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Guidebook to Highway Contracting for Innovation:

The Role of Procurement and Contracting Approaches in Facilitating the Implementation of Research Findings

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SIDNEY SCOTT, III
Trauner Consulting Services
Philadelphia, PA

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

Note: The Transportation Research Board, the National Research Council, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the individual states participating in the National Cooperative Highway Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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FOREWORD

By Staff
Transportation Research Board

This report contains the findings of a study to identify and evaluate procurement and contracting approaches for design and construction of highway facilities and to identify approaches that are expected to facilitate the implementation of innovations and research findings. The report provides guidance on the selection of procurement and contracting approaches to stimulate innovations to improve design, construction, and quality of the highway system. The contents of the report will be of immediate interest to state highway personnel and others involved in the administration of construction contracts.

Great promise and risk are inherent in the conduct of research. The underlying expectation is that "research pays off" by yielding innovative products and practices that will benefit future transportation users and providers. In an initial phase of research under NCHRP Project 20-33, "Facilitating the Implementation of Research Findings," themes for future research were recommended to test the more viable strategies for moving transportation research into practice. This research also indicated that procurement and contracting practices for the design and construction of highway facilities play an important role in the timeliness and effectiveness of research results.

Under NCHRP Project 20-33(2), "The Role of Procurement and Contracting Approaches in Facilitating the Implementation of Research Findings," Trauner Consulting Services, Inc. of Philadelphia, Pennsylvania was assigned the task of identifying strategies to encourage use of procurement and contracting approaches that will facilitate implementation of research findings. To accomplish this objective, the researchers reviewed relevant literature, surveyed the transportation community, convened a focus group, evaluated traditional and nontraditional procurement and contracting approaches, and then developed a *Guidebook to Highway Contracting for Innovation* to aid practitioners in selecting and using approaches to promote innovations and research findings. The guidebook documents the findings of this work.

The information included in this report provides guidance to encourage use of procurement and contracting approaches that will facilitate implementation of research findings. This information will be particularly useful to highway agencies and is appropriate for consideration and adoption by AASHTO as a supplement to AASHTO's "Guide Specifications for Highway Construction."

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CONTENTS

Guidebook to Highway Contracting for Innovation

EXECUTIVE SUMMARY

CONTENTS

Procurement and contracting (p/c) approaches can play an important role in the effectiveness and timeliness of implementing research results. This Guidebook presents the results of a literature review, a comprehensive survey of the transportation community, and focus group discussions involving high-level transportation officials to identify the individual p/c approaches and combinations of p/c methods with the greatest potential for implementing research or promoting innovation. This Guidebook will aid practitioners in selecting and using p/c approaches to promote research findings or innovation. It includes a description of the benefits and considerations for using each p/c approach, corresponding survey results, representative case study projects, and preferred combinations of p/c approaches used by the highway industry to stimulate innovations to improve the design, construction, management, and quality of our highway system.

I. INTRODUCTION

"If you do what you always did, you'll get what you always got."

Yogi Berra

Building and operating a better highway system cannot be accomplished simply by managing the existing system better. The key to growth and improvement is identifying innovative products and processes and putting them into practice. The rate of improvement depends on how successfully the highway industry implements these innovative products and processes. One attribute of a successful organization is its ability to foster and implement innovative products and processes–to embrace change, not fight it.

National Cooperative Highway Research Program (NCHRP) Project 20-33, "Facilitating the Implementations of Research Findings," concluded that "research often fails to change practice because of limited understanding, organizational inertia, inflexible standards, preoccupation with first costs, mistrust of change, or a desire to perpetuate jobs." One tool available to contracting agencies to help move research results into practice is the way they contract for services and manage projects. This Guidebook presents a process for selecting and information for evaluating p/c approaches to facilitate the implementation of new p/c and innovative products and processes in the highway industry.

This Guidebook, prepared under NCHRP Project 20-33(2), "The Role of Procurement and Contracting Approaches in Facilitating the Implementation of Research Findings," presents information derived from a survey of 443 highway industry professionals. Responses were received from 40 state departments of transportation and 31 large and small highway contractors throughout the United States. The results were validated by a focus group of 14 high-level highway industry officials and careful review of existing transportation research, literature, and case studies. The information was compiled into a final report from which this Guidebook was derived. The purpose of this Guidebook is to convey the results of this research to the highway industry.

The terms "research findings," "research results," and "innovations" are used often in this Guidebook. The terms "research findings" and "research results" refer to the product of formal research. The term "innovations" is broader, including both the results of formal research and improvements that might derive from experimentation in the field or other practical experience.

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- Adrian Bastianelli, Bastianelli, Brown & Kelley, Chartered, Washington, District of Columbia
- John Chisholm , American Road and Transportation Builders Association, Washington, District of Columbia
- David Cox, Federal Highway Administration, Washington, District of Columbia
- Brian Deery, Associated General Contractors of America, Washington, District of Columbia
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- Robert Harrison, Maryland State Highway Administration, Baltimore, Maryland
- Greg Henk, Flatiron Structures Company, LLC, Irvine, California
- Richard Lewis, Granite Construction Company, Escondido, California
- Richard Morgan , National Asphalt and Pavement Association, Lanham, Maryland
- Frank Palise, New Jersey Department of Transportation, Trenton, New Jersey
- Ron Williams, Arizona Department of Transportation, Phoenix, Arizona
- Russell Zapalac, Transportation Corridor Agency, Santa Ana, California

II. THE ORGANIZATION OF THE GUIDEBOOK

This section of the Guidebook has two purposes: (1) to help the user decide what p/c approach or combination of p/c approaches to use to implement research findings or innovations, and (2) to help the user find essential information regarding each p/c approach in Sections III and IV of this Guidebook.

This section is organized into the following subsections, with each subsection addressing these purposes from different perspectives:

- Top-Ranked Approaches
- Traditional and Non-Traditional Approaches
- Procurement Approaches and Contracting Approaches
- Combinations of P/C Approaches by Responsibility

Table 1 found at the end of this section refers to the detailed descriptions of each p/c approach located in Section III of the Guidebook and case studies in Section IV of the Guidebook.

If you find that none of these subsections appear to adequately address your needs, you can just read through each of the p/c approach descriptions in Section III, starting on page 9, until you find what you are looking for.

Ranking of P/C Approaches Based on Ability to Promote Innovation

1. Partnering
2. Value Engineering
3. Incentive/Disincentive
4. Performance/End-Result Specifications
5. Pilot Projects
6. Constructability Reviews
7. Multi-Parameter Bidding
8. Construction Warranties
9. Privatization
10. Bid Alternates/Design Alternates
11. Design-Bid-Build
12. Design-Build
13. Lane Rental
14. Material and Method Specifications
15. Construction Management

Top-Ranked Approaches

State and local government agencies, highway construction contractors, and highway industry associations were surveyed, as indicated in the introduction, to evaluate which approaches were best at promoting innovation and implementing research findings. The chart in the sidebar gives the resulting rank for each p/c approach from the survey.

As indicated in the ranking, the highest rated p/c approach was "Partnering," while the lowest rated p/c approach was "Construction Management." The rankings are based on the number of respondents that ranked each p/c approach first, second, or third compared to the total number of respondents for each approach. Aside from Partnering and Value Engineering, the top six approaches were closely ranked. This indicates that Incentive/Disincentive, Performance/End-Result Specifications, Pilot Projects, and Constructability Reviews are equally effective in terms of their ability to promote innovation. The survey responses also indicated that Partnering, Value Engineering, Incentive/Disincentive, and Bid Alternates/Design Alternates were the approaches most frequently used for the implementation of research findings or to foster innovation. Finally, the survey revealed that Design-Build and Privatization were used less frequently but had a high rating in terms of contributing to the success of innovation.

Traditional and Non-Traditional Approaches

From the beginning, the highway industry has been interested in fostering innovation and moving the results of successful research into practice to continuously improve the cost, time, and quality of highway construction. Some practitioners have expressed that the traditional p/c approaches, Design-Bid-Build, and Material and Method Specifications, tend to inhibit innovations from the private sector. In this traditional sense, the responsibility of implementing research lies primarily with the contracting agency. Over the years, a variety of p/c approaches have emerged, commonly called non-traditional or innovative approaches, that give the private sector greater opportunity and incentive to innovate.

The distinction between these two categories is not easy to make, since what is traditional for one agency may be non-traditional for another. In general, non-traditional p/c approaches tend to shift responsibility and risk for innovation to the private sector. Table 1 at the end of Section II, entitled "Responsibility for Innovation and Combinations of P/C Approaches," distinguishes between traditional and non-traditional p/c models and identifies p/c combinations related to these models.

Procurement Approaches
- Design-Bid-Build
- Design-Build
- Privatization
    - Public-Private Partnerships
    - Wholly Private Ventures

Contracting Approaches
- Bid Alternates
- Constructability Reviews
- Construction Management
- Construction Warranties
- Incentive/ Disincentive
- Lane Rental
- Material and Method Specifications
- Multi-Parameter Bidding
- Partnering
- Performance/End-Result Specifications
- Value Engineering

Procurement Approaches and Contracting Approaches

The difference between a procurement approach and a contracting approach is one of scope. A procurement approach is a general scheme for purchasing services. A contracting approach is a specific technique used under the larger umbrella of a procurement approach to provide techniques for bidding, managing, and specifying a project.

There are several approaches to procurement that a contracting agency uses in the highway industry. Refer to the box in the sidebar for a list of the p/c approaches addressed by the Guidebook. It is noted that Pilot Projects are not included in the sidebar list. Contracting agencies commonly use Pilot Projects in the form of the Design-Bid-Build procurement approach to test and implement new products or processes. Pilot Projects have also been used to test and implement innovative p/c approaches. In the context of this Guidebook, Pilot Projects are addressed in terms of a Design-Bid-Build procurement approach.

Procurement approaches that were not included in Section III of this Guidebook include the following:

- Negotiated procurement (for construction)–an approach a contracting agency uses to (1) rank and select the contractor based on qualifications and (2) negotiate costs for award determination.
- Indefinite delivery/job order contracting–an approach used by a contracting agency that involves issuing individual work orders/job orders for a contract term, thus eliminating the need for separate contracts.

At this time there is not sufficient experience with these approaches by the transportation community to determine their roles, if any, in implementing research or promoting innovation. With more experience, these procurement approaches can potentially be combined with the contracting combinations shown in Table 1 to enhance their effectiveness in implementing research or promoting innovation in highway construction.

Combinations of P/C Approaches by Responsibility

The selection of p/c approaches for implementing research findings on highway construction projects depends upon a contracting agency's knowledge and confidence in the research finding, and the contracting community's ability to implement the research finding. Table 1 presents alternative p/c approaches grouped by responsibility for innovation. A contracting agency may choose one of these levels of responsibility depending upon its interest in implementing a specific research finding or promoting innovation on a project. The p/c approaches are addressed in Section III of this Guidebook in terms of survey results, benefits, considerations for use, project types, and useful combinations. Case studies that illustrate specific p/c approach combinations are listed in Table 1 and discussed in Section IV of this Guidebook.

Table 1: Responsibility for Innovation and Combinations of P/C Approaches

	Responsibility for Innovation	Procurement Approach	Preferred Contracting Combinations	Case Study
Traditional Models	Contracting agency has full knowledge and assumes the risk of implementing research or innovation	Design-Bid-Build	Pilot Project Material and Method Specifications Bid Alternate/Design Alternate	No. 4 - US-67 San Angelo Bridge Project No. 8 - I-83 Resurfacing No. 11 - K-96 Pavement Test
Non-Traditional Models	Contracting agency and contractor share the risk of implementing research or innovation. Agency desires to innovate but does not want to assume all the risk or does not have sufficient knowledge to implement alone	Design-Bid-Build	Partnering Value Engineering Incentive/Disincentive Constructability Review Construction Warranties Bid Alternate/Design Alternate Multi-Parameter Bidding Lane Rental	No. 1 - Oak Point Link Rail Project No. 2 - Central Artery Tunnel No. 3 - I-70 Pavement Rehabilitation No. 7 - I-75 Bridge Deck Replacement No. 10 - I-287 Bridge Replacement No. 12 - Route 139 No. 13 - Raleigh Beltline Rehabilitation Project
		Design-Build	Partnering Value Engineering Incentive/Disincentive Performance/End-Result Specifications Construction Warranties	No. 5 - I-15 Reconstruction No. 6 - New York City Bridge Renovations
		Public-Private Partnerships (Privatization)	Partnering Pilot Projects	No. 15 - Pavement Overlay Test No. 16 - San Joaquin Hills Transportation Corridor
	Private sector assumes the majority of the risk of innovation	Private Ventures (Privatization)	Partnering	No. 9 - Confederation Bridge
	Other parties are responsible for innovation such as: Suppliers Developers Financiers Construction Managers	Design-Bid-Build or Design-Build	Partnering Value Engineering Incentive/Disincentive Construction Warranties Bid Alternate/Design Alternate Construction Management	No. 14 - Corridor 44 Project

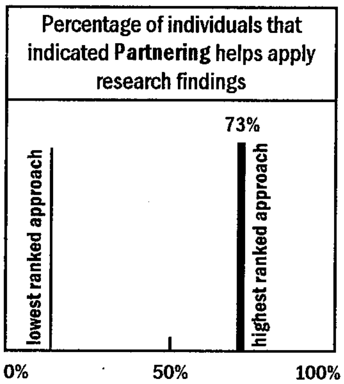
III. P/C APPROACHES

This section presents a detailed description of each p/c approach and its ability to facilitate the implementation of research findings or innovations. The p/c approaches are arranged in the order of ranking in Section II. Each given p/c approach description is presented in the following format:

- ***Survey Results***-Indicates the percentage of respondents that said the p/c approach helped apply research findings or innovations.
- ***Benefits***-Presents the positive aspects of the p/c approach that encourage the implementation of research findings or innovations.
- ***Considerations***-Presents potential problems that a contracting agency should address when selecting the p/c approach.
- ***Project Types and Examples***-Describes the type of projects that have been found to work well with the p/c approach and references examples, described in Section IV of this Guidebook, of actual projects that have implemented innovations and research findings as a result of the p/c approach.
- ***Useful Contracting Combinations***-Presents other contracting approaches that can be combined with the p/c approach to enhance the ability of the p/c approach to facilitate the implementation of research findings or innovations and the potential results of the sum combinations.

Partnering

Partnering is a method for establishing a relationship that focuses on achieving mutually beneficial goals through a formal procedure for better communication, shared risks, and resolving disputes at the lowest level. Partnering in the broadest sense can be performed between the contracting agency, contractor, and other parties at the project level, among disciplines within the contracting agency, or between the contracting agency and industry organizations on a broader scale.



Survey Results

Seventy-three percent of members of the highway community said the use of Partnering helped apply research findings and innovations. Partnering had the highest ranking among the p/c approaches included in the survey.

Benefits

- Develops trust and communication.
- Helps reduce perceived risk by building confidence in the project participants.
- Helps the contracting agency and the contractor reach a mutually acceptable decision on the proposed innovation.
- Provides open communication and tools for working through the unavoidable problems and contracting agency's concerns.

Considerations

Though practitioners rank Partnering as the most likely approach to promote innovation, the link between Partnering and innovation on a project is not always easy to identify. Partnering may not encourage innovation by itself, but serves as a catalyst for innovation or for the formal implementation of research findings in combination with other project delivery approaches. Partnering can also be viewed as a long-term partnership between a contracting agency and the industry. In this sense, the partners often share in the costs, risks, and rewards related to implementing new products or processes.

Innovations proposed by the contractor may meet initial resistance or opposition from the contracting agency. This can occur if (a) the innovation involves a material or process that the contracting agency has never used before and (b) the innovation involves changing an aspect of the project after construction has started or changing the requirements in the specifications. If the contracting agency accepts a new material or process, it is taking on the risk that the material or process will work as anticipated. To improve the chances of success, the contracting agency should consider a risk-sharing/reward-sharing approach to the implementation of innovations.

Project Types & Case Studies

All project types, especially projects with higher risks or unknowns at the time of award. Projects where Partnering encouraged innovation or the implementation of research include the following case studies (see Section IV):

- No. 1–Oak Point Link Rail Project
- No. 2–Boston Central Artery Tunnel
- No. 3–I-70 Pavement Rehabilitation
- No. 4–US-67 San Angelo Bridge Project
- No. 5–I-15 Reconstruction
- No. 6–New York City Bridge Renovations
- No. 8–I-83 Resurfacing
- No. 13–Raleigh Beltline Rehabilitation Project
- No. 14–Corridor 44 Project
- No. 15–Pavement Overlay Test

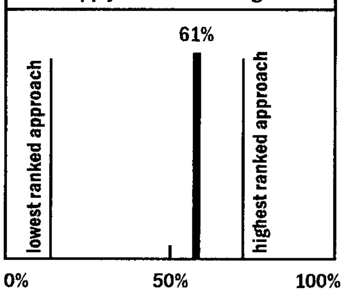
Useful Contracting Combinations

As discussed above, Partnering may be combined with any other p/c approach to facilitate the implementation of research findings and innovations on a project. Partnering findings are often combined with Value Engineering at the project level to provide an incentive to innovate, resulting in shared improvements in cost, time, or quality.

Value Engineering

Value Engineering in Design: Value Engineering (VE) in design is the analysis of a design or process to identify individual components or functions that can be provided with improved quality or the same quality at a reduced life-cycle cost.
Value Engineering in Construction: VE in construction takes the form of proposals by the contractor that could produce a savings to the owner without impairing the essential functions and characteristics of the facility, including service life, economy of operation, ease of maintenance, desired appearance, and safety.

Percentage of individuals that indicated **Value Engineering** helps apply research findings



Survey Results

Sixty-one percent of members of the highway community surveyed said the use of VE helped apply research findings and innovations. VE ranked second among the p/c approaches included in the survey.

Benefits

- Encourages innovations from an in-house or consultant VE team that may result in a reduction in project cost or an improvement in the functionality of the design (VE in design).
- Provides a means for the contractor to suggest innovative changes to the design or construction of the project with a Value Engineering Change Proposal (VECP), resulting in a savings in cost or time (VE in construction).

Considerations

VECP contract provisions reward the contractor for savings in cost or time. The savings is usually a shared savings, in which the contractor and the contracting agency each receive a portion of the amount saved. Therefore, there is incentive for both the contractor and the contracting agency to identify areas where VECPs may be useful to the project and to expedite the review of VECPs. The contracting agency must respond quickly to VECPs for the contractor to incorporate the changes into the project as the work progresses to avoid loss of time and savings. The contracting agency should perform life-cycle cost analyses of VECPs involving alternate designs to determine if savings are as great as expected.

When using VE in Design-Build projects, the contracting agency must clearly define what will be considered for VECPs and what will be considered part of the design process. The contracting agency and the contractor may share the potential savings in the portion of the design developed by the contracting agency through a VECP. The contractor is involved in the completion of the design, it may realize a savings through innovation in the design process not applicable to VECP. The larger the portion of design completed by the agency, the less savings the contractor can realize through design efforts, reducing the contractor's incentive to innovate in this area.

Project Types & Case Studies

VE is mandated for NHS projects in excess of $25 million. VE may apply to complex multi-stage projects, major bridge and roadway structures, projects with utility or right-of-way impacts, or projects with new bridge or roadway alignments. Projects where VE in design encouraged innovation include the following case studies (see Section IV):

- No. 13–Raleigh Beltline Rehabilitation Project

Projects where VE in construction encouraged innovation include the following case studies (see Section IV):

- No. 10–I-287 Bridge Replacement
- No. 12–Route 139 Hoboken Viaduct Replacement
- No. 16–San Joaquin Hills Transportation Corridor

Useful Contracting Combinations

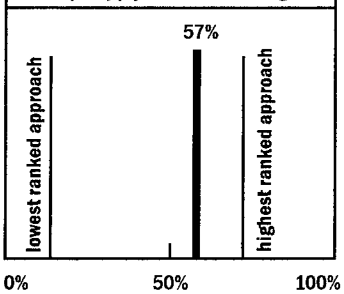
The following contracting approaches have been used successfully in combination with VE to encourage innovation, implement research findings, and address some of the considerations that accompany the use of VE:

- Partnering: this is useful for both VE in design and VE in construction to address proposed VE changes for the goals of the contracting agency and the contractor.

Incentive/Disincentive

Incentives/Disincentives (I/D) are contract provisions intended to motivate a designer/contractor to complete the work on or ahead of schedule or to provide a product at a higher level of quality, safety, or overall performance.

Percentage of individuals that indicated **Incentive/Disincentive** helps apply research findings



Survey Results

Fifty-seven percent of members of the highway community said the use of I/D helped apply research findings and innovations. I/D ranked third among the p/c approaches included in the survey.

Benefits

- Provides opportunity to try an innovative technique to meet I/D requirements that have an associated financial bonus.
- Promotes innovations to reduce construction time in areas such as (a) construction phasing or maintenance of traffic or (b) the use of innovative materials.
- Encourages innovation to improve quality or safety through new methods or materials or in other ways.

Considerations

The specifications should stipulate clear criteria by which an I/D goal will be judged. The contracting agency should consider the potential cost of the incentive. While I/D clauses are a good way to save time or improve quality, the final cost of the project could be high if the contractor achieves the maximum incentive. The I/D value should be sufficient to motivate the contractor but not be excessive relative to the goal.

If the I/D clauses are intended to reduce time on a project, the contracting agency should gear I/D goals toward a useable product. For example, the goal should be based on completion of a pavement surface instead of completion of landscaping. In addition, the contractor must have control of the work related to the I/D goal.

I/D clauses for time increase the risk to the contractor and the contracting agency. The contractor's risk increases as the contractor attempts to accelerate the work. Acceleration to meet I/D goals may mean accelerating a project that is already accelerated because projects that include I/D may also include other approaches designed to save time, such as Multi-Parameter Bidding. The contracting agency's risk increases with the need for additional inspectors, tests, and accelerated reviews of submittals or other issues beyond the contractor's control that may affect its ability to earn an incentive. One method of mitigating the increased risk is using better scheduling tools to manage the project.

The contracting agency must ensure that if the I/D clause applies to the same performance period as a liquidated damages clause, the I/D does not duplicate the liquidated damages.

Project Types & Case Studies

I/D clauses for time have been used on major rehabilitation projects for highways or bridges with significant impact to users. I/D clauses for quality have been used on asphalt or Portland cement concrete resurfacing or rehabilitation projects. Projects where an I/D clause encouraged innovation are the following case studies (see Section IV):

- No. 3-I-70 Pavement Rehabilitation
- No. 7-I-75 Bridge Deck Replacement
- No. 8-I-83 Resurfacing
- No. 13-Raleigh Beltline Rehabilitation Project

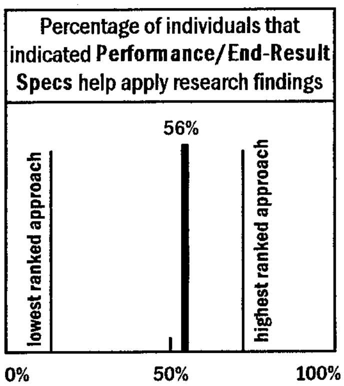
Useful Contracting Combinations

The following contracting approaches have been used successfully in combination with I/D to encourage innovation, implement research findings, and address some of the considerations that accompany the use of I/D:

- Partnering: this facilitates open communication and rapid issue resolution–it is also useful when reduced time or improved quality is a concern.
- Multi-Parameter Bidding: this is almost always used with I/D provisions in order to reinforce the importance of time on a project.
- Performance/End-Result Specifications: when using I/D provisions for quality, Performance/End-Result Specifications give the contractor greater flexibility to determine how to meet the I/D goals.

Performance/End-Result Specifications

Performance/End-Result Specifications define the required results of construction using measurable criteria or properties of the finished product. The measurable criteria or properties are used to verify compliance with the specifications when the work is completed. Performance/End-Result Specifications differ from Material and Method Specifications in that they specify the performance requirements of the end product and let the contractor determine how these performance criteria are to be met.



Survey Results

Fifty-six percent of members of the highway community said the use of Performance/End-Result Specifications helped apply research findings and innovations. Performance/End-Result Specifications ranked fourth among the p/c approaches included in the survey.

Benefits

- Provides flexibility in the design or construction of a project by allowing the contractor to be creative in its approach to construction to meet the specifications.

Considerations

With a Design-Bid-Build procurement approach, a contracting agency might use Performance/End-Result Specifications to specify one or more aspects of the project, such as the pavement. The Performance/End-Result Specification can define the properties of the finished pavement layer or structure (rideability, strength, density, etc.) that the contracting agency desires, allowing the contractor flexibility in designing and constructing the pavement to meet the requirements. The rest of the project requirements, including geometry, structures, and traffic control, can be designed by the contracting agency and specified using Material and Method Specifications.

With a Design-Build approach, Performance/End-Result Specifications are used to specify the requirements for some or all of a project. This allows the contractor greater flexibility to innovate in both design and construction. Areas where innovations may occur when using Design-Build and Performance/End-Result Specifications include design features, time, materials, phasing, and means and methods. For example, the contracting agency may specify the number of lanes, service life, and maximum number of piers for a bridge, allowing the designer-builder to choose the materials and design that best meet these requirements.

The use of Performance/End-Result Specifications and Material and Method Specifications for the same work item can lead to ambiguity or conflicting requirements in the contract. Other contract requirements, such as an approved products list, also may limit the materials a contractor can choose from, reducing the contractor's control over the end product. Overall, as the contractor's control over the work decreases, its ability to innovate in these areas also decreases.

The performance or service life of the end product is an important consideration when using Performance/End-Result Specifications. The contracting agency should address the length of time for which the final product should meet the performance requirements in the specifications. Construction Warranties use performance criteria and thresholds to define a required level of service for a specified period of time. A Construction Warranty decreases the contracting agency's risk that the end product will not perform over time, and further encourages the contractor to innovate in order to reduce future repair costs.

Project Types & Case Studies

Performance/End-Result Specifications have been used to encourage innovation on projects involving concrete and asphalt paving, bridges, pavement markings, and some or all work on Design-Build Projects. Projects where Performance/End-Result Specifications encouraged innovation include the following case study (see Section IV):

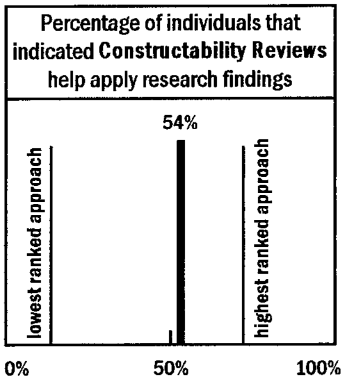
- No.5 - I-15 Reconstruction

Useful Contracting Combinations

The following p/c approaches have been used successfully in combination with Performance/End-Result Specifications to encourage innovation further, implement research findings, and address some of the considerations that accompany the use of Performance/End-Result Specifications:

- Construction Warranties: these provisions encourage improved performance.
- Partnering: this encourages communication regarding different interpretations or understandings of the Performance/End-Result Specifications. Partnering can also foster an understanding of the innovations being developed through the Performance/End-Result Specifications.

Constructability Review



Project Types & Case Studies

Constructability Reviews have been used on complex, multi-stage projects with flexibility in design and in construction means and methods. Projects where Constructability Reviews encouraged innovation include the following case studies (see Section IV):

- No. 1–Oak Point Link Rail Project
- No. 13–Raleigh Beltline Rehabilitation Project

A Constructability Review is a method of applying construction knowledge and experience during the planning and design of a project prior to bidding. The contracting agency brings in one or more contractors to review the design and offer comments on ways to simplify the design, propose alternatives, or otherwise make changes to ease construction.

Survey Results

Fifty-four percent of members of the highway community said the use of a Constructability Review helped apply research findings and innovations. Constructability Reviews ranked sixth among the p/c approaches included in the survey.

Benefits

- Brings a contractor's ability to innovate and integrate construction know-how into the design process by incorporating innovations into both the plans and specifications based on the Constructability Reviews.

Considerations

The contracting agency must consider a contractor's interest in bidding on a project when it brings the contractor in to review the design. The contracting agency must also consider the time required for a constructability review and the time needed to make any potential modifications to the design based on the constructability review. Constructability Reviews have greater value with a Design-Bid-Build procurement. In a Design-Build approach, Constructability Reviews should be an integral part of the Design-Build process.

Useful Contracting Combinations

The following contracting approach has been used successfully in combination with Constructability Reviews to encourage innovation, implement research findings, and address some of the considerations that accompany the use of Constructability Reviews :

- Partnering: this can be performed between the contracting agency and the design consultant to establish the scope of the Constructability Review and focus on the impacts of recommended changes on the designer's work.

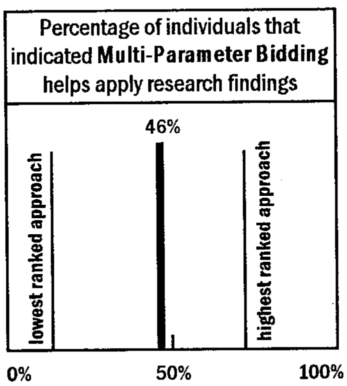
Multi-Parameter Bidding

Multi-Parameter Bidding is an alternative to the low bid system where the agency selects the low bidder based on a monetary combination of the contract bid items and one or more additional parameters. This approach is most often used with one additional parameter, time, in an approach called cost-plus-time or A+B bidding. For an A+B project, the bidder's estimate includes:

A = bid item cost; and

B = time performance multiplied by a daily cost to the road user estimated by the agency.

A "C" parameter, such as a Construction Warranty or a quality characteristic of the end product, has been added to the equation as A+B+C or A+B+C bidding.



Survey Results

Forty-six percent of members of the highway community said the use of Multi-Parameter Bidding helped apply research findings and innovations. Multi-Parameter Bidding ranked seventh among the p/c approaches included in the survey.

Benefits

- Multi-parameter (A+B) bidding encourages contractor innovations to save time, including innovative work phasing or proposals to use different materials to speed construction.
- Multi-parameter (A+B+C) bidding encourages contractor innovations to improve quality or reduce life-cycle costs in addition to decreasing construction time.
- Multi-parameter bidding can lead to innovations that typically improve the quality of the end product in addition to reducing future repair costs.

Considerations

The contracting agency should consider whether the project requires utility adjustment, as the time and scheduling of utility adjustment work can impact the overall because project time. Utility work can also place limitations on the contractor's ability to innovate in traffic control and in areas where the utilities will be working. Multi-parameter (A+B) bidding typically is combined with I/D provisions. If the agency includes time as a component of the bid and assesses I/Ds for time, it must establish a reasonable basis for the value of time. This value represents the daily inconvenience to the road user caused by the construction.

If a contracting agency includes a quality component in the bidding process, it must establish measurable, objective criteria for the determination of the value of quality (smoothness, warranty, etc.).

Project Types & Case Studies

Multi-parameter Bidding has been used to encourage innovation on projects involving rehabilitation or replacement of high-volume roadways, roadways with safety concerns, or projects with severe impacts to local communities or businesses. Examples of these projects include the following case studies (see Section IV):

- No. 3-I-70 Pavement Rehabilitation
- No. 10-I-287 Bridge Replacement

Useful Contracting Combinations

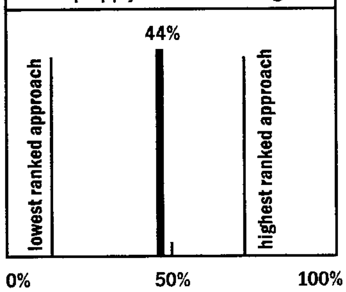
The following contracting approaches have been used successfully in combination with Multi-Parameter Bidding to encourage innovation, implement research findings, and address some of the considerations that accompany the use of Multi-Parameter Bidding:

- I/D: this reinforces the importance of time, quality, or both.
- VE: this offers a way for the contractor to propose design changes that can reduce construction time or improve quality, depending on the parameters used.
- Partnering: this facilitates quick resolution of issues that may impact completion time.
- Construction Warranties: as discussed above, these can be used as a parameter in the bid evaluation to encourage innovations to improve quality or reduce cost.

Construction Warranties

Construction Warranties are contract provisions that guarantee the integrity of an end product or component of the project and the maker's responsibility for the replacement or repair of deficiencies for a specified duration after construction completion. Typically, many materials and products used in construction will carry a short-term manufacturer's warranty. A Construction Warranty is different from a normal manufacturer's warranty in that it is typically for five years or more and applies to the work as well as the materials used.

Percentage of individuals that indicated **Construction Warranties** help apply research findings



Survey Results

Forty-four percent of members of the highway community said the use of Construction Warranties helped apply research findings and innovations. Construction Warranties ranked eighth among the p/c approaches included in the survey.

Benefits

- Encourages contractor innovation to increase the quality of the work with a new material or process in order to reduce future repair and replacement costs because the contractor is responsible for the work after construction.
- Encourages implementation of manufacturer research of new materials or processes, which is warranted for a specific length of time.

Considerations

Construction Warranties that encourage innovation can involve a new material or process, as described above, or the performance of an item of construction. The contractor may propose the substitution of a new material or process for the one specified by the contracting agency. As described above, this material or process is usually covered by a manufacturer's warranty. A Construction Warranty on an item of construction can involve any number of things. The Construction Warranty may cover products, such as bridge expansion joints, a single item of work, such as bridge painting, or a large portion of the project, such as an asphalt pavement.

The responsibilities for repair and replacement under a Construction Warranty should be clearly defined. There have been cases of disagreement over whether the contractor or manufacturer is responsible for repairs when a manufacturer's warranty is included in the contract. In addition, the contracting agency should clearly define the performance requirements for any materials or work covered by a Construction Warranty. A clear definition of these requirements will reduce the possibility of confusion over when and what repair work must be done.

Because the contractor has responsibility for the long-term performance of items covered by Construction Warranties, the contractor should have control over the selection or design of these items. Contractors will be reluctant to participate in projects with Construction Warranties if they do not at least have input into selection or design. Construction Warranties may be combined with Design-

Build and Performance/End-Result Specifications to give the contractor more control over the design and the contracting agency more confidence in the work.

The contractor incurs additional costs to obtain a warranty bond or performance bond during the warranty period and the potential costs associated with remedial work on warranted items. The contracting agency may be relieved of some inspection duties during construction. The contracting agency is also relieved of the costs to perform remedial work while the Construction Warranties are in effect. However, the contracting agency assumes the risk that factors beyond the control of the contractor, such as excessive loading, environmental conditions, or extreme weather conditions may negate the Construction Warranty or that the causes of failure under a Construction Warranty will be difficult to determine. Contracting agencies have addressed this risk by selecting Construction Warranty projects with predictable loading and environmental conditions and well-defined procedures for evaluating the condition of the end product under warranty.

Project Types & Case Studies

Construction Warranties have been used more frequently on paving, bridge rehabilitation projects, pavement marking, and painting projects. Projects where Construction Warranties encouraged innovation include the following case studies (see Section IV):

- No. 3-I-70 Pavement Rehabilitation
- No. 5-I-15 Reconstruction
- No. 14-Corridor 44 Project

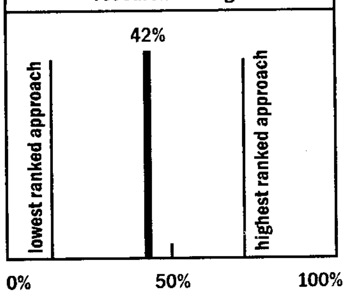
Useful Contracting Combinations

The following contracting approaches have been used successfully in combination with Construction Warranties to encourage innovation, implement research findings, and address some of the considerations that accompany the use of Construction Warranties.

- Partnering: when performed among the agency, contractors, and suppliers, Partnering can help address responsibility issues early in a project, especially when a manufacturer's warranty is involved, and can aid in the development of equitable warranty specifications. Partnering can also help with the coordination of the many parties involved with this type of project.
- Performance/End-Result Specifications: these give the contractor more control over the work under Warranty than Material and Method Specifications would.
- Design-Build: this gives the contractor more control over the design and warranteed items.

Privatization

Privatization is a procurement approach in which a private entity finances or invests in a transportation project and develops, designs, builds, and maintains a roadway or bridge for a specified duration in return for toll revenue, the cost of long-term financing, or development rights. The financing can take the form of a public-private partnership or a wholly private venture. Privatization also applies to contracting with a private entity for maintenance or other services traditionally performed in-house by the public agency.



Percentage of individuals that indicated **Privatization** help apply research findings

Survey Results

Forty-two percent of members of the highway community said the use of Privatization helped apply research findings and innovations. Privatization ranked ninth among the p/c approaches included in the survey. Privatization was not highly ranked because of its relatively low use. When used, the survey respondents gave Privatization a high rating in terms of contributing to the success of innovation.

Benefits

- Encourages the private entity to innovate or implement research findings to reduce maintenance costs, to ensure long performance, and to allow for recovery costs.

Considerations

Privatization is similar to Design-Build in that the increased responsibility, risk, and financial interest of the private entity may deter competitors from proposing on privatized projects.

Privatization places a greater emphasis on long-term performance and preventative maintenance than a Design-Bid-Build or Design-Build project might, because the private entity recovers its investment over the long term through the operation of the bridge or roadway after completion. Maintenance costs during the lease period are the responsibility of the private entity. High maintenance costs during this period would reduce net income and extend the investment recovery period. The private entity also may spread its investment out over the lease period, investing less initially and adding features over time (additional lanes, new pavements, etc.) to enhance performance and increase return on investment (ROI).

In Privatization projects, the private entity has a large financial interest in the performance of the project. The private entity gives primary consideration to ROI, not necessarily innovation. The innovations introduced by the private entity will most likely reduce overall costs and shorten the time to recover the investment. The contracting agency should balance the private entity's financial interest with the public interest in cases where the public and private interests are different.

The time needed to develop and obtain approval for a privatized project may offset the perceived advantage to the contracting agency to build a major project much sooner with private funds than within a publicly-funded construction program. One study recommended that the contracting agency or developer separate the project into two phases. The first phase would involve clearing the project, including acquiring right-of-way, obtaining the necessary permits and public approvals, and performing the preliminary design. The second phase would involve the award to complete the final design, finance, construct, and operate the facility. With this two-phase approach, a major financial commitment would not be necessary until the project was cleared to proceed, reducing the risk to investors.

Proposed Privatization projects in the United States have experienced significant opposition from taxpayers, public groups, and industry organizations representing trucking interests and the interests of the traditional highway and infrastructure contractors. Contracting agencies must demonstrate that (1) a genuine and compelling need for the project exists, (2) traditional sources of public funding are not sufficient for the project to be constructed soon enough, (3) the need for the facility would outweigh negative reaction to the use of a toll or other source of repayment, and (4) the projected long-term ROI would attract a sufficient number of qualified private investors. To gain public support and approval, the contracting agency must actively promote and "market" the benefits of a privatized project to the public.

A relatively new concept called shadow tolls may allow wider use of Privatization. Shadow tolls are tolls paid by the agency rather than by the road users. The shadow tolls paid are based on road usage.

The U.S. tax code discourages the use of private capital for infrastructure projects. The code restricts tax-exempt financing for projects involving private equity investment. Tax-exempt financing, however, is available for public infrastructure projects solely owned and operated by public owners or operated by "63-20" non-profit corporations. These tax disincentives do not exist outside the U.S., which explains in part why Privatization is more common in other countries.

Project Types & Case Studies

Privatization is used on large, high-volume highways or bridge projects amenable to tolls, though shadow tolls may allow wider use of this approach. Projects where Privatization has stimulated innovations include the following case studies (see Section IV):

- No. 9–Confederation Bridge
- No. 16–San Joaquin Hills Transportation Corridor

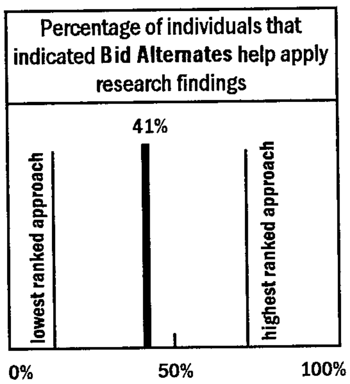
Useful Contracting Combinations

The following contracting approaches have been used successfully in combination with Privatization to encourage innovation, implement research findings, and address some of the considerations that accompany the use of Privatization:

- Performance/End-Result Specifications: these allow the private entity maximum flexibility to innovate.
- Partnering: this has been found to be useful and desirable on all projects of Partnering's ability to improve communication among all parties involved in a project.

Bid Alternates

A Bid Alternate is a contracting approach in which the bidders submit alternate bids or design proposals. The contracting agency may use one of the following approaches: (1) the contracting agency may specify two or more alternates for an aspect of the project, and the contractor bases its bid on one of the alternates; or (2) the contracting agency specifies one or more designs and allows the contractor to propose an alternate design that meets or exceeds the function and service of the specified design.



Survey Results

Forty-one percent of members of the highway community said the use of Bid Alternates helped apply innovations and research findings. Bid Alternates ranked tenth among the p/c approaches included in the survey.

Benefits

- Encourages an innovative option on a Design-Bid-Build project, allowing contractors to choose to construct with a more familiar material or work with an innovative material they have never used before, thus leaving the design-related risk with the contracting agency.
- Provides the contractor the incentive to propose an alternate innovative design that may improve upon the specified design and lower the life-cycle costs.
- Gives the contracting agency a perceived advantage using this approach over VECPs in that the bidders can participate in the submission of innovative alternates at the time of bid.

Considerations

The first benefit described above allows the contracting agency to encourage an innovative option on a Design-Bid-Build project. For example, assume precast concrete has never been used by a contracting agency. The contracting agency may offer two designs for a bridge, where the first design uses steel and the second design uses precast concrete.

Currently, in the second benefit, often called Design Alternates, the contracting agency provides a design, and the contractor can bid on that design or develop and bid on an alternate design that meets specified criteria. This approach differs from Bid Alternates in that the contractor may perform actual design work or may substitute an alternate material or product.

The contracting agency evaluates all bids on an equivalent basis to account for the different construction and life-cycle costs of the alternate products or materials. This approach allows contractors to work with the suppliers or designers they are most comfortable with and encourages innovation to lower the cost of the work.

Because of the different approaches that Bid Alternates can take, the contracting products list may prohibit the choice of some design alternates or the submission of new or untried products.

Bid Alternates are sometimes difficult to evaluate on an equivalent basis. For example, different pavement designs have different life-cycle costs and service lives. Evaluation of the bids on an equivalent basis is necessary both for fairness to the bidders and to ensure that the contracting agency is receiving the best product at the lowest cost.

Project Types & Case Studies

Bid Alternates have been used to encourage innovation on projects involving bridge replacement, retaining walls, and more recently pavement designs. An example of such projects is in the following case study (see Section IV):

- No. 10-I-287 Bridge Replacement

Useful Contracting Combinations

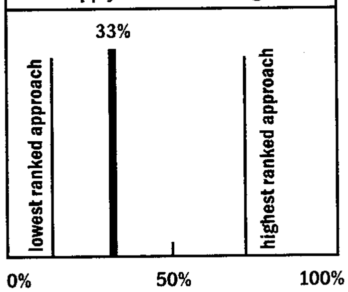
The following contracting approach has been used successfully in combination with Bid or Design Alternates to encourage innovation, implement research findings, and address some of the considerations that accompany the use of Bid Alternates:

- Partnering: open communication between the contracting agency and the contractor can help resolve design-related issues that may arise from the use of alternate designs.

Design-Bid-Build

Design-Bid-Build is the traditional procurement approach for a project. The contracting agency provides the completed plans and specifications and procures the construction services based on the lowest bid, in sequential order. A Design-Bid-Build project that involves research implementation by the contracting agency often takes the form of a Pilot Project. Contracting agencies use Pilot Projects to test new products or processes that are being considered for use on a broader scale by the agency.

Percentage of individuals that indicated **Design-Bid-Build** helps apply research findings



Survey Results

Thirty-three percent of members of the highway community said the use of Design-Bid-Build helped promote research findings and innovations. Design-Bid-Build ranked eleventh among the p/c approaches included in the survey.

Benefits

- Offers, as a Pilot Project, the best opportunity for contracting agencies to assess research findings on a controlled basis before using them on a broader scale.
- Offers control to the contracting agencies to implement research.
- Allows the contracting agency to incorporate research findings into the design of the project and to expect the project to be built as specified.
- Allows for testing and monitoring the innovation as a Pilot Project.

Considerations

The primary intent of a Design-Bid-Build project is to build the project exactly as the contracting agency specifies. The ability of the contractor to innovate is limited because of this.

When using Design-Bid-Build with a Pilot Project, the contracting agency should consider the long-term objectives of the Pilot Project. Pilot Projects are usually observed and tested over time, perhaps several years, to determine the long-term behavior of the materials or techniques used. Some Pilot Projects use materials from a specific manufacturer. The manufacturer may include a warranty of its own to encourage the use of the material. The contracting agency should clarify if the manufacturer or the contractor is responsible for repairs under the manufacturer's warranty.

Design-Bid-Build was not highly ranked in the survey. To boost effectiveness, contracting agencies can use Design-Bid-Build with other p/c approaches that increase its ability to accommodate and encourage innovation. If the project is a Pilot Project, though, the contracting agency should consider whether there is any overlap or conflict between the research being implemented and potential contractor innovations. For example, if VE is included on a project testing a new material, it should be made clear that VE proposals will not be accepted for replacement of the material or modification of the procedures necessary to use the material. Clarifying this will prevent the contractor from expending effort on a VE proposal that can not be accepted because of the contracting agency's Pilot Project goals.

Project Types & Case Studies

As the traditional project delivery approach, Design-Bid-Build is used for all types of projects, from new construction to resurfacing. This flexibility of use applies to implementing research through Pilot Projects as well. Projects where Design-Bid-Build in concert with a Pilot Project was used to implement research include the following case studies (see Section IV):

- No. 1–Oak Point Link Rail Project
- No. 4–US-67 San Angelo Bridge Project
- No. 7–I-75 Bridge Deck Replacement
- No. 11–K-96 Pavement Test
- No. 13–Raleigh Beltline Rehabilitation Project

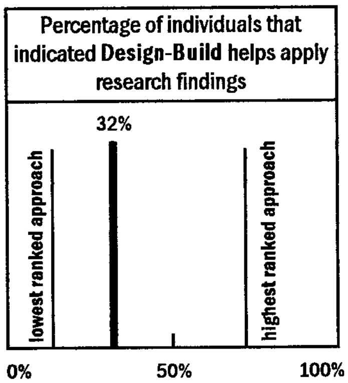
Useful Contracting Combinations

The following contracting approaches have been used successfully in combination with Design-Bid-Build to encourage innovation, implement research findings, and address some of the considerations that accompany the use of Design-Bid-Build:

- Material and Method Specifications: traditionally used with Design-Bid-Build and Pilot Projects, these allow the contracting agency to precisely specify how the research findings will be implemented.
- Bid Alternates: this can encourage innovation or give the contracting agency flexibility in the implementation of research. Bid Alternates may conflict with Pilot Project goals.
- Multi-Parameter Bidding: this can encourage time-saving innovations or quality improvements.
- Lane Rental: this can encourage time-saving innovations.
- Partnering: this approach is useful for clarifying the contracting agency's and contractor's goals as they pertain to the research findings or innovations.
- VE: this allows the contractor to propose innovative design changes to save time or money. VE may conflict with Pilot Project goals.
- I/D: this can encourage time-saving or quality-enhancing innovations.
- Constructability Reviews: this allows innovations before design is completed to save time or money, or address construction-related issues specific to the project before bid.
- Warranties: these are useful on a Pilot Project to provide for long-term repair of new materials used if offered by the manufacturer.
- Construction Warranties: these can also be used on Design-Bid-Build projects to encourage quality-related innovations.

Design-Build

Design-Build is a procurement approach where the contractor provides both design and construction through a single contract between the contracting agency and the design-build contractor. The contracting agency will prepare a portion of the design, usually 15 to 35 percent, before bid.



Survey Results

Thirty-two percent of members of the highway community said the use of Design-Build helped apply research findings and innovations. Design-Build ranked twelfth among the p/c approaches included in the survey. Design-Build was not highly ranked because of its relatively low use. When used, the respondents gave Design-Build a high rating in terms of contributing to the success of innovation.

Benefits

- Allows the contractor to be innovative during the design phase because the designer and the contractor are on the same team and constructability-related issues can be addressed during design.
- When used with Performance/End-Result Specifications, Design-Build allows the contractor greater freedom to innovate.

Considerations

The statutes in many states restrict the use of a two-step, "best value" Design-Build procurement based on price and technical criteria. A Design-Build procurement based on a one-step, low bid selection reduces the ability of the contractor to innovate. The contracting agency should carefully review the statutes to ensure that a "best value" Design-Build selection is legally possible.

The close coordination between the designer and contractor allows the construction to proceed much sooner and more efficiently. Design-Build involves the contractor in coordinating with utilities and cooperating with surrounding communities at a much earlier stage than traditional Design-Bid-Build projects. This allows for improved coordination between the contractor, utilities, and others.

The contracting agency should consider including stipends in the contract during the proposal phase to encourage contractor participation, which may result in more innovative proposals. Contracting agencies pay stipends to the short-listed bidders on a project to compensate them for their effort in developing the detailed technical/cost proposal. In return for the stipend, the agency may incorporate ideas from unsuccessful proposers into the project.

Design-Build projects are typically advertised after part of the design has been completed. The extent to which the design is complete should be considered, because the completed portion can limit the contractor's ability to innovate. Innovation in a Design-Build project comes from the fact that the contractor is responsible for both design and construction. The greater the amount of design completed before the request for proposals (RFP) is issued, the less the contractor will be able to innovate in the design phase of the project.

Design-Build projects reduce the control the contracting agency has over the approach to delivering the end result because Design-Build leaves the majority of the design to the contractor.

Design-Build projects can be specified using Material and Method Specifications or Performance/End-Result Specifications. Material and Method Specifications will be more restrictive and leave less room for innovation, but they will give the contracting agency more control over how the project is built. Performance/End-Result Specifications give a greater potential for innovations or alternate designs from the contractor, but they may not be practical for all items of work and must be clearly written or there may be room for misinterpretation by the contractor. Care must be taken not to specify the same or overlapping items using Material and Method Specifications and Performance/End-Result Specifications.

Design-Build projects shift much of the risk that is generally associated with contracting agencies and designers to the Design-Build contractor. This may include the risk for environmental mitigation, permits, utility coordination, differing site conditions, and design errors and defects. The contracting agency should consider the extent risk is shifted to the contractor because higher risk may reduce the number of proposers and increase the potential for disputes. Agencies should assume responsibility for the unknowns over which the contractor has little or no control.

Project Types & Case Studies

Design-Build is most useful on larger, more complex highway and bridge projects where significant design effort or outside expertise from the private sector is desired, and the requirements can be described in terms of performance criteria. Design-Build is also useful on small projects or particularly technical or proprietary projects. Projects where Design-Build was used to implement research include the following case studies (see Section IV):

- No. 5– I-15 Reconstruction
- No. 6–New York City Bridge Renovations
- No. 9–Confederation Bridge
- No. 16–San Joaquin Hills Transportation Corridor

Useful Contracting Combinations

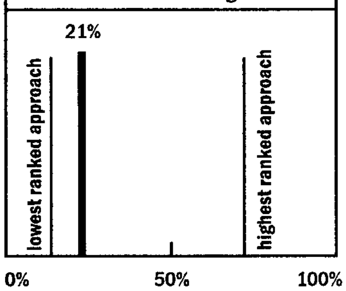
The following contracting approaches have been used successfully in combination with Design-Build to encourage innovation, implement research findings, and address some of the considerations that accompany the use of Design-Bid-Build:

- VE: this is useful when a relatively larger percentage of design is completed before bidding and the contracting agency wants to encourage further innovation after contract award.
- Partnering: this can help clarify everyone's roles and responsibilities on the project, which is important since Design-Build is not a widely used procurement approach.
- Performance/End-Result Specifications: these can offer additional flexibility to the contractor, with an eye toward improving quality for the contracting agency.
- I/D: this can be used to encourage improvements in time and quality.
- Construction Warranties: these encourage the contractor to consider long-term repair in both design and construction of the project.

Lane Rental

Lane Rental provisions assess the contractor daily or hourly rental fees for portions of the roadway that are out-of-service during the project. These provisions encourage the contractor to minimize the time that the roadway restrictions impact traffic. For bidding purposes, Lane Rental can be treated in different ways. The method used by several states is for the contractor to include the Lane Rental costs in its bid. Lane Rental charges are then assessed against the bid amount. If total Lane Rental charges exceed the amount bid, the contractor pays the excess amount to the contracting agency as a disincentive payment. If the contractor does not use the full amount bid, it receives the extra money as an incentive payment.

Percentage of individuals that indicated **Lane Rental** helps apply research findings



Survey Results

Twenty-one percent of members of the highway community said the use of Lane Rental helped apply research findings and innovations. Lane Rental ranked thirteenth among the p/c approaches included in the survey.

Benefits

- Encourages innovation by the contractor to decrease the time required for construction, usually involving traffic control and construction phasing.

Considerations

Lane Rental is similar to Multi-Parameter Bidding, where the only parameters are (A+B). The difference is that Lane Rental is based on the time a traffic lane or shoulder is actually closed, while Multi-Parameter Bidding focuses on construction time for the overall project or project milestones.

While Lane Rental results in time savings and may promote innovations to achieve these savings, the costs to the contracting agency can be higher than on a conventionally bid project. For example, the final project cost may be higher because of the incentives that accompany early completion by the contractor, and the administrative and staffing costs of the contracting agency may increase in order not to impede the contractor's progress.

Lane Rental increases the risk to both the contractor and contracting agency on a project. The contractor has additional risk associated with estimating time and minimizing lane closures. The contracting agency also has risk associated with potential claims for delay because lane closure time is more important to the contractor on Lane Rental projects than on other types of projects. The contracting agency can take steps to mitigate its and the contractor's risk by ensuring the design is complete before bid, addressing utility coordination and all necessary permits before work begins, having the project adequately staffed at all times, and using better scheduling tools to manage the project.

Project Types & Case Studies

Lane Rental is used on roadway or bridge rehabilitation projects with high traffic volumes and impractical detour routes. Projects where Lane Rental encouraged innovation include the following case studies (see Section IV):

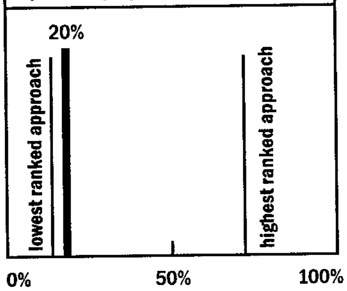
- No. 3-I-70 Pavement Rehabilitation
- No. 7-I-75 Bridge Deck Replacement

Useful Contracting Combinations

The following contracting approaches have been used successfully in combination with Lane Rental to encourage innovation, implement research findings, and address some of the considerations that accompany the use of Lane Rental:

- Partnering: this can address risk-related concerns early in the project.
- VE: this allows contractor-proposed changes to reduce lane closure time.
- Constructability Review: this can identify time-saving innovations to reduce lane closures before bid and ensure that there are no obstacles to rapid completion.

Percentage of individuals that indicated **Material and Method Spec.** help apply research findings



Project Types & Case Studies

Material and Method Specifications have been used with all types of projects. When used to introduce a new material or techniques, they can still be used on any type of project, from new construction to minor repair work. Projects where Material and Method Specifications encouraged innovation include the following case study (see Section IV):

- No. 8-I-83 Resurfacing

Material and Method Specifications, also called "recipe" or prescriptive specifications, establish precisely what the contractor is to provide and may even prescribe the equipment and procedures to be used to place the materials or perform the construction. Material and Method Specifications are the traditional method of specifying construction requirements.

Survey Results

Twenty percent of members of the highway community said the use of Material and Method Specifications helped apply research findings and innovations. Material and Method Specifications ranked fourteenth among the p/c approaches included in the survey.

Benefits

- Gives the contracting agency sole control over the materials used in a project and over the end product of construction.
- Can be used to implement research findings, because the contracting agency specifies exactly what it wants.

Considerations

With control comes responsibility and risk. If the contracting agency specifies a material or procedure and the end product fails, the responsibility lies with the contracting agency as long as the contractor performs the work according to the specifications.

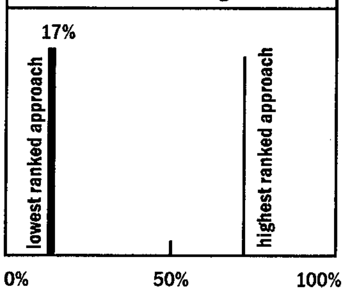
The use of these specifications with a Design-Bid-Build project usually does not motivate contractors and suppliers to provide more than the minimum standard. These projects are awarded based on the lowest bid. The bidders must offer the minimum required by the specifications, but offering more than what is required may result in a higher cost, displacing the contractor as low bidder.

Useful Contracting Combinations

The following contracting approach has successfully been used in combination with Material and Method Specifications to encourage innovation, implement research findings, and address some of the considerations that accompany the use of Material and Method Specifications:

- Partnering: this opens communications between the contractor and contracting agency, which is useful when implementing research findings.

Percentage of individuals that indicated Construction Management help apply research findings



Construction Management is a contracting approach in which an agency contracts with an independent construction manager (CM) to provide program or project management, or administrative services. The CM acts on the contracting agency's behalf in overseeing and coordinating design and construction. With an agency-CM scheme, the CM does not contract directly with the construction contractors.

Survey Results

Seventeen percent of members of the highway community said the use of Construction Management helped apply research findings and innovations. Construction Management ranked fifteenth among the p/c approaches included in the survey.

Benefits

- Can bring innovative or state-of-the-art techniques to the management of large or complex construction projects, such as improvement of cost control, identification and resolution of potential changes earlier in construction, or reduction of the construction time through fast-tracking design and construction activities and closely coordinating and tracking multiple design and construction contracts in a master schedule.

Project Types & Case Studies

CM is used on large, multi-phase projects involving multiple design and construction contracts. Projects where Construction Management encouraged innovation include the following case studies (see Section IV):

- No. 2-Boston Central Artery Tunnel Project

Considerations

Construction Management in and of itself does not appear to encourage the implementation of research or innovation. Instead, Construction Management provides an opportunity for innovation in the area of project management. For example, on a job with multiple contractors, the CM can innovate to provide better management of the various aspects of the project to control construction phasing and identify potential conflicts between contractors.

The contracting agency must delegate contractual authority to allow the CM to manage more effectively. If the contracting agency limits a CM's decision-making authority, the CM may in turn inhibit innovation by the contractor. This can happen because the less authority the CM has, the more often the CM has to obtain approval from the contracting agency for a contractor-proposed change. This delay in decision making can reduce the usefulness of contractor-proposed innovations when the innovation is related to time savings or to a critical work

Useful Contracting Combinations

The following contracting approaches have been used successfully in combination with Construction Management to encourage innovation, implement research findings, and address some of the considerations that accompany the use of Construction Management:

- Partnering: this facilitates communication between the multiple parties involved and aids in clarifying decision-making responsibilities.

IV. CASE STUDIES

This section presents 16 case studies that demonstrate how the different p/c approaches have been used to implement research findings or innovations. Each case study includes the project title, contracting agency, project description, and identification of the p/c approaches used. For each case study, the p/c approaches that specifically contributed to innovation are listed in bold for easy identification, and are also listed in the sidebar to make it easier to locate a specific p/c approach. These case studies are:

No. 1–Oak Point Link Rail Project

No. 2–Boston Central Artery Tunnel

No. 3–I-70 Pavement Rehabilitation

No. 4–US-67 San Angelo Bridge Project

No. 5–I-15 Reconstruction

No. 6–New York City Bridge Renovations

No. 7–I-75 Bridge Deck Replacement

No. 8–I-83 Resurfacing

No. 9–Confederation Bridge

No. 10–I-287 Bridge Replacement

No. 11–K-96 Pavement Test

No. 12–Route 139 Hoboken Viaduct Replacement

No. 13–Raleigh Beltline Rehabilitation Project

No. 14–Corridor 44 Project

No. 15–Pavement Overlay Test

No. 16–San Joaquin Hills Transportation Corridor

1

OAK POINT LINK RAIL PROJECT

New York City Department of Transportation (NYCDOT)

CONSTRUCTABILITY REVIEWS
- Design-Bid-Build
- Partnering

This project consisted of building a 1.8-mile rail trestle along the Harlem River in New York City. The original project had been terminated because of varied subsurface conditions over the length of the project. These subsurface conditions led to problems with caisson installation and other foundation work. NYCDOT redesigned the project and included a **Constructability Review** with an experienced marine contractor. Several recommendations resulted from the constructability review that simplified the construction process. To verify the adequacy of the redesign and provide more information to bidders, the constructability contractor recommended a preconstruction pile driving and load testing program. The contractor also recommended including separate pay items for ordered length and driven length of caisson pipes to reflect potential subsurface conditions. Additionally, NYCDOT gave the bidders the option of using work performed before the first contract was terminated or performing all the work themsleves.

NYCDOT and the contractor hired after the redesign implemented partnering at the beginning of the project. The use of **Constructability Reviews** and **Partnering** with this **Design-Bid-Build** project resulted in a project completed without additional delays or claims despite the potential difficulties.

2

BOSTON CENTRAL ARTERY TUNNEL

Massachusetts Highway Department (MHD)

CONSTRUCTION MANAGEMENT
- Partnering

This project consists of the construction of an underground highway and tunnels through central Boston and the Boston Harbor. The project replaces a 40-year-old highway that currently carries more than twice its design volume and includes work on I-90, I-93, and connecting roadways throughout Boston.

The project is so large that the expected completion date is in 2004. MHD is using an agency-**Construction Management** approach to speed construction and coordinate the multitude of design and construction contracts for the project. There were more than 100 contracts active as of October 1998, and a number of additional contracts will not even be let for bidding for two years.

The Construction Manager is taking an innovative approach to monitoring the costs of the project. This approach includes an early change identification program and a design-to-cost program. The early change identification program helps reduce delays and disputes regarding changes in the work. The design-to-cost program ensures that the design consultants develop designs that support the agreed upon construction cost baseline amounts.

To manage the overall project further, all the project participants engaged in partnering. **Partnering** has helped the Construction Manager keep the project within the budget and schedule, maintain quality on the project, and more effectively coordinate the work.

3

CONSTRUCTION WARRANTY
- Multi-Parameter Bidding
- Lane Rental
- Partnering
- Incentive/Disincentive

I-70 PAVEMENT REHABILITATION

Indiana Department of Transportation (INDOT)

This project consisted of removing an existing pavement overlay and placing a new asphalt overlay on a reinforced concrete pavement. INDOT defined the contract as a **Multi-Parameter** (A+B+C) concept. The contract used **Multi-Parameter (A+B)** to shorten the construction time for the project, and included Part C, the cost of a five-year **Construction Warranty** for the pavement overlay, to emphasize the quality of the finished pavement. The contract also included **Incentive/Disincentive** clauses and **Lane Rental** to reduce construction time further.

The contract required that the contractor submit a pavement mix design. The **Construction Warranty** provisions then required the contractor to make any repairs to the pavement for five years after project completion. This combination provided the contractor greater flexibility and control of the work and encouraged a higher quality pavement. The contractor used several innovative techniques to achieve better compaction at the longitudinal joints. The contractor retrofitted the paver screeds with matching devices to ensure that the proper amount of material was placed at the joint. The contractor also fitted the joints with a German-made joint tape that bonded the two paved lanes together at the joint. The contractor made this extra effort to address the raveling and potholing that typically occur at the longitudinal joints. Nine months after completion of the work, Accelerated Pavement Testing indicated that the pavement is more resistant to rutting than standard asphalt pavement.

Partnering between INDOT and the contractor played an important role in promoting innovation in two aspects of this project. First, **Partnering** facilitated the **Lane Rental** requirements and helped with timely project completion. Second, **Partnering** between INDOT, FHWA, contractor organizations, and material suppliers assisted in the development of the **Construction Warranty** provisions.

4

DESIGN-BID-BUILD (Pilot Projects)
- Partnering

US-67 SAN ANGELO BRIDGE PROJECT

Texas Department of Transportation (TxDOT)

This project consisted of the construction of two adjacent multi-span bridges in San Angelo, Texas. The project, one of the several projects developed by TxDOT to demonstrate the use of High Performance Concrete (HPC), was developed as a **Pilot Project** in conjunction with FHWA and the University of Texas, through an informal **Partnering** agreement.

The HPC is tested in comparison to conventional concrete that is used in a similar structure carrying a similar load. For the San Angelo Bridges, two bridges were built next to each other. One bridge carries eastbound traffic and the other carries westbound traffic. The eastbound bridge was built entirely of HPC, including the deck, beams, and substructure. The decks of five spans of the westbound bridge were also built with HPC, and the rest of the bridge was built with conventional concrete. This design allows (a) comparison of an HPC substructure and beams to a conventional concrete substructure and beams, and (b) comparison of an HPC deck to a conventional concrete deck where both deck materials carry exactly the same amount of traffic. The comparison of the performance of these two bridges over time will indicate whether or not HPC is superior. Incorporating HPC in **Pilot Projects** also gives TxDOT first-hand information on the use of the material, allowing them to develop standards for its use in future projects.

5

I-15 RECONSTRUCTION

Utah Department of Transportation (UDOT)

DESIGN BUILD
- **Construction Warranty**
- **Performance / End-Result Specifications**
- **Partnering**

This project consists of the demolition, redesign, and reconstruction of 17 miles of I-15 in Salt Lake City, Utah. The existing highway was deteriorating, and it carried a traffic volume higher than the design volume. Based on these conditions, UDOT decided to completely rebuild the highway instead of making repairs. This work includes widening I-15 to 10 lanes and building 137 bridges. The work, which will cost $1.3 billion, is scheduled to be completed in 4½ years in order to be ready for the winter Olympics that will be held in Salt Lake City in 2002.

A Design-Bid-Build approach would have required 10 years to complete. UDOT decided to perform the project on a **Design-Build** basis to reduce this time. In addition to the time constraints, UDOT was interested in receiving a high-quality highway. Therefore, UDOT used **Performance/End-Result Specifications**, **Construction Warranties,** and a preventative maintenance program. UDOT developed the **Performance/End-Result Specifications** using task forces composed of consultants, professional associations, UDOT, and FHWA. This **Partnering** approach ensured that the **Performance/End-Result Specifications** addressed the needs of the contractors, designers, and UDOT. UDOT also provided a $950,000 stipend for each unsuccessful bidder on a short list of qualified bidders.

The contractor introduced a number of innovations to the project through the **Design-Build** process and the **Performance/End-Result Specifications**. For example, on the **Design-Build** side, the contractor was able to address traffic maintenance concerns as the design was developed. The contractor planned to install portions of the Advanced Traffic Management System (ATMS) early in the project so that the ATMS could be used to reduce construction impacts on the public.

On the **Performance/End-Result Specifications** side, the contractor used the flexibility of the specifications to introduce innovations and improve the quality of the project. For example, the geotechnical specification stipulates maximum allowable soil settlement values for the embankments and substructures, but did not specify the means for mitigating settlement. The contractor chose to take an aggressive approach that combined the use of wick drains, surcharge loads, and lime cement stabilization with the use of Styrofoam fill in the embankments to meet the settlement requirements.

The contractor also introduced innovations to address the maintenance requirements of the projects. For example, the contractor used pipes embedded in the bridge abutments to allow grout to be injected into the abutments, to stabilize them if settlement occurs.

6

DESIGN-BUILD
- Partnering

NEW YORK CITY BRIDGE RENOVATIONS
NEW YORK CITY DEPARTMENT OF TRANSPORTATION (NYCDOT)

This project consisted of replacing five bridges in Brooklyn, New York, and the rehabilitation of one bridge in Queens, New York. All the bridges crossed train tracks and were located around a number of utilities. NYCDOT chose to perform this project as a **Design-Build** project to reduce construction time and costs. The contractor took advantage of the flexibility of **Design-Build** and incorporated several innovations to reduce time and costs. For example, the contractor proposed to construct new bridge abutments behind the existing abutments on the five bridges in Brooklyn. This allowed existing electrical ducts to remain in place. The Contractor used lightweight fill behind the abutments to decrease the lateral earth pressure on the abutments, requiring less material to construct the abutments. The contractor also designed integral abutments for three of the bridges to eliminate the need for expansion joints, thereby reducing future maintenance costs.

The contractor also used innovative approaches in coordinating different utilities, incorporating the utility companies' requirements into the initial design. The utility companies had the opportunity to review and comment on the designs at the same time NYCDOT reviewed them. This informal **Partnering** coordination resulted in simplified utility work, that facilitated new expedited construction.

Partnering on this project also helped to address concerns of the contractor's and designer's increased risk due to the **Design-Build** project delivery approach.

7

I-75 Bridge Deck Replacement

Florida Department of Transportation (FDOT)

LANE RENTAL
- Incentive/Disincentive

This project consisted of demolishing and rebuilding the northbound and southbound bridges of I-75 over Alligator Creek. The new bridges were to be constructed from cast-in-place concrete. The bridges needed to remain open at all times, which meant work could only be performed on one lane of each bridge at any given time. Both bridges needed to be replaced in a minimal amount of time to reduce construction impacts on traffic. To accommodate FDOT's needs, the project included **Lane Rental** provisions and a maximum construction time of 185 days. The project also included an **Incentive/Disincentive** clause that provided a bonus for completion within 120 days.

The contractor used an innovative approach to phasing the construction and to expanding the work day in order to meet the time requirements for the project. The contractor began work on the northbound bridge to avoid lane rental costs on the southbound bridge. The contractor completed work on the northbound bridge in less than 15 days, an average of one week for the demolition and reconstruction of each lane. The contractor then began working on the southbound bridge, which was more complicated because one lane and a ramp had to be open at all times. Because of the contractor's innovative approach, the contractor was expected to complete the work in less than 120 days and earn the full incentive bonus.

8

I-83 Resurfacing

Maryland State Highway Administration (MDSHA)

Design-Bid-Build (Pilot Project)
- Materials and Method Specifications
- Incentive / Disincentive
- Partnering

This project consisted of resurfacing a section of I-83 using the latest AASHTO procedures for Superpave. This project was part of the nationwide implementation effort of Superpave using the latest AASHTO procedures and mix designs. MDSHA's goals for the project included recommending changes to published Superpave procedures based on experience and developing internal guidelines for specifying Superpave mixes. **Partnering** among MDSHA, the Maryland Asphalt Association, FHWA, and paving contractors facilitated the accomplishments of MDSHA's goals.

The project was a **Pilot Project** that included **Materials and Methods** specifications for a 12.5-mm Stone Matrix Asphalt (SMA) for the project based on MDHSA's experience with 19.0-mm SMA. The project also included an **Incentive/Disincentive** clause related to the quality of the final pavement. The **Incentive/Disincentive** provided a financial bonus for superior rideability of the final surface. The contractor used a material transfer device to place the SMA that resulted in reduced segregation and improved rideability. As a result, the contractor met the requirements for the rideability incentive. MDSHA later nominated the project for the National Asphalt Pavement Association award for quality.

9

PRIVATIZATION
- Design-Build

CONFEDERATION BRIDGE

Canada Transportation Ministry (CTM)

This project consisted of building a 7.7-mile–long bridge across the Northumberland Strait, which separates New Brunswick and Prince Edward Island, Canada. The project was proposed to the CTM by Strait Crossing Development, Inc. (SCDI), a private corporation established to develop a bridge between the two provinces. CTM developed the project as a **Privatization** project in which SCDI would finance, design, and build the bridge and then operate it until 2032, at which time ownership would revert to the government. SCDI performed the project on a **Design-Build** basis to allow it to address the design, environmental, and time issues for construction. SCDI introduced several innovations through the **Design-Build** process to simplify and expedite construction. These innovations were developed through the design review aspect of **Design-Build**. For example, the contractor designed the bridge using segmental precast concrete. This allowed the bridge segments to be cast during the winter, when no other work could proceed because of ice floes in the Northumberland Strait. The contractor used HPC in the design because it reduced the number of piers required, which reduced construction time and provided extra durability to help meet the goal of a 100-year service life. Finally, the contractor designed all precast concrete segments based on the construction equipment that would be used. For example, the piers had a maximum width of 22 m to fit between the pontoons of the floating crane used to place them.

Using these innovations, SCDI was able to complete the project in 14 months. These included three winter months when work could not be performed, making actual construction time eleven months. The rapid construction time allowed SCDI to open the bridge earlier than would have been possible under a traditional contracting approach.

10

VALUE ENGINEERING (Construction)
- Incentive / Disincentive
- Multi-Parameter Bidding
- Bid Alternates

I-287 BRIDGE REPLACEMENT

New York State Department of Transportation (NYSDOT)

This project consisted of replacing two high-volume bridges in New York City. Because of the volume and the fact that the bridges needed to remain open to traffic, NYSDOT used **Multi-Parameter Bidding** to reduce construction time. The contract also contained an **Incentive/Disincentive** clause based on project completion to encourage faster construction. The contract included **Bid Alternates** allowing the contractor to choose from steel or concrete girder construction.

The successful bidder chose the steel alternate for the bridges. The contractor then proposed several innovative changes through **Value Engineering**, such as precast post-tensioned concrete piers in place of the specified cast-in-place piers. Precast post-tensioned piers had never been used in New York before. NYSDOT estimated that the change in pier design would reduce construction time by one year. The contractor also proposed the use of precast concrete deck panels in place of cast-in-place concrete, which also resulted in a time savings because work proceeded during the winter.

The use of precast, post-tensioned piers and precast concrete deck panels did not result in a reduction in construction costs, but did reduce significantly the construction time of the project. In addition, NYSDOT estimated that the use of precast concrete segments will extend the life of the bridges by 10 to 15 years before rehabilitation is required.

11

DESIGN-BID-BUILD (Pilot Projects)
- Partnering

K-96 PAVEMENT TEST

Kansas Department of Transportation (KDOT)

This contract consisted of replacing the pavement on an 11-mile section of K-96 in rural Kansas. The project was procured using a **Design-Bid-Build** approach. After the contract was awarded, KDOT issued a change order to pave 6 miles of the 11-mile section with High Performance Concrete Pavement (HPCP). This was done as a **Pilot Project** to test HPCP for possible future use in Kansas. The test sections of the pavement were co-sponsored by the American Concrete Pavement Association, KDOT, and FHWA in what was essentially an informal **Partnering** agreement.

The pavement test section consisted of 12 segments ranging from 0.3 to 0.6 miles. One segment was a control segment that was paved with HPCP using the control mix design. The other segments had different designs in order to test different products and construction techniques. All segments were designed by KDOT as part of the change order. Items tested included experimental load transfer devices, polyolefin fibers, recycled asphalt, high-range water reducer, two-lift construction, and saw cuts with no joint sealant. The test segments will be monitored over a five-year period, and the observations and data gathered will be used in the development of future KDOT paving products.

12

VALUE ENGINEERING (Design)

ROUTE 139 HOBOKEN VIADUCT REPLACEMENT

New Jersey Department of Transportation (NJDOT)

This project consisted of the rehabilitation of a viaduct in Hoboken, New Jersey. The viaduct carried eastbound and westbound traffic on its lower level, and eastbound traffic on its upper level. In addition, westbound traffic was also carried on an embankment parallel to the upper level of the viaduct. The viaduct was more than 60 years old and needed to be rehabilitated or replaced. NJDOT developed a rehabilitation plan for the viaduct. The plan included resurfacing the lower level, replacing the deck on the upper level, and removing the concrete encasement from the concrete-encased steel beams that supported the upper level. The cost for this work was estimated at $51,150,000.

NJDOT assembled a **Value Engineering** (VE) team to review the design of the rehabilitation project to provide an equal or improved product at a reduced life-cycle cost. The **VE** team identified maintenance of traffic and the beam rehabilitation as the two most expensive items in the design. These two items accounted for roughly 40 percent of the estimated project cost. The **VE** team proposed several modifications to the design. These modifications included moving traffic from the upper level of the viaduct to a partial embankment section adjacent to the viaduct. The upper level could then be demolished, except for the cross streets over the viaduct's lower level, which would be repaired. The cost of the revised design was $39,000,000, which was $12,150,000 less than the original design. In addition, the **VE** team calculated the net present worth savings based on a life-cycle cost analysis. The calculations indicated that the net present worth of the savings in future maintenance costs was $39,700,000. Thus, the **VE** design proposal led to an overall present worth savings of $51,850,000.

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VALUE ENGINEERING
- Design-Bid-Build
- Multi-Parameter Bidding
- Incentive / Disincentive
- Partnering
- Constructability Reviews

RALEIGH BELTLINE REHABILITATION PROJECT

North Carolina Department of Transportation (NCDOT)

This project consisted of rehabilitating part of I-440, the primary roadway that encircles Raleigh, North Carolina. The work needed to be performed with a minimum impact on traffic flow and in a short period. NCDOT held informal **Constructability Reviews** during the design phase. These reviews focused on phasing of the construction, material deliveries, and waste disposal. The **Constructability Reviews** also helped to refine and produce highly detailed traffic control plans intended to expedite construction.

The construction contract used **Multi-Parameter Bidding**. The contract also included **Incentive/Disincentive** provisions to reinforce the importance of time on this project. Typically, an owner uses **Incentive/Disincentive** clauses to promote early completion of the project. In this case, however, NCDOT used **Incentive/Disincentive** clauses to promote rapid completion of median widening. Completion of the median widening ahead of schedule allowed traffic to be shifted off the shoulders and into a safer traffic pattern before the winter season.

The contractor made several **Value Engineering** changes intended to speed construction further. One such change, using hot-mix asphalt for the base course instead of the originally designed base course, has been adopted by NCDOT for use on subsequent projects. The incorporation of innovations into the project from the design phase through paving allowed the contractor to finish construction ahead of schedule and earn a substantial incentive payment.

The use of **Partnering** promoted teamwork, resolved problems quickly, and expedited construction. NCDOT acknowledged that **Partnering** fostered a "do whatever it takes" attitude that was important to keeping the project moving.

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CONSTRUCTION WARRANTY
- Privatization

CORRIDOR 44 PROJECT

New Mexico State Highway and Transportation Department (NMSHTD)

This project consists of the expansion and upgrade of 120 miles of NM44 from Bernalillo to Bloomfield, New Mexico. The project is needed to improve highway capacity to northwestern New Mexico, an area that is expected to see growth and traffic volume increases during the next decade. NMSHTD procured the project under a **Privatization** approach, in which the project development contractor (PDC) would finance, design, manage, and warrant the project. The project, estimated to cost approximately $240 million, was awarded to Mesa Developers in early 1998. The project is being financed through tax-exempt bonds issued by the New Mexico Finance Authority.

The project includes a number of special challenges for the PDC, such as limiting the project within the existing right-of-way through Native American lands, designing the project for a wide spectrum of environmental and geological conditions, completing the design/construction in three years, maintaining quality and consistency among multiple contractors during construction, and providing a long-term **Construction Warranty** for the project. In particular, the **Construction Warranty** requirements for NM44 go far beyond what has been used for similar roadway projects. The NMSHTD requested that the PDC warrant and maintain the entire roadway–including the base, side slopes, bridges, and minor structures–for not less than 5 years with options for 10 or more years up to the service life of the pavement.

In response to the required 5-year minimum warranty with options to extend, the contractor proposed an unprecedented 20-year warranty on a trademarketed asphalt on pavement design that is new to the industry. This product is being marketed in conjunction with its long-term warranty for this and other potential projects. In this case, the **Construction Warranty** requirement is used by the owner to promote improved performance and transfer the responsibility for performance and preventative maintenance to the private sector. Conversely, the contractor is offering the **Construction Warranty**, with its inherent risk and responsibility, to introduce and sell an innovative and untested product to the industry.

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PILOT PROJECT
- **Partnering**

PAVEMENT OVERLAY TEST
Mississippi Department of Transportation (MDOT)

This project consists of testing an ultra thin whitetopping (UTW) pavement overlay on 1,200 meters of I-20 near Jackson, Mississippi. This section of I-20 carries a high volume of truck traffic and exhibits significant rutting. As a result, the road has been rehabilitated four times since 1983. This rehabilitation work is expensive and severely impacts traffic flow in the area. The U.S. Army Corps of Engineers approached MDOT about testing a UTW fiber additive believed to extend the service life of the UTW and allow longer spacing between joints in the overlay, which would reduce both construction and life-cycle costs.

The project was developed as a **Pilot Project** and involved **Partnering** among the FHWA, U.S. Army Corps of Engineers, the Mississippi Concrete Industries Association, MDOT, and a fiber manufacturer. This **Pilot Project** was atypical in that it did not involve a design-bid-build procurement. Instead, a field test was designed that would test the impacts of the fiber manufacturer additive on UTW thickness and joint spacing. The UTW performance would be monitored over five years and be compared with the performance of road sections topped with UTW that had a different additive and with plain concrete.

FHWA funded 80 percent of the project and MDOT funded the 20 percent balance. The Mississippi Concrete Industries Association gave the contractor a discount for the concrete. The cost of the project was $125,000, which represents an estimated savings of $65,000 due to the discounts. The concrete industry and the U.S. Army Corps of Engineers provided technical support in the areas of mix design, structural analysis, and quality assurance.

After nine months of the study, corner cracking developed in the UTW sections but not in the plain concrete sections. No intermediate cracking has been observed. As a result, MDOT has decided to use plain concrete sections for the next road overlays.

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PRIVATIZATION
- **Design-Build**
- **Value Engineering**

SAN JOAQUIN HILLS TRANSPORTATION CORRIDOR
California Department of Transportation (Caltrans)

This project consisted of constructing a 15-mile, limited access, 6-lane toll road to connect the Corona Del Mar Freeway with I-5 in Orange County, California. The project cost approximately $834 million. The project was intended to relieve I-5 and I-405 of congestion and carry as many as 170,000 vehicle trips per day by the year 2010. Construction was performed through a **Privatization** approach in which the Transportation Corridor Agencies (TCA) funded the construction by issuing "non-recourse" toll revenue bonds and through the collection of development impact fees at designated areas along the corridor. At completion of construction, Caltrans assumed ownership and maintenance responsibility for the corridor. TCA will operate the toll facilities under a long-term agreement.

The financial stakeholders in the project were interested in meeting or exceeding the projected ROI through toll revenues. This entailed building the project as quickly as possible and then attracting a sufficient number of repeat users over time to meet the repayment schedule. To build the project quickly, TCA used **Design-Build** to "fast-track" the design and construction. Additionally, to attract users, the project incorporated a state-of-the-art toll collection system, called "FasTrak," allowing cars equipped with special tags (transponders) to pass through at full speed. The toll system was designed, manufactured, installed, maintained, and operated by Lockheed Martin IMS under a turnkey contract with TCA. The toll collection system is compatible with transponder toll systems used throughout the state, promoting easy access, better traffic flow, and less travel time through the corridor.

The design allows for phased expansion as volume increases in the corridor. An 88-foot median was set aside to accommodate a high-occupancy vehicle (HOV) lane and, if feasible, transit systems. The project was also designed to have the least environmental impact for a project of its kind, incorporating four wildlife under crossings and the creation of more than 26 acres of wetlands.

The project included an innovative approach to financing change orders. Under the plan, the contractors carry $30 million of the project debt and finance change orders in return for payment certificates, which function like treasury bills. The payment certificates earn interest below current market rates during maturation, and in the TCA's view serve as a deterrent for change orders.

The project was built according to Caltrans specifications and procedures, which tended to restrict innovations. Despite this, the contractors made changes through **VE** proposals that improved the design and reduced costs. The design was roughly 35 percent complete when the project was awarded to the Designer-Builder. The contractor tended to discard the preliminary design and start over, resulting in duplication of effort and cost. On future projects, TCA is planning to complete the design to 5 percent at bid time. For evaluation purposes, contractors will bid on quantities on a unit price basis. After award, the contractor will present a lump sum bid when 35 percent of design is complete.

FINAL REPORT AND APPENDIXES A THROUGH D

UNPUBLISHED MATERIAL

The agency's final report and Appendixes A through D are not published herein. For a limited time, copies of that report, entitled, "The Role of Procurement and Contracting Approaches in Facilitating the Implementation of Research Findings," that contain these appendixes will be available on a loan basis or for purchase ($16.00) on request to NCHRP, Transportation Research Board, Box 289, Washington, D.C., 20055. The available appendixes are titled as follows:

Appendix A:	References
Appendix B:	Survey Instrument, Data Analysis, and General Comments
Appendix C:	Examples of Contracting/Procurement Approaches
Appendix D:	Focus Group Information

The **Transportation Research Board** is a unit of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's mission is to promote innovation and progress in transportation by stimulating and conducting research, facilitating the dissemination of information, and encouraging the implementation of research results. The Board's varied activities annually draw on approximately 4,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The National Academy of Engineering was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. William A. Wulf is president of the National Academy of Engineering.

The Institute of Medicine was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Kenneth I. Shine is president of the Institute of Medicine.

The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purpose of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both the Academies and the Institute of Medicine. Dr. Bruce M. Alberts and Dr. William A. Wulf are chairman and vice chairman, respectively, of the National Research Council.

Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation