are often in progress, past the hayride truck, and past the greenhouse where the Wards grow flowers and vegetable plants for the suburban gardeners. Eventually we were out in the field. The Wards planted sunflowers on the edges of the cornfield, and these plants lined the walk. By late August, the flowers were tall and bursting toward the sky. We reached the blueberry bushes and headed inland, away from the easy pickings in the front rows, which had been already plucked. Deeper in the forest of stubby bushes, we found the mother lode, bushels of ripe and near-ripe blueberries. In a few minutes, our baskets were full.

Ward's Berry Farm has changed over the years. It started out as a small truck farm, growing vegetables. With time, many suburban-friendly features have been added. In addition to blueberry picking in late summer, you can pick your own strawberries earlier in the season.

During the warm months, there are many birthday parties with hayrides out at the field and playground. The Wards have a traditional New England pumpkin patch in October, along with a corn maze. Recently, they built a new store to replace the vegetable shed. The store is stocked with their fresh, locally grown farm vegetables, and some fresh but not-so-local produce, because oranges and pineapples don't grow in New England. You can sip fruit smoothies and coffee at the smoothie bar in the back, next to the new outdoor patio. The lunch counter has some pretty good sandwiches.

The farm has a 4-H station with many farm animals. This is one of our favorite places to visit. For a dollar, we can buy a bag of bunny food. Then Rachel and I visit the bunnies, which are comfortable, well-fed creatures that look like fat, medium-sized dogs. We do our Bugs Bunny–Daffy Duck routine:

Daffy Duck: "It's rabbit season!"
Bugs Bunny: "Duck season!"
Daffy Duck: "Rabbit season!"
Bugs Bunny: "Duck season!"
Daffy Duck: "Rabbit season!"
Bugs Bunny: "Rabbit season!"
Daffy Duck: "Duck season!"
[Kablooyee!!]

After feeding the corpulent bunnies, we walk over to the billy goats. There is a pen full of goats who stampede to the fence once they see that Rachel has food. At this point, the goat bodies seem to vanish, and the creatures consist of a mass of heads that swirl, jump, and maneuver for food at the fence. The throng of twisting goat heads looks like Medusa's hairdo.

Ward's Berry Farm has the appearance of a small farm out in the country, and this is part of its allure. Yet the site is not rural, but in the middle of suburbia. In the blueberry fields at the south edge, the farm's rural illusion is shattered. When you pick the blueberries, you are next to Sharon Woods, which are not woods but a standard suburban housing development. As Rachel and I picked the berries, we could hear kids splashing in their backyard pool a few bushes away. This adjacent housing development is representative of another kind of land use—the predominant American sprawl pattern of housing, shopping centers,

freeways, and office parks. In case the point is lost, you can also hear the hum of the semis barreling down Interstate 95 a mile from the farm. At the I-95 interchange is a midsized strip mall on one side of the road. The other side features a cranberry bog and some actual woods. But within a year or so, the bog and woods will be replaced by a new shopping mall, this one a larger "lifestyle center," which is a name for a fancier strip mall.

In the past, farms were for growing food, not for providing entertainment. Ward's Berry Farm has evolved from a traditional farm into a workable, profitable land use that bucks the trend toward suburban sprawl. In other words, it is a land use in the suburbs that is not a shopping mall, office park, housing development, or parking lot. To make the operation viable, traditional farm income generated by growing food is supplemented by birthday parties and the sale of nonnative oranges, pineapples, and smoothies, among other revenue sources. The Wards earn much of their living not by growing corn, but by entertaining the guests who come to see the corn grow. Farm purists may object, but this approach has proven to be a good way to preserve the land for growing things. A debate rages on about land use and preservation throughout New England. Little farms are not competitive with massive, factory-production-type farms in California and other warmer areas. A small family farm can't compete, and it is more profitable for owners to subdivide the land to build new housing developments and shopping malls.

The economic factors behind the transformation may be shortsighted, however. The change in land use tends to be a one-way street: you can always convert a farm to a housing development, but it's very difficult to convert a housing development to a farm. So once farmland has been converted to a nonfarm use, the land is no longer available for growing food. Today, it may be more efficient to grow produce in California and ship it to New England. But if the price of a barrel of oil goes up a few more orders of magnitude, it may make economic sense to have more local food-growing capacity as well. The relative value of farmland for growing food would go up. If this happens, some local farms will be needed. Perhaps in the future, an infrastructure design challenge will be to figure out how to build a farm out of a defunct shopping mall.

For now, agritainment results in land preservation. Even if the farms are not purely farms in the traditional sense, corn is still being grown, the blueberries are ripe for the picking, and fresh local produce tastes good in August.

Glacial Potholes

Rachel and I like to visit the old-style swimming hole in Shelburne Falls, Massachusetts. On a hot summer day, the locals wander down to the glacial potholes at the base of the dam across the Deerfield River. The river water here courses through and across a series of rocks and ledges that were sculpted by retreating glaciers thousands of years ago. The rocks are smoothed out, and round indentations named "potholes" were formed when the ice melted (figure 1). The potholes are four or five feet deep and filled with water. The sun warms the rocks, and the potholes become natural hot tubs. Next to the potholes, water from the dam streams across the rocks and rushes across little waterfalls. It looks like an amusement water park, with pools, cascades, and rapids. But unlike an amusement park, it is all unplanned and wild.

Visitors to the glacial potholes display different levels of courage. Considering that officially they're not open to the public, it takes some courage just to swim there. The older folks watch the proceedings from deck terraces in souvenir shops high above the rocks at the top of the dam. Slightly more adventurous types wander down onto the rocky ledges, some spreading out blankets to read and sunbathe. The local teenagers really run the place, jumping off the ledges down into the pools of cool water. Some of the jumps are not so tall, only a few feet. Others seem like the cliff dives at Acapulco. During our last visit, it took Rachel an hour to work up enough courage to try one of the jumps. But she didn't try one of the high ledges, and her dad wouldn't have given her the go-ahead anyway.

The village of Shelburne Falls is not well known for its glacial potholes. But it has made a name for itself from an interesting creation called the Bridge of Flowers (figure 2). The town, at the eastern edge of

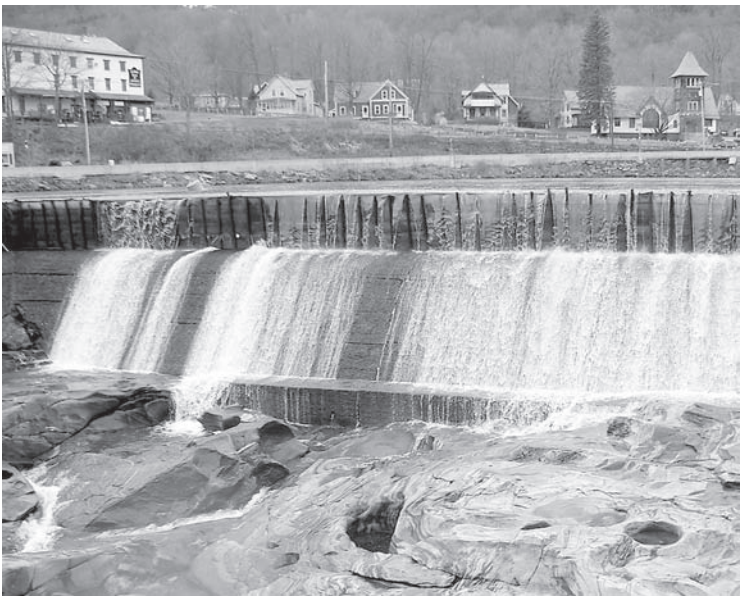

Figure 1. The dam across the Deerfield River in Shelburne Falls, Massachusetts. Note the glacial potholes in the rock in front of the dam.
Source: Courtesy of Rachel Brenner.

Figure 2. Bridge of Flowers, Shelburne Falls.
Source: Courtesy of Rachel Brenner.

the Berkshires, built a trolley line in 1908 running to neighboring Colrain. The trolley carried passengers and supplies to nearby factories. But it couldn't compete with the trucking routes that came into service, and the trolley company went out of business 20 years later. The company left a nice, but unused, multispan concrete arch bridge across the river. In 1929, the town came up with the novel idea of turning the bridge into a tourist attraction. They hauled over some topsoil, and planted the bridge deck with flowers, vines, and shrubs. The formerly nondescript trolley bridge was transformed into the widely advertised and acclaimed Bridge of Flowers, and visitors came flocking to the town. Now during the warm season, the bridge is lushly planted. Guests walk down a pathway surrounded by a beautiful garden, with local and exotic flowers blooming for six or seven months of the year. Crossing the bridge is an exhilarating walk, with its colorful spectacle of flowers, the novelty of shade trees planted on a bridge, and the wide river surging below.

But crossing the bridge is a short walk, and for the town to be a more complete destination, Shelburne Falls needed more than a flowering bridge. Fortunately, the village itself is charming and a nice place to visit. It is situated in a beautiful valley a mile or so off the Mohawk Trail, surrounded by modestly tall wooded hills. The village Main Street has a traditional layout, with 19th-century storefronts and a defined town center that doesn't dribble out into Walmart parking lots with Burger Kings and KFCs. Many of the stores are deliberately or unintentionally retro, like the drugstore with its counter of soda shop stools. After swimming in the river, Rachel and I sat on the stools and drank some sodas. Elvis wasn't singing in the background, but he would have fit in. Since the town was out of the way, if Elvis really were alive and in hiding, he could have lived in Shelburne Falls. Next, we retreated to the terrific bookstore (independent, not chain) to browse its assortment of new and used books. A block or so away was the not-major-chain coffee house, with a glass shelf full of diet-breakers and several worn, plush couches scattered about an old hardwood floor.

For bridge fans, Shelburne Falls has a second river crossing that is even more interesting than the Bridge of Flowers: a 19th-century iron truss bridge runs alongside. This three-span, through-Howe truss carries Route 2A over the river (figure 3). Its classic, industrial truss form, nestled in the sleepy valley, adds to the impression of Shelburne Falls

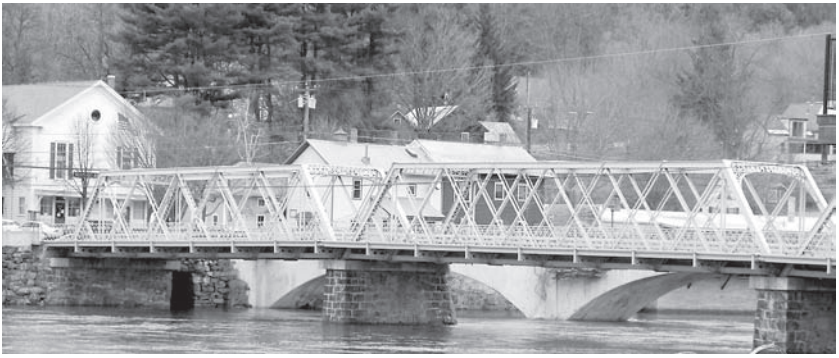

Figure 3. Shelburne Falls Truss Bridge.
Source: Courtesy of Rachel Brenner.

as a place lost in time. The scale of everything here—the bridges, the village, the river, and the way it all fits in the little valley, is about right.

Much of Shelburne Falls' layout can be attributed to history, geography, and luck. They just don't build villages the way they used to. Nowadays, the town's beautiful, quaint Main Street, with its blocks of two-story brick-front stores and offices, would not be allowed by most suburban zoning codes. So if you proposed to build a version of Shelburne Falls from scratch, your proposal would not be approved. The town also benefits from its beautiful location, and of course it helps to have two great bridges.

But the town's present condition is not just a happy accident. The terrific old truss bridge was scheduled for demolition in the 1980s. By that time, the structure had deteriorated to the point that it was ready to go. In 1985, the Massachusetts Department of Public Works announced plans for replacement. However, residents of Shelburne Falls understood that the bridge had value beyond the function of moving cars from one side of the river to the other. It also was a living museum, a town symbol, and a structure perfectly located and scaled for the village. Town residents banded together to save the historic bridge. Their story is documented in an article in the *New York Times*. Public Works Commissioner Jane Garvey said, "There are times when an historic bridge is so special, it absolutely must be preserved."*

* http://query.nytimes.com/gst/fullpage.html?res=940DE7DF133BF930A25750C0A96E948260 (accessed December 23, 2008).

The problem comes in figuring out just what those times are, not just for historic bridges, but for our infrastructure in general. The more we build, the more the infrastructure becomes an amalgamation of new and old. The new facilities are obviously so much better than the old ones. They are sleeker and stronger, and they provide better function and better capacity. But when we consider how older structures teach us about history and the meaning of place, and how they actually shape and define the places that we inhabit, the shiny new replacement structures are not so much better after all. Massachusetts, which has much more older infrastructure than most of the rest of the country, is ahead of the curve in figuring out what to save and how to save it. Of course, we're infrastructure neophytes in comparison to parts of Europe and Asia, where, for example, the ancient Roman aqueduct in Segovia, Spain, still carries water thousands of years after its construction. Sometime in the future, if residents of Segovia no longer need a water aqueduct, they could consider planting flowers on it, and then people will still come to visit it.

See the Squirrels, Find the Nuts

The best travel companies feature elaborate tours to exotic destinations. These deluxe tours have glossy brochures and Web sites offering the allure of a James Bond adventure for those who aren't secret agents. The tours are exotic, but they all follow a careful script. You're supposed to do this and see that, in a particular sequence, during certain times. The vacation may unfold with a degree of elegance and panache not usually experienced in real life, but it is all preplanned. When you get to the scenic photo lookout, you're supposed to gasp and take a picture.

Though not always. When our children were younger, Lauren and I took them to visit the Grand Canyon. The Grand Canyon features maybe the mother-of-all-scenic-overlook moments. Most people bring expectations about what they will see, having looked at pictures and read descriptions before actually going there. We were mentally prepared for the big moment, the first view looking over the edge of the precipice. We cautiously approached the National Park entrance from the south, which was not much of a Grand Canyon experience at all, since it was cluttered with motels and fast-food restaurants. The National Park boundary is about 10 miles or so from the rim of the canyon. Once inside the hallowed park gates, the government took over, and the scenery was transformed to a carefully preserved layout of high Western woods, without motels. The next fifteen minutes were a tease, as we drove north on the high volcanic plateau approaching the rim. There was no hint of what was about to come.

Then we reached the first turnout and walked over to the edge of the abyss. Ten billion years of history was geologically mapped before us, in blazing desert light on the sheer canyon cliffs. Falcons cried and

soared in hot air currents just over the rim. The tiny ribbon far below was the raging Colorado River. Light reflected and glowed off the odd angles and shapes of the canyon walls, adding a sense of mystery to the colorful rocks. As we watched, unworldly patterns of colors and shadows shifted. It really was a spectacle, everything we imagined it would be, and we had imagined a lot.

The kids watched for about 10 seconds. Then they shrugged and found the squirrels. A colony of desert squirrels had set up shop in the nooks and crannies beyond the rock wall at the canyon edge. Over the years, the squirrels had become accustomed to National Park life. They had become domesticated. My kids took turns feeding them popcorn and trying to get them to perform tricks. The squirrels were happy to participate, and this interaction went on for a good 45 minutes or so. As Dan and Rachel played with the squirrels, the Colorado River flowed thousands of feet below in its awesome march through the sands of time. Destiny, mortality, and the full weight of prerecorded history were there in an awesome display. If you listened closely, you could hear a concert orchestra playing a sublime, mystical desert concerto, with prominent violin riffs. But the kids were perfectly content to ignore the spectacle and play with the squirrels. Therein lies a good lesson for the adults—if you can see the squirrels, you can find the nuts.

We live in the present, in a sequence of moments. A moment that hasn't arrived yet is in the future, and one that is over is in the past. I think that engineers are trained not to be spontaneous. Our education and way of thinking is based on the idea of building things step by step to arrive at the future. We are a sequential, linear group. To design and build a bridge, you don't just have the thought and experience of "bridge" at that moment, and then it becomes a bridge. You have to conceptualize it, and then concept-design it, and then analyze it, and then draw it, all of that before a footing is poured or a beam is placed. The structure itself requires a rigorous sequence to be built properly. The piers have to be built before the spans, and the footings and piles before the piers. Some limited variation in the sequence is possible, but the overall concept is pretty rigid.

So we engineers plan every day for the future. At the same time, we are haunted by the past. Our methods and approaches are developed and refined largely based on what went wrong before we even begin.

Our suspension bridge designs have deep stiffening trusses or airfoil deck shapes to avoid the fate of the first Tacoma Narrows Bridge (figure 1). You can see the reflections of the past in the design of the second Tacoma Narrows Bridge (figure 2) and the addition of the third Tacoma Narrows Bridge (figure 3). Structural engineers, in a sense, relive every past earthquake by updating the analysis approach to account for new ground motions that weren't known before. The tragedy of the Hyatt Hotel in Kansas City has become a cautionary tale that is studied to glean knowledge of how organizations can fail.

Our great engineering ability to build for the future, and respect and worry about the past, is part of the process that leads to the amazing projects that we may take for granted, but in fact are actually miraculous. The whole built form and infrastructure of human civilization exists thanks to us, the engineers. Lawyers or actors (no offense, they are very nice people also) don't build squat.

But in embracing the engineering process, I think we personally end up paying a price. We don't see the squirrels, and so sometimes we don't find the nuts. Before arriving at the rim of the Grand Canyon, I had

Figure 1. First Tacoma Narrows Bridge.
Source: Library of Congress, Prints & Photographs Division, HAER WASH, 27-TACO, 11-31.

Figure 2. Second Tacoma Narrows Bridge.
Source: Library of Congress, Prints & Photographs Division, HAER WASH, 27-TACO, 11-1.

Figure 3. The second Tacoma Narrows Bridge (left) and the third (right).
Source: © iStockphoto.com/Jeremy Edwards.

planned for an experience of awe. When the moment arrived, the actual experience was very different. It was a kid-moment playing with squirrels, and a terrific one at that, but it wasn't what I had carefully planned for. My engineering nature rebelled against the idea of enjoying the kids' interaction with the squirrels, because to do so, I would have to scrap the plans and specs, which dictated Grand Canyon shock-and-awe.

So I think we engineers don't appreciate the present moment as much, because the prize is always on the horizon. Probably actors learn to appreciate the present moment very much, and thus fully experience it. They have no choice. The present is it for them, no contract drawing deliverables 10 months in the future. To be a successful actor, I suspect you really have to inhabit and live in the present.

Engineers should not end up behaving like lawyers or actors (no offense, they really are very nice people), in the sense that we probably have a more deeply developed capacity for reflection and perspective that comes from planning deeply for the future and worrying continually about the past. But it is good for us to remember and appreciate the majesty and grandeur of what we're doing—while we're doing it. In other words, sometimes at work we should also live in the present. Sometimes we need to step back from the process and think about the act of creation that we are actively cultivating. Since the engineering and construction process is often tedious, this is not such a bad idea.

Today, if you ask Rachel and Dan what they remember from our trips to Arizona, they would tell you three things. One is the story about feeding the squirrels. The second is about when we went horseback riding in Monument Valley. Unlike guides at more controlled, touristy destinations, our Native American guides let us gallop at full speed, and little Rachel got to ride on her own horse in and around the buttes. There was no script here, just a bunch of cowboys (and girls) galloping off in the desert toward the setting sun.

The third event, maybe even better than the squirrels and horseback riding, is also the least expected and planned. We had rented a beautiful, rustic cabin in Sedona. The cabin was just east of town in a quiet canyon next to a babbling brook. The cabin was rustic, but not too rustic, in that it had complete kitchen facilities, and we stocked the fridge with some staples for the week. On our last morning there, pretty much everything had been eaten, except for a big vat of vanilla ice cream. It seemed like a

shame to let that go to waste, so the kids, Lauren, and I sat on the front porch with the vat and four spoons. For the next few minutes, we quietly feasted on ice cream for breakfast. In that lazy scenic canyon, the brook babbled, and time stood still.

Ice cream with chocolate syrup is not usually what's for breakfast. I must have turned off my inner engineer that morning.

Fallingwater

It was mid-November, and I was driving down the Pennsylvania Turnpike. Zooming by at about 70 miles per hour, I spotted a distressed vehicle on the side of the road. For a brief moment, I intended to pass by and continue on—what if the driver were an ax murderer? But then my better instincts kicked in. I pulled into the breakdown lane and slowly inched back the 1/8 of a mile or so to the stopped vehicle. The driver was an older woman who looked confused. She was trying to find Greensboro, Pa., but had gotten lost on the Turnpike. My destination was the town of Mill Run, the site of the Frank Lloyd Wright house, Fallingwater. In this area of Pennsylvania, it is easy to get lost, and if you do, you pay a stiff penalty. The Turnpike has an old-school, unforgiving, toll-road design should you miss your exit. To reduce the number of toll collectors and the overall infrastructure, the exits were widely spaced, 10 miles on average. So if you miss an exit, you have a long way to go for another chance.

As luck would have it, the next exit was only a mile away, just over the rise. I was able to put the lady on her way and earn bonus Good Samaritan Points in the process.

Once off the pike, I drove up into the Laurel Highlands. The late fall landscape was beautiful and stark. The leaves had mostly fallen, but it was so mild that day that it felt more like mid-September than mid-November. The thermometer topped 70, and a low autumn sun sparkled in a clear blue sky, illuminating the stark, muted brown hills.

As I drove south, I passed many garish signs advertising roadside tourist attractions, although not the one I was looking for. Several signs directed drivers to the Jellystone Park campground, but signs for

Fallingwater were few and far between. I followed the road to the town of Mill Run. I reached the village center and passed through it, still with no sign of my destination. Maybe I had gone too far and passed the entrance? I had Googled a map with directions before I left Pittsburgh. The map placed a star on Mill Run, but that was it—no indication of Fallingwater.

A moment later, I found the entrance. The driveway for Fallingwater didn't have a kitschy billboard like at Jellystone Park. Instead, the entrance was marked by a modest stone tablet, which looked a little bit like a headstone.

Fallingwater, the former summer home of the Kaufmann family, is maintained as a museum by the Western Pennsylvania Conservancy. The Kaufmanns were wealthy owners of a prominent department store in Pittsburgh. In the 1930s, they spent their summer vacations in the highlands to the southeast of the city. Today, downtown Pittsburgh is a nice place to visit, but not so long ago, it was a place to escape. The city was the center of U.S. steel production before most American heavy manufacturing relocated offshore. The area was renowned for its terrific manufacturing productivity as well as its noxious stench. For those who could afford to flee the city in the summer, the nearby mountains provided untainted vistas and breathable air.

The well-off Kaufmanns—mother, father, and son—had vacationed in the area for many years. In 1936, they decided to build a summer home. The son, Edgar, had been an apprentice of Frank Lloyd Wright, and they commissioned Wright to design their new retreat. The product of Wright's work, Fallingwater, is regarded as an American architectural masterpiece. This astonishing place gives architects and engineers a lot to chew on regarding infrastructure and how we interact with it. I had wanted to visit the house for many years and with a trip scheduled to Pittsburgh, I finally got my chance.

The approach to the house is dramatically staged. You don't get to see it driving into the parking lot. In fact, the first structure you see is the visitor center. Fallingwater is so well known and appreciated that design of the visitor center must have been quite a challenge for some poor architect: how do you design a building at the site of one of the most famous houses in the world? The visitor center's design is pleasant and functional, but overall not very successful. The layout is like a wheel.

The center has a central hub for ticketing and four pods radiating from the center. The pod structures include a cafeteria, the gift shop, restrooms, and a small lecture room. The interior of the visitor center building is open to the outside air, with natural lighting and tree branches strategically protruding into the space. The idea was to mimic Wright's approach with Fallingwater, in which the division between the beautiful forested site outside and the structure's inside is deliberately blurred. But unlike the masterpiece that I was about to see, the visitor center had a forced, artificial layout. The Fallingwater house seems to ramble in random directions, but the visitor center was symmetric. Fallingwater was placed in such a way that it seemed to fit naturally on its hillside, almost like another outcrop of rock. However, the visitor center didn't look like it was part of the landscape. It seemed to have dropped down from space.

Each tour of the house was limited to 15 or so guests, and the visits were carefully spaced so that people didn't climb over each other. Soon my tour number was called, and the guests assembled at the head of a path for a five-minute hike to the house. We climbed down the path through the beautifully maintained, wooded grounds. The final approach is alongside Bear Run, the stream that figures so prominently in the design of the house. We hiked around a bend in the path, and there it was. On that unusually warm November day, the sun bathed the quirky, linear structure in its sharp, leafless light.

We met our tour guide at the bridge in front of the house, crossing Bear Run. We were warned: stay together, no photos, no cell phones, don't touch the furniture. Fallingwater wasn't built adjacent to the mountain stream, but placed on top of it. The centerpiece was a modest waterfall that coursed directly below soaring terraces and patios. The soothing sound of gurgling water could be heard in every room of the house.

As with many of Frank Lloyd Wright's designs, the visual focus of Fallingwater is horizontal, not vertical (figure 1). The patios and terraces are stacked up the rocky hillside rising from the stream bank. The structural edges form sweeping lines that both mark the extent of the building and recede up the slope. The building façade is largely made of concrete, glass, and stone. Protruding patio structures mimic outcrops

of rock. The overall effect is of a structure so molded into the hillside that it seems to be part of it.

The entrance to the house is carefully staged. We walked up a path around the back side of the structure and under a trellised way that marked the transition between inside and outside. We passed through the narrow front door (back door?) and entered the living room.

The main room resembles what would be called the Great Room in a contemporary design. It features a combination living room and dining room, with glass walls on three sides. The floor is made of stone. Near the fireplace, the hillside rock protrudes into the space and forms part of the floor. The Conservancy maintains the original furniture, which was also designed by Frank Lloyd Wright. The built-in bookcases, tables, and chairs are linear, in keeping with the overall theme.

The waterfall makes its presence known at all places in the house. In the main room, the coursing water forms a hushed, pleasing backdrop of sound and spray. The Kaufmanns requested the addition of a series of steps down to the stream, so that they could dip their toes. The house was not designed for swimming in the brook, but a swimming pool fed by stream water was constructed in a later addition. This was a great luxury at the time, when few homes had their own pools.

We followed the tour to other rooms: the cramped kitchen (which at the time was a luxurious space), the master bedroom, and guest rooms. Each room had what seemed like an imposed viewpoint and layout. The random, organic layout was not so random after all. Much of the placement and presence of light, rock, water, and the trees seemed almost theatrical, with the intended reaction to be reverence and awe.

Fallingwater is truly beautiful and astonishing, but I wondered what it must have been like to live there. Most of us don't live in museum spaces. Perhaps our homes have some architectural layout and display, whether generic or more customized. My grandparents lived in a cottage by a lake in western Massachusetts. It was one of my favorite places to visit. No architect planned this house. It was a ramshackle layout of exposed wood floors, beams, and throw rugs. My grandparents never met an antique they didn't like. They would purchase old furniture and lamps from dusty shops. My grandfather had an elaborate wood shop where he brought the furniture back to life. My grandmother would knit

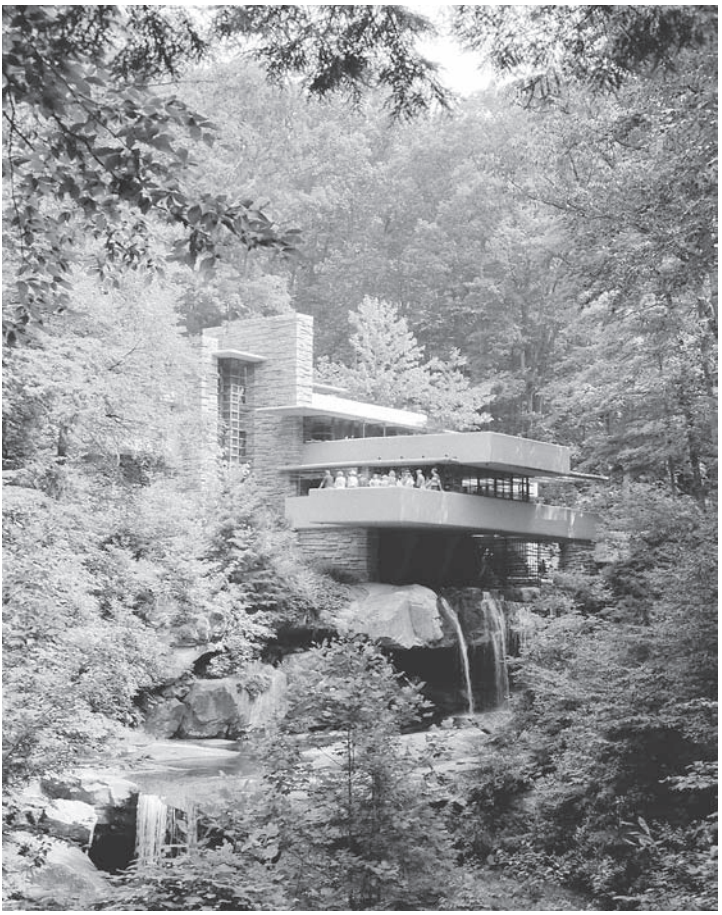

Figure 1. Fallingwater.
Source: ©iStockphoto.com/Avery Photography.

and crochet covers and pillows. I didn't know it at the time, but it was a vision of a Grandparent's Country House. It was theirs.

After a while, a person's space becomes personalized. This process may not have been easy at Fallingwater, where the vision of the great architect trumped any misguided personal activities, such as leaving clutter or adding random furniture. At Fallingwater, all the furniture was preselected and designed—no antiques. Our tour guide commented that the house design featured one of the first uses of open air "carports" in place of covered garages. The architect was afraid that if he built a garage for the Kaufmanns, they would fill it with detritus and the beautiful house would be cluttered. Wright had a keen prescience about how garages would actually be used.

Even with the architect's dominating vision, our tour guide pointed out some small signs of rebellion. Mrs. Kaufmann didn't like the original dining room chairs that Wright designed. These austere chairs ended in an upstairs room. Mrs. Kaufmann selected some more comfortable, rustic chairs for her guests.

The division between architecture and engineering is a relatively recent development. In ancient times, master builders were responsible for guiding the use of space and its design. The Romans didn't separate engineers from architects. They built from accumulated empirical knowledge, without benefit of analysis and analytical techniques. The development of analysis brought today's division of labor between engineers and architects. The analysis became so complex that it required a separate set of skills and labor to complete. But the division of the two is unnatural, because the layout of space and its supporting analysis go hand in hand. With increased automation and computer tools, much of the grunt work that justified the division of labor is no longer required. Engineers can perform the functions of architects, and vice versa.

We can see a cautionary tale in the division of labor at Fallingwater. Frank Lloyd Wright was a master in envisioning space, selecting materials, and putting the whole design together. But he didn't have great knowledge of certain aspects of engineering, and apparently his ego impaired his ability to recognize this failing. Fallingwater has a series of spectacular concrete patios that cantilever from the hillside over Bear Run. The horizontal surface of the patios, along with the glass windows, gives the house its distinctive appearance. But the concrete patios were

not properly reinforced, and over time they started to sag and were on the verge of collapse. For several years, the house was closed to visitors as the patios were shored and then reinforced with post-tensioned rods.

Although architects primarily call the shots in building design, they are few and far between when it comes to bridges. Some prominent bridges have architectural design input, but in most cases, structural engineers manage the work. This approach has had pluses and minuses. If you are a structural engineer, you decide the shape and proportion of the bridge, and it is grounded in engineering principles—with any luck, no patios will collapse. But many structural engineers do not receive good training or develop experience in the layout and design of space. Perhaps, for bridges, this lack of experience is not much of a problem, because the clients live in homes and offices, not on their bridges, except during really bad traffic jams. The aesthetics of infrastructure design—the "artsy" parts—have long been relegated to architects. But aesthetics should be in the realm of bridge engineers as well as architects. For this reason, engineers should make the pilgrimage to Fallingwater, to revel in the builder's vision of space.

The Wall

In the house where I grew up, originally my bedroom door did not face the hallway. The hallway had been added during construction of an extension to the house. What became my childhood bedroom started out as a part of the master bedroom. A few years after my family moved into the house, my parents decided that it was time to either expand it or move to a bigger one. My father, the engineer, really wanted to build onto the house so he could design all the improvements. So we lived for a period of months in what became a construction project, as the back wall of the old house was ripped out, and its size essentially doubled. The extension included a new double garage, a large master bedroom suite, a new living room, and a beautiful den. The den is where a seven-foot-long stuffed shark hangs over the fireplace. I caught it when I was 14, and in the decades since, it has terrorized the grandchildren.

To get to the new master bedroom in the back, my father designed a hallway that ran through the old master bedroom. My new bedroom was carved out of this old room. As I reflect back on this many years later, it occurs to me that the construction was a relatively early example of mansionization, a trend that currently can be found all over suburbia and that seems to be accelerating.

In the early suburbs of Levittown and the like, cookie-cutter detached houses were built with 1,000 square feet of living space. These post–World War II homes were built as part of the first suburban sprawl neighborhoods. To generations living in overcrowded housing and just recovering from the deprivations of the Great Depression and the war, the new homes must have seemed like palaces. But many decades later, what used to be a palace is now considered a starter home, with small

rooms and cramped quarters at best. All over the United States, 1950s ranch-style homes in the inner suburbs have become less valuable than the land they're built on. Plots are purchased not for the existing homes, but as tear-down opportunities so that the 1,000-square-foot ranches can be demolished and replaced by 6,000-square-foot colonials with all the trimmings. In neighborhoods where this process is under way, the effect can be startling. Some streets contain both the original, modest houses side by side with giant McMansions. A street in transition can appear to be caught in a time warp: beautiful, modern, spacious homes side-by-side with quaint, antiquated little ranches. Over time, market forces lead to the demolition and replacement of all the old homes, and then time resets the present.

The process of mansionization leads to the question, How much space is enough? At the same time that houses are getting bigger, the average number of people living in them is decreasing. Spaces of the past that were considered to be a great luxury for much larger households are considered inadequate for today's smaller broods. To use all of this additional space, today's homes have new types of rooms that weren't thought of during the original construction of Levittown: exercise rooms, entertainment rooms, great rooms, and the like. You would think that at some point, all of that extra space would become superfluous. A few extra rooms in your house may seem pleasant, but if you live in a 50-room mansion, it's not possible to appreciate and experience all of that extra space. In reality, we put our pants on (for those who wear pants) one leg at a time, and this is done in one room at a time, not 50. The other 49 rooms have to be cleaned, heated or cooled, and maintained, although if you can afford a 50-room mansion, this is probably not an issue as far as personal expense is concerned.

For many, even the extra space is not enough extra space. So another trend related to mansionization is the proliferation of do-it-yourself storage yards. These new facilities are where you can rent a garage-like storage space for all of the extra stuff that doesn't fit in your 6,000-square-foot colonial. My favorite example is a facility adjacent to the Expressway in Boston's South Bay area. This self-storage facility advertises that it has "museum quality" storage, as opposed to damp basement quality storage. In addition to its advertising motto, the building has a giant, inflatable padlock anchored to its façade during much of the year, visible

to everyone stuck in Expressway traffic during the long slog home. The giant balloon padlock is one of the top two most recognized and appreciated roadside attractions in New England. The other is a giant cockroach on the roof of an exterminator's office next to I-95 in Providence.

It is in our nature to want more stuff. There is probably an evolutionary explanation for this: hoard or perish. Until fairly recently, the amount of stuff to be had and the desire to have it were in relative equilibrium. We all craved a lot of stuff, but most of us didn't have the means or opportunity to accumulate it. Clutter is not a problem for those living at subsistence levels, so hoarding was not a big issue in prehistoric times. Then, along came modern Western civilization, which has been able to satisfy the natural human craving for stuff in a way unparalleled in the history of humankind. We now have the opportunity to accumulate the goods, but we have no experience or tradition of managing and storing the stuff we crave. It is a good thing not to want, but it is not so good to be overloaded with possessions.

Infrastructure is only now starting to catch up with our need for and ability to acquire more possessions, in the form of megahouses and offsite "museum quality storage." But our human psyches haven't yet adapted to the abundance of excess. It is bad news to be overwhelmed by possessions, and many of us can't seem to help ourselves. If we extrapolate from Darwin's theory, then, excessive hoarders who fail to adapt will get eaten by dinosaurs. Then they won't have offspring, and future generations will stop accumulating things. At that point, we'll have a mental handle on hoarding, and we will be able to comfortably and with great satisfaction move back to Levittown.

What Happened to John T. Mongan?

Here are two letters. The first letter was sent by the Massachusetts Institute of Technology admissions office to attract high school students to attend the institute. The second letter was a response by one of the prospective students, John T. Mongan.

Mr. John T. Mongan
123 Main Street
Smalltown, California 94123-4567

Dear John:

You've got the grades. You've certainly got the PSAT scores. And now you've got a letter from MIT. Maybe you're surprised. Most students would be.

But you're not most students. And that's exactly why I urge you to consider carefully one of the most selective universities in America.

The level of potential reflected in your performance is a powerful indicator that you might well be an excellent candidate for MIT. It certainly got my attention!

Engineering's not for you? No problem. It may surprise you to learn we offer more than 40 major fields of study, from architecture to brain and cognitive sciences, from economics (perhaps the best program in the country) to writing.

What? Of course, you don't want to be bored. Who does? Life here *is* tough *and* demanding, but it's also *fun*. MIT students are imaginative and creative—inside and outside the classroom.

You're interested in athletics? Great! MIT has more varsity teams—39—than almost any other university, and a tremendous intramural program so everybody can participate.

You think we're too expensive? Don't be too sure. We've got surprises for you there, too.

Why not send the enclosed Information Request to find out more about this unique institution? Why not do it right now?

Sincerely,
Michael C. Behnke Director of Admissions

P.S. If you'd like a copy of a fun-filled, fact-filled brochure, "Insight," just check the appropriate box on the form

The second letter was Mr. Mongan's response:

May 5, 1994

Michael C. Behnke
MIT Director of Admissions
Office of Admissions, Room 3-108
Cambridge, MA 02139-4307

Dear Michael:

You've got the reputation. You've certainly got the pomposity. And now you've got a letter from John Mongan. Maybe you're surprised. Most universities would be.

But you're not most universities. And that's exactly why I urge you to carefully consider one of the most selective students in America, so selective that he will choose only *one* of the thousands of accredited universities in the country.

The level of pomposity and lack of tact reflected in your letter is a powerful indicator that your august institution might well be a possibility for John Mongan's future education. It certainly got my attention!

Don't want Bio-Chem students? No problem. It may surprise you to learn that my interests cover over 400

fields of study, from semantics to limnology, from object-oriented programming (perhaps one of the youngest professionals in the country) to classical piano.

What? Of course you don't want egotistical jerks. Who does? I *am* self-indulgent *and* overconfident, but I'm also amusing. John Mongan is funny and amusing—whether you're laughing with him or at him.

You're interested in athletes? Great! John Mongan has played more sports—47—than almost any other student, including oddball favorites such as Orienteering.

You think I can pay for your school? Don't be too sure. I've got surprises for you there, too.

Why not send a guaranteed admission and full scholarship to increase your chance of being selected by John Mongan? Why not do it right now?

Sincerely,
John Mongan

P.S. If you'd like a copy of a fun-filled, fact-filled brochure, "John Mongan: What a Guy!" just ask.

Copies of these letters have been making the rounds on the Internet.* I had been invited to give presentations to MIT classes and functions, and what better way to start a talk than by reading them? But, I wasn't sure if these were real letters or not, and I needed to know. Who was John T. Mongan? I did a little research.

As far as I can tell, John T. Mongan is a real person. Apparently, he did not end up going to MIT. He never applied. This is too bad, because it would have been great to see how his application would be received. Mr. Mongan went to Stanford instead, where he graduated with a bachelor of science degree in chemistry. He learned some programming and worked as a consultant for Autodesk in 2000. Mr. Mongan coauthored a book, *Programming Interviews Exposed: Secrets to Landing Your Next Job,* published by Wiley. Mr. Mongan later earned a doctorate in bioinformatics from the University of California at San Diego.

* See, for example, http://funnies.paco.to/MITLetter.html or http://www.jr.co.il/humor/mit.txt (accessed December 23, 2008).

For this discussion, the story of John T. Mongan could stop here. We are indebted to Mr. Mongan, via the Internet, for his unique contribution to the literature of college application letters. As I read the documents, it's not clear that MIT was serious in its original letter to the high school students. Some references suggested that the MIT admissions office wrote the original letter as a "non-stuffy" and off-the-wall way of getting high school students' attention.* If this is true, then the letter surely must have succeeded. In the crowded marketplace of bland, wholesome college brochures, Mr. Behnke's letter used a slightly different approach. It certainly got my attention! The spin from MIT is that its letter was a parody, and that perhaps Mr. Mongan took it a bit too seriously in his response.

But the sequence of letters from 1994 takes on new resonance considering what happened to the MIT dean of admissions. In 2007, word was leaked to the press that the dean had been imprecise about her qualifications. Apparently she did not attend the colleges listed on her résumé.

By all accounts, the MIT dean of admissions was superb at her job. She was a national leader in a reform movement aimed at reexamining the hypercompetitive environment of college admissions. Especially for the extremely selective schools, the college admission process had become an intense, nerve-wracking, high-stakes beauty pageant. Winning candidates needed to have perfect SAT scores, varsity letters in six sports, and a résumé full of extracurricular activities demonstrating increasing levels of responsibility and decreasing levels of daily sleep. The MIT dean tried to temper the process, adding new items to the admissions sheet such as asking students to write about what excited them in life. Her goal was to develop a process that evaluated the whole student as a young human being, and not a collection of accolades.

The dean's fate was ironic, in that she was deposed by a process she tried to reform. In requiring the dean's resignation, MIT was placed in a tough position and arrived at a difficult, but ultimately correct, decision. But the process calls into question the meaning and importance of prerequisites and qualifications. What happened to the MIT dean presents

* http://web.archive.org/web/19990203153258/www.stanford.edu/~john/resp.html (accessed December 23, 2008).

a cautionary tale for the rest of us, particularly engineers. Led by ASCE, civil engineers are engaged in a wide-ranging debate about what qualifies an aspirant to be an engineer. The ASCE Body of Knowledge (BOK) committee has taken on the difficult task of defining the body of knowledge, the accumulated information that qualifies an individual to be a responsible civil engineer. This is no easy task, because the world is vast and the amount of appropriate knowledge is seemingly endless.

To practice as a civil engineer at a high level requires mastering a complex suite of skills, knowledge, and background, both technical and nontechnical. When analyzing, designing, and constructing a bridge, for example, engineers have to be well-versed in thousands of details for analysis, modeling, drawing, communicating with the client, scheduling, estimating, and many other skills. All of this happens in a competitive environment where representatives of different disciplines are vying for limited resources, under tight constraints.

Ending up with a good bridge is tough enough. But how should society measure whether someone is qualified to be a bridge engineer? After the BOK committee defines the BOK, then it must be validated and measured. We have agreed-upon tools for this, such as the accreditation process for university engineering programs, and the engineer-in-training (EIT) and professional engineer (PE) exams. But over time the accreditation process has become more of a performance specification and less prescribed, and the rigid examination process, as represented by the EIT and PE exams, is being challenged by those who feel that exams don't measure the whole student or are biased. In a way, these are two sides of the same coin. In terms of having experienced, capable engineers, we say what we want in the end. But no one wants to say, in any detail, what are the right means to achieve that end. The thinking is that as long as we get there, it's better to provide as much flexibility as possible for picking the route. But what if people get lost or can't find the road?

I wondered what John T. Mongan thought about all this. How should we measure qualifications? Should it be prescribed or performance specifications? How do we know for sure that an engineer is ready to engineer? John would know what to do.

I wrote him a letter:

Dear John,

You've got the book. You've got the knowledge. And now you've got a letter from Brian R. Brenner. Maybe you're surprised. Most engineers would be.

But you're not like most engineers. And that's exactly why I urge you to consider carefully one of the most challenging engineering questions of our time: determining how to measure and validate qualifications.

The level of potential reflected in your response to MIT as a high school student is a powerful indicator that you might well be an excellent candidate to interact with Brian R. Brenner. It certainly got my attention!

Civil engineering's not for you? No problem. It may surprise you to learn that determining engineering qualifications in our increasingly complex world is important to more than 40 major fields of study, from mechanical engineering to biomedical, from economics to such oddball favorites as computer programming.

What? Of course, you don't want to be bored. Who does? Figuring out who is qualified as an engineer *is* tough *and* demanding, but it's also *fun*. Well, maybe it's not fun.

You're interested in athletics? You're an engineer?

You think engineers get paid enough? Don't be too sure. We've got surprises for you there, too.

Why not respond to Brian R. Brenner to interact with him on this challenging topic? Why not do it right now?

Sincerely,
Brian R. Brenner, Famous Civil Engineering Author and a Legend (In his own mind)

Here is Mr. Mongan's response….

Postscript

In my effort to contact John Mongan, I sent some e-mails out to addresses that I thought were his. In November 2008, I got a response. John Mongan is, in fact, a real person. He lives in northern California. That

following March, I had an ASCE editors' meeting south of San Francisco, and with great excitement I arranged to meet John and his wife for dinner.

What a terrific time I had! John T. Mongan, the actual person, is a great guy (figure 1). He is funny, personable, a little bit shy, and very sharp. Lurking beneath the surface is the snarky sense of humor that made its notable appearance in the spring of 1994. John described himself as a "wiseass," but it isn't in an annoying or offensive way. In 2008, John married Ann, who was also a Ph.D. student at UCSD. Ann emigrated from Vietnam to the United States when she was in the 10th grade. Although she arrived without speaking English, she completed high school here and went on to college. Today, Ann works for a biomedical research company in South San Francisco. John is currently a resident at a hospital in San Francisco, en route to becoming a radiologist.

During dinner, John shared some backstories about the letters. After prompting from his friends, he was the one who originally uploaded the letters onto the Internet. He got quite a lot of feedback after that—not surprisingly, I was not the first person who wanted to meet the real John T. Mongan. John noted that his letter helped to secure his first job offer, once his (future) employer got up after rolling on the floor with laughter. As a freshman at Stanford, John was offered a scholarship to

Figure 1. Cell phone shot of Brian Brenner (left) and John T. Mongan.
Source: Courtesy of Ann Mongan.

switch schools when someone in another university's admissions office read the letter (and then presumably checked John's credentials).

John's letter to MIT is great. It doesn't cure cancer or establish world peace. But in the realm of high school student letters to universities, it is probably at the pinnacle of achievement. John's fierce, funny response letter is so distinct and unique, it almost invents its own form of art. I was curious: What process led to this achievement? John said that he thought about the subject of the response letter for a while, but actually wrote it in about 30 minutes. From John's story, it seems that four ingredients contributed to his success.

- John's education was such that he was prepared to answer the call of greatness when it knocked on the door. This speaks highly of the Northern California public schools that he attended before Stanford and UCSD. His education didn't ensure that he would be great, but it did provide a foundation so that he would be ready when opportunity knocked.
- John's response letter was the act of an individual, not the product of a committee. John mentioned that some Q/A was involved in the work, when his father questioned whether the letter should be sent. Otherwise, the letter's creation was the act of a single person who had the ability to create and the inclination to do so.
- A third ingredient was luck. John was the right high school student, in the right place, at the right time.

A fourth ingredient is his excellent upbringing. John's parents also had a big part in his success. They were kind enough to offer their take on John as the high school letter-writer. Mary Lou Mongan commented:

> I remember well the afternoon that John wrote his response letter to MIT. I was working for a small pharmaceutical company at Point Richmond and returned home in time for dinner. John greeted me with his letter in hand, inviting me to read it. I read, laughed, then said: "Your letter is very funny, but you aren't planning to mail it are you?" Of course, he had already done so.

The legend of John T. Mongan (such as it is) lives on, 15 years after the letters were written. John's letter may have been written in a throw-away moment, but today's technology allows it to be easily accessible and live on forever. That is a cautionary tale, considering that the author was 17 at the time.

My mini-quest is complete. I am indebted to John and Ann for a terrific evening and for sharing the details of how the letter came to be written. Thanks also go to John for existing as a real person. Without a doubt, he will go on to great things as a medical doctor and radiologist. For now, we are grateful for his contribution to the literature of college response letters.

Leaving Things on Top of the Car

Lauren and I have developed the bad habit of leaving things on top of the car. We race to the garage with packages in our hands. We can't get into the car with our hands full, so we put the packages on the car roof. Then we open the car doors, climb inside, and drive off. Whatever we had been carrying remained on the roof. At least for the first mile or so.

For example, we were invited to dinner at a friend's house, and Lauren made a salad. Lauren's salads are special. They are elaborate, containing not just lettuce and a slice of cucumber, but a variety of less common vegetables like pea pods and multiple colors of peppers. The salads are often garnished with sliced almonds and mandarin orange segments. They have homemade dressing—not goop from a jar, but a recipe carefully and lovingly mixed and artfully placed. Lauren's are attractive, tasty salads, not the ones that sit uneaten on the table because servings of pasta with marinara sauce are still available. These are salads that you want to eat as a first choice instead of as a filler. Lauren put the bowl containing her artistic salad on the car roof, and we drove off, forgetting it was there. The salad ended up tossed, but not in the recommended way.

On our trip to England, we decided to go see the Humber Bridge, Britain's longest-span suspension bridge. Well, that's not completely accurate. I decided that we wanted to see the Humber Bridge, and Lauren went along with the decision. We had a deal in which I got to see all the English bridges as long as she got to go see the Queen and the nonengineering tourist attractions, whatever those were. The Humber Bridge is currently number four on the list of longest bridge spans, but at the time of our visit, it was the world's longest span. The bridge is a bit off the beaten track, in an area where there were no castles, Victorian

Figure 1: The Humber Bridge.
Source: http://commons.wikimedia.org/wiki/File:Humber_Bridge.png (accessed March 26, 2009). Courtesy of Tonyharp.

things to see, or guards being changed. We drove south from Scotland, admiring the sleek British motorways and the tunnel under the river at Newcastle upon Tyne. Well, that's not completely accurate, either. I admired all the sleek motorways and the tunnel, and Lauren counted the minutes until we returned to London to see the Queen.

The Humber Bridge is spectacular, but its setting is not all that impressive as large bridges go (figure 1). It crosses a wide, flat river estuary. The surrounding terrain does not feature deep canyons or narrow passages requiring heroic, leaping bridge spans like the more dramatic suspension bridge sites of the Golden Gate in California or the Verrazano-Narrows in New York. Just looking at the river, it's not obvious why a huge suspension span was needed there. The terrain is so flat that the river, while very wide, cannot be very deep. Maybe a beam bridge with more modest spans would have worked. But someone decided to build the gargantuan span, it was impressive, and I was ready with my camera. I took dozens of shots: the approaches from the north, driving on the bridge (slowly), and the usual backdrop shots of me standing on the shore and proudly pointing to the towers and span.

After spending an hour or so at the bridge, our next stop was the town of Boston, another not-as-prominent tourist destination, unless you're from the American version of Boston. We got into the car, drove on the wrong side of the road again, and a few miles down the road, I

heard a "thunk." We didn't think anything about it at the time, but when we made it to the British town of Boston, the camera was gone. The "thunk" was the sound of the camera hitting the road, because I had left it on the roof. To this day, all I have from our Humber Bridge visit is a tourist brochure. The photographs of me and the bridge went off-road somewhere between Kingston upon Hull and Boston.

Not all of our car roof adventures have ended in splattered cameras and salads. Sometimes things placed on the roof have miraculously stayed on the roof. Not long after our return to the United States, it got cold in Boston (the American version). A nor'easter roared up the coast and dumped a foot of snow on my driveway. I spent an hour shoveling but it was still icy and the slope needed some sand. I had a few sacks of sand ready, but they were tightly bound. I couldn't pry them open, so I used the hedge clippers to open the sacks. Then I placed the clippers on top of the station wagon while I spread the sand. By now, you can probably see where this story is going. Once the driveway was clear, Lauren took the wagon out for a ride on I-95. Drivers frantically waved and gestured to her. Lauren was perplexed—the drivers seemed to be unusually friendly that day, and Massachusetts drivers are not known for being friendly, or for being able to drive, for that matter. Amazingly, when she returned home, the hedge clippers were still on the car roof where I had left them.

Leaving things on the car roof can provide a spectacle for pedestrians, so it was only a matter of time before someone tried to cash in with an advertising campaign featuring a premeditated car roof placement. A cup of coffee was deliberately attached to the roof, and a gentleman drove around San Francisco pretending to be oblivious to it. Onlookers frantically waved to the driver to let him know that he had left a cup of coffee on the roof. The driver knew, of course, and the onlookers were subtly (or not so subtly) exposed to the brand name. After all of that excitement, they probably all needed to go to the coffee shop to relax. Hopefully, the excitement resulted only in frayed nerves and not road accidents.

I have been glad to learn that we're not the only ones leaving things on the car roof. Just about anything that can be left on the roof, has been left on the roof. A thread on a Mac-user forum* collected various

* http://forums.macrumors.com/showthread.php?t=382938 (accessed June 20, 2008).

examples, including a case of CDs, a pizza (extra cheese), a PC (his wife's), a laptop (his brother's), and orchestra sheet music. The gentleman who left the music on his car reported it to the conductor, a version of having the dog eat your homework, orchestra-edition. The conductor had an even better story about a 100-year-old violin left on top the car and soon after smashed to pieces on the expressway. When I asked my friends about their car roof episodes, they eagerly (with some embarrassment) embellished the list. Additions included all sorts of food as well as car keys and pocketbooks.

Leaving inanimate objects on top of the car is of concern. If the object is an infant, the concerns are magnified. A better approach for leaving things on top of the car is to use a roof rack. Sometimes when the kids were younger and misbehaving, I would threaten that they would have to ride on the roof. This worked up to a point. Then the kids decided that it would be fun to ride on the roof, and I had to come up with a different threat.

For transporting things besides kids, roof storage containers are available to double your trunk space. These are aerodynamically shaped and designed to stay on the roof, unlike salad bowls or baby car seats. To get Dan's stuff home from college, I borrowed a roof container from a friend. The container had a futuristic pod shape, like Mr. Spock's coffin in the *Star Trek* movie where Mr. Spock dies (but before the one where he comes back to life). I was impressed with how well the pod was engineered. It easily attached to the car roof, and it was framed in such a way with its spring latch device that you could stuff a lot of material into it and still get it closed. We took advantage of that feature. On the way back from Maryland, we filled the pod with several weeks' worth of Dan's unwashed laundry. Back home in Massachusetts, while unloading the car, I opened the latch and the roof pod burst open, spewing its formerly compressed contents into the air. For a minute, it was raining boxer shorts.

It's commendable to try to get the most out of your vehicle space, but at a certain point, stuff on the roof is too much stuff. The vertical outer limits of vehicle space are tested in early fall every year in Boston. This is the period when college students return to their apartments and dorm rooms. They arrive in overloaded vans and trucks. Some Boston area highways are well known, at least to the natives, for limited

overhead clearance, like the Memorial Drive underpass in front of MIT and the Storrow Drive bridges. These highways were built well before current standards for minimum vertical clearance. In the case of Memorial Drive, there is only 10 feet or so from the road to the bottom of the bridge beam, a bit less than the recommended minimum of clearance. This underpass and similarly restricted ones are posted with ominous warnings and physical chain barriers to alert truck drivers to the approaching obstacle. But even with the warning signs and barriers, the vertical limitations are not so well known to the college students, and one or two trucks get stuck each fall. Some offices run pools to guess the date of the first van wedging.

Over the years, Lauren and I have gotten better, leaving fewer things on the roof. At the same time, technology is catching up to our foible. All sorts of alert mechanisms are available in new cars and SUVs. Now you can get a service to open your car doors remotely when you lock the keys inside. You can also talk to newer model vehicles, asking the car to play a song or come up with the location of the nearest Chinese restaurant. In one recent TV commercial, hapless pedestrians attempt to talk to other inanimate objects. One woman commands a building door to open, but it doesn't and she walks face-first into the glass. After running into other unresponsive, inanimate objects, finally she gets to her car. The car is sympathetic to her plight, and the door opens and the radio plays when she requests it. By then, the woman probably has a black eye and several bruises. But at least her car is listening.

It's only a matter of time before someone figures out how to put sensors on the roof to warn distracted drivers. After the next snow storm, I'll leave the hedge clippers on the roof, and the car's warning device will blare: "Alert! Alert! You've left the hedge clippers on top again, you moron!" With our new protection device active, we will again become blissfully forgetful, and we'll do it without consequences. We'll go to our friends for dinner, and Lauren's salads will end up tossed on the dining room table and not on the interstate.

Don't Rezone for Brickstone

In the spring, a young man's fancy turns to starting romance and stopping housing developments. As the daffodils bloomed all over town, political action signs also popped out of the ground. In my home town of Sharon, three large projects were proposed more or less simultaneously: the Pine Woods, Sharon Commons, and Sharon Hills. All three had pleasant, innocuous names that didn't communicate what was proposed. In each case, acres of woods and fields were to be plowed over for purposes more directly suited to human material needs. But not all the human natives were pleased. In reaction to the proposals, opposition signs were posted on available telephone poles and on residents' lawns. The signs had short, catchy phrasing, such as "Stop Pine Woods," which were hung next to traffic stop signs, and the more poetic "Don't Rezone for Brickstone," in reaction to the Sharon Hills project, which was proposed by Brickstone developers. The battle of the signs and subsequent debate reflects on the status and trends for land development all over the United States.

My beautiful home town has a lot going for it, thanks to its history and geography. About a third of Sharon's land area is preserved in a natural condition or as open space. Some of this acreage is under several feet of water, covered by Lake Massapoag and surrounding wetlands. Some of the preserved land is included in Borderland State Park, with its acres of forest and fields surrounding the mansion of the late Oliver Ames. Some of the land is preserved by the Moose Hill wildlife sanctuary, managed by the Massachusetts Audubon Society. On top of that, many acres have been set aside as town forest or as gifts to the town from private owners.

Of the acreage that is not preserved in its natural state, much has been built according to the traditional New England land use pattern, with a defined village center and streets arranged in a grid. In terms of the appearance and layout of the town, Sharon has benefited from its high percentage of preserved land and its historic, old-town style of development. But considering today's system of town finance and local taxation, these benefits may not be so beneficial.

Until recently, Sharon's undeveloped land featured outlying fields, farms, and woods—the country. This arrangement of a defined village center and outlying woods lasted until the 1960s, when the I-95 expressway was built on the western edge of town. Then came a wave of more typical suburban development. Bucolic Sharon suddenly was in easy driving distance to Boston and Providence. Much of the remaining, developable land was built out in the usual suburban subdivisions, with some upper-end houses, some lower-end houses, but all built in the same formless, sprawling pattern. The developments had streets named after ridges, farms, and woods, or the developer's children.

Unlike the charming, traditional street grid at the town center, the newer developments were designed with curving streets and cul-de-sacs. Every house was intended to be its own little castle, with a front yard moat. While it is possible for cottages to congregate and form a village, castles are remote and separate, each plot its own fiefdom with little spatial connection to anything else. So, Sharon's charm today derives from good geographic luck, a lot of preserved land, and a strong older core. The newer construction is nice on the inside, but like the rest of suburban America, cookie-cutter and formless on the outside.

Much of the town's development has been done in piecemeal fashion, but there have been some notable turning points. Sharon's most fateful land use decision came in the 1970s, when there was a debate on what to do with a swath of land next to the new I-95 expressway on the south side of town. The area featured fields and old sandpits. Being next to a limited access highway, this area was a natural location for some type of industrial development. But the town residents didn't see it that way, and instead the land was developed as Sharon Woods, which were not woods but an upper-end housing development.

Sharon Woods provided homes for many new residents, but it did not provide as much local tax revenue. In the suburban town budgeting

system, houses are financial loss-leaders. The local tax paid by a homeowner is usually not enough to cover the costs of town services such as schools, fire, and police, which the new residents need. From this perspective, each new house represents an increased financial burden to the town instead of a benefit. Therefore, in order to stay solvent, suburban towns must balance housing with industrial and retail uses. Factories and store owners pay local taxes, but they don't send kids to school. With enough nonresidential land owners, the residential tax rates can be kept in balance, and residents can actually afford to live there.

Unfortunately for Sharon, the residential/nonresidential mix was way out of whack. Along with the preserved land, which provided no tax income, and the subdivisions, which didn't provide enough, little land was being used for retail and industrial purposes, which might have provided tax income. Some acreage had been developed as Sharon Industrial Park on the west side of town across I-95, and there were a few modest shopping plazas. But this wasn't enough, and homeowner tax rates soared to provide the extra money needed for schools, police, etc. The town was fast approaching a state of build out, where there would be no developable land to build on. On this stage, in the spring of 2007, with town residents suffering from high tax anxieties, the three new development projects were proposed.

Of the three, Sharon Commons seemed to generate the least opposition. Sharon Commons was proposed for a large patch of woods and a cranberry bog on the south side of town, adjacent to I-95. The proposal was for an outdoor shopping mall, renamed a "lifestyle center" to quell opposition with a positive spin. But it was still a shopping mall. The developers made the case to cash-starved residents that the center would pump millions of dollars of tax revenue into the town coffers. The residents were impressed and convinced, and they voted to change the town zoning to allow its construction.

Developers of Pine Woods used a different approach and ended up with much different results. They proposed their project under the Massachusetts Chapter 40B provision, which allows developers to bypass most of the local zoning rules. In order to qualify as a 40B project, it had to feature "affordable" housing. The intent of the 40B legislation was to encourage construction of smaller, denser housing amid the two-acre McMansions of the tony suburbs. Because many more units could be

built on a particular parcel, the housing could be both "affordable" to the buyer and profitable to the developer.

Although the legislative goal was construction of affordable housing, the reality was that many developers have used the provision as a club to get their way with town zoning boards. The developer starts by making a standard housing subdivision proposal. When the local not-in-my-two-acre-backyard opposition ensues, the developer then threatens to replace his proposed 20 single-family homes with 120 apartments in clustered, five-story buildings. These apartments don't qualify under the local two-acre zoning laws. But with a 40B proposal, town zoning objections can be bypassed. The town residents are defenseless against the construction onslaught, and their only recourse is to compromise with the developer: build 18 houses instead of 20, leave a few trees, and throw in a new truck for the fire department.

The Pine Woods developers proceeded with a 40B proposal that, unfortunately for them, had a fatal flaw, even taking into account the less restrictive 40B rules. Independent auditors determined that the developers greatly inflated the value of the building site. In effect, this reduced the developer's reported profits, at least on paper. But the 40B rules had percentage limits for how much profit was allowed. When a more realistic cost of the site was figured in, the developer's profit soared. It was much greater than what was allowed under the 40B provisions. Therefore, the Pine Woods proposal violated the rules and was rejected. So for now, the woods remain as woods, and both sides have gone back to the drawing board. But, it remains to be seen what will happen in the long run. Nature abhors a development vacuum, and the woods remain prime, developable land.

For the last of the three big proposals, Brickstone developers proposed to build a senior housing complex on Rattlesnake Hill. The site is one of the few remaining, large undeveloped tracts of land in Sharon. It sits adjacent to Mountain Street, a road that doesn't actually climb a mountain but does ascend the modestly tall Rattlesnake Hill. Part of Mountain Street is unpaved. With the woods of Rattlesnake Hill on one side and the wilds of Borderland State Park on the other, the effect driving down the unpaved road is of being, momentarily, deep in the wilderness, away from it all.

Brickstone developers claimed that their proposed senior housing complex would generate a lot of tax revenue, and that it would even lead to the preservation of most of Rattlesnake Hill. The complex would generate a positive revenue stream to the town because senior residents would not be likely to have school-age children. The developer sent a glossy propaganda sheet to all town residents claiming many other benefits. For example, a new water distribution system would be donated to the town. Opponents pointed out that this new water system was no altruistic donation, but in fact it had to be built anyway to provide service for the new complex. Another aspect of the proposal that attracted a lot of attention was the plan to mass the construction in several 8- to 10-story buildings. These structures would be taller than anything previously built in Sharon, by several stories. Those fighting the proposal showed renderings of massive structures, which they claimed would transform the bucolic woods into a grim, urbanized place of dark, windswept concrete canyons. The developer countered by floating balloons at the site to show that, in most cases, no one would be able to see the buildings based on the topography.

At a special town meeting, the developer won the first round and rezoning was approved. Most town residents were convinced that the proposal would in fact fill the tax coffers and help preserve what remained of Rattlesnake Hill. It helped that relatively few Sharon residents were directly in this particular development line of fire, the site being at the most remote corner of town. But despite winning the battle, the developer may not yet have won the war. While Sharon residents may not be as directly affected, the site is adjacent to the neighboring town of Stoughton. Access to the site would need to be provided by Bay Road, a charming, winding country road on the border between the two towns. Bay Road barely functions today, so it's not clear how it could successfully provide access to many hundreds of new residents and support staff. New traffic signals, additional capacity, and straightening out some of the Bay Road curves would probably be needed.

Once these projects are completed in one form or another, Sharon will have little acreage left for new developments. Future construction will be only on smaller infill plots and rebuilding on land already occupied. So it's useful to take a step back and reflect on what has been built to get to build out. Sharon's built form is an aggregate of infrastructure

facilities: homes, schools, government buildings, parks. This infrastructure provides fortunate town residents with a high standard of living.

Suppose that it were possible to clean the slate and provide the same high level of service and infrastructure, but with a better, more efficient overall layout. Could the same beautiful homes and streets be placed in such a way as to provide better public space, perhaps an extension of the traditional New England grid but with yards that were a little bit smaller? Then more woods and fields could be preserved as woods and fields. Maybe senior housing could be placed in the center of town, near services that seniors could walk to, instead of a remote location five miles from the library, town square, and coffee shop and only accessible by car.

Now let's step back further, and think about the tax system. The funding mechanism for local schools is tied to building more stores and industrial parks. Without these facilities that pay in and don't take out, schools and other facilities must be paid for by residential tax rates. In this system, it makes perfect sense to convert a cranberry bog and woodland area into a lifestyle center, which is largely an asphalt parking lot. Of course, the lifestyle center will have to compete for its life, because recent articles reported that many other towns up and down the South Shore are planning to do the same thing. It's not clear that there are enough shoppers to support all of the new shopping malls. In a worst-case scenario, the lifestyle center could fail, and in place of the working cranberry bog and woodlands, the town could be left with dead, decaying pavement.

In spite of the high local taxes and financial travails of living in Sharon, residents overall are lucky. The schools are good, and the quality of life is high. The combination of wetlands, preservation, and historic development has resulted in a human-scaled town that is nice to look at and nice to live in. This is still true even with the more recent cruddy construction. But Sharon's path to build out is via a cockeyed system that turns out places that are not so charming. The United States has many decades to go before it is built out. The challenge before infrastructure professionals and the public at large is to step out of the fishbowl we all live in and take a broader look at what is being built and why it looks and functions the way it does.

Riding the Rails

With the Amtrak Northeast Corridor electrification project complete, it is possible to ride the train from Boston to New York City in less than four hours. Prior to 1996, all trains stopped in New Haven to switch from diesel to electric locomotives, and the trip could take more than five hours. Now, all-electric trains run every day and don't require this delay. One of the early trains from Boston is scheduled to arrive at New York's Penn Station at 10:10 a.m. Once, when I had a 10:30 a.m. meeting in Manhattan, I took the train instead of the air shuttle. The train was a great ride and got me thinking about travel in general and about riding the rails.

On the morning of my ride, the Acela express pulled into the Route 128 station on schedule. Boarding the train took about two minutes, not the 15 minutes it required to pack a sardine-can jetliner. I took my seat in coach and stretched my legs. When you ride on this train, you get a lot more leg room. You can cross your legs. This was a revelation. If you try to do this in coach on a plane, all blood circulation in your body stops unless you are a yoga guru. The train pulled out of the station and the scenery zoomed by outside the windows, a parade of green trees and yellow sunlight. I decided to do some work, but that impulse lasted for only a few minutes. Instead, I thought I'd have a snack, so I walked to the snack car. The food was pretty good. I had a nice fresh fruit cup, with no little bags of peanuts anywhere in sight.

The Boston–New York rail route has some exceptional stretches of scenery. Not far south of Providence, you ride next to the harbor. My first sight of water was a cove on Narragansett Bay with bobbing sailboats and sunlight glistening on the water. Further along, I saw a few

miles of Long Island Sound's rocky coast and sandy beaches, with outcrops of gray-shingled beach houses and small villages. The train coasts through this unperturbed scenery.

People seem to talk a lot more on the train than they do on a plane or in a car or bus. Maybe it's because of the more comfortable riding conditions, the ability to move around freely, and the thrill of the ride. On this train, there was an established social scene. The conductor was insulting some of the regulars, and they were lobbing it back to him. The passengers included a mix of families with young kids, and college-age students and retirees. On the air shuttle, you see a lot more suits than on the train, and they don't talk much, wedged into the tiny seats with their peanut bags and laptops.

The view from the tracks is much different from what you see when you are traveling by car or bus. Automobile travel in the United States is mostly a blur of traffic, billboards, and interstate sprawl, where the fast food restaurant and service station sign towers are higher than the trees. If you have a window seat on the plane, what you see is not a landscape, but an overview of one with adjacent puffy white clouds. From the train, the landscape is at eye level and seems more natural, immediate, and in proportion. At least along the Boston–New York run, the tracks in most areas fit in right along with the houses, stores, and woods. The right-of-way seems to be integrated into the landscape and not separate from it. It doesn't feel like the gash in the terrain formed by a busy highway. No fast food restaurants or strip malls appeared beside the tracks, except near the highways. The train rushes through a landscape that doesn't seem to be disturbed by its presence.

For some people, taking the train is not so much a travel experience as a trip in nostalgia. Although this is not the case for the younger generation, older riders still remember the days of their youth when they rode trains everywhere. I'm still a bit young for nostalgia, but the train ride conjured up some memories of my own. Many years ago, when I left the nest to go to college in Boston, I was loaded up with a big suitcase and deposited at the train station. It was early fall, and I can see myself boarding and sitting on the train. Out the window was my family waiting on the platform. It was an electric-powered train, but I remember it as the steam engine starting to churn, a loud whistle, and the conductor crying out, "All aboard!" Slowly, the train chugs out of the

station, picking up speed. I see my mother running down the platform, tears in her eyes, crying out something (it was either "Don't go!" or "You forgot your toothbrush!"). At this point, the scene fades and the camera pulls back. We're in downtown Atlanta, during the Civil War. Approximately two million wounded Confederate soldiers lie bleeding on the ground. The theme from *Gone With the Wind* plays. Maybe this isn't exactly how it happened, but that's how I remember it.

Nowadays, rail travel in the United States seems like an anachronism. To go on a real trip, you take either a car or an airplane. Cars are for all short trips. Planes are for all long trips. There is some dividing line in between, with overlap, where you either take a car or a plane. The idea behind the Amtrak Northeast Corridor project was to make the train competitive at this border line. If the trip to New York could be cut down to around three hours, then the train would take about as long as the air shuttle and would be faster than driving. I found this to be about right. I took an air shuttle flight home. The plane had about 35 minutes air time, and an hour and a half for boarding, sitting on the runway, and other delays. Including connections, it was about the same amount of time by plane as by rail on the fast electric train. The equation is improved by the fact that my meeting was near Penn Station in downtown Manhattan, while the airport is an hour or more away in heavy traffic.

Even when the train is as fast or faster than the other modes of travel, I wonder if a cultural adjustment will be necessary for Americans to appreciate this. Unlike people in other parts of the world, especially Europe, Americans expect to drive short and fly far, which is what we have done for decades. But for this trip to New York, I was able to buck the trend and take the train. I rode past the tranquil New England landscape, munching on Amtrak's fresh fruit. Soon we passed the New York state border. In a lilting, sing-song train voice, the conductor announced that we would arrive at Penn Station in a few minutes. The train sped atop the Randall's Island trestle, with the panoramic Manhattan skyline in view. We were over the Hell Gate on the grand old arch bridge, with the suspended spans of the Whitestone and Throgs Neck floating in the distance. The train dove into its tunnel below the East River, pulled into Penn Station, and eased to a stop. We had arrived.

Postscript

This essay was originally written before September 2001, at the time when Amtrak first started its Acela service. In the years following 9/11, the inconvenience and delays associated with air travel have increased. It may take 15 minutes to board a plane, and 60 minutes to get by the security screening. More recently, jet fuel prices have skyrocketed, leading to big increases in airplane ticket prices. At the same time, transit and rail ridership has also increased. With these developments, travel by rail may not be such an anachronism in the future.

My mother has no memory of the *Gone With the Wind* scene at the train station. But she might have the last laugh. In 2008, I drove my son, Dan, and his college friend to the train station at Route 128. They were taking the Acela to go to Newark airport, to catch a long flight for a winter break trip. As the train started to pull away, I suddenly felt a moment of great sadness that he was going (forgetting about the fact that he was away at college now most of the time anyway). So I jogged down the platform and waved my goodbyes as the two embarrassed boys tried hard not to notice.

The Dumbest Generation

The Dumbest Generation is a book written by Mark Baurlein (published by Penguin in 2008). Its title is a parody of The Greatest Generation, the expression coined by Tom Brokaw to describe the generation that endured the deprivations of the Great Depression and rose to the challenges of World War II. After the trials of World War II, soldiers from the Greatest Generation returned home to build America and to create the Great Society. An iconic moment for the Greatest Generation was the raising of the American flag over Iwo Jima. The Pulitzer Prize–winning photograph capturing that moment symbolizes the rise and ultimate triumph of the United States. A similar image graces the cover of *The Dumbest Generation:* an American flag is being raised by a group of soldiers in the pose made famous by the photograph, but in this case the soldiers raising the flag are not people, but video game robots. Baurlein's thesis is that American youth are systematically getting stupider, thanks to computer access and, in particular, the Internet.

This thesis seems counterintuitive. The Internet has provided unparalleled access to knowledge and the world of ideas. Humankind's recorded intelligence is no longer concentrated in fragile repositories such as the ancient library of Alexandria. Thanks to the miraculous Internet, facts, interpretations, great works, the whole collected works of recorded human thought, are easily accessible everywhere, often in seconds. Painstaking research that used to take days can be done in a few keystrokes. You don't have to go to a dusty library anymore. You don't have to open books. You just need to sit on a sofa with your laptop, wireless card, and Google. Basic facts and more in-depth studies are immediately available. A centralized location for facts is no longer

needed, and this is one reason why the basic function of libraries today is being challenged and reassessed. Who needs a library when you have your couch and Wi-Fi?

With this incredible distribution of knowledge and easy access to it, clearly we should be experiencing an educational Renaissance. Today's students should be wizards, exposed to more thoughts, intellectual challenges, and experiences than any group of adolescents in history. They should all be burgeoning Einsteins.

Baurlein points out that this Renaissance has not occurred. It is true that the Internet has provided virtually unrestricted access to the stored knowledge of humankind. Unfortunately, it has also provided unrestricted support for teenage self-absorption. Today's youngsters do not use the Internet to expand their heads. They use it to log into Facebook. Adolescents have never been the most self-disciplined bunch. Today, they have unlimited distractions in instant messaging, blogging, gaming, and so on. Teenage students are wired in but tuned out to deep thinking.

The genie has escaped and the Internet is here to stay, at least as long as we still have a civilization to support its use. I don't think the Internet is necessarily a bad thing. In writing this essay, I was able to quickly Google some facts and figures, saving me time and energy over the old-fashioned way. As I was typing, I looked over at my old, ratty high school dictionary. It was sitting forlornly on top of a bookshelf. If dictionaries had feelings and were sentient, mine would be wondering why I abandoned it. It was nothing personal, really. But since Microsoft Word alerts me with a red squiggly line every time I misspell something, and the program even types in the correct spelling for me, I don't have to look the words up manually. Of course, I am probably losing the capability to spell by myself.

Computers are tools, and criticism should not be directed at the tool but how it is used. General education has not caught up with the reality of computer use and misuse. Analogous processes are at work in engineering education. Computers have facilitated exceptional ease for engineering data management, analysis, and design. Consider the following examples from structural engineering. In the old days (not that old actually), indeterminate frames could be solved by the painstaking hand method of moment distribution. This method is time-consuming

and increasingly tedious for more complex structures. Frame analysis using moment distribution could take hours or even days. It had to be performed meticulously and with great care, lest one simple mistake throw in doubt an entire sequential calculation. To be successful, this task required great concentration, organization, and planning.

Yet, embedded in the tedium was the development of an understanding of structural behavior. To succeed in using the analysis method of moment distribution, you had to learn and understand the basics of structural analysis. You had to get a feel for the structure—the shape of the moment and shear curves, where the tension was, where the compression was. You had to know and apply basic rules such as the equilibrium of forces and moments to check results and stay on track. Engineers who wrestled with moment distribution received the benefit of learning how structures behaved. The method could not be treated as a black box.

Today, indeterminate frames can be solved in seconds with structural software—no more tedium. But when used the wrong way, our application of this excellent, miraculous software may be throwing the baby out with the bathwater. Structural engineers no longer have to struggle for hours distributing moments and calculating carryover factors. Structural analysis has been made into a video game: Grand Theft Auto, Building Frame Version. But with instant gratification, young engineers can lose a feel for and understanding of the structural behavior.

The fix for this problem need not involve reintroducing tedious manual methods. Nothing is inherently wrong with having spectacular analysis and design tools. In fact, these are good things if we learn how to use them properly. Graham Powell, professor emeritus at the University of California at Berkeley, shared his thoughts on this topic in two articles in *Structure* magazine.* In the first article, he writes: "I do agree that problems can arise when computers are used for structural analysis. However, the computer is not at fault. The computer is merely a tool, and

* G. H. Powell, "Structural analysis: Are we relying too much on computers? Part 1: The problem." *Structure,* November 2008, http://www.structuremag.org/article.aspx?articleID=798 (accessed March 23, 2009); and "Structural analysis: Are we relying too much on computers? Part 2: A solution." *Structure,* December 2008, http://www.structuremag.org/article.aspx?articleID=813 (accessed March 23, 2009).

like all tools it must be used in a craftsman-like fashion. In my opinion, the problem lies not with the computer but with the craftsmanship."

In each application, we need to consider the underlying concepts and processes. In the structural engineering examples, analysis should be taught with aspects of the old manual methods alongside the new computerized approaches. For concrete column designs, students should be taught to derive column moment–axial design curves by hand, then apply them. They should then apply concrete analysis software and compare the results. At every step of the way, the key question is, "Why?" This is a question that should also be asked in engineering practice, long after classes have concluded.

Measurement of progress also requires some updating. In his follow-up article, Powell writes: "Currently, the structural analysis sections of professional licensing examinations require analysis of statically indeterminate structures by hand. Why? To get a driver's license do you have to show that you can ride a horse?"

In *The Dumbest Generation,* Baurlein directs some of his most caustic comments at educators and mentors. He believes that adults have, to an extent, defaulted on their roles of managing and guiding students. The digital world makes it easier than ever for adolescents to fly off into the ether of their own self-absorption, and it makes it harder for adults to follow. The kids spend their time at Google and Facebook. The adults smile and marvel at how adept the kids are at maneuvering around the computer.

To avoid The Dumbest Engineering Generation, we have to learn to work with computers in a way that maximizes their great ability to streamline analysis and data management, without turning the users into bleary-eyed idiots. As Powell points out, this can be done by focusing on what we're trying to accomplish and then working backwards to figure out a better process to get there.

Where Old Bridges Go When It's Time

Many infrastructure projects include a requirement for a "design life." This is the specified period of time for which the project should be designed, maybe 75 or 100 years. Exactly how design life is achieved is unclear, because it's difficult to quantify precisely many long-term factors such as corrosion, future service demands, and maintenance. Even though design life is hard to calculate, the concept has taken on new relevance in the aftermath of the Minneapolis I-35 bridge collapse in August 2007, which heightened public awareness of the fragile state of U.S. infrastructure.

For a bridge design, initial-state conditions and calculations are relatively straightforward to determine. But the design life requirement is harder to quantify. How should the design life be measured? Do different components have a different design life, maybe 50 years for the beams but 20 years for the deck? If the project is designed for a 100-year design life, is it then to be scrapped at a minute past midnight in year 100? Can the specified design life be extended by proper maintenance? In contrast to the traditional design-bid-build approach for project procurement, other methods like design-build-operate-maintain, where one organization is responsible for building and operating the project, impose extended responsibilities on designers and builders. But even with a design-build-operate-maintain contract, how can anyone know whether the contractor will be in business for the full specified design life?

At a certain point, regardless of design life, most bridges wear out their welcome. For some iconic bridges, like the Golden Gate or Brooklyn Bridge, the idea of a design life may not apply. Nobody seriously proposes

to knock down and replace either of these beloved structures, so they have essentially achieved bridge immortality. At least, they will live many years beyond any specified design life. Instead of replacement, programs are implemented for continuous maintenance and repair. Painting on the Golden Gate Bridge never stops, and so many parts of the Brooklyn Bridge have been replaced that it can be argued that the current structure is actually a new bridge that looks a lot like the old one.

Maybe the ultimate expression of infrastructure design life can be seen at the end of the original *Planet of the Apes* movie (spoiler alert: if you are one of the three people who has not seen the original *Planet of the Apes,* please skip this paragraph). In the near future, astronaut Charlton Heston crashes his spacecraft on a strange planet dominated by intelligent, talking apes. The native humans, in comparison, are unintelligent and enslaved by the smart apes. Heston escapes from the apes and ends up riding a horse galloping down the beach, where he keeps his appointment with destiny and the shocking surprise ending. There, on the beach, he sees the Statue of Liberty, which is buried up to her neck in the sand. At this point he overemotes, pounding the sand about "those bloody apes." It turns out that Charlton Heston wasn't on the Planet of the Apes after all, but a future version of earth. The statue looked in pretty good condition, even though Armageddon had struck. What this implies is that the statue had a design life of several centuries. The French constructors in those days were good.

Unlike the Statue of Liberty and bridge icons, for run-of-the-mill, average bridges, a fate other than immortality typically awaits. Time is now catching up with the interstate highway building boom of the 1950s and '60s. Many steel stringer viaducts are being demolished and rebuilt in place. Older truss bridges are also being demolished and replaced. ASCE reports that a large percentage of the nation's bridges are either obsolete or structurally deficient.* The most recent grade has improved slightly, but ASCE still reports that more than a quarter of U.S. bridges are deficient in some way.

Several older bridges, while not iconic, have historic value. These structures are representative of past industrial techniques and reflect the

* http://www.asce.org/reportcard/2005/page.cfm?id=22 (accessed June 28, 2008).

Figure 1. Northern Avenue Bridge in Boston.
Source : Library of Congress, Prints & Photographs Division, HAER MASS, 13-BOST, 84-18.

times in which they were built. Sometimes, the demolition–restoration debate plays itself out publicly, as with the old Northern Avenue Bridge in downtown Boston. The structure is a swing span truss crossing the head of the Fort Point Channel near South Station (figure 1). The structure was built in 1908. It has a late-19th-century erector-set look, evocative of Boston's past in an area that has largely been rebuilt with more modern structures. Time and salt spray have taken their toll, and the structure was closed to vehicular traffic. In 1996, a modern, prestressed-concrete stringer bridge opened just upstream of the old bridge. The new bridge is elegant and sleek, but somewhat characterless. Unlike the old Northern Avenue Bridge, which evokes memories of past industriousness, the new bridge evokes thoughts of southern California.

With the new bridge in place, some concluded that the deteriorating truss bridge was obsolete and ready for demolition. Not only that, but the sleek new bridge had political connections. It was named for the deceased wife of a Massachusetts congressman. So, many wanted the

old bridge demolished, in part to improve sight lines to the favored new span.

But a plan to demolish the Northern Avenue Bridge was not a slam dunk. Boston has a strong tradition of historic preservation. Organizations such as the Boston Preservation Alliance campaigned to preserve the span.* Some creative plans call for reusing the structure to house shops or an art gallery. Reusing the structure will be challenging.

A few bridges die young. Unlike the dowdy Northern Avenue Bridge, some bridges never experience the dislocations and indignities of old age. If you wanted to compare a bridge to Jim Morrison, and it's not clear that you would want to, but if you did, you might pick the original Tacoma Narrows span. Here was a bridge that knew how to party! This span lived a charmed early life, lauded in its creation and birth. It was a beautiful young bridge that liked to dance. Unlike some of the clunkier spans of its day, the first Tacoma Narrows Bridge was graceful and slender, maybe a little bit too slender. The bridge was nicknamed Galloping Gertie because of the way the deck rolled as you drove across it. During its brief, tragic life, it became a tourist attraction for its undulating roller-coaster deck. Unfortunately, the party didn't last long, because less than four months after opening, the span writhed too much and crashed into the water during a moderate windstorm. But the Tacoma Narrows Bridge got to die young and pretty.

An alternative to demolition might be the equivalent of a rest home for bridges. Worthy old bridges could be moved out of service to a pleasant pastoral retreat (figure 2). Bridge preservation fans in Michigan have actually developed such a place in Calhoun County. Several old truss bridges that were obsolete, no longer functional, or both, were disassembled, transported to a historic bridge park, and rebuilt. At this unique park, you can hike, have a picnic, and wander over and around four beautifully restored old truss bridges. The website notes:

> Historic Bridge Park, located a bit southeast of Battle Creek in Calhoun County, Michigan, is a unique park whose focus is on the historic truss bridges that have been moved to and restored within the park. The park allows truss bridges that have become insufficient for their original location to be

* http://www.bostonpreservation.org/past/2007_f.html (accessed December 23, 2008).

Figure 2. Bauer Road Bridge, Historic Bridge Park in Michigan.
Source: Courtesy of Nathan Holth, Historic Bridges of Michigan and Elsewhere.

preserved for their historic and aesthetic value. Historic Bridge Park is the first of its kind in the entire United States.*

The park may eventually be home to 15 old, restored truss bridges that have lived out their lives and are ready for retirement. Bridge historian Nathan Holth notes that the park provides a terrific opportunity for bridge education. This living history museum provides visual demonstration of materials used at the time (cast iron, wrought iron, steel), methods of standardization during the truss era, and unique methods of construction from that period, such as pin connections, use of rivets, eyebar designs, built-up members and chords, and other approaches. Many old truss bridges have narrow decks, too narrow to fit large trucks and vehicles. This would not seem to make much sense until you remember that when the bridges were built, passengers rode in buggies pulled by horses. These were a bit more narrow than semis.

Fans of the park look for good bridges to rescue and renovate. The process in itself is a celebration of bridge history, where the bridge parts are carefully disassembled, moved, and reassembled using historically

* http://www.historicbridges.org/info/bridgepark/index.htm (accessed June 28, 2008).

accurate methods. From about Thanksgiving through New Year's, the old truss bridges are lit up with festive lights, providing a visual spectacle of glowing bridges from the past.

In Massachusetts, an effort has been under way to restore and preserve lenticular truss bridges.* The lenticular truss shape is distinctive and interesting. Unlike most boxy, angular truss bridges, lenticular trusses have top and bottom chords that curve, more closely following the shape of the imposed bending curve. Professors at the University of Massachusetts, Amherst, inspected nine remaining truss spans out of 300 hundred or so that were built in the 19th century. Two of the bridges were disassembled and rebuilt as pedestrian bridges on the UMass. campus.

The decision to rebuild versus replace is not easy, because the issues involved are often not directly comparable. For example, how do you compare deficient safety in an existing structure with historic value for landscape preservation? Both are clearly important, but there is an apples-and-oranges aspect to the discussion. The Indiana division of the Federal Highway Administration provides a checklist of alternatives.† These include the "Do Nothing Alternative," rehabilitation alternatives, bypass alternatives, and relocation alternatives. The discussion, alternatives, and process is similar to the debate about sustainability, for which civil engineers are also trying to develop rational procedures and ways of comparing disparate issues to support the decision-making process.

Infrastructure will always include a mix of the old and the new. Over time, we all hope that the process will result in preservation of what deserves to be preserved. But exactly what is worthy of preservation is hard to say. Maybe we will never clearly define what is worth saving, so we will always have to engage in an informed debate. Beauty, or in this case, grace, may only be in the eye of the beholder. Like many other things in life, when you encounter a really good historic bridge, one that should be saved for future generations, you'll know it when you see it.

* http://www.ecs.umass.edu/cee/cee_web/bridge/1.html (accessed June 28, 2008).
† http://www.fhwa.dot.gov/indiv/brdgaltr.htm (accessed December 23, 2008).

Covered Bridge

Connecticut is one of the most densely populated states in the nation. But when you drive south on Route 7 in the Housatonic River valley, you wouldn't know it. Connecticut's northwestern corner is rural and remote, more like the northwestern United States than the northeast. Long stretches of the highway are isolated, with only a few farms and summer homes nearby. Route 7 parallels the Housatonic River for many miles. In the summer, whitewater kayaks ply the rapids and tubes just float upon the calmer parts of the river. The forested Litchfield hills rise along both sides of the river in an enveloping, agreeable way.

Besides being naturally beautiful, the valley is home to several covered bridges. A good covered bridge tour starts just north of the border in the village of Sheffield, Massachusetts, where the Upper Sheffield Bridge crosses the Housatonic (figure 1). This bridge, with an impressive 93-foot span, was built in 1832 and reconstructed in 1998. About 20 miles south is a terrific bridge at West Cornwall, Connecticut (figure 2). The West Cornwall Bridge has two spans, with a total length of 242 feet. As covered bridges go, this one is a giant. It features Town Lattice and Queenpost Trusses, and it was built in 1841. A little bit further south is Bull's Bridge, a covered bridge built in 1842 and spanning 109 feet over a fork of the river (figure 3)

Covered bridges were constructed during a brief period in bridge building history. If you consider the history of bridges as a progression from primitive fallen logs across streams to today's magnificent, complex suspension bridges, covered bridges occupy a quirky niche in the technological development sequence. At the start of the 19th century, the industrial revolution was under way, and demand increased for

Figure 1. Upper Sheffield Bridge crossing the Housatonic River in Sheffield, Massachusetts.
Source: Courtesy of Rachel Brenner.

Figure 2. Covered bridge in West Cornwall, Connecticut.
Source: Courtesy of Rachel Brenner.

reliable roads and bridges. The rivers that needed to be crossed were wider and deeper than what had been spanned before. But bridge builders only had stone, wood, and mortar to work with, because the new materials of steel and reinforced concrete had not yet evolved for wide use. The bridge with the first large use of structural steel, the Eads Bridge crossing the Mississippi, was built decades later, with construction starting in 1867.

Without concrete and steel, longer-span bridges were built out of wood trusses. Wood is a versatile material, readily available in the northeast and easy to fabricate and form. But it is susceptible to rot and bugs, and unprotected timber bridges don't last very long. One way to build longer-lasting wood bridges is to keep rain and moisture off the trusses. In the early 1800s, builders knew how to keep their houses dry by building a roof with shingles. So the idea was adapted to the wood bridges.

For only a few decades did it make sense to build what was essentially a bridge-house. Then, the technology advanced, and covered bridges were no longer needed. But many of the ones that were built

Figure 3. Bull's Bridge in Kent, Connecticut.
Source: Courtesy of Rachel Brenner.

remain. The bridges are charming, idiosyncratic structures, snapshots of a time that came and went quickly.

Covered bridges are often cherished, by both visitors and local residents. Although the bridges are greatly appreciated, preserving them for current and future generations is not easy. From a strict bean-counting analysis, covered bridges can be replaced by contemporary steel-and-concrete structures for less money than it may take to rehabilitate and maintain the timber bridges. The skills required to maintain the structures in their historical forms, while common in the early 1800s, are not widely available today. Rebuilding timber trusses using correct details requires knowledge and ability in carpentry. This can be expensive.

Another challenge is the need to upgrade the structures to satisfy modern transportation requirements. They didn't have large, heavy tractor-trailers barreling down the interstates in the 1840s. They didn't have interstates. For covered bridges to function as actual bridges, and not just museum artifacts, they must handle truck loading, with weights and impacts much greater than a horse and buggy. Even if a timber-covered bridge is in perfect condition, it probably can't carry such large loads. Also, application of the current bridge design code requires not just support of vertical loads, but also lateral loads resulting from wind and earthquakes. Very few early 19th-century bridge builders gave a whole lot of thought to designing their structures for earthquakes.

So rehabilitators of covered bridges have a problem. If they try to update the bridges to meet modern requirements, the structures often can't handle them. Supplemental framing and structural elements are necessary—new timber beams, new connections, even steel beams and framing. At a certain point, the structure is no longer a covered bridge, in the sense that the loads are now supported by the new structural elements and not the original parts of the bridge. For example, the Chiselville Bridge in Arlington, Vermont, has a modern, supplemental steel beam framing system supported by a concrete pier. The steel beams and pier form a separate, independent bridge, with the original timber framing remaining in place, but not carrying the traffic loads. So the structure looks like a covered bridge. The original parts are still there, but function only as a shell covering the real load-carrying structure.

Which brings us to a historical-philosophical debate: at what point does the bridge become a shadow of its former self? When is it not a

real covered bridge anymore? How much rehabilitation is too much? Yet, without proper rehabilitation, the bridge may no longer be able to function as a bridge and, eventually, we are left with nothing. Without its steel beams and concrete pier supports, the Chiselville Bridge might have been demolished altogether. At least with the modern improvements, we get to experience the appearance and illusion of a covered bridge, if not the real, load-bearing structure.

If you're hungry in northwestern Connecticut, West Cornwall village has a nice restaurant with an outdoor patio near the bridge, making it a great place to enjoy dinner. The food is good but, even better, you sit only a few feet away from the churning Housatonic River and the beautiful double-span covered bridge. The structure carries one lane of traffic, and as your entrée is delivered to your table, you can hear the clapping of the floorboards as cars from opposite directions take turns driving slowly across the span. In between the passage of cars, you are treated to the countryside murmur of the bubbling river, singing birds, and chirping crickets. The bridge looks just right, nestled in a green valley next to the perfectly scaled country village. As an example of cutting-edge technology, the West Cornwall Bridge's moment in the sun has come and gone. But the bridge still graces the valley as an unconventional monument to the ways things used to be built.

Infrastructure at the End

Rachel's hamster, Wolf, was a happy rodent who liked to be hand-fed seeds and fall asleep in the pocket of Rachel's hoodie. He lived to a ripe old hamster age, something like the human equivalent of 220 (which leads me to suspect that there's something fishy about the "human equivalent" calculation—you know, dog years, cat years, and so on). In his final days, Wolf started to lose his hair and became lethargic, not moving around much or playing. He stopped drinking, and Lauren took him to the vet, where he was prescribed a hamster antibiotic. The medicine seemed to make things worse. Rachel set up a heat lamp to keep him warm that night, and he was still breathing, but we didn't hold out much hope.

The next morning, Wolf was gone. We had prepared for the moment with a formal ritual. A lot of the ritual was based on physical things, as a way of accounting for things that can't be accounted for. We tried to acknowledge the fact that one minute Wolf was here and the next he wasn't. We had a solemn ceremony in the back yard, with some prayers. Wolf was a good pet, and we tearfully prepared a small grave and memorial rock for his resting place.

Mortality is the fundamental, unknowable mystery. To deal with what is essentially not dealable, we have developed an infrastructure of familiar things to help us cope. Some of the greatest engineering feats from antiquity are mortal attempts to achieve or at least address immortality. The pyramids have no practical use that we know of in this world, but they have risen for centuries over the Egyptian desert. The spectacular Taj Mahal is frequently referred to as the world's most beautiful building. Yet it is actually a mausoleum completed in 1648. The Mughal

emperor of India, Shah Jahan, commissioned the Taj Mahal as a mausoleum for his favorite wife, Mumtaz, who died in childbirth.

Modern cemeteries are cloaked in common things. They have infrastructure components that the living are used to seeing. Many are designed as otherworldly villages, with streets and destinations. In larger cemeteries, the intersections have stop signs and basic traffic control devices. I don't know of any cemeteries with signalized intersections, since the traffic demands of the living are not that great at these locations. We can only hope that we will not be dealing with graveyard freeways anytime soon. But otherwise, the layout of cemeteries tends to be very geometric and familiar, especially for civil engineers. Cemeteries have plots and plot plans, as if they were housing subdivisions, but not quite. Older cemeteries remind you of Transylvania, with hideous, spooky trees and scattershot, disorganized spaces.

With the passing of time (which there is a lot of at cemeteries), the spatial designs have become more refined and delineated. There is even distinction between upper- and lower-end facilities. Upper-end cemeteries can be like luscious parks, with ponds, beautiful but serene landscaping, and all sorts of special accoutrements. Loved ones may feel that the beautiful surroundings ease the way for the departed—a final resting place that's nice to be at and that is actually restful. But, of course, the living don't really know whether the departed appreciate the park-like surroundings. So the plush facilities ease the way for visitors.

Although it is cloaked in everyday things, a cemetery is a place where we are forced to confront otherworldly issues. So the boundary between a cemetery and the outside world is uneasy at best. Some larger and newer cemeteries in the suburbs are set back in the woods, and the living world is shielded from the other world by a green belt of trees. But older cemeteries in more densely built areas are not so well separated. At one cemetery I visited, a street with houses juts awkwardly into the cemetery space. This cul-de-sac is surrounded on three sides by the rolling greens of the plots and tombstones. The borderline is marked by a black metal fence, slightly upgraded from a gray chain link fence. I wonder what the people are thinking here, both the home owners who are surrounded by the graves, and the funeral goers who must listen to kids splashing in the backyard pools during the service. These uses of space

seem mutually exclusive, and yet there they are, placed side by side and somehow coexisting.

After a long enough period of time, a cemetery no longer fills the role of being a cemetery, in the sense of its direct connection between the living and their departed loved ones. In downtown Boston, several burial grounds are situated next to busy streets, surrounded by tall, modern buildings. The deceased have long since stopped receiving visits from relatives. Instead, the visitors are tourists who come to pay respects to notable gravesites, but also to take in the spectacle of the discordant site. A cemetery is not something that belongs in the heart of the modern city, the nerve center of commerce and a temple of the living. So its presence is both jarring and interesting.

In Kevin Brockmeier's novel, *The Brief History of the Dead,* the hereafter is described in concrete, graphic terms. In this story, people congregate after death in a city that is not heaven and not hell, but something in between—a vast, working city with all the features and infrastructure forms of modern day life. The people have jobs, apartments, and travel around living their afterlives. They exist for decades in this strange city, frozen in time and place. The city itself is not other-worldly at all. It has streets, subways, districts, factories, stores, and a riverfront with a large suspension bridge. The suspension bridge crosses the river and goes somewhere, but we never find out where.

Maybe expressing ideas about mortality in terms of infrastructure is the best we can do. Infrastructure is common and understandable, and it surrounds and defines our everyday lives. But, of course, there's no way of really knowing. I like the idea about suspension bridges in the hereafter. I hope they are beautiful and well-designed.

Marina Bay in Winter

On an unseasonably warm winter evening in December, I was driving home on the Southeast Expressway in Boston. The thermometer was close to 60. Strangely enough, so was the indicator on my speedometer—in the middle of rush hour. For no good reason, the traffic was ripping, flying past the windmill, accelerating past the yacht club and the gas tank, with not a brake light in sight. To celebrate my good fortune, I took a little detour and stopped at Marina Bay. I pulled off the expressway, crossed the Neponset River, and drove into the parking lot.

Marina Bay was largely deserted. Without the typical throngs visiting in summer, the boardwalk was empty. Most of the boats had been pulled from their slips in the water. Some were up on cement blocks in the parking lots. Others had been placed in their winter berths inside the large nearby hangers.

The quiet of the warm winter night was disturbed only by the occasional roar of the jets approaching Logan Airport on the southern glide way. Otherwise, everything was still. The outdoor music nightclub was shuttered. The palm trees had been uprooted and moved inside. Because the winter was so warm this year, the trees could have stayed out. But the unusual warm streak couldn't be relied upon for palm tree health in the Boston winter.

For a moment, I imagined that the nightclub was open and alive. The people were back on the boardwalk. The bars overflowed, and guests sipped colorful drinks with little umbrellas. A band was playing—waves of music bounced off the unfrozen water. It was Don Henley singing "The Boys of Summer." Thoughts of summer faded. There was nobody on the road, nobody on the beach.

I walked slowly down the lonely boardwalk, past the gazebo to restaurant row. The restaurants were open but mostly empty. The outdoor seating areas had long since been closed, and the chairs stacked. Marina Bay was really a summer destination. People didn't think of eating there in December, even on that peculiar, summer-like night.

When the air temperature is a good 30 or 40 degrees above what it should be in Boston, you can't help thinking about global warming. Beyond dark, misty Spectacle Island looming in the distance, you could imagine porpoises and manatees frolicking in the strangely warm bay. A tropical breeze gently massages the waters of Stellwagen Bank, and further out over the Atlantic, the warm air ruffles the site of the *Titanic*'s underwater grave. All of Greenland and the Arctic could be melting, and sheets of ice crack, crash, and float in the water in a last gasp of polar frigidity. Like ice cubes in a warm soft drink, they bob and weave until they too melt, the final vestiges of a colder time.

As much as these things are possible—and a consensus has formed that the earth is rapidly getting warmer—you can't conclude that the earth is warming after one night. One freakishly warm December night in Boston may provide emotional evidence for global warming, but it still doesn't provide concrete data. A few weeks later, the weather turned, as it often does in New England. Then, a freakishly cold February provided contrary emotional evidence that a new ice age was about to begin.

But putting aside the emotional debate about cause, effect, and human impact on the environment, and assuming that (for whatever reason) the climate is getting warmer, the implications are dire and the future responsibilities for civil engineers are significant. In the same period of time that the climate has warmed, the number of people living and building along the coasts has greatly increased. The development of Marina Bay itself is based on an unspoken assumption that sea level will stay at its current elevation, more or less, and not increase by, say, 10 feet. Even a rise of a few inches would place Marina Bay at risk of more severe flooding from coastal storms. Today, the bay forms a pleasant backdrop in its current location. But if the boats start to end up in people's living rooms, it would be less pleasant.

One of New England's benchmark natural disasters, the unnamed hurricane of 1938, was a Category 4 storm that threaded a needle to

land and crossed the Long Island and Connecticut shore lines. As we now know, it is not easy for a Category 4 hurricane to make landfall in New England. The factors for such a storm include a limited window of opportunity in September, warm water up the Atlantic coast, and an unusual storm path and size that had to hit New England and move in just such a way as to cause maximum destruction. The storm surge led to massive flooding, including the inundation of downtown Providence. The flooding resulted in hundreds of deaths, and massive harbor floodgates were built in both Providence and New Bedford in response. You can see the hurricane barrier in Providence while driving across the beautiful new I-195 tied-arch bridge at the head of the river (see photograph, p. 141).

Many who study global warming are concerned that severe coastal storms will be more frequent and intense. What will we do, then, if hurricanes as strong as the one in 1938 regularly pummel the New England coast?

Part of the debate about global warming focuses on whether the climatic change is human-made. So discussion has focused on steps to be taken to cool things down. Activities such as conservation and alternative sources of energy besides fossil fuels make sense anyway, regardless of warming trends. The problem with the debate is that it is often emotional and political, veering away from science and engineering.

If sea level is going up, whether caused by humans or climatic cycles or both, and more people choose to live at the coast, then engineering may be the only defense. Civil engineers have successfully protected most of the entire nation of Holland, which is largely below sea level. Following catastrophic floods in 1953, Dutch engineers developed a sophisticated system of dikes and flood control devices that have successfully kept the North Sea out. That entire nation's existence is dependent upon good civil engineering, and to date the engineers have come through.

The U.S. experience is less impressive. After years of warnings, most of New Orleans was flooded by Hurricane Katrina. The dikes held except at a few locations where they didn't, and that was enough to lead to the destruction of wide swaths of the city. New Orleans was reported by many to be a disaster waiting to happen. If most of New Orleans could be submerged, what would happen to the rest of the country if

the ocean rose? Downtown Boston is only about 10 feet or so above sea level. Many parts of New York City are likewise susceptible to flooding. The area surrounding the Sacramento River in California is thought to be susceptible to a Katrina-like disaster.

Civil engineers will be responsible for dealing with many of the impacts of global warming: higher sea levels, more flooding, changes in rainfall patterns, and water supply to cities. During a warm December night, I enjoyed the breeze at Marina Bay. It may have been the calm before a much bigger storm. The bay was serene, the empty docks gently bobbed. A hint of a breeze came from the west—a cold front was approaching, and tomorrow, the temperatures would be a little bit closer to what is today considered normal for the winter.

Bridge Circuits

I was driving across the Harvard Bridge towards Cambridge on a beautiful late summer night. It was a truly spectacular sight, with the sun low on the western, Fenway Park horizon. Light bounced off the Charles River and the State House dome. The joggers were out in full force on both sides of the bridge, soaking in the late sunlight and the atmosphere of the place. I was feeling a little sorry for myself—I wanted to stop the car and jog around the Esplanade too. It was a nutty idea, until I remembered that I had my gym bag in the trunk with running sneakers. I pulled into a spot on Memorial Drive, discreetly (as much as was possible) changed into running clothes, and I was off.

Starting on the Massachusetts Institute of Technology side along Memorial Drive, I moved into an easy gait. The riverfront was totally packed that night. Everyone was out running and biking. Now the sun had just set, and a full moon rose between the Prudential and Hancock Towers. With the gold State House dome rising on Beacon Hill across the water, it was one of those storied Boston moments that appear on postcards, truly one of the most beautiful urban views in America. Several tourists had set up camera tripods at the junction of Mass. Ave. and Memorial Drive to try to capture the scene. These weren't casual cell phone shots, but real photographs, with lots and lots of pixels or maybe even high-resolution film. Moonlight reflected off the gently shaken surface of the Charles, egging on the photographers.

I moved out onto the Harvard Bridge, picking up the pace a little. I wasn't in college anymore, but I didn't want to run a 15-minute mile, not with all the students zooming by. I'd been out of college for several decades, but this is where I used to run when I was in school. Also, the

Green Line wasn't anywhere nearby, so I couldn't pull a Rosie Ruiz.* I wanted my run to be respectable.

The wind was salty and aromatic, with a different fragrance than what I remembered from the Charles River of the past. The Charles has been cleaned up. The river isn't quite swimmable, but it's getting close. Clean water groups are organizing river swims, and the concept isn't as daring as a few decades ago, when you could do the crawl and your arm could potentially dissolve. It won't be long before Magazine Beach in Cambridge will be an actual swimming hole and not just a name on the map. Then "Dirty Water," Boston's unofficial theme song, will sound quaint, harking back to the good old days when whatnot floated in the Charles.

The magnificent Charles River basin was made possible by a series of civil engineering triumphs. When the colonists arrived, the Back Bay was converted from a wetland into a fetid, miasmal swamp. It was a dumping ground for the growing city until a vast land reclamation project filled it in. The area is now home to the most organized grid of streets in Boston, with the city's archetypal, Victorian brick architecture and gas lamps. The amazing Newbury Street is the area's commercial spine. Its lively street life offers intimate storefront nooks and crannies, where you can sit in the summer at patio cafes and watch the scene. Charming Newbury Street was built out of the ooze.

To build the basin, the Charles River was dammed twice, creating the widened stretch of river that looks more like a lake. Parks were constructed along the river bank and extended for several miles upstream. Today, it is possible to string together paths of different intervals by connecting to different bridges. You can run or bike three miles, 30 miles, or some amount in between, depending on how you mix and match the bridges. The connecting paths are known by the natives as "bridge circuits."

My impromptu jogging circuit that evening was one of the most popular routes, connecting the Harvard and Longfellow Bridges. The Harvard Bridge crosses the river at its widest point and features about

* Rosie Ruiz was the first woman to cross the finish line first in the 1980 Boston Marathon. But she didn't win the race when it was determined that she didn't actually run most of the route. See, for example, http://www.museumofhoaxes.com/day/04_20_2001.html (accessed December 22, 2008).

Figure 1. Harvard Bridge crossing the Charles River in Boston.
Source: Library of Congress, Prints & Photographs Division, HAER MASS, 13-BOST, 79-3.

half a mile of low-slung trestles spanning the water (figure 1). It seems to me that this bridge is perfectly proportioned for its site. The low, modest spans that leapfrog across the water make the river appear wider than it really is, accentuating the spanning and distance between shores. The Harvard Bridge fits really well at its site, but unfortunately it is not well-named, since it actually connects the Back Bay to MIT and not Harvard.

Even though it was called the Harvard Bridge, MIT students still made their mark. The bridge features unusual, geometric sidewalk markings. Joggers and bikers would pass by a series of numeric tick marks on the concrete called "Smoots" (figure 2). The backstory involves an MIT freshman, Oliver Smoot (Class of 1962), who was pledging for a fraternity back in the late 1950s.* One night he sipped a little too much, and then his fraternity brothers thoughtfully decided to use him to measure the bridge. They used his body as a giant yardstick, measuring the span and marking off its length. The official length of the bridge is 364.4 Smoots plus one ear. As a community service, the MIT fraternity repaints the bridge markings every fall. Even when the entire bridge

* http://web.mit.edu/spotlight/smoot-salute/ (accessed December 22, 2008).

Figure 2. Harvard Bridge sidewalk with the marker for 10 Smoots.
Source: Library of Congress, Prints & Photographs Division, HAER MASS, 13-BOST, 79-20.

was rebuilt two decades ago and the original concrete sidewalks were demolished, the frat brothers returned to the rebuilt bridge to mark the Smoots so that the tradition could live on.

Jogging toward Boston on the Harvard Bridge, I could see Fenway Park to the right and the Hatch Shell to the left. On some humid summer nights, the lights would be on in the Park, and the roar from the baseball crowd would carry all the way to the river. Most nights the Hatch Shell was quiet, except on July 4, when hundreds of thousands of Bostonians camp out on the Esplanade for the Boston Pops concert. Then, the paths and lawns are packed with the revelers waiting for the traditional *1812 Overture* and blast of cannons. On that day, with so many people out and about, it isn't so easy to complete a bridge circuit, but you could. In fact, I was jogging on a July 4 when I first met my future wife, Lauren.

At the midpoint across the bridge, I looked out over the water. Down on the basin, a lone kayaker lazily paddled on the moonlit, shimmering surface of the Charles. He was a college kid, maybe 19 or 20. He wasn't going anywhere very fast, just content to glide gracefully through the light swells on the wide river basin. In front of him the city presented itself, the best of Boston: the Esplanade, the Hatch Shell, the dome, the brick byways of Beacon Hill. Gas lamps were lit on the hill, and if you imagined hard and ignored the traffic on Storrow Drive, you might think it was the 19th century and not the 21st. The college kid looked and paddled like he didn't have a care in the world. I wondered what he was thinking.

List of Bridges

Acknowledgments

It is well known that ASCE Press Acquisitions Editor Betsy Kulamer is one of the best technical editors around. I am very fortunate and grateful that she edited my writing. What is not as well known is that Betsy was proposed to on a bridge (and how excellent is that!). I learned this interesting and important fact during the editing of this book. I suggested that we include a photo of a lenticular truss bridge. One of the candidate bridges, the Smithfield Street Bridge in Pittsburgh, turned out to be where the proposal took place. We have not learned the details of the event, such as whether or not bridge statistics were cited during the discussion. I know that's what I would have done.

Betsy's colleagues at ASCE are terrific. I am grateful for their ongoing support and encouragement for both my books and my work on ASCE journals. Thanks go to Managing Director Bruce Gossett and the publications crew, including Bill Nara, Charlotte McNaughton, Melissa Junior, Kelly Anderson, and Beth Staehl. The Boston Society of Civil Engineers Section of ASCE also has been very helpful for my writing work—special thanks go to Civil Engineering Practice Editor Gian Lombardo and journal editorial board members Jim Lambrechts and Ali Touran.

Some of the world's best bridge engineers work at Fay, Spofford & Thorndike. That is a shameless plug as well as the truth. I am grateful for the opportunity to work with Robert Bertolino, Len Dzengelewski, Paul Harrington, Danny Lee, Erik Vilmunen (big Erik), Eric Pheifer (little Eric), Joe Tierney, Elizabeth Schweihs, Ed Laracy, Stephen Cotter, Guy Ford, Henry Law, Nelson Sosa, Bhikhu Khalifa, and many other

colleagues. This paragraph gets me off the hook a little bit, because only one FST engineer, Wael Abdulkader, made it into an essay in the book. Although unfortunately he's not even a structural engineer, he's still a good guy.

The chance to be a professor has turned out to be a great joy. Students have provided endless fodder for my musings. Also, I have determined that there are few opportunities in life (well, actually, no opportunities in life) where a group of people have to shut up and listen to me talk for an hour, several times per week. My bridge class has contributed some excellent suggestions for the title essay, "Bridginess." They also were treated to the experience of an entire lecture based on the Mrs. Degree. Thanks to my former student Danny McGee, who did some research in his senior year in support of several essays.

Many thanks go to my bridge research colleagues, Masoud Sanayei and Erin Bell. Not only are they both brilliant, but the two have inspired many essays.

My family and friends (those friends who are left) are very familiar with the story of my 16th birthday. Maybe they've heard the story a few times too many. It's possible that I may not have remembered the events completely accurately. So it seemed only fair to give them a chance to tell their understanding of what happened, perhaps to shed a little light on the momentous occasion.

Here's what my mom has to say:

> A Word about Brian's Sixteenth Birthday…
>
> First of all, let me say that had it not been for Brian's whining about the occasion all these years, I would have very little memory of what actually happened. What I do remember is that my two oldest children, Brian and his sister Beth, have birthdays one week apart in March. Very often, the birthdays are celebrated together. As Beth was in from college that week, this was a time that a joint celebration was planned.
>
> It is unfortunate that Brian was not able to join us—it certainly was not our intent to traumatize him over the years. For this—my sincere apologies.

The moral of this story is: Parents, beware! Don't ever *not* celebrate your child's birthday—he'll never let you forget it!

Love ya, Bri,
Mom

My technological friend, Seth Frielich, shares the following comments:

> Brian and I were in Israel for vacation with our families and a group of friends. After traveling around the country and seeing all sorts of amazing sights, we arrived at the base of Mount Masada. Masada is the ruins of a fortification on the top of a mountain near the Dead Sea, where Jewish resisters withstood a two-year siege by the Roman Tenth Legion.
>
> After a late start we arrived at the base of the mountain, just as the sun was reaching its peak intensity. The journey started out uneventfully, but as we climbed the steep trail up to the fort, the temperature soared past 110 degrees. Some of the members of our group were not prepared for this level of physical activity, so Brian and I assisted the slower climbers by sharing our water and snacks. After a grueling climb up the mountain we arrived at the fort on the summit, where a local villager had set up a stand and was selling freshly squeezed orange juice. Brian took one look at the fresh squeezed cool drink and bought a cup right away. (It was only when we were back in the air-conditioned bus that he realized that cup of juice cost him $27!) As Brian was drinking the juice, he looked at the salesman and said, "Did I ever tell you about my 16th birthday?" Brian proceeded to tell the man in excruciating detail all about his 16th birthday, and how his parents went to his birthday dinner without him. All while he was home in bed sick.
>
> The local man politely smiled and nodded his head. Brian has never realized that the gentleman did not understand English.

A close second to Seth's story above would be the time I took him to the emergency room. Seth had an unfortunate battle with a glass shower door, and the door won. I presented Seth, bloody and covered in shards of glass, to the doctor.

The doctor said, "Your friend is not in great shape."

I said, "That may be true, but you should hear what happened when I turned 16."

My beautiful, wise, and spectacular wife has this to say:

Having been married to Brian for almost 25 years and together for two years prior to that, I have heard his rendition of his 16th birthday incident on many, many, many, many occasions. Friends would tell their tales of woe and then (as I would clearly hear the theme to the *Jaws* movie in my head) I knew the next thing Brian would say would be, "Well, let me tell you about the time…." His trauma about his 16th birthday experience was also his rationale for not wanting to make a big deal about birthdays (thank goodness our kids had me for that) and other "special" days. Now, please don't misunderstand, birthday events aside, Brian has many good qualities, including his sense of humor and writing talents. But his memory of events is not one of them. Regarding his birthday, he does not remember that his family was also celebrating his sister's birthday. This fact was a topic of conversation last summer at a family birthday party. If Brian really wants something to get upset about, it should be that at his 16th birthday dinner, his family thoughtfully ordered a dessert to take home to him. They ordered Baked Alaska and then proceeded to eat it at the restaurant—so there was no special dessert for him, to add insult to the situation.

In conclusion, I am personally relieved that Brian is sharing this story in the book. Having endured this retelling, as well as having climbed a mountain to get proposed to and played backgammon while in labor in order to select a name for our first-born, I hope that now no one is left on the planet

who does not know about his 16th birthday, and we will all be spared from hearing about it another time.

Respectfully,
Lauren

Gotta acknowledge the kids: My excellent son, Daniel, is going to be a senior at the University of Maryland this year. He was on the dean's list and he continues to amaze me and make me proud. My beautiful and talented budding writer, daughter Rachel, contributed a great poem to lead off the book, and her photographs grace several essays.

Life is short, but with my friends, family, and colleagues, it is sweet. Thank you.

Publishing Credits

The following essays first appeared in *Civil Engineering Practice* and are reproduced with permission from the Boston Society of Civil Engineers Section: "Mass General, without the M," "Back to School," "Aqua Teen Hunger Force Attacks I-93!" "Buffalo on 495," "Gephyrophobia," "Managing to Avoid Congestion," "Providence," "What Happened to John T. Mongan," and "Don't Rezone for Brickstone."

The following essays first appeared in *Journal of Leadership and Management in Engineering*: "My Name," "The MRS Degree," "Niche Knowledge," "Back at the Olive Garden," "Airport Inspection," "Bridges at the Beach," "Go Jump Off a Bridge," "Glacial Potholes," "See the Squirrels, Find the Nuts," "Leaving Things on Top of the Car," "The Dumbest Generation," and "Marina Bay in Winter."

The following essays first appeared in *PB Network,* the internal technical journal of Parsons Brinckerhoff, and are reproduced with permission: "What the Future Should Look Like," "Managing to Avoid Congestion," and "Riding the Rails."

The following essay first appeared in *Tufts Journal* and is reproduced with permission from Tufts University: "Horse Management and Suspension Bridge Design."

About the Author

Brian Brenner, P.E., F.ASCE, is a vice president and structural engineer with Fay, Spofford & Thorndike in Burlington, Massachusetts. His work includes bridge design projects throughout New England and the New York metropolitan area. Brenner also holds the post of Professor of the Practice at Tufts University, where he teaches the bridge and concrete design classes and advises students on research projects. In 2008, he received the Fischer Award, given to the Tufts Engineering School Professor of the Year.

Brenner is active with several ASCE and Boston Society of Civil Engineers committees. He is the editor of ASCE's *Journal of Leadership and Management in Engineering* and editor emeritus of ASCE's *Journal of Professional Issues in Engineering Education and Practice*. He has published more 70 articles on structural analysis and design, engineering education, and other topics. His previous collection of essays, *Don't Throw This Away! The Civil Engineering Life,* is the ASCE Press all-time best seller in the category of civil engineering humor. Until now, it was also the only entry in the category of civil engineering humor.

When not teaching about or designing bridges, Brenner is fortunate to spend time with his spectacular wife, Lauren, and the world's two best children, Dan and Rachel. Brian is proud to report that he still builds sand castles at the beach, and he still takes Lauren on bridge dates.

That's Nice!

So Steve and I went biking in the wee hours of the morning. We got up while it was still dark and moved out in the pre-dawn. It was going to be one of those perfect summer days with bright blue sunshine and puffy gray clouds—you could just feel it. The birds were starting to wake up and perform their chirpy morning symphony.

We biked down Pond Street to the lake. The rest of the town was still asleep, with no one out and about. You could see a mist rise from the lake water as the sky started to freshen and the stars fade. Effortlessly we glided through the dim, cool morning light. Riding around East Foxboro Street to the other side, there is a point where you can see across the lake to the east. At that moment, the sun popped over the horizon. Lake mist was bathed in an orange glow. The birds stopped chirping and watched in awe.

As we biked onto Beach Street, I said to Steve: "That's nice!"

Now to appreciate the rest of the story, you would need to hear my tone of voice at that moment. You weren't there, and this is written material, but I'll try my best to communicate how it sounded. I didn't say "That's nice" in a quizzical way, or with irony. I didn't say it matter-of-factly, like when someone takes out the garbage and the garbage is no longer there and you say, "That's nice." I didn't say it in a distracted way, as if to brush off someone when you're thinking about something more important—for example:

Steve: "I've just discovered the cure for cancer!"
Brian (watching the Red Sox): "That's nice."

No, my tone of voice, my "That's nice!" was in recognition of the beauty and awe of the universe and all of creation. My utterance of the word "nice" was issued in an unctuous, overenthusiastic, drawling tone, as if I had just eaten a pint of Häagen Dazs ice cream (for the first time, I might add) and was savoring every molecule of fat. The word "nice" required about three seconds to express, with the sound of the vowel hanging: "That's Niiiiiiiiiiice!!!!!!!!!!!!!"

It was the birth of creation, the Big Bang, the moment of awe, joy to the world—all the boys and girls. That's what I saw. It was nice.

Little did I realize that there was another thing to see immediately after the sunrise. A young lady, maybe 25, was jogging on the other side of the road. She was attractively attired. Thanks to my loud, enthusiastic voice, the startled young lady could also hear my outburst of joy to the rising sun. However, Steve didn't think I was commenting on the sunrise.