

Construction in the 21st Century: Quality Concerns

ORRIN RILEY

The author is a consulting engineer in New York City.

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The abstraction *quality* has five dimensions: quality of labor, equipment, and materials, plus the elusive dimensions of time and space. The reality called *construction* also has five dimensions: planning, design, building, maintenance, and usage.

With regard to labor, we are in for a streak of good luck because of the changing demographics of the United States. In 1790 the population of the United States was 4 million people (and the center of that population was east of Baltimore, Maryland). Most of these people were from Western Europe—Great Britain, France, and the like. By 1890 the population had grown to 63 million—a 16-fold increase (and the center of that population was then in Indiana). The largest influx was from Central and Eastern Europe—Sweden down to Italy. In the 1990 census, 249 million were counted (and the center of the population had shifted to Missouri). The ethnic heritage most often listed in the 1990 census was not English but German. The fastest-growing continental group by far was the Asians, with an increase of over 100 percent in 10 years.

There are two unmistakable trends in these changing demographics. As the United States grows, the center of its population moves inex-

orably westward. But the source of that population moves eastward—to Russia, India, China, and the like. It is anticipated that by the year 2090 the U.S. population will have doubled to 500 million. Most of that increase will come from the largest and most populated continent, Asia. This is good news because that population has shown an interest in and an aptitude for the engineering sciences, as a glance at the winners of the Westinghouse Science awards or the rosters of many engineering graduate schools will demonstrate.

As for construction planning, the outlook is cloudy. There are currently about 186 million registered motor vehicles in the United States. Three trends will drive that number ever higher: the aforementioned population growth; the increasing percentage of licensed drivers (in the past 10 years the population grew by 10 percent, but the number of licensed drivers grew by 15 percent); and the increasing ratio of vehicles to drivers (there are currently 113 motor vehicles for every 100 licensed drivers).

It will not be politically feasible to disengage Americans from their worship of the private vehicle. There is the need for personal space, to hear a talk show; the need for the expression of taste, to hang a pair of furry dice from the mirror; the need for status, to show that mine is bigger than yours. The private vehicle is here to stay. It is the road that must change—but we are not changing it.

The “smart cars” currently touted are changing. But they are feather dusters, moving the particles chaotically from where they were to someplace else. What we need is a smart car “guideway,” not a highway. One plugs in at home to store energy, then tools around town or heads to the guideway, where one logs on to the increasingly fast lanes—6 feet wide for a 5-foot-wide vehicle—at a metered cost depending on speed needs and paid by inserting a debit card. Of course, once one is logged on, one’s battery is turned off. State-supplied power, paid for

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by user fees, whisks the car along at 1-meter spacing from a neighboring vehicle at 200 kilometers per hour. One manipulates one's control panel to signal an exit, whereupon the car's battery is reengaged and the drive is completed.

But perhaps travel is a conceit. We think people have to get to work, or to the casino, but do they? Would it matter, say, if those who update our specifications did so from the computer in their office or the one they have at home? Telecommuting may make highways quaint, like letters.

There is also the notion of the vertical city. Within one-quarter mile of my apartment are 12 movie theaters, 19 tablecloth restaurants, 7 supermarkets and my favorite oxymoron—5 “minisuper,” 2 hospitals, 11 drugstores, 17 bars, 2 dozen dry cleaners, 14 dentists, 8 nail salons, and a river. And if you think New York City is Gomorrah, there are also 8 churches, 2 synagogues, a mosque, and 6 museums. I would no more buy a car than a pig. What would I do with it? (The car, I mean; I could eat the pig.)

The quality of construction equipment is of no concern at all. There is a calumny heard throughout the land that somehow America has lost its way in making quality goods. It is absolute nonsense. Boeing airplanes, Caterpillar tractors, IBM computers, Timberland boots, Kodak films, Kellogg cereals, and Gem paper clips are all high-quality items of American origin that are in great demand around the world.

On the matter of materials, there is some cause for concern. The North American continent has always been blessed with an abundance of high-quality construction materials, from brick clay to clean gravel, to granite aggregates, to iron ore, to crude oil for asphalt. Of course, these materials are all depletable, and depleting. It would be foolhardy to suggest otherwise.

However, manufactured aggregates will come into play. There are now ceramics that are harder than steel, so there is no loss of quality, only an increase in cost. But with that increase in cost comes an increase in quality because we can order up the shape of aggregate we want. All the coarse aggregates can be in the shape of tetrahedrons—three-sided pyramids—nature's strongest shape.

Design, and its stepchild detailing, have been saved by three-dimensional computer imaging. There is no longer any excuse for a bridge pier cap with so many number 11 bars that one cannot get the anchor bolts in. CADD (computer-aided design and drafting) drawings give us the X-ray vision we once wished for.

And we are finally learning to live without that monster of maintenance, the top layer of reinforc-

ing steel in bridge decks. Work in Colorado and in Canada has shown that it is not needed. With fiber-reinforced concrete, we can at last get rid of that devilish mat and watch durability, which is the child of quality, take a quantum leap.

On the matter of materials testing, we are coming of age. Two ancient tests, the Marshall for asphalt and the flexure for concrete, are old design tools. They have no place in the monitoring of construction because they relate to a peculiar kind of strength, not durability, which is the dimensional quality of time. These tests have, alas, become metaphors. But belief in them as predictors of longevity is akin to belief in the tooth fairy. Thanks to the Strategic Highway Research Program, we will not endure them much longer.

As for the fifth dimension of quality, place (which is analogous to usage, the fifth dimension of construction), I would offer the following observations.

With regard to the great natural calamities that the work of the transportation sector must endure—the great floods of the Mississippi, the hurricanes in Florida, the earthquakes of California—we seem to be getting it right. Our hydrologists are remarkably close in their predictions and capacities for 50- and 100-year floods. Hurricanes have not caused a massacre of our overhead signs. Our track record on earthquakes is less sanguine. Will “the big one” bring down one of our signature bridges? We cannot be as certain. But the threat has been taken seriously. And the seismologists cannot tell us just how big the big one will be. As an existentialist, I accept that life is full of peril. In fact, it can be said that life is a terminal disease.

So how do we fare on the index of concern for quality in the 21st century? We fare very well. Of the five dimensions of quality, I see a positive score on labor, materials, and equipment. I would not score us well on durability because we are still prone to testing and evaluating the wrong parameters. And our awareness of place—our vulnerability—is warily neutral: we are ahead of the curve on wind and water, but have a sense of sublime impotence with plate tectonics.

Of the five dimensions of construction, we get a positive score on design because of a bright work force and improved computer tools, a positive score on building because of a genius with innovative equipment, and a positive score on maintenance because we will have slain the bridge deck dragon. But we are about to suffer a setback in planning because we are not ready for automated highways with high-speed vehicles at 1-meter intervals, and we get a negative score on usage because we never, ever, fully consider the robust needs of trucks.