Reason Foundation Policy Brief 97
February 2011

Transportation Mega-Projects and Risk

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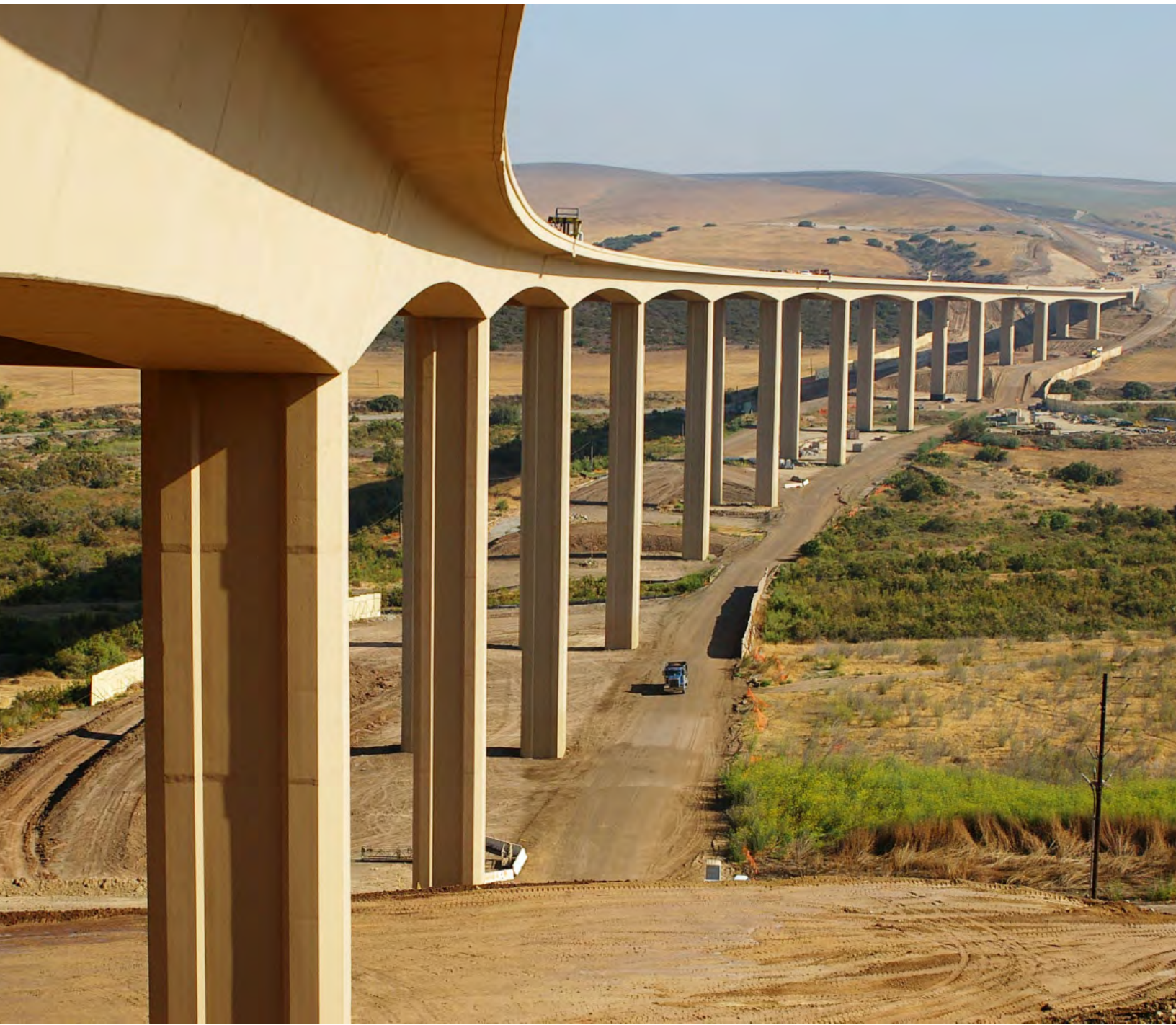

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Part 1

Introduction

Mega-projects in transportation have been uncommon in the United States for the past two decades, following completion of the Interstate highway system and a shift of emphasis in many metro areas from highways to transit. But two recent trends suggest that mega-projects may soon make a return. The first is a growing recognition that major investments in increased mobility are needed, both to relieve urban traffic congestion and to rebuild and modernize major portions of the Interstate system as they reach the end of their original design life. And the second trend is the growth in infrastructure investment funds, with over $150 billion in equity to invest in projects that can produce a reliable revenue stream (such as toll roads, bridges and tunnels).

But the observer may raise a legitimate concern at this point. What about the inherent risks of multi-billion-dollar projects? Isn't there a sorry track record of such projects costing far more than initially projected and attracting far fewer users than forecast? There are indeed such risks, and no recent U.S. project exemplifies them better than Boston's Central Artery/Tunnel project, the first portion of which opened to traffic in 2003, with all portions in operation by 2007. Popularly known as the Big Dig, this project can teach many lessons about risks involved in such mega-projects.

Part 2

Case Study: Boston's Big Dig Mega-Project

Just as American military policy has to contend with the Vietnam syndrome, American infrastructure management has the Big Dig legacy to cope with. When faced with a big, challenging project, elected officials and commentators often immediately say something like: "We don't want to get bogged down in a Big Dig scenario."

To be sure, the Big Dig is something of a paradox. As a pure civil engineering concept, it is a triumph, replacing an ugly and congested elevated freeway with a technically challenging set of tunnels and a new bridge. Indeed, now that it is in full operation, it has more than fulfilled initial promises of saving time by slashing traffic congestion. A recent study by respected consulting firm EDR Group estimated the time savings as worth $177 million per year (2005 dollars), with another $120 million per year in new property tax revenue, thanks to $7 billion in new development made possible by removal of the former elevated highway.[1]

But as an example of management, the Central Artery/Tunnel project (the Big Dig's official name) was a shambles. This $2.6 billion (in 1982 dollars) project ended up costing $14.8 billion (2007 dollars), and its development dragged on for almost two decades. The state (a.k.a. the taxpayer) has been left to carry a huge debt without any revenue to service it. It is a financial disaster. Quality control was also a disaster, as evidenced by defective concrete work, thousands of leaks, and the collapse of a tunnel ceiling.[2] Project administrators were left with near-zero public credibility and confidence. A U.S. Senate report stated of the Big Dig: "These management problems exact a terrible toll on public trust and confidence… A degree of public skepticism toward our government is healthy. Rampant cynicism is not."[3]

A. History of the Big Dig

The concept for the Big Dig was to replace the elevated I-93 expressway through downtown Boston with a tunnel. The concept is attributed to engineer and contractor Bill Reynolds in the early 1970s.[4] Chief proponent Fred Salvucci was a planner at the Boston Redevelopment Authority and then transportation consultant to Boston Mayor Kevin White. Salvucci was appointed state secretary of transportation in 1974 by new governor Michael Dukakis, but made no progress on the Big Dig. When Dukakis was not re-elected, Salvucci spent the next four years at MIT as an

engineering professor. In that period Republican Gov. Edward J. King began planning one part of what later became the Big Dig—the third tunnel to Logan Airport, now known as the Ted Williams Tunnel. Governor King's alignment for the tunnel approach through East Boston caused outrage.

Reynolds came up with the idea of combining the nascent I-93 undergrounding with an I-90 extended alignment through entirely industrial South Boston for the third airport tunnel in 1982. He sold his idea to Salvucci, who was working transportation policy for Dukakis's re-election. Dukakis embraced the idea early in his second term in 1983, and the legislature supported the project that year at the governor's urging. At that time the cost of the whole project was put at $2.2 billion.[5]

The general plan was to replace the elevated six-lane I-93 with an eight-lane, mainly underground, highway system for about three miles north-south, including a new bridge over the Charles River and construction of a new four-lane expressway to extend I-90 from its then-terminus downtown eastward to the airport. The project involved a big, new I-90/I-93 interchange. Though only 7.5 miles in overall length, it encompassed 161 lane-miles of roadworks.[6]

U.S. House Speaker Tip O'Neill became the Big Dig's most powerful proponent once the airport tunnel had been routed away from his East Boston constituency into South Boston. In Washington, DC, O'Neill had to fight the Reagan administration; Transportation Secretary Elizabeth Dole declared the project cost was "not justified on the basis of transportation benefits to the nation." But the Big Dig was incorporated in the Surface Transportation Assistance Act of 1987. Reagan vetoed the bill, singling out its support for the Big Dig as an example of unwarranted federal spending, but his veto was overridden, winning the project federal support.

Responsibility for the project in the state was always unclear. The Department of Public Works headed it initially, although the Highway Department was the recipient of federal funds. At the very height of construction in 1997, the Massachusetts Turnpike Authority gained nominal control of the project. But from its inception in 1985, a joint venture of Bechtel and Parsons Brinkerhoff (B/PB) managed the project, working as consultants to the state on an hourly basis.[7] The B/PB team had their own people doing design, which was also subcontracted by them to other consultants. Despite many years of pre-construction design, the project became notorious later for bids being put out with incomplete designs and sketchy data on existing conditions. Contractors found themselves with hundreds of change orders. The project ultimately consisted of 118 prime contracts.

Salvucci, then state secretary of transportation, said that as soon as federal funding came in sight the politics got more difficult: "Special interest groups, government organizations and individual communities all wanted a piece of the well-funded actions." For example Mayor Raymond Flynn made a splash in 1990 demanding that the Bid Dig fund a rat control program to cover the whole city on the argument that road construction would displace millions of rats and cause them to invade even distant neighborhoods, if they were not put down with federal dollars.[8] Scores of buildings got money for noise control. Indeed, some assessments put "mitigations" of this sort as accounting for one-third of the project's $14.8 billion ultimate cost.[9]

The airport tunnel portion was broken away from the rest of the project in the early 1990s and construction began by the end of 1991. It opened in 1995, without connections, at a cost of $2 billion. On the main part of the project, the undergrounding of I-93 and the I-90 extension approach roads to the Williams Tunnel, the big interchange and the bridge design and permitting process continued for seven expensive years from 1987 through 1994. Amid intense lobbying, new expensive features were being added constantly.

In 1987 project cost was put at $3.2 billion. By 1991, when construction of the airport tunnel portion began, it had grown to $5.8 billion, and by 1994, when the design had firmed up enough for construction to begin on its main portions, the projected cost was officially put at $7.8 billion. But a 2001 report by the Massachusetts inspector general found that B/PB in 1994 had forecast that eventual costs would be in excess of $13.8 billion; however, this finding was suppressed by Gov. William Weld's office, which worked with local Federal Highway Administration (FHWA) officials to reduce the "official" estimate by $6 billion (to $7.8 billion), to avoid jeopardizing requests for continued federal funding.[10]

Before the spring of 2000 the Big Dig's acknowledged project cost had increased to $10.8 billion. Then, in a moment of great drama, then-Govenor Paul Celucci accused Turnpike Chief James Kerasiotes of intentionally concealing $2 billion worth of cost overruns and destroying the trust of the feds. He was fired. FHWA's main office in Washington by this time had discovered the fraud. Costs were now put at $13.5 billion or more. By the time the Big Dig was fully completed with all lanes open to traffic in 2007, the final cost was put at $14.8 billion.

B. Big Dig Lessons

The lessons of the Big Dig have been the subject of many discussions[11] and will be the subject of many more. Many of the lessons are somewhat obvious. Mega-projects need:

- Teamwork;
- Goals, benchmarks and schedules set more precisely;
- Projected costs expressed in construction year dollars and, where uncertain, in ranges of dollars rather than single numbers;
- Contingencies carefully estimated;
- Cooperation of the various stakeholders;
- Champions to fight for these projects;
- Honesty and candor throughout; otherwise bad news will come as a shock, losing public confidence, and
- Vigilance against project creep.

The major source of cost increases in mega-projects is project creep. The scope of the project grows as it is developed, adding unanticipated elements and unforeseen complexity. Special interest groups inject new objectives that serve their agendas on the windfall of funding. Groups

opposing the project need to be appeased to enlist their support. In other words, everyone wants something out of the project.

As Jim Sinnette of the Federal Highway Administration major projects team writes: "Big projects are sometimes perceived as opportunities for piggybacking additional projects, completing multiple projects, or producing prominent public symbols such as a signature bridge rather than opting for a less costly but less prominent design."[12] Sinnette also notes that people expect projects to be "highly responsive to constituents' needs."[13]

Political appointees tend to have very short time horizons. Heads of state departments of transportation and state turnpikes are usually appointed by the governor. They expect to be replaced when the governor's term is up. Massachusetts Turnpike chairmen and chief executives (the two roles were combined during most of the Big Dig's construction) had an average tenure of about two years. Often these people were former legislators or persons aspiring to higher political office. Their preoccupation was to avoid trouble, or more precisely, the perception of trouble, during their short time at the helm. This drive to avoid short-term embarrassment sometimes goes higher still, politically. Massachusetts Inspector General Robert A. Cerasoli reported, "Bechtel Corporation's president and a senior partner flew to Boston in December 1994 to inform the Governor and his senior advisors about B/PB's real cost forecast . . . . Big Dig managers decreased the $13.8 billion estimate to $8 billion for public relations purposes in 1994–1995 by applying a series of exclusions, deductions, and accounting assumptions. This reduced the estimate by $6 billion."[14]

Politicians do not have to live with the consequences of projects like the Big Dig because most of them have left office long before the project is completed, let alone before its viability as an operational project can be subjected to scrutiny. Voters and the media will have long forgotten them by the time it becomes apparent that traffic forecasts were exaggerated, costs were underestimated, and expensive political perks were added.

Part 2

The General Problem of Mega-Projects and Risk

Boston's Big Dig project is not an isolated case. The track record of transportation mega-projects is terrible. The costs are usually significantly underestimated, and traffic is typically dramatically overestimated. Many recent rail projects have similar, well-documented histories. It will be difficult to get public and political support for much-needed mega-projects without better-performing project delivery models.

This challenge was taken up several years ago by Danish academic Bent Flyvbjerg and colleagues in a book called *Megaprojects and Risk* (Cambridge University Press, 2003).[15] They document the global nature of the problem, analyze its causes and offer useful ideas on doing better.

First, Flyvbjerg and colleagues cite studies showing that this is hardly a new problem, nor is it unique to a few countries. One of the most comprehensive studies (from Aalborg University) covers 258 highway and rail projects ($90 billion worth) in 20 countries.[16] Nearly all (90%) suffered cost overruns, with the *average* rail project costing 45% more than projected, the *average* highway project 20% more. Traffic forecasts were also far from accurate, with rail projects generating an average of 39% less traffic than forecast (though highway projects averaged a 9% *under*-estimate of traffic).

Flyvbjerg concludes that the "cost estimates used in public debates, media coverage, and decision-making for transport infrastructure are highly, systematically, and significantly deceptive. So are the cost-benefit analyses." Many other analysts have reached similar conclusions. Flyvbjerg goes on to explain why this comes about. First, he cites two MIT researchers' conclusion that "the incentives to produce optimistic estimates of viability are very strong and the disincentives weak." And the reason for that is a lack of accountability of the parties involved, not a lack of technical skills or insufficient data.

Another key insight is that "risk is simply disregarded in feasibility studies . . . by assuming what the World Bank calls the EGAP principle: Everything Goes According to Plan." But in mega-projects like the Big Dig, the Channel Tunnel or the Los Angeles Red Line subway, things seldom go according to plan, and nobody should expect that they would.

Asking *why* risk is disregarded leads Flyvbjerg to question the conventional approach to project development, in which government is the project promoter and financier, and private firms are only

too happy to do the best-case feasibility studies, produce the designs, and take on construction contracts fattened by numerous change orders. That is sometimes called a "public-private partnership," but it is a perverse use of the term, since that model does not adequately protect the public interest. The conventional approach puts the major risks—of cost overruns and of inadequate traffic—onto the shoulders of hapless taxpayers. If somebody else is picking up the tab, neither government officials nor private contractors have strong incentives to anticipate the kinds of things that will lead to problems and then costly change orders. Not only is this inherently undesirable, but a system set up in this way "is likely to increase the total risks and costs of a project." It leads directly to the kinds of results seen with the Big Dig and documented in the Aalborg University study.

A much better delivery model is a true public-private partnership that more appropriately "allocates risks to parties who have an incentive to reduce the negative impacts," as Flyvbjerg puts it. It would be far better to put commercial-type risks, such as construction cost risk and traffic risk, on the shoulders of investors. But to bring that about requires that there be true risk capital involved in a mega-project. Indeed, one of Flyvbjerg's strongest conclusions is that the decision to proceed with such a project should be based on "the willingness of private financiers to participate in the project without a sovereign guarantee." By *putting their own capital at risk*, such investors will be personally and financially involved in monitoring how the project is done, to mitigate the risk to themselves. And if such private parties shy away from investing in proposed mega-projects, that should be a signal to government that the project may not be fiscally sustainable or even viable.

One recommended model is what Europeans call the long-term concession or build-operate-transfer (BOT) model, under which a private consortium, selected by a competitive process, gains a long-term ownership interest in the project, sufficiently long that it has a reasonable likelihood of making a return on the investment. Because of this long period of responsibility, the consortium will also have strong incentives to build it right in the first place and to minimize lifecycle costs (as opposed to just upfront costs). The point is to create accountability and risk-management, which the conventional government-dominated model simply does not provide.

A private sector consortium with its own funds at stake is also likely to be better equipped to resist expensive additions. It has a clear bottom-line orientation. Its expenditures must be related to the transportation service it provides and for which customers pay (via tolls.) The consortium is limited by what money it can raise in the capital markets to the amount that tolls can service. It is better placed to "just say no" to demands for ancillary expenditures. "We just can't do it," the consortium can honestly say. By contrast, the public tends to view government as some kind of bottomless pit of money. Even government officials themselves, who do not suffer decreases in pay if projects result in cost overruns, have no true incentive to rein in runaway costs. With a private consortium betting its survival on good project management, limits on the capital that can be raised will force the project to be administered austerely.

Basing a project on prospective toll revenues introduces a strong constraint on capital spending that is absent in projects funded by governments, where the argument can always be made that by reordering priorities, borrowing more or getting additional grant funds, extra money can be found. When the private sector takes on a major project and puts a financing package into the capital

markets, it usually only gets one shot. After the financial closing, it has a discrete sum beyond which it cannot spend. This inherent discipline throughout the detailed design and construction of the project argues favorably for transferring risk to the private sector.

Melbourne's CityLink is a tolled mega-project that includes major elevated and tunnel portions through downtown Melbourne, Australia. It was built during the same time as Boston's Big Dig, in a similar urban environment. Both projects had to cope with awful soil conditions: Boston's in bay edge fill, Melbourne's in river and creek beds of deep muck. Both had to go to Herculean lengths to maintain existing rail transit services and underground utilities, and not interfere with traffic during construction. Boston's tunnels were much bigger, but Melbourne's were much deeper, involving enormous water pressures and uplift. Each encountered significant construction problems. Each included a signature bridge. Both projects had smart, competent engineers and managers. Yet Melbourne's was built in one-third the time and at one-third the cost ($27 million per lane-mile vs. $91 million per lane-mile).

A key difference was the project delivery model. CityLink was developed as a long-term concession, by a private firm funded with equity and debt. The chief constraint on cost escalation was provided by the company's need to limit overall project spending to that which could be supported by tolls. There was always a firm limit to which everyone had to work in Melbourne. There never was any limit in Boston, just a constantly growing "estimate" for which no one was accountable.

There is growing empirical evidence that this sort of delivery model has a better track record—in terms of meeting the planned schedule and keeping costs under control, In 2007, Allen Consulting Group and the University of Melbourne studied the performance of 54 large infrastructure projects, nearly half of which were in transportation. Of that total, 21 were done via the private finance (public-private partnership) model and the other 33 via traditional public sector procurement. Cost overruns on the PPP projects averaged 1.1%, compared with 15% for the traditional projects. In terms of schedule, the PPP projects averaged 3.4% ahead of schedule, compared with 23.5% late completion for the traditional projects.[17]

Part 3

Shifting Risk from Taxpayers to Investors

To further understand how much difference it can make to shift the model for mega-project development, consider a $2.5 billion urban tunnel project—perhaps the missing link in the Los Angeles area's Long Beach Freeway (I-710) through South Pasadena. Under the conventional approach, a government agency (e.g., Caltrans or the Los Angeles County Metro) would be the project developer. It would do the preliminary design, go out to bid for detailed design, and once that design was in hand, it would go out to bid for one (or a set of) construction contractors. After the project was built, the agency would operate and maintain the project out of annual budgetary appropriations.

Let's think about the incentives involved. The design contractor will not be responsible for building or maintaining the project, so it will seek to do a straightforward job of design, meeting the required specifications but not being overly concerned about constructability or the ongoing cost of operations and maintenance. That is not its problem. And the construction contractor will bid what it thinks the job will cost, but will know that as problems and unknowns are discovered during construction, it will be able to submit change orders, which the government agency will mostly approve. To the extent that the contract provides incentives to control costs, those incentives typically focus only on initial cost to construct. That incentivizes the contractor to make decisions that may reduce the initial cost at the expense of higher costs to maintain the project in future years—but that's not its problem. Likewise, conventional contracts for large projects seldom provide meaningful incentives for on-time completion (or if they do, they suffer from the same problem of implicitly encouraging initial short-cuts that may carry a higher long-term cost in operations and maintenance).

Now let's think through how the long-term concession model pioneered in Europe and Australia would address the same project. Under this model, the responsible government agency does a feasibility study and preliminary design and then goes out to bid for a firm or consortium to detail-design, finance, build, operate and maintain the project for a long period of time, typically 30 to 50 years. It is up to this consortium to cover all the costs of building, operating and maintaining the tunnel project out of the user-fee revenues it generates (unless a portion of the initial cost will be provided by the public sector, in a transparent and publicly approved process). Consider the very different incentives involved in this model.

First, the fact that businesses have bid on the project suggests that it is fiscally viable and sustainable. The winning consortium will almost certainly use the design-build method, in which a single team designs and constructs the project, thereby facilitating constructability because everyone has the same incentives. Design-build also generally cuts the overall development time significantly.

Second, since the investors who finance the project (banks, toll revenue bond buyers and equity investors) have a very strong interest in avoiding cost overruns, the design-build team will be held accountable to a fixed price that allows for various contingencies. This exerts strong pressures to produce a buildable design and to solve problems efficiently—because it's the consortium's own money that is at stake in cost overruns. (Design-build has an excellent track record of delivering large projects on-time and on-budget; recent examples include California's Alameda Corridor and Utah's rebuild of I-15 in Salt Lake City.)[18]

Third, because the investors are very concerned about toll revenues beginning to flow on time so the consortium can start making the required debt-service payments, they will typically insist on a guaranteed completion date, with significant daily financial penalties (called liquidated damages) if that date is not met.

And fourth, because the team that develops the project will also be responsible for operating and maintaining it (and turning it back to the government agency in good condition at the end of the concession term), it will have strong incentives to design and build the project in ways that minimize not its initial cost but its *lifecycle* cost. This is why toll roads and bridges, in general, are typically built in a more durable way. Stronger and more durable pavement means lower maintenance expenses over time. And furthermore, the investors typically require legally enforceable bond covenants that guarantee proper maintenance of the facility over the life of the bonds, to protect the asset value of their investment.

Table 1 provides a summary of key differences between the concession model and the traditional model.

Table 1: How Project Management Models Compare

	Traditional	Long-Term Concession
Funding source	Highway trust fund	Toll revenue bonds & equity
Procurement process	Design-Bid-Build	Design-Finance-Build-Operate-Maintain
Cost overruns?	Taxpayers	Investors
Schedule slips?	Drivers	Investors
Traffic risk?	Taxpayers	Investors
Maintenance funding	Annual appropriations	Toll revenues
Maintenance incentive	Public complaints	Investors' asset value

Part 4

What Happens if the Project Fails?

One obvious question provoked by this discussion is: what happens, in a concession project, if the investors guess wrong and the project ends up with significant cost overruns and/or much less usage than projected? A good example of such an outcome is the Channel Tunnel between the U.K. and France. Developed privately under a 55-year concession agreement with the two governments, the "Chunnel" opened in 1994, several years late and 80% over its original budget. After six years in operation, its traffic numbers had reached only 43% of the original estimate for the opening year. Clearly, this must rank alongside the Big Dig as a mega-project debacle.

Yet unlike the Big Dig, where taxpayers footed the bill for enormous cost increases, the lower revenues and higher costs of the Channel Tunnel were borne entirely by the investors (mostly European banks and about a million individual shareholders). The project had to be refinanced, with the banks taking a significant "haircut." And the share price plunged to a few percent of what it had been in the project's early days. The only relief offered by the two governments was to extend the life of the concession, so that the investors would, over a very long period of time, have some possibility of receiving an eventual return on their investment.

In two other cases in the past decade, concession projects have actually gone under, after seriously overestimating traffic and toll revenues. The first is a truck-oriented toll road near Laredo, Texas called Camino Columbia. The 21-mile tollway was built to offer trucks a shorter route from a border crossing near Laredo to I-35, a key NAFTA highway route. It opened in 2000, but attracted so little traffic that it declared bankruptcy at the end of 2003, after lenders foreclosed. Principal creditor John Hancock Life Insurance Co. purchased the project at auction in January 2004 for just $12 million for the toll road that had cost $90 million to develop. Five months later, the Texas DOT purchased the toll road from John Hancock for $20 million (about 22 cents on the dollar). It is still in service today.

The other case is a toll tunnel in Sydney, Australia's largest city: the Cross-City Tunnel. Intended to reduce congestion on major downtown streets, the four-lane, 1.3 mile $585 million project opened in 2005, but attracted only one-third of the forecast traffic. By the end of 2006 the concession company filed for bankruptcy. At that point, a syndicate of creditors appointed a receiver, which took control of the tunnel and has kept it in operation while the finances are sorted out.

There are several important lessons to be drawn here. The first is that having to persuade investors to part with capital for such mega-projects will typically produce a far higher degree of scrutiny of the project's underlying feasibility than is all too often the case for conventionally done mega-projects. The second is that even when such scrutiny is overtaken by events and a concession project does badly, it is investors who are at risk, rather than taxpayers. Third, despite financial difficulties, the project remains in service, meeting transportation needs. In extreme cases the original company may go bankrupt and the assets get purchased by new owners (with approval of the government agency that is a party to the concession). By purchasing the asset at a fraction of the original cost, the new owners hope to operate it in a financially sustainable manner (much as happened with failed telecom companies such as Global Crossing and Iridium).

Thus, the case for using the concession approach for transportation mega-projects is a strong one. In the case of typical mega-project risks of cost overruns and insufficient traffic and revenue, experience has shown that the private sector can and will take on those risks under well-drafted concession agreements.

Mega-projects are inherently risky. That doesn't mean they should not be done. But it does mean that public policy should allocate those risks to the parties best able to handle them: those with not only financial incentives for success but with dire consequences for failure.

Endnotes

[1] Economic Development Research (EDR) Group, "Economic Impact of the Massachusetts Turnpike Authority & Related Projects," Vols. I and II, Massachusetts Turnpike Authority, 2006.

[2] On Jan. 23, 2008 Bechtel and Parsons Brinckerhoff reached a settlement with the state and federal governments in which they acknowledged serious failures as contract managers and designers, and agreed to pay $458 million to resolve criminal and civil complaints.

[3] "Government at the Brink," report by committee headed by Sen. Fred Thompson, cited by Federal Highway Administrator J. Richard Kapka in *Public Roads*, July/August 2004, p. 3.

[4] Dan McNichol and Andy Ryan, *The Big Dig* (New York: Silver Lining Books, 2000) p. 35.

[5] "Federal Task Force on the Boston Central Artery/Tunnel Project: Review of Oversight and Costs," Federal Highway Administration, undated, no page numbers, at www.fhwa.dot.gov/reports/tunnel.htm.

[6] The physical aspects of the project are nicely described on the official website www.bigdig.org.

[7] Bechtel's website reports the following: "In 1999, just as construction activity was peaking, the MTA (Massachusetts Turnpike Authority) converted from a traditional program management model to an integrated project organization, which led to the management shifting to MTA. Although adopted for the stated purpose of streamlining the management structure and trimming costs, it also had the effect of blurring accountability and responsibilities, and discouraging proactive project management." (www.bechtel.com/2008-01-23.html.)

[8] McNichol and Ryan, p. 43.

[9] Nicole Gelinas, "Lessons of Boston's Big Dig," *City Journal*, Autumn 2007.

[10] Office of the Inspector General, "A History of Central Artery/Tunnel Project Finances, 1994–2001," Report to the Treasurer of the Commonwealth, March 2001.

[11] For example, the July/August 2004 issue of the FHWA journal *Public Roads* is devoted to ten articles on megaprojects, many of which dwell on the Big Dig.

[12] "Accounting for Megaproject Dollars" *Public Roads*, July/August 2004, p. 41.

[13] Ibid, p. 44.

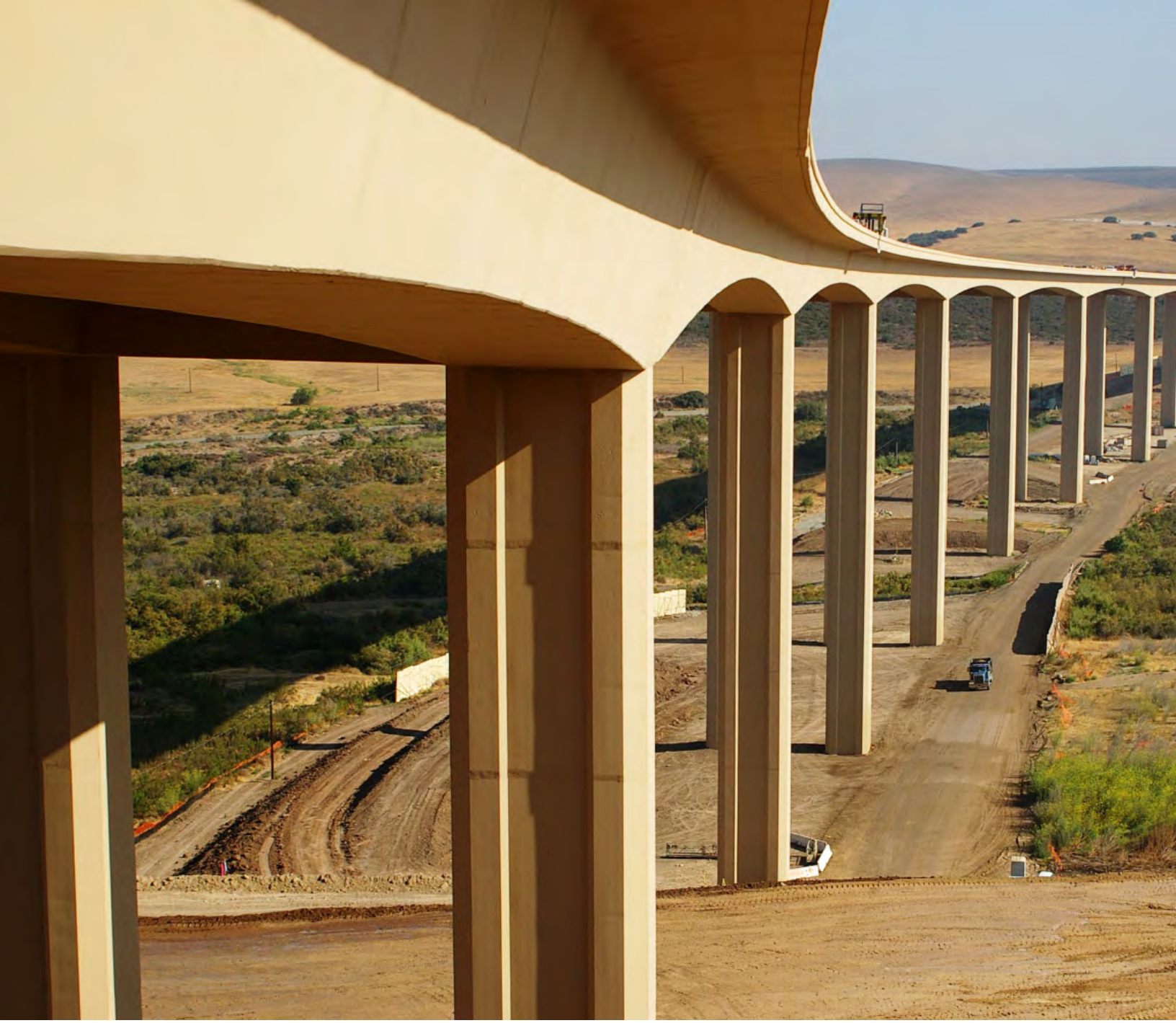
[14] Office of the Inspector General, "A History of Central Artery/Tunnel Project Finances," March 2001.

[15] Bent Flyvbjerg, Nils Bruzelius and Werner Rothengatter, *Megaprojects and Risk* (Cambridge, UK: Cambridge University Press, 2003).

[16] Bent Flyvbjerg, Mette K. Holm and Soren L. Buhl, "Underestimating Costs in Public Works Projects: Error or Lie?" *Journal of the American Planning Association*, Vol. 68, No. 3, Summer 2002, p. 279.

[17] The Allen Consulting Group and the University of Melbourne, "Performance of PPPs and Traditional Procurement in Australia, Final Report," Infrastructure Partnerships Australia, Nov. 30, 2007 (http://infrastructureaustralia.org/research/pdf/InfrastructurePartnershipsAustralia_PPPReport_Final.pdf).

[18] SAIC, AECOM Consult, University of Colorado at Boulder, *Design-Build Effectiveness Study, Final Report*, Federal Highway Administration, January 2006.



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