

Transaction-Cost Economic Analysis of Institutional Change toward Design-Build Contracts for Public Transportation

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Overview of the Research

Design-build is a relatively new form of public contracting in the United States, and one that has been accelerated by federal programs in surface transportation. Design-build, in which one contract bundles together design and construction services, is an alternative to traditional contracting techniques, which separate these bids.

Since 1990, the Federal Highway Administration (FHWA) has advanced two experimental programs to promote, guide, and evaluate the use of design-build. By the end of 2002, the first of these programs (Special Experimental Project Number 14, or SEP-14) amassed 140 completed design-build projects across 24 states (plus the District of Columbia), at a total cost of \$5.5 billion (SAIC 2006). The second (Special Experimental Project Number 15, or SEP-15), is aimed primarily at public-private partnerships, of which, design-build is an integral part. Today, 31 state departments of transportation use this form of contract, many in pilot programs or for contracts of limited purpose (Nossaman 2006). California is not among them.

While growing in popularity, this seemingly innocuous, small-scale form of privatization is controversial. Highly organized groups strive to promote and prevent the practice from state to state, each marshalling resources to generate reports of success and failure. Promoters of design-build suggest that close interaction between designers and constructors enables value engineering and reductions to cost and schedule. Promoters often represent firms interested in expanding the private sector market for highway engineering, while detractors represent unions of public sector engineers.

The arguments for and against design-build are as varied and complex as the projects themselves, and very few arguments are supported by empirical tests. Systemic problems with cost estimating in the transportation sector (Flyvbjerg 2002) limit valid research designs to the comparison of outcomes from projects delivered one way or another. Objective measures are difficult to develop or rarely utilized, owing in part to the political nature of contracting, but also to the implicitly neoclassical economic approach common in the literature of project delivery; an approach focused on the cost of production (payments to private construction firms), when delivery is actually a service, requiring extensive support to develop and execute the contract (the job of public

agencies and their consultants, which we will call transaction costs). Production costs and schedules are easy to find and compare; public expenditures are usually not included, and rarely exhaustive. As a result, research has not coalesced on a proven methodology for determining cost-effectiveness (Warne 2003).

This study uses institutional economics to shed light on many of the issues plaguing the evaluation of design-build contracting. The purpose is to assist lawmakers in the State of California as they contemplate the adoption of enabling legislation. In institutional economic terms, design-build involves the switch from public to private ordering of design services such that the design firm, which used to serve as the public client's advocate during construction, is instead at the service of a general contractor or constructor. California is relatively rich in institutions supporting union agreements and environmental protection. In the transition to design-build dramatic changes to procedures, roles, and responsibilities ensue, which may include impacts to organized labor. Existing research suggests that design-build shortens delivery schedules by allowing construction to begin before design is complete, but the benefits of shortened schedules may come at the expense of public participation if design information presented during environmental review is inadequate.

Should California use design-build? Picture a planner responsible for deciding whether a stretch of highway should be developed with design-build or design-bid-build procedures. Which process is more efficient? If design-build is more efficient, do such gains come at the expense of organized labor and environmental compliance? These questions were addressed through a transaction-cost economic analysis of recently completed design-bid-build and design-build projects in several states, with attention to variations in the institutions governing transportation delivery from state to state.

The Study

This research proceeded on three levels, characterized by the comparative study of state institutions, programs, and projects. This was mixed methods research. Theoretical models of contracting under conditions of high asset specificity (prone to bilateral monopoly, information asymmetry, and moral hazard) framed a protocol for case selection, semi-structured interviews, the review of archival records, and the collection of project-specific data.

States were selected for variations in approach and experience managing design-build highway projects, with attention to similarities with California in terms of institutional design for project delivery. Programs were researched historically, with reviews of regulations and policy debates supplemented by interviews with policymakers.

Projects were selected in pairs (one design-build, one design-bid-build) to control for extraneous variance associated with the scope of the project, quality of product, location of product, timing of delivery, and public entity in the project management role. Comparability was ensured by the collection of measures of scale with strong relationships to project cost, including the area of footprint (a measure of land disturbance), the cubic mass of the structure, the surface area of bridge, the surface area of wall, and acreage of wetlands impacted. Project-level data collection was served with templates recording basic project data, ex ante and ex post project costs (within and outside the transportation department), a list of environmental permits and documents,

and the schedule of project development and contract execution. Interviews with project management validated data with descriptions of major events experienced during the course of project development.

Everywhere the approach was to triangulate evidence from multiple sources, to maintain a chain of evidence in the service of establishing (or refuting) theoretical claims of cost, schedule, and labor or environmental compliance impacts attributable to the type of contract. The research is described in some detail in the following four sections. After that, the output of the research is listed.

The States, the Programs, and the Projects

California's experiments with design-build are limited to toll roads (State Routes 91 and 125), and one locally led development (in Orange County, still under construction). To find recently completed design-build projects required research out of state, but research sensitive to California's issues and institutions. The projects we found had to be similar in nature and management to those that could be undertaken in California and their outcomes had to resonate with the concerns of the California Department of Transportation (Caltrans) and Legislature.

For these reasons, much of this report is focused on one pair of projects from the State of Washington. Like California, the State of Washington supports collective bargaining, and has long recognized the rights of public engineers in the transportation sector. Environmental values and procedures are prominent in both states. Two interchange projects – one design-build, the other design-bid-build – were recently completed by Washington's Department of Transportation (WSDOT), on the same stretch of highway, about two miles apart from one another.

Where necessary, the analysis of Washington has been supplemented with data from other states, each known for their extensive or innovative use of design-build. Ohio is unique in its application of design-build to small scale projects using low-bid selection criteria. Florida has been using the design-build method longer than any other state. Each has completed more than 50 design-build projects. Texas and Oregon have made unique improvements to environmental review in the context of design-build contracting. Findings were also supported by a thorough review of the professional literature, as well as attendance to conferences on design-build in the transportation sector.

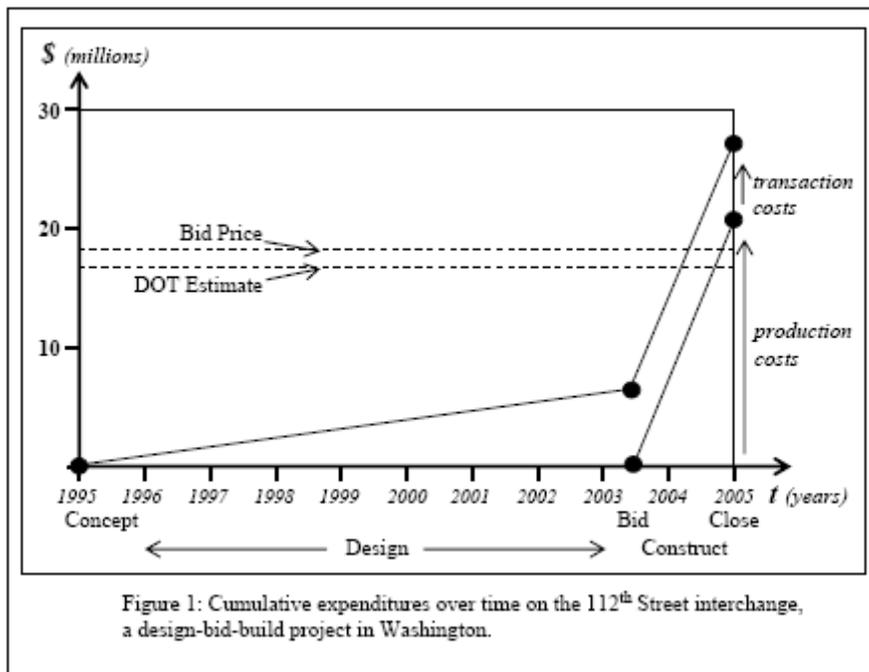
The Cost and Schedule of Design-build vs. Design-bid-build Delivery

In 1998, the State of Washington passed a bill authorizing a pilot program for design-build (SB 6439). Recommendations from a Blue Ribbon Commission, published in 2000, endorsed design-build for its potential to reduce the cost and time of project delivery. Two projects were selected. In 2003, one was completed; an interchange at State Route 500 and Thurston Way. In 2005, construction was completed on a comparable interchange, using the traditional design-bid-build method of delivery. This project was also on State Route 500, at 112th Street.

WSDOT estimated the cost of the projects at about \$17.5 million, within about \$214,000 of one another. On Thurston Way, WSDOT generated 30 percent of the design in-house (also known as "bridging"), and went to bid for design-build, best-value, lump

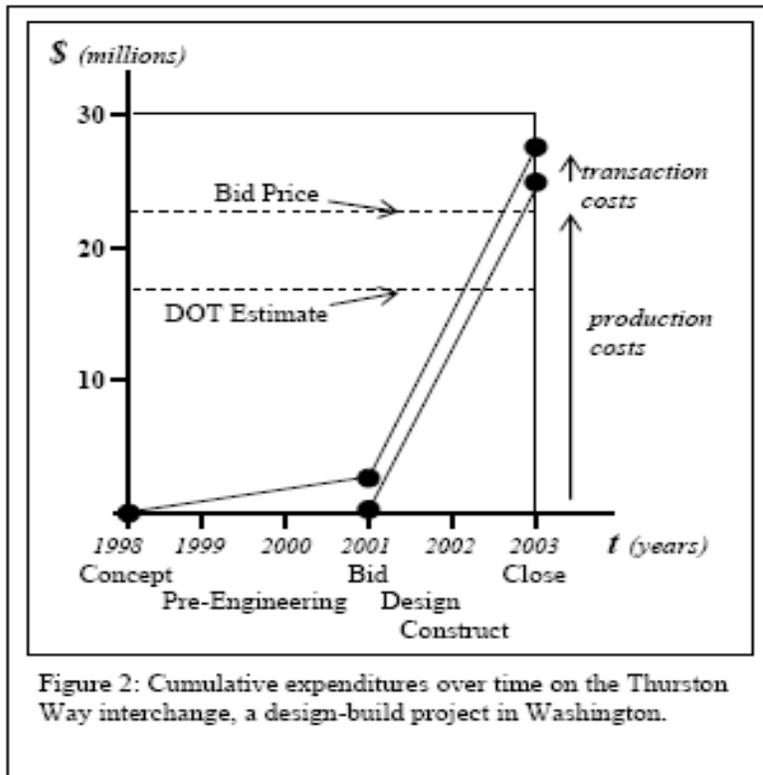
sum. The bids came in high, the winning bid was 29 percent above the estimate. On 112th Street, WSDOT completed design and the low bid was just 2 percent above the estimate. These figures validate concerns that owners express about the difficulty of estimating costs at the conceptual level, especially when bids are lump sum. Bidders can and do submit designs that deviate from owner expectations. In a closed-book process, it is almost impossible to determine whether high bids represent the real cost of labor and materials, the assumption of risk, or profit-seeking.

Cumulative expenditures (actual costs) over time for 112th Street are shown in Figure 1. WSDOT went through several iterations of design before going to bid, bids were close to estimates, and construction costs (shown as production costs) exceeded estimates. There were 76 change orders filed on 112th Street, at a cost of over \$3 million.



When DOT costs are included (shown as transaction costs), the total cost of the job rises even further above estimates. Transaction costs are paid in the process of scoping projects, developing and administering contracts, conducting ancillary studies (geotechnical, environmental, utilities, rights-of-way), negotiating third party agreements, monitoring the contractor, and resolving disputes. The cost of engineering on the part of the DOT may also be considered transaction costs; this categorization is especially relevant to the engineering and construction literature, which tends to omit or irregularly account for DOT expenditures. The total cost of 112th Street was just over \$27.7 million; 56 percent above DOT estimates. About \$20.6 million was paid to the contractor, while another \$7.1 was spent internally, some on consultants.

Cumulative expenditures on Thurston Way are shown in Figure 2. Construction costs on Thurston Way also exceeded estimates, though they remained closer to bid prices than 112th Street. There were 29 change orders filed for Thurston Way, at a cost of about \$250,000. In total, the contractor was paid about \$24.6 million. Transaction costs added another \$2.5 million, for a total cost of \$27.1 million; 55 percent above DOT estimates.

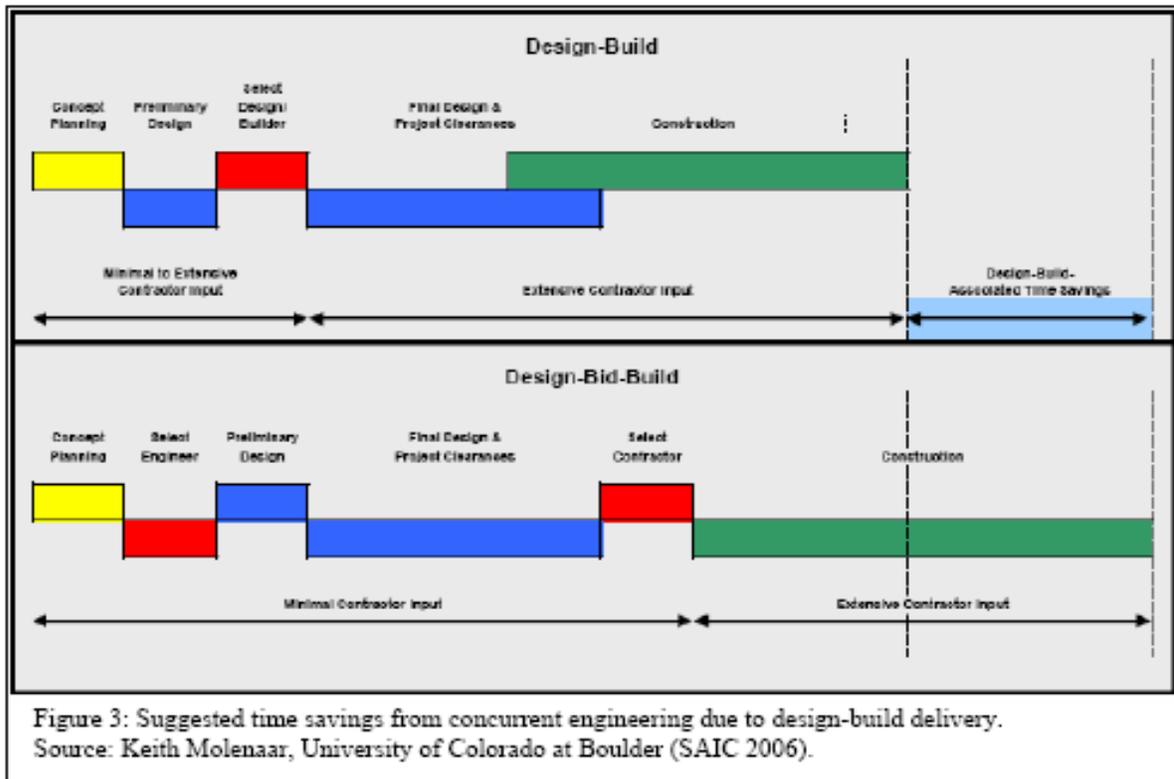


Despite arguments about the expense of public compared to private engineering, these costs did not differ. Breakdowns of cost suggest other differences, however. WSDOT spent \$1 million more on ancillary studies, \$1.3 million more on administration, and \$3 million more on change orders to support 112th Street in comparison to Thurston Way. Internally, WSDOT spent \$7.1 million on 112th Street, and only \$2.5 million on Thurston Way, but any savings this may have represented were paid out to the contractor, which earned \$4 million more on Thurston Way.

On the whole, design-build at Thurston Way offered no cost advantage. This finding is supported by a recent report to Congress from the US Department of Transportation on SEP-14, which analyzed DOT costs (i.e., preliminary engineering, developing the request for proposals, contract administration and inspection) as well as the costs paid to contractors. Results include comparisons of cost growth between 9 design-bid-build and 11 design-build projects, and suggest favorable costs using traditional methods.

The striking difference between the contracts is evidenced in the time it took to deliver 112th Street compared to Thurston Way. 112th Street was delivered in ten years, and Thurston Way was delivered in five.

The professional literature and promoters of design-build tout the savings possible when construction begins before design is complete, as suggested in Figure 2, taken from the US DOT report to Congress. This is precisely the reason for the design-sequencing program in Caltrans: to capture savings to schedule from concurrent engineering, sometimes known as “fast-tracking.” Our observations in Washington suggest, however, that few savings occur in this way. The bulk of savings come from another source, particularly salient to California.



In Washington, as in California, state funds are allocated to projects geographically. In California, funding is not only geographic; it is for six discrete phases of project development, such as engineering, right-of-way, and environmental review. Geographic allocation may be politically desirable, but in terms of project schedule, it can be incredibly inefficient. 112th Street funding stopped and started several times, resulting in a seven year period of design development. Design-build requires the allocation of funds up front, or rather early in project development (depending on the extent of “bridging”).

The Washington Legislature has recognized the ability of design-build to expedite delivery. Since the passage of enabling legislation for design-build in 2001 (again in 2006), they have participated in the selection of projects in major bond packages (2003 in a nickel gas tax increase, 2005 in a 9.5 cent gas tax increase) on the promise of shortened schedules, going so far as to stipulate deadlines for going to bid for each project. In institutional economic terms, the differential ability of design-build to deliver projects faster creates a new form of currency for the Legislature; a political body whose efficient workings depend on the ability to trade.

The Question of Impacts to Labor Organization

To deliver fast requires significant changes in internal organization, especially when the department is arranged in stovepipe fashion, or by function, as has been the case in California. More importantly, in political circles, however, is the need to clarify the place of design-build contracting in an already complex array of institutions supporting organized labor. At the top of this list are public engineers.

Design-build is a form of privatization. For owners accustomed to completing designs in-house (as in Caltrans), design-build requires transferring anywhere from 70 to 100 percent of engineering on any given project to the private sector. In Ohio and Florida, design-build has been accompanied by layoffs of approximately 30 percent of the transportation department. Thurston Way (design-build) required far fewer WSDOT personnel than 112th Street (design-bid-build); in terms of expenditures in-house, this amounted to \$2.5 compared to \$7.1 million.

Like California, Washington supports collective bargaining for public engineers, and has for many years. Prior to the passage of design-build legislation, Washington's DOT experienced some loss of personnel when an anticipated transportation package failed to earn voter support. At the time, public opinion polls found voters dissatisfied with the speed and expense of project delivery from WSDOT. Perhaps in relation to those reductions, WSDOT gradually began to contract out for design. Today this rate is somewhere between 20 and 30 percent across the state, though variations between regional offices are extreme. It makes sense to contract out in locations difficult to serve with state levels of pay, for example.

WSDOT personnel interviewed for this study referred to an agreement between public engineers and the State that supports the use of design-build contracting (and any other form of private engineering) as long as those contracts do not result in a state employee losing his or her job. WSDOT publishes a quarterly review of projects, known as the Gray Notebook, which includes levels of employment, making this agreement easy to monitor. Design-build can harness the private sector in ways that increase the productivity of the department (when productivity is measured in terms of the speed or cumulative value of projects delivered in relation to the number of public employees). Washington uses design-build to temporarily increase the workforce in times of peak demand, and to allow the temporary hire of special engineering services for projects of unusual magnitude or scope, such as the Tacoma Narrows Bridge, currently under construction by a partnership of Bechtel and Kiewit.

Private sector unions do not always promote design-build: large engineering and construction firms have the most to gain. Small firms need to reorganize to enter the market, and compete by generating plans with bids that may only result in partial compensation (a stipend). Thurston Way was won by an engineering firm and construction firm prominent in the local market and new to design-build, and the recent report to Congress finds no appreciable difference between the percent of project costs paid to small firms on design-build in comparison to design-bid-build (both average around 32 percent).

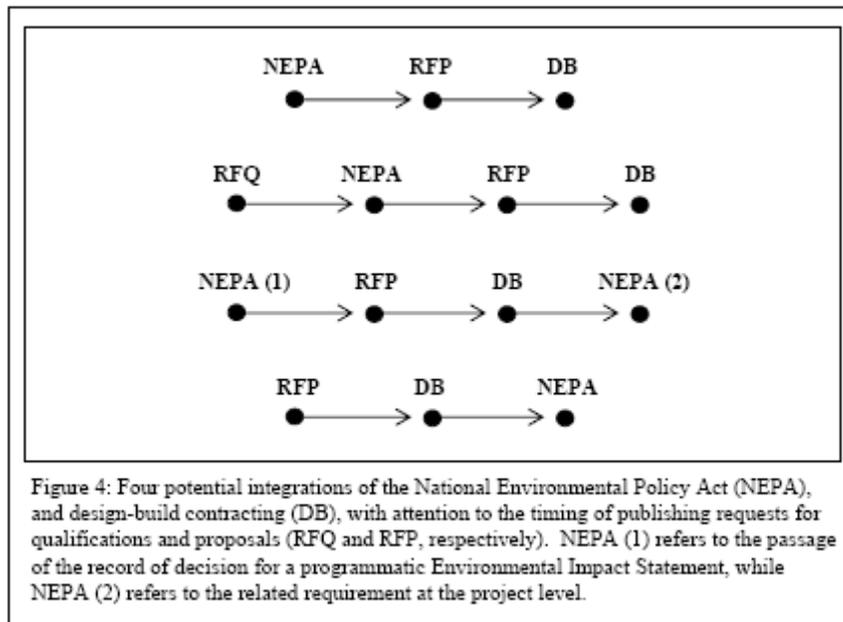
In California and Washington, prevailing wage laws would remain in place, even on design-build projects. The Davis-Bacon Act still applies. On the project level, however, other issues arise from the authority, timing and order of this type of contract. On traditional jobs, the design is complete before going to bid, and it is relatively easy for the public authority to stipulate special requirements for project delivery, such as the amount of work taken up by unions and firms owned by minorities, women, and the disabled. On design-build jobs, the contract is signed before design is complete (sometimes before design has begun). If contractors are asked to list their subcontractors on the job at the time of signing, those subcontractors may benefit from the locked in relationship forged

between their firm, the contractor, and the state. Having monopolized their service, they may raise their prices at will.

Project labor agreements can stipulate the details of contract the State would like exercised during the course of project delivery. Care should be exercised in their use, however, because case law may allow the project labor agreement to supersede statewide collective bargaining agreements.

Environmental Compliance: Permitting, Review, and Monitoring

The efficient management of design-build depends on the State's use of performance standards and the private development of design within the parameters set by those standards, but our environmental institutions do not yet have the capacity to manage (or monitor) contracts for project delivery in this way. The National Environmental Policy Act (NEPA) and its state-level equivalents were designed to fit a design-bid-build process. Consider the following diagram, illustrating four tried methods for integrating environmental review with design-build.



While administrating SEP-14, the FHWA required most design-build projects to complete NEPA requirements prior to publishing the request for proposals. Thus, most design-build projects have been delivered using the first process (shown above). There are several problems with this order of events.

Environmental review depends on a shared understanding of what can and will be built. Impacts do not occur in isolation; they occur as the result of planned and executed actions on the part of engineers, constructors, and the state. In institutional economic terms, the environmental impact statement is a contract between the public, the state, and contractors, and is no less binding than any other agreement. A great deal of information is required to surmise the alternatives for development and the affects they will have on

the environment. Designs are a necessary ingredient to environmental review, because environmental consequences flow from design.

Economically speaking, it is in the state's best interest, when hiring a design-builder, to limit in-house design work to a minimum. The design-build industry suggests that states provide as little as a footprint: a line marking the limit of work. Environmentally speaking, it is impossible to assess the impact to the environment based solely on the limit of work. That is, many of the calculations necessary to determine impacts would be unavailable. For example, one may be able to identify impacts to terrestrial wildlife habitat from a limit of work, but without designs drainage and stormwater runoff cannot be determined, and these are critical determinants of impacts to aquatic species.

In institutional economic terms, environmental review is supposed to conclude with a commitment to a design (the preferred alternative), and it is economically difficult to do that when a contract with a designer has not yet been signed. Ex post, complications mount, because contractors will make and change designs, and those changes have environmental implications that - if not caught early - may have to be addressed in the field. This turn of events on the Legacy Parkway (Interstate 15, Utah) led to a court case requiring a supplemental environmental impact statement (EIS) and revised 404 permit. Even if a supplemental EIS is not required, environmental changes lead to change orders. In design-build, change orders can bear an unusual expense; we have heard of a state paying as much as \$1000 per change per sheet for each adjustment to plans. These findings are reinforced in the recent report to Congress, which found that change orders occur less often but tend to be more expensive on design-build jobs.

Texas has made use of the second process (see above) on a public-private partnership: they issued a request for qualifications (RFQ), selected a short list of qualified teams, and involved those teams in the NEPA process. Teams reviewed each alternative and provided comments to managers of the NEPA process. After the record of decision was issued, the request for proposals was published, and the teams submitted technical and price proposals. This procedure may benefit projects facing complex environmental issues, especially those that could conceivably benefit from design innovations. It could also be more expensive, requiring either larger stipends to losing firms or the need to limit its use to projects suitable for large scale engineering and construction firms.

Oregon has made use of the third process, on a large scale effort to replace over 350 bridges across the state. In advance of contracting, the state spent about \$20 million studying the environmental context for these projects, compiling data into a statewide geographic information system. They then coordinated a series of programmatic agreements, including a biological opinion for the Endangered Species Act, a general permit for Section 404 of the Clean Water Act, archaeological excavation agreements with tribal groups, and prioritized sites for mitigation banking. Importantly, these bridge replacements did not involve expansion; the limited scope of work allowed the agencies to develop environmental performance standards. When the design-builders were brought on board, they had an environmental baseline report to review for each bridge site; they performed preconstruction assessments and submitted preliminary designs to environmental agencies for approval. Other states have tried programmatic environmental review, though Oregon's approach seems thorough for the way it addresses the entirety of environmental compliance (review, design, and permitting) and captures economies of scale.

The fourth method has been used by several states on public-private partnerships, including California, on State Route 125. Under this model, the design-builder is hired before NEPA review. Though problems of inadequate design information during environmental review are eliminated with this course of action, other problems arise. It is difficult to contract with a design-builder prior to environmental review because the design-build contract is supposed to be based – especially when bid lump-sum – on a particular design that the contractor has in mind, yet the alignment and basic elements of design are not supposed to be selected until environmental review is concluded. Contractors will have preferences for alignment and design that result from their past experience, equipment, and skill sets. It is so difficult for a contractor to be unbiased in this process that some have termed it “NEPA with Advocacy”, meaning the contractor becomes an advocate for the alternative in environmental review that they prefer. There are also cost consequences. It took over 10 years to acquire environmental approvals for SR 125, and this only occurred after the alignment moved to avoid impacts to a nature preserve.

Setting aside environmental review, one other complication afflicts design-build. Realizing the need for design to inform environmental decisions, states have begun to contract out environmental permitting to the design-builder. When projects take advantage of concurrent engineering, environmental permits can become the last items preventing the contractor from starting construction. The pressure to build quickly creates strong disincentives for environmental permitting and performance. On Thurston Way, Washington kept environmental permitting in-house. The managers of the project felt this pressure, prompting state agencies to closely examine the environmental implications of design-build.

References

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SAIC, AECOM Consult, et al. (2006). *Design-Build Effectiveness Study: As Required by TEA-21 Section 1307(f)*. Washington, D.C., US Department of Transportation, Federal Highway Administration.

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Research Output

Presentations

Jan Whittington

“New Institutional Economics & Planning: Looking at Infrastructure,” American Collegiate Schools of Planning, Kansas City, Missouri, 2005.

“New Institutional Economics & Infrastructure Costs,” World Planning Schools Congress, Mexico City, Mexico, 2006.

Expected future output

This research is ongoing. The principal product is Jan Whittington’s Ph.D. dissertation, expected for filing in December 2006. In the coming months, we expect to generate products for several journals, as well as trade publications, and show results in transportation-specific venues, such as the World Conference on Transportation Research.