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Performance Effectiveness of Design-build, Lane Rental, and A + B Contracting Techniques

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Experimentation with innovative contracting methods over the last several years has produced several techniques recently formally approved for use by the Federal Highway Administration. While the FHWA has recognized and defined many standard practices for innovative contracting, the need has arisen to compare the effectiveness of different innovative contracting methods to each other.

Performance and cost and value implications of A+B contracts, design-build contracts, lane rental contracts, and traditional contracts were investigated. Specific performance and cost measures considered are Administration Costs, Project Costs, Management Complexity, Disruption to Third Parties, RUC, Innovation**,** Product/Process Quality, and Funding Flexibility. Performance parameters are compared on nine different project types; the methodology utilized a survey of national experts who rated each innovative contracting method for each performance factor on each of the project types.

This study resulted in fifteen recommendations for improving management practices in the use of innovative contracting for transportation projects. These recommendations are also intended to assist the Minnesota Department of Transportation in determining which contract method is likely to be most effective given certain project criteria and construction options and to determine directions for future research, particularly on emerging methods such as design-sequencing and A + B + C contracting.

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Final Report

Prepared by:
Kelly Strong

Iowa State University
Department of Civil, Construction and Environmental Engineering

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Minnesota Department of Transportation
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395 John Ireland Boulevard, MS 330
St. Paul, Minnesota 55155-1899

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Executive Summary

The objectives of the research are to compare performance, cost, and value implications of A+B contracts, design-build contracts, lane rental contracts, and traditional contracts. Specific performance and cost measures considered are Administration Costs, Project Costs, Management Complexity**,** Disruption to Third Parties, RUC, Innovation**,** Product/Process Quality, and Funding Flexibility. Performance parameters are compared on nine different project types. The research compares the three innovative contracting techniques to traditional contracting on relevant performance factors for each project type, resulting in a “best practices guide” along with project selection criteria for innovative contracting methods. The research methodology utilized a survey of national experts who rated each innovative contracting method for each performance factor on each of the project types. Results of the findings from the survey of national experts as well as summaries of case study interviews are described and discussed.

Chapter 1
Introduction

Many governmental agencies charged with delivering public infrastructure have been experimenting with innovative contracting methods over the last several years. Many of the more common techniques have recently been formally approved for use by the Federal Highway Association (FHWA) (1). One particular federal program, Special Experiment Projects – 14 (SEP-14), has helped to accurately define and clarify many of these new innovative contracting methods to ensure that the processes and practices involved with innovative contracting are implemented effectively. The primary objective of SEP-14 was to review specified innovative contract techniques as they were applied to specific projects, which were monitored closely to measure the effectiveness of innovative contracting compared to the traditional design-bid-build method or other acceptable methods. The specific innovative contracting methods under investigation in this report are:

- A + B with an Incentive Option (I/O)
- Lane rental
- Design-build contracts

A + B contracting is sometimes referred to as cost plus time contracting, or bi-parameter bidding. For the remainder of this report, the term A + B contracting will be used for simplicity. A + B contracting (both with and without I/O) and lane rental contracts have been labeled as acceptable practices by the FHWA since 1995 and are no longer considered experimental. These two contract types were subjected to the FHWA's protocol of approving new innovative contract types (Special Experiment Projects – 14) from 1990 to 1995.

The FHWA is continuing to develop guidelines and regulations for design-build contracting as mandated by section 1307© of the Transportation Equity Act for the 21st Century (TEA–21), enacted on June 9, 1998. The TEA–21 required the Secretary of Transportation (Secretary) to issue regulations to allow design-build contracting for selected projects. The regulations list the criteria and procedures that will be used by the FHWA in approving the use of design-build contracting by state Departments of Transportation (DOT). The regulation does not require the use of design-build contracting, but allows state DOTs to use it as an optional technique in addition to traditional contracting methods. Use of design-build was formalized by the Federal Highway Administration in 2002 with the issuance of the Final Rule (2).

Now that innovative contracting methods have been practiced for several years in many states, and the federal government has recognized and defined many standard practices for innovative contracting, the need has arisen to examine and compare the effectiveness of different innovative contracting methods to each other instead of independently comparing them to the traditional method of delivery.

Research Purpose

The following research report presents the findings of a national survey of innovative contracting preferences, along with case studies of three A + B projects, one lane rental project, and one design-build project in the state of Minnesota. The results of this study, along with a review of the literature, have been used to create a set of recommendations for improving management practices in the use of innovative contracting for transportation projects. These recommendations are also intended to assist the Minnesota Department of Transportation (Mn/DOT) in determining which contract method is likely to be most effective given certain project criteria and construction options.

Several states have researched innovative contracting methods with the objective of developing a protocol to assist agency personnel in selecting the most effective contract type based on certain project parameters. There also have been reports by various non-governmental organizations and institutions that have researched one or more innovative contracting techniques. The main reports and most comprehensive studies are outlined in the following section in order to develop an integrated summary and synthesis of current thinking on comparative effectiveness of innovative contracting methods.

Chapter 2
Abbreviated Literature Review

For the sake of brevity, the following review highlights only a few of the most important, comprehensive, and/or innovative reports in the literature. The studies discussed below reflect a mix of comprehensive studies examining a variety of contracting methods as well as some studies that focused on a single contracting method, some that looked at performance criteria and some that used project criteria as a basis for selection. This selection of readings represents a reliable cross section of the types of reports extent in the literature.

The South Dakota DOT hired Trauner Consulting Services, Inc. to assist them in defining criteria and guidelines that South Dakota could use to determine the most effective innovative contracting methods (3). For their study Trauner researched innovative contract types such as I/O, A + B, and lane rental. The South Dakota guidelines based the selection primarily upon project criteria with some consideration of performance characteristics such as cost, time, and road user cost (RUC).

The Ohio DOT has internally developed a manual (4) to assist in developing construction contracts through the help of a selection criteria process. The innovative contracting methods matrix included in the Ohio DOT manual lists approximately fifteen different project types and assigns a yes/no assessment on the suitability of various contracting methods for each project type. They examine I/O, lump sum incentive, work day, liquidated savings, design-build, A + B, and warranty contract types in their report. Each contracting method is analyzed in a specific section of the report, which includes 'Definition', 'Objectives', and 'Project Selection Criteria' sections, to help define which practice best suits certain project parameters. There is little discussion of performance criteria other than can be inferred from project characteristics.

Bolling and Holland (5) at the Utah Technology Transfer Center also generated a best practice guide for innovative contracts. The contract types that were examined in their report included design-build, A + B, lane rental, warranty, and job order contracting. This report is similar in style and content to the Ohio DOT manual, but offers more definitive discussions of performance implications of the different contracting types. The Utah Technology Center report examined the impact of different contracting methods on five performance parameters: administration, risk, time, cost, and complexity. In addition, the report listed project parameters that would lend themselves well to the different contracting methods.

A study by Shr, Thompson, Russell, Ran, and Tseng (6) examined A + B contracting as it had been practiced since 1990 and determined that some loss of value or suboptimum contracting was possible if state DOTs did not place an upper and lower limit on the time parameter of the bid. If there is no minimum placed on the "B" portion of the bid, a bidder could possibly submit an unattainable schedule ("B" amount), but inflate the "A" portion of the bid in an amount greater than the disincentive amount or liquidated damages. In this scenario, highway user benefits cannot be protected and the award results in suboptimum performance. If no maximum limit on the "B: portion, a bidder could submit a low "A" amount (cost) and an unnecessarily long "B" amount, with a strategy of increasing the final payment amount through incentives. The payout of unreasonable incentive fees again results in suboptimum performance. Shr, Ran, and

Sung followed up this study in 2004 (7), adding that the factors of incentive fees and disincentives or liquidated damages costs should be added to RUC and then optimized against the A + B (cost plus time) parameters in each of the bids received in order to choose the lowest cost option. This optimization process shifts much of risk to the contractor while maximizing the agency's resources. However, the optimization modeling process is cumbersome for practical use, requiring specific cost modeling on a project-by-project basis accounting for construction type, location, economic factors, and project specific cost-to-duration indices.

The primary intent of the lane rental contracting method is to bring the cost of inconvenience to the public into the contract award equation. Under the lane rental contracting method, contractors are forced to consider and include both construction costs and the costs to the public in their bid. Lane rental is particularly valuable when alternative routing and detours are unavailable, and when the time savings can be readily calculated in dollar terms. (8).

Of particular relevance to the ROC-52 project and the design-build contracting method is a report prepared by Tom Warne and Associates, LLC, on behalf of the California Design-build Coalition (9). The study looked at 21 different design-build highway projects nationwide; ROC-52 in Minnesota was among these, as were several projects in Arizona, California, Colorado, South Carolina, and Virginia. Projects ranged from $83 million to $1.3 billion. The report, titled *Design-Build Contracting for Highway Projects*, contains two major components: 1) an assessment of performance in several project parameters and, 2) an examination of design-build practices used on the projects.

Warne's assessment of design-build performance considered each of the 21 projects, relying upon the following four key parameters by which project success is measured: schedule, cost, quality, and owner satisfaction. The report stated that on 13 of the 21 projects studied, schedule was the primary reason behind selection of design-build as a delivery method. The effectiveness of schedule on a design-build project can be evaluated in two different ways: 1) comparing the project's actual completion to the latest allowable completion date in the owner's request for proposal or, 2) comparing the design-build schedule to the expected scenario using traditional design-bid-build delivery. In the first case, 76% of the projects in the study were completed ahead of the original time allotted by the owner. For the second case, interviewees were asked to estimate the time the each project would have taken if the project had been delivered by design-bid-build, and those estimates were compared to the time taken using design-build. In 100% of the projects, the design-build projects were built faster than they would have been with design-bid-build.

Warne points out that comparing and contrasting costs between two different projects is difficult because of the multitude of confounding factors, uncertainties, and variables that influence the comparisons made. The most prominent conclusion made about cost in design-build projects is that price certainty is higher because cost growth is reduced. The projects in the study exhibited an aggregate cost growth rate of less than 4%, compared to the 5%-10% growth rate typical on design-bid-build projects.

The report also emphasizes the cost savings that come from the accelerated construction schedule in design-build. When these projects finish ahead of schedule, often in terms of months or years, “enormous” construction cost savings are realized because of inflation and other factors. In addition, there are positive economic impacts resulting from earlier completion of design-build projects because of their faster schedule.

Views about quality were collected from interviewees from each of the projects in the study. The report states that quality on every project was declared to be better than or equal to the quality which would have been achieved under design-bid-build delivery.

The final area of the Warne study’s performance assessment was in the area of owner satisfaction. Owners from the 21 design-build projects responded to a series of questions about their views of the project and whether they would have interest in doing future design-build projects. The owners were universally pleased with the design-build process, and would want to use design-build delivery in the future based on their experience with the project in question.

Design-Build Contracting for Highway Projects also considered several characteristics of the processes involved in implementing these 21 projects. These include project management roles, the decision to use design-build, funding, quality, stipends, and selection processes. Each project in the study showed its own unique characteristics in the application of the design-build process.

Design-build delivery affects the roles and responsibilities of all the major players on a project including the owner, designer, and contractor. From an owner’s perspective, project management often involves non-traditional functions during the planning, RFP, and bidding phases of the project. On more than half of the projects considered, the project is managed by state DOTs with help from an outside consultant. Staffing needs were identified as the primary reason for this; state agencies typically did not have adequate numbers to manage the project in-house, and it is easier to hire a consultant for these one-time projects than to hire permanent staff and deal with the challenge of relocating them upon project completion. On the contractor side, a greater level of management of day-to-day project activities is required, notably on design management and quality management. On many projects they also assume more responsibilities for coordinating work with utilities and local governments.

Commonly, the decision to use design-build is driven by the need for an accelerated schedule and quicker project delivery. As stated, thirteen of the twenty-one projects cited schedule as the primary motivation for using design-build. In some cases, the decision to use design-build is also motivated by the need to accommodate funding conditions. Some projects, including ROC-52, have limited time windows for spending available state and federal funding that only design-build’s accelerated nature can accommodate.

Funding for design-build comes from a range of sources, including federal and state governments, tolls, and private enterprise. Federal and state monies were the most common source of funding, which is no surprise since they have traditionally been the biggest revenue sources for transportation projects. Seven of the 21 projects were at least partially funded by revenue generated from tolls.

Although quality was not mentioned as a primary reason why owners choose design-build, it is nonetheless an important factor in overall success of the project. The use of design-build requires contractors and owner to accept roles different than those on traditional projects to reach quality objectives, particularly in the way of quality control and quality assurance. A major shift in design-build projects is that quality control (QC), the process of ensuring that craftspeople perform in a manner that meets or exceeds project requirements, is the responsibility of the contractor in nineteen of the 21 projects reviewed. Quality assurance (QA), oversight and testing to make sure QC standards are met, is retained by the owners in ten of 21 cases, with QA done by a consultant on four of the projects.

Some agencies were willing to pay unsuccessful bidders for their proposals. Thirty-eight percent of owners in the study offered a stipend to non-winning teams to reimburse the cost of their proposal efforts. Owners' requests for proposals (RFPs) for design-build projects typically require a proposing team months of plan analysis and cost estimation to complete. Design-build proposal preparation tends to take the contractor more time because conceptual plans are less complete (typically around 20 to 30 percent) and the projects tend to be larger and more involved than design-bid-build. Those owners that offered a stipend to unsuccessful bidders typically paid 0.1–0.2 percent of the winning bid amount.

Many other user guides, reports, and studies were examined as part of this research study (see Appendix A), but were either very similar in scope and findings to the studies listed above, or were not comprehensive enough in their coverage to add value to the understanding of current state of the art in innovative contracting; therefore, they were not discussed in detail in the literature review above. The following section summarizes the definitions and general custom and usage of innovative contracting methods.

Chapter 3
Innovative Contracting Methods

There are a few types of innovative contracting techniques that are used by various states. The more common types are A + B, with or without Incentive Options (A + B w/ or w/o I/O), lane rental, design-build, warranty, and job order contracting.

These contracting techniques have been introduced over the last several years as alternatives to the traditional method of design-bid-build approach. This report specifically addresses:

- A + B
- Lane rental
- Design-build
- Design-bid-build

A + B

A + B is a contract method that uses both a project cost estimate of contract bid items (A) and a time to complete the project (B), which is usually represented by calendar days. The A and B portions of the bid are assigned dollar amounts and are combined together to yield a total contract value estimate. Bid award is based on two criteria instead of merely low bid. Frequently, A + B contracts are awarded with I/O clauses, which is a provision that is primarily based on a calculated daily RUC. RUCs are calculated individually by each state and attempt to capture how much the road is worth to the drivers. Contract incentives both discourage unbalanced bidding techniques and promote early completion of the project. Disincentives such as liquidated damages are contained in contractual language to discourage extending the construction period in an effort to save money or minimize equipment costs. The “B” portion of the initial contract is based on the contractor’s proposed completion date or construction duration as contained in the bid, but the final value of “B” portion will not be known until incentives or disincentives are factored in at the time of completion. Therefore, final contract amount, exclusive of scope changes and design clarifications, cannot be determined until the project is completed. The time savings associated with A + B w/ I/O come primarily from contractor motivation to minimize construction time induced by offering bonuses for early completion and contractual penalties for late completion. Because of the common practice of combining A + B contracts with I/O clauses, it can be difficult to determine how much of the schedule acceleration is due to A + B contracts, and how much is due to I/O language within the contract.

Lane rental

Lane rental contracting methods alter the contract basis by assessing the contractor fees based on an hourly or daily rate for prohibiting traffic on a lane, shoulder, or combination of the two while performing construction. Typically, any obstruction lasting more than 15 minutes is considered for contract adjustment. The goal of this contracting method is to have the contractor minimize the roadway restrictions that will ultimately impact the traffic flow. The lane rental assessments are derived from the RUCs and may or may not also include costs incurred by the agency. Both types of rental fees (RUC + Admin costs) are normally addressed in daily charges, which may be modified downward if the rental amount is deemed onerous to the contractor.

Design-build
Design-build contracts assign sole responsibility for both the design and construction of the project to one entity. Therefore, only one contract needs to be administered by the owner with the design-builder. The use of lump sum, design-build contracts eliminates many of the change orders and time extension requests resulting from design errors and conflicts found in many traditional contracting systems. Use of design-build contracting methods also allows for phased or fast track construction resulting in dramatic reductions of overall project time. Because the designers and builders are part of an integrated team and communicate frequently, the level and detail of design documents can be reduced, potentially reducing design costs and time. The level of detail necessary for a project to be "buildable" is generally less than the level of detail needed to be considered "biddable" because of intense, real-time coordination and communication between designers and builders in the design-build delivery system.

Design-bid-build
The design-bid-build method had dominated highway contracting for many years until the early 1990s, primarily because it was the only method allowed under the statutory purchasing and procurement laws of many public agencies. In the traditional contracting method, an owner/agency will have a design consultant or staff designers generate a complete project design and then send the project out for bidding amongst contractors. The contract is then awarded to the contractor submitting the lowest bid, and the construction phase begins. Procurement costs are very low in the traditional system, and the owner contains control of the design, but also retains the risk of additional costs associated with plan errors. Nevertheless, the need for faster project completion schedules and better cost/risk choices have led owners and contractors to search for these new, innovative contracting methods.

The definitions and findings from the literature can be synthesized into a best practices summary as described in the following section.

Chapter 4
Synthesis of Best Practices for Innovative Contracting

The development of the current thinking on best practices for using innovative contracting methods was derived from prior research in the field, followed by discussions within the Iowa State University research team and between the ISU team and national experts on transportation construction delivery systems (see Appendix B: Interview Questions). Based on the findings of prior research and the judgment of the researchers and national experts, the effectiveness of various contracting methods (three innovative plus traditional) are discussed in the following paragraphs. To better understand the variations in contract effectiveness introduced by project parameters, the advantages and disadvantages of each contracting method are described below, along with project criteria most likely to benefit from use of the contracting method under discussion.

A + B

A + B contracts are used to motivate the contractor to minimize the construction time on high priority and high road-usage projects. Other project phases (design, planning, Right of Way (ROW) acquisition) are not affected by use of this contracting method. The I/O provision provides further incentives to the contractor to finish early to obtain bonuses offered by the owner or to bear the penalty of a late completion date. It appears from the results of previous studies that the best practice is to use A + B with I/O to shift appropriate risk to the contractor while maximizing agency resources. A + B without I/O may result in over-payment and therefore suboptimum use of resources, while I/O only contracts may force the agency to retain a disproportionate amount of risk.

When using A + B contracting with I/O, pre-bid meetings between the owner and bidders can be helpful in determining the likely competitive responses to possible bonus and penalty language. Potential third party issues need to be identified and conflict resolution steps also need to be established in the contract prior to award. Agency reviews are also required to ensure that the innovative contract type is appropriate for the project.

Advantages of using A + B with I/O:

- Shifts more risk to contractor in terms of bidding optimum combinations of time, costs, efficient planning, and managing work.
- Utilizes contractor’s expertise
- Contractors will propose both aggressive schedules and competitive costs
- Discourages contractors to use unbalanced bids
- Encourages scheduling innovation
- Reduces construction time and user costs/delays
- Greater coordination between prime bidders and their subcontractors prior to bid

Disadvantages of using A + B with I/O:

- Requires 100% design prior to award
- Risks potential claims by the contractor for contract changes
- Risks limiting the incentive payments to the contractor due to overtime costs and increased administration costs

- Needs minimum RUC to be effective
- Owner needs to resolve potential issues that could cause delays after construction start
- May cause staffing concerns by local district personnel

A + B w/ I/O is recommended for projects with the following parameters:

- Safety concerns are paramount
- High RUCs, especially those where traffic restrictions, lane closures, and long detours occur
- Potentially significant disruptions to businesses and/or the local community
- Public demands quick completion or critical turnover date
- Potential for negative public reaction to long delays to the traveling public
- Traffic control phasing can be used to the contractor's advantage to assist in minimizing the time to complete the project
- Project relatively free of utility conflicts, design uncertainties, and ROW issues that may impact the award date and the critical path of the project schedule
- Agency seeks contractor's expertise to identify the earliest possible completion date

The Utah Technology Transfer Center report (5) recommends A + B contracting for all project types. However, the inclusion of I/O clauses is not recommended on resurfacing and overlay projects, nor for guardrail, striping, signal, and signage work. Some experts recommend that large, sophisticated projects should not use A + B because of the potential for long delays and complex negotiations if significant third party conflicts occur.

Lane Rental

Lane rental contracts examine costs associated with delays, detours, and accidents. These issues can then be managed by the contractor to develop the best construction means and methods to perform the project work effectively at minimum total cost. The RUCs will be closely examined because the lane rental costs are based from the RUCs calculated by the state. Some experts suggest contract language to allow for the return of unused lane rental fees to the contractor upon contract completion as an incentive to minimize disruption. However, conservation of funds is an issue when using contracting methods that do not "lock in" a final contract amount (exclusive of changes in scope and design errors) until project completion. If unused lane rental fees are to be returned to the contractor in the form of a contract bonus or add change order, then larger budget contingencies may be prudent.

Advantages of using lane rental contracts:

- Utilizes contractor's expertise
- Allows innovation in the scheduling of activities
- Considers costs associated to the lane closures
- Reduces detours and delays for traveling public

Disadvantages of using lane rental contracts:

- Requires 100% design prior to bid

- Requires individual RUCs calculated for each project, along with a determination of reasonableness
- Requires definition of essential project expectations from agency
- Lacks flexibility in maintenance of traffic plans (no alternate routes or traffic bypass methods can be considered)

Lane rental is recommended for projects with the following parameters:

- Major roadways, bridges, and interchanges with high average daily traffic (ADT) counts
- Projects or portions of projects involving temporary lane, ramp, or bridge closures
- Emergency repair work
- Areas where high RUCs are projected by the state
- Off-site detours and the use of alternate routes is impractical
- Traffic control plan can be designed by the contractor to allow for flexibility in scheduling work
- Owner seeks the expertise of the contractor to minimize the lane closures
- Scope and design of the project are certain
- Free from major third party issues and ROW acquisition concerns
- Benefit to the highway user is greater than the additional costs to minimize lane closures
- Can be used to limit intermediate disruptions to traffic, such as flagging operations

Design-build

Design-build contracts promote time savings and usually provide for the shortest overall project time compared to other contracting methods because the design phase can be shortened and the construction phase and design phase can be overlapped. Design-build contracts do not need a definite and final design to proceed with the RFP; in fact, it is better to have less than 30% design completion at the time of bid. The responsibility for completing the design is placed upon the design-builder, which helps to reduce/eliminate change orders, requests for time extension, and other claims arising from design errors, conflicts, and omissions. Design-build contracting maximizes the contractor's ability to use innovative designs, materials, scheduling, staging and construction techniques. Design-build also offers expertise of the contractor for the project. Depending on how risk and responsibility is allocated, the use of design-build can also reduce negative public opinion and improve communications within the community where the project is located. In design-build, award can be made based on best value and/or most qualified status rather than just low bid. This makes design-build ideal for projects requiring a high degree of technical expertise since the owner can choose the proposer with the best qualifications and/or the best technical solution, rather than being forced to take the lowest bidder. Many projects have unique technical challenges, time constraints, or space limitations. In design-build, the proposal evaluation criteria can be tailored to individual project needs so that these unique challenges can be met by highly qualified proposers.

However, procurement costs for design-build are higher than for traditionally procured projects, and there remains some reluctance to embrace the design-build philosophy within many agencies and agency personnel because of its newness. Also, capabilities to internally manage and administer design-build projects may be limited because the design-build delivery method represents a fundamental shift in contracting philosophy which may be in conflict with longstanding policies, job descriptions, and procedures within the agency. Design-build is not recommended for projects where risk cannot be equitably allocated or for projects where time is not of the essence.

Advantages of using design-build contracts:

- Does not require 100% design prior to award
- Allows for some construction work to be performed before final design approval
- Allows for innovative scheduling, construction techniques, and materials
- Creates single entity contractual responsibility
- Reduces errors, omissions, and rework claims
- Saves on time and third party/RUC costs
- Allows for more costs to be included in capital project budgets
- Improves utility coordination by allowing the contractor to schedule activities directly with utilities
- Allows early commitment by design-builder to overall project cost

Disadvantages of using design-build contracts:

- Demands time sensitivity regarding permit approvals and ROW acquisition
- Results in higher procurement costs
- Increases potential for reduction of the number of bidders willing to submit proposals due to the possibility of high upfront costs for bidders
- Increases potential for many project uncertainties if clarity of scope is not well defined at time of proposal and can result in inequitable risk assignments
- Creates possible confusion about the process between the owner and design-builder due to lack of familiarity with the process
- Requires greater time demands for calculating risk allocation
- Causes owner to transfer design and some other project functions (e.g. QC, inspections,) depending on how contract is structured
- Makes the practice of “bridging” by owner problematic in an attempt to retain control
- Creates a system where design reviews need to be based on contract requirements rather than personal preferences

Design-build is recommended for projects with the following parameters:

- Emergencies requiring very fast completion
- Scope, design basis, and performance requirements are clearly defined
- Utility conflicts, right-of-ways acquisitions, hazardous materials, wetland, environmental concerns, and other unresolved issues are manageable and explained in the RFP
- Design effort is significant to promote the money and time savings during the design phase
- Expertise required is not available in-house from the owner
- Innovative designs and construction techniques can be implemented
- Time is the critical constraint, such as those with very high RUC, significant disruptions to third parties, or have a defined need for a speedy completion date (upcoming major event such as the Olympics or bridge openings)

Design-bid-build
Traditional design-bid-build procurement was the primary method used before innovative contracting was introduced in the last twenty years, primarily because of statutory public purchasing laws. In the traditional system, project award is based solely on cost, with no consideration of qualifications, schedule, or past performance. In a traditional delivery system, the design is 100% complete before the owner is able to solicit bids. The process requires the longest overall project time to completion. Also, with the design 100% complete, there is little room for the contractor to use innovative techniques that can save money and time on the project.

Advantages of traditional delivery contracts:

- Agency retains control of design
- Greater certainty of means and methods to be used by contractor on the project
- System is familiar to most organizations in the highway construction industry

Disadvantages of traditional delivery contracts:

- Much longer time to completion for overall project
- Many risks remain with the owner
- Limited ability to work with highly qualified contractors for certain projects
- Projects are awarded on the basis of a single factor- cost
- Agency does not have access to contractor knowledge and experience to optimize design and resulting construction cost implications
- System can be litigious if many claims for extension and add change orders occur.

Traditional method is recommended for projects with the following parameters:

- Time constraints are not controlling factors
- Agency resources are sufficient to complete the design and administration of the project
- Projects with a high potential for scope changes after contract award
- Politically sensitive projects

Having established an understanding of current thinking on innovative contracting, the research plan for this study could be established. The research team decided to survey both state DOT construction engineers and in-depth case studies, and conduct personal interviews of personnel for at least one project in each of the innovative contracting methods under investigation. Prior to undertaking the research, however, the research team needed to establish relevant performance criteria as discussed in the following section.

Chapter 5
Performance Parameters

In evaluating the effectiveness of different contracting methods, it is important to understand the parameters that define an "effective project." The Minnesota Statewide Transportation Plan of 2003 includes a description of 'Performance Framework and Measures' that focused on certain performance measures of construction that need attention in setting project objectives. Using Mn/DOT Performance Framework as a guide, the following performance measures were chosen as bases of comparison of the effectiveness of innovative contracting methods.

- **Administration Costs**
  Costs of executing and reviewing change orders, state approved reviewers, agency labor including the number of employees on the project, inspections performed by agency employees, costs associated with acquiring ROW, and of warranties (risk)

- **Construction Costs**
  Total project costs including engineering and design costs, ROW, environmental remediation and abatement, construction first costs, construction change costs, and management costs

- **Time**
  Overall length of the project, including planning, funding/appropriations, design, construction, and extensions, etc.

- **Management Complexity**
  Utilities conflicts, ROW turnover issues, project definition, scope definition, communication and coordination of the work, and procurement costs

- **Disruption to Third Parties**
  Disruption on businesses, schools, civic and religious places, neighborhoods, establishments, and destinations along the route

- **Road User Costs**
  Calculated by the state, each state has their own formula to help derive the RUCs ─a value represented as a daily amount including (among other things), fuel consumption, traffic accidents, value of driver time, maintenance of vehicles, etc.

- **Quality of Project**
  Finished product's life cycle and the use of best methods to sustain a long life cycle for the product, integrated design reviews, and administrative oversight

- **Funding Flexibility**
  Degree to which the state would be able to utilize funds from DOT operating or capital budgets, and the number of successive years legislative appropriations will be required for project completion

- **Innovation**
  Degree to which the contractor can use their knowledge and expertise to promote a faster process, new construction techniques, advanced technology, scheduling and sequencing of the work, and lower cost construction techniques

These nine performance measures were used to develop a research plan comparing the effectiveness of four different contracting methods (A + B, lane rental, design-build, and traditional), as discussed in the next section. The findings of the research were used to develop recommendations for Mn/DOT to optimize performance for each contract type based on which performance criteria are most critical given the project type and parameters.

Chapter 6
Research Overview

The goal of the research is to investigate the effectiveness of alternative contracting methods on different types of transportation projects across an array of performance objectives. Specifically, the purpose of this research project was to compare innovative contracting methods (A + B, lane rental, and design-build) to the traditional system of design-bid-build contracting and, ultimately, to provide Mn/DOT with insight and recommendations for use in transportation projects.

The research is comprised of two parts:

> Part one is a wide-ranging investigation of several types of alternative contracting techniques presented in SEP-14, including A+B contracts, lane rental contracts, and design-build contracts. This portion of the research project included a survey of leading national authorities on the subject along with case review of three A+B projects and one lane rental project. The purpose of this phase of the project is to provide insight about success factors related to the different contracting approaches based on the perspectives and opinions of DOT construction engineers.
>
> Part two of the research effort is an in-depth case study of the reconstruction of Trunk Highway 52 through Rochester (ROC-52). Mn/DOT utilized a "best value" design-build approach for a highway project for the first time in Mn/DOT history on ROC 52. The purpose of the case study is to thoroughly investigate the ROC-52 project using several different performance parameters, which are mostly qualitative in nature, and to prepare a set of recommendations to improve the administration of future design-build projects in Minnesota.

The research plan for each part of the research program is described in their respective sections.

Research Part 1: National Survey and A + B and Lane Rental Case Studies

Research Objectives and Methodology

The purpose of part one of this research project is to examine the preferences of state DOTs for using different innovative contract methods and to provide transportation managers and educators with insight and recommendations for the use of innovative contracting in transportation policy. Part one of the research project is comprised of two principal components, a national survey of state DOT construction engineers and a more in-depth case study of recent innovative contracting projects in Minnesota (other than design-build). The purpose of the national survey is to provide insight into the preferences of state DOT construction engineers regarding the project and performance factors that appear to favor different contracting methods.

The research methodology in this study utilized multiple methods of analysis incorporating both qualitative and quantitative techniques. The first step in the methodology was to identify relevant performance criteria. Mn/DOT has identified relevant performance factors to be used in determining project success. The research team chose a subset of those performance factors related to construction procurement and contracting value. The eight relevant performance factors were:

- Administrative Cost–types of internal costs Mn/DOT incurred in tracking processes: contract administration, inspections, reviews, right-of-way (R/W) acquisition, and environmental assessment and monitoring
- Construction Cost–first costs, costs of change orders, cost of engineering and design, environmental remediation
- Time–overall length of time spent in project planning, funding/appropriations, design, construction, and extensions
- Management Complexities–relative difficulty of coordinating issues encountered over the course of the project, specifically management-related aspect of the project such as planning and establishment of scope, logistical challenges, utility relocation and coordination, adjustments to unforeseen problems that arose during execution of the project, etc.
- Disruption to Third Parties–disruptions to businesses, schools, churches, residential neighborhoods, and other establishments or destinations along the route
- Road User Costs–costs incurred by the motoring public resulting from the project. Some examples of RUC include accidents, driver time, and additional vehicle mileage resulting from detours
- Quality–level of workmanship and the end products' performance versus what is expected by the owner, as well as the amount of post-construction call-backs and required maintenance of the facility
- Innovation–degree to which contractor is able to use new or less conventional concepts, methods, or materials on the project, their flexibility to make design changes and pursue alternative ideas or techniques aimed at reducing cost and schedule

To determine which types of projects would be candidates for use of innovative contracting in the opinion of state DOT construction engineers, state DOT construction engineers were asked to compare A + B contracting, traditional design-bid-build, lane rental, and design-build by ranking the four procurement and delivery methods for each performance factor on a variety of project types. The project types represented a cross-section of project characteristics involving a range of anticipated Average Daily Traffic flows, construction complexity, Maintenance-of-Traffic issues, and design effort. The nine project types chosen were:

- Major corridor realignment/expansion
- Multi-lane highway rehabilitation through a city, with detours
- Multi-lane highway rehabilitation through a city, under traffic
- Rural bridge replacement
- Metropolitan bridge replacement
- Two-lane highway resurfacing
- Mill and overlay
- Unbonded concrete overlay
- Preservation project with culvert replacement during two-lane highway resurfacing

Not all performance criteria will be of equal importance on the different project types. Therefore, a sub-sample of the DOT construction engineers was surveyed to determine the relative importance of each performance factor for each of the project types. The sub-sample of DOT construction engineers was asked to distribute 100 points across the eight performance factors for each of the nine project types. The assignments of these points were aggregated and averaged to generate a weighting coefficient for each performance factor on each of the project types.

The DOT construction engineers from each of the fifty states were sent blank templates for each project type and asked to rank the four different procurement methods from 1 (best) to 4 (worst) on each performance factor. Nineteen usable responses were received. The individual rankings were reverse scored (1=4, 2=3, 3=2, 4=1) so that high effectiveness scores would correspond to effective contracting methods. The reverse scored cell matrices were multiplied by the weighting coefficients and summed and averaged across all respondents to create an aggregate mean effectiveness score for each contract method in each project type. The mean effectiveness scores for each contract type were analyzed using a pairwise t-test for comparison of means. The mean effective scores of the four contract methods were listed from highest to lowest, with the highest score reflecting the preferred method, or the method that maximized the performance factors for each project. The rankings are listed in the following tables 6.1-6.9 and discussed in the following section, with statistical significance noted.

National Survey Ranking Data

For *major corridor realignment/expansion projects (see table 6.1)*, the weighted performance preference rankings are as follows:

1st preference (28.80) A+B Contracting
2nd preference (26.16) Design-build
3rd preference (22.95) Traditional
4th preference (22.09) Lane Rental

Table 6.1 Major corridor realignment/expansion projects

	A+B vs. L.R.	**A+B vs. DB**	**A+B vs. DBB**	**L.R. vs. DB**	**L.R. vs. DBB**	**DB vs. DBB**
p-Value	p<.0005	.25<p<.10	.025<p<.10	.01<p<.005	.05<p<.025	.25<p<.10

For *multi-lane highway rehabilitation projects through cities with detours (see table 6.2),* the weighted performance preference rankings are as follows:

1st preference (31.40) A+B Contracting
2nd preference (24.14) Design-build
3rd preference (22.76) Lane Rental
4th preference (21.95) Traditional

Table 6.2 Multi-lane highway rehabilitation projects through cities with detours

	A+B vs. L.R.	A+B vs. DB	A+B vs. DBB	L.R. vs. DB	L.R. vs. DBB	DB vs. DBB
p-Value	$p<.0005$	$p<.0005$	$p<.0005$	$.25<p<.10$	$.40<p<.25$	$.40<p<.25$

For *multi-lane highway rehabilitation projects through cities under traffic (see table 6.3),* the weighted performance preference rankings are as follows:

1st preference (30.59) A+B Contracting
2nd preference (24.62) Lane Rental
3rd preference (23.29) Design-build
4th preference (21.56) Traditional

Table 6.3 Multi-lane highway rehabilitation projects through cities under traffic

	A+B vs. L.R.	A+B vs. DB	A+B vs. DBB	L.R. vs. DB	L.R. vs. DBB	DB vs. DBB
p-Value	$p<.0005$	$p<.0005$	$p<.0005$	$.40<p<.25$	$.40<p<.25$	$p>.40$

For *rural bridge replacement projects (see table 6.4),* the weighted performance preference rankings are as follows:

1st preference (29.96) A+B Contracting
2nd preference (25.55) Design-build
3rd preference (23.68) Traditional
4th preference (20.81) Lane Rental

Table 6.4 Rural bridge replacement projects

	A+B vs. L.R.	A+B vs. DB	A+B vs. DBB	L.R. vs. DB	L.R. vs. DBB	DB vs. DBB
p-Value	$p<.0005$	$.05<p<.025$	$.01<p<.005$	$.01<p<.005$	$.025<p<.01$	$.40<p<.25$

For *2-lane highway resurfacing and upgrade projects (see table 6.5),* the weighted performance preference rankings are as follows:

1st preference (30.33)	A+B Contracting
2nd preference (24.97)	Lane Rental
3rd preference (23.18)	Traditional
4th preference (21.51)	Design-build

Table 6.5 Two-lane highway resurfacing and upgrade projects

	A+B vs. L.R.	A+B vs. DB	A+B vs. DBB	L.R. vs. DB	L.R. vs. DBB	DB vs. DBB
p-Value	$p<.0005$	$p<.0005$	$.01<p<.005$	$.25<p<.10$	$p>.40$	$.25<p<.10$

For *metropolitan bridge replacement projects (see table 6.6),* the weighted performance preference rankings are as follows:

1st preference (31.78)	A+B Contracting
2nd preference (24.82)	Design-build
3rd preference (22.76)	Lane Rental
4th preference (20.65)	Traditional

Table 6.6 Metropolitan bridge replacement projects

	A+B vs. L.R.	A+B vs. DB	A+B vs. DBB	L.R. vs. DB	L.R. vs. DBB	DB vs. DBB
p-Value	$p<.0005$	$.005<p<.001$	$p<.0005$	$.05<p<.025$	$.10<p.05$	$.25<p<.10$

For *mill and overlay projects (see table 6.7),* the weighted performance preference rankings are as follows:

1st preference (31.55)	A+B Contracting
2nd preference (26.48)	Lane Rental
3rd preference (23.19)	Traditional
4th preference (18.79)	Design-build

Table 6.7 Metropolitan bridge replacement projects

	A+B vs. L.R.	A+B vs. DB	A+B vs. DBB	L.R. vs. DB	L.R. vs. DBB	DB vs. DBB
p-Value	$p<.0005$	$p<.0005$	$.001<p<.0005$	$.005<p<.001$	$P<.40$	$.025<p<.01$

For *unbonded concrete overlay projects (see table 6.8),* the weighted performance preference rankings are as follows:

1st preference (31.87) A+B Contracting
2nd preference (25.49) Lane Rental
3rd preference (21.84) Traditional
4th preference (20.79) Design-build

Table 6.8 Unbonded concrete overlay projects

	A+B vs. L.R.	**A+B vs. DB**	**A+B vs. DBB**	**L.R. vs. DB**	**L.R. vs. DBB**	**DB vs. DBB**
p-Value	$p<.0005$	$p<.0005$	$p<.0005$	$.10<p<.05$	$p>.40$	$.25<p<.10$

For *preservation projects with culvert replacement during 2-lane highway resurfacing (see table 6.9),* the weighted performance preference rankings are as follows:

1st preference (30.15) A+B Contracting
2nd preference (25.48) Traditional
3rd preference (23.48) Lane Rental
4th preference (20.88) Design-build

Table 6.9 Preservation projects w/culvert replacement during two-lane highway resurfacing

	A+B vs. L.R.	**A+B vs. DB**	**A+B vs. DBB**	**L.R. vs. DB**	**L.R. vs. DBB**	**DB vs. DBB**
p-Value	$p<.0005$	$p<.0005$	$.025<p<.01$	$.40<p<.25$	$.25<p<.10$	$.05<p<.025$

Results from the national survey show that A + B contracting is the preferred contracting method for all project types, with statistically significant mean different effectiveness scores compared to all other contracting methods for all projects types except for major corridor realignment, where design-build contracting was not statistically different from A + B.

All of the participating states have used innovative contracting. Five of the nineteen states have used A + B, lane rental, and design-build, nine states have used two of the three innovative contract types, and five states have used one form of innovative contracting. Most states have used some form of A+B and lane rental contracting

Almost all of the states had used A + B and/or lane rental contracts, but the sample was more evenly split regarding the use of design-build. Twelve states had used design-build delivery systems, while seven states had no experience with design-build. Design-build did not achieve statistically significant difference compared to the traditional delivery method for any project except mill and overlay projects. Given the tremendous performance advantages associated with design-build on certain types of projects, this result was somewhat surprising. Because of this unexpected result, a follow-up analysis was performed to examine perceptual differences between the construction engineers from states that have used design-build compared to those from states without design-build experience.

The following tables 6.10 through 6.18 show these comparisons for each of the project types under consideration.

Table 6.10 Major corridor project comparison DB vs. non-DB

Contract Type	States w/ DB n=12	States w/o DB n=7
A+B	29.18	28.16
Lane rental	21.83	22.53
Design-build	28.37	22.37
Design-bid-build	20.62	26.95

Table 6.11 Multi-lane rehab w/detour comparison DB vs. non-DB

Contract Type	States w/ DB n=12	States w/o DB n=7
A+B	30.71	32.59
Lane rental	23.71	21.12
Design-build	24.62	23.32
Design-bid-build	20.95	23.67

Table 6.12 Multi-lane rehab under traffic comparison DB vs. non-DB

Contract Type	States w/ DB n=12	States w/o DB n=7
A+B	30.09	31.43
Lane rental	25.03	23.92
Design-build	24.27	21.62
Design-bid-build	20.61	23.04

Table 6.13 Rural bridge replacement comparison DB vs. non-DB

Contract Type	States w/ DB n=12	States w/o DB n=7
A+B	30.56	28.89
Lane rental	20.81	20.80
Design-build	27.41	22.35
Design-bid-build	21.91	27.96

Table 6.14 Two-lane resurface & upgrade DB vs. non-DB

Contract Type	States w/ DB n=12	States w/o DB n=7
A+B	31.64	28.28
Lane rental	25.82	24.75
Design-build	22.25	20.33
Design-bid-build	20.99	26.64

Table 6.15 Metro bridge replacement comparison DB vs. non-DB

Contract Type	States w/ DB n=12	States w/o DB n=7
A+B	30.99	33.01
Lane rental	23.24	22.00
Design-design	26.74	21.79
Design-bid-build	19.02	23.19

Table 6.16 Mill & overlay comparison DB vs. non-DB

Contract Type	States w/ DB n=12	States w/o DB n=7
A+B	31.70	31.10
Lane rental	25.80	27.51
Design-design	19.72	18.14
Design-bid-build	22.78	23.24

Table 6.17 Unbounded concrete overlay comparison DB vs. non-DB

Contract Type	States w/ DB n=12	States w/o DB n=7
A+B	32.04	31.62
Lane rental	25.70	25.14
Design-design	21.39	19.76
Design-bid-build	20.89	23.48

Table 6.18 Preservation w/culvert comparison DB vs. non-DB

Contract Type	States w/ DB n=12	States w/o DB n=7
A+B	31.10	28.51
Lane rental	25.33	20.32
Design-design	19.79	22.75
Design-bid-build	23.77	28.41

For seven of the nine project types, those states that had experience using design-build rated it higher than the traditional delivery method, while those states without design-build experience ranked the traditional method as more effective than design-build for every project type. This suggests that one of the biggest barriers to the effective implementation of design-build projects is a lack of understanding by state DOT personnel. Once a construction engineer has experienced design-build, they are much more likely to rate it as a more effective delivery method than the traditional design-bid-build method.

In addition to the performance ranking survey, each respondent was asked to list project criteria favorable to the use of innovative contracting as well as any other issues they believed were critical to effective use of innovative contracting. The most interesting finding from the open-ended questions was that most respondents indicated that they favored the inclusion of I/O clauses and several indicated that they set a maximum (B) time value for A+B bids that is intended to make the I/O clause meaningful and enforceable.

Finally, four innovative contracting projects in Minnesota were examined to gain further insight into some of the issues involved in effective use of innovative contracting. The case study of these projects incorporated interviews with Mn/DOT project managers along with project cost analysis and comparison to traditional contracting on projects of similar scope. The results of the cost comparisons along with findings from the case study interviews are presented in the following section.

A + B/Lane Rental Case Study

In addition to the national survey data, phone interviews were conducted with four project managers from Mn/DOT with experience in A+B and lane rental projects. Also, internal Mn/DOT documentation was reviewed to increase our understanding of some of the issues surrounding the use of A + B and lane rental contracting. Information gained from the interview process was mostly qualitative in nature, while reviews of internal Mn/DOT documents yielded quantitative data.

The questions asked in the interviews were geared to address the rationale behind the weighting of each performance criteria. Specifically, the research team was interested in learning how the use of innovative contracting may have impacted the overall performance of the project. In addition to the performance criteria questions, two general questions were asked during the interviews to address perceptions about the strengths and weaknesses of A + B and lane rental contracting. Interviewees were not necessarily expected to be able to comment on all areas of performance but those who were selected for interviews were able to speak to most of them.

Each interviewee was chosen because he or she had first hand experience in administration of an A + B or lane rental contract and knowledge of the specific projects forming the basis of the case study. Interviewees for this case study were chosen after receiving input from Mn/DOT team leaders. Three interviews were conducted during March and April of 2005.

The questions asked in the structured interviews follow:

Q1: How would you compare the original bid contract terms (cost and schedule) to projects of similar scope that were procured using traditional methods? Does A + B/lane rental have higher, lower, or the same bid costs compared to traditional contracts? Does A + B/lane rental have shorter, longer, or the same bid durations compared to traditional contracts?

Q2: How would you compare the final bid contract terms (cost and schedule) to projects of similar scope that were procured using traditional methods? Does A + B/lane rental have higher, lower, or the same final costs compared to traditional contracts? Does A + B/lane rental have shorter, longer, or the same final durations compared to traditional contracts?

Q3: Can you give examples of issues that resulted in cost or schedule changes from the original award on the projects where A+B/lane rental was used?

Q4: How would you compare overall internal costs for Mn/DOT on A+B/lane rental contracts compared to traditional projects?

Q5: What categories of internal costs are most impacted by use of A+B/lane rental?

Q6: Are RUC for A+B/lane rental projects higher, lower, or equal to traditional projects?

Q7: Are third party impacts for A+B/lane rental projects higher, lower, or equal to traditional projects?

Q8: What issues add complexity to A+B/lane rental contracting beyond what would normally be anticipated on a traditional project?

Q9: What types of projects are best suited for A+B/lane rental contracting?

Responses to these questions are summarized in tables 16.19a and 16.19b on the following page.

Table 6.19a Summary of responses to questions 1-5

Interviewee	Q1	Q2	Q3	Q4	Q5
Lane Rental PM	Equal	1.6% - 2.2% more	Night Work	Minimal Difference	Incentive Payment
A+B PM1	Higher	Equal	Utility Location	Same 6%–7% of Total Cost	Inspections
A+B PM2	Equal	Equal	Negotiating Time	Higher	Contract Administration
A+B PM3	Lower	Equal, but sensitive to time claims	Low "B" Bid	Higher	Contract Administration

Table 6.19b Summary of responses to questions 6-9

Interviewee	Q6	Q7	Q8	Q9
Lane Rental PM	Night Construction Avoided High RUCs	Night Construction Avoided High RUCs	None	High Traffic Volumes
A+B PM1	Lower	Reduced	Building Demo., Limit ROW	No Good for Rural Areas with Detours
A+B PM2	None for Unbonded Conc. Overlays	None	Prefers no incentive w/ A+B; Resolve Issues	Unbonded overlays, Bituminous Overlays, Grading projects
A+B PM3	Lower	None	Sequencing Operations, Through Preconstruction Phases	Larger Mill & Overlay Under Traffic, Any project

The internal document review examined three A+B projects performed by Mn/DOT (no data was available on lane rental projects). Specifically, these projects were analyzed to determine project performance for comparison to a project of similar scope using design-bid-build contracting. The cost comparison examined first cost, final cost, bid durations, final durations, and approximate internal administrative costs as function of total project cost. There was a “control project” of similar scope that utilized traditional design-bid-build delivery. Each of the four projects (three A+B and the control project) involved unbounded concrete overlay projects on Interstate or trunk highways. Project data are noted in table 6.20.

Table 6.20 A + B comparison project data

	Bid cost/mile	Final cost/mile (without incentives)	Bid duration/mile	Final duration/mile	Percent internal cost
A + B Projects					
Project 96	$926,396/mile	$1,023,860/mile	9.35 days/mile	12.10 days/mile	9.9% of contract
Project 81	$926,009/mile	$949,344/mile	7.3 days/mile	7.62 days/mile	5.9% of contract
Project 41	$778,831/mile	$799,940/mile	8.13 days/mile	7.25 days/mile	6.8% of contract
Average of A + B	$877,078/mile	$924,381/mile	8.26 days/mile	8.96 days/mile	7.5% of contract
Design/Bid/Build Comparison Project	$815,442/mile	$923,032/mile	10.36 days/mile	10.14 days/mile	10.6% of contract

The findings from the case study comparison should be viewed with caution because of the small sample sizes and use of a single project type (unbonded overlays) and a single control project for traditional delivery. The intent of the comparison was to make a very exploratory analysis of whether A + B contract performance (cost and time) could be compared to traditional contracting, and if so, what measures could be extracted from existing Mn/DOT databases. The exploratory analysis confirms that such a comparison is possible, but the effects of incentive clauses are difficult to separate from the effects of A + B contracting. After the start of this research project, Mn/DOT completed a more thorough analysis of several innovative contracting methods, including A + B contracting and lane rental (10), which are compared to the preliminary findings at the end of this section.

Summary of A + B/Lane Rental Case Study Findings

As shown in table 6.20, the average first cost per mile was higher for A+B projects than for the traditionally procured project. First costs were approximately 7.5% higher, although for each of the A + B projects in this study, the bidder with the lowest “A” amount (lowest cost bid) received the award for each of the projects. However, the final cost per mile for A + B contracting (excluding I/O payments) was virtually identical to the traditionally procured project. Cost increases were 5.4% on average for A+B projects compared to 13.2% for the traditionally procured job. A + B projects were executed in a more timely fashion, with 8.26 days per mile bid by the contractor for A+B projects compared to 10.36 days per mile bid by the contractor for traditionally procured projects. A+B contracting appears to lead to a schedule reduction of 25% at the time of the bid. There were differences in schedule accelerations, with A+B projects averaging an 8% growth in schedule, while the traditional project was completed 2% faster than the original schedule estimate, but overall final durations were lower for A + B contracting. There were also differences noted in the internal, or DOT administrative costs. Internal DOT administrative costs averaged 7.5 % of contract amount (excluding I/O bonuses) for A+B contracts compared to 10.6% of contract amount for the traditionally procured project.

For the most part, these differences are consistent with predicted practices for A + B. Because A + B contract awards attempt to optimize cost AND schedule, it is reasonable to anticipate that first costs would be slightly higher and estimated schedule would be shorter than for comparable traditionally procured projects. Also, because of the need for efficient work flow once construction begins, construction documentation and coordination issues are developed more thoroughly by the contractor and Mn/DOT construction engineers in pre-construction than for a traditional project. This could explain the lower cost growth for A + B contracts than for traditional projects. Also, the opportunity for bonus payments may reduce the perceived need among contractors to boost margins through aggressive pursuit of claims in low-bid project awards. The schedule growth is also consistent with anticipated contractor behaviors if the impact of I/O payments is considered. If the contractor can get schedule extensions through the pursuit of delay claims, it will result in higher incentive payments. Therefore, the schedule growth described in the case comparisons is logical given the presence of substantial margin impact from I/O payments. The higher rate of schedule growth for A + B contracts in our case comparison may be caused by I/O language, and not by the use of A + B contracts per se.

The reduction in internal administrative costs was a bit of a surprise, is contrary to the opinions of many experts, and does not support the perceptions of the project managers on A + B projects, which are summarized later in this section. It is important to note that the administrative costs as a percentage of project costs did NOT include incentive payments under the A + B projects. If these payments were included, the administrative costs as a percent of project cost would be even lower. Although not specifically tested in this study, it is possible that the more thorough coordination in pre-construction has administrative efficiency benefits later in the project that result in lower administrative costs. Also, the efficient operations of the contractor may carry over to more efficient operations for field-based internal labor (field inspections, QA, etc.). In other words, the contractor’s ability to effectively and efficiently plan, coordinate, and communicate the work schedule to other members of the project team may translate to more efficient and effective operations for certain administrative functions within Mn/DOT.

Another possible explanatory factor for the lower internal administrative costs is the presence of I/O language. The typical contractor’s goal on a publicly bid project is to increase margin to reduce risk. With the opportunity for bonus payments under the various I/O clauses in the contract, it is possible that the contractor has a more inward focus, looking for means and methods to improve the efficiency, quality, and speed of construction to increase the chance for bonus payments. On a traditional low-bid project, the effort is typically directed externally at seeking constructive change order claims, which results in higher administrative costs for the DOT.

Again, it is important to note that this research project was not designed to examine these issues, but the findings of the case study comparison did provide some intriguing results. Future research aimed at determining contractor behavior motivations and the impact of I/O language would be useful in gaining increased understanding of the most appropriate use of innovative contracting combinations.

The results of the five year review of innovative contracting by Mn/DOT Office of Construction and Innovative Contracting (10) were generally consistent with the findings of the exploratory study described in this report. Differences in methodologies make a direct comparison of the results from the Mn/DOT study impossible. For instance, the cost comparisons in the Mn/DOT study were made against the engineer's estimate, not against a similar project using traditional procurement, as was done in the exploratory study described in this report. Also, actual and bid durations were compared to maximum allotted times in the request for bids in the Mn/DOT study, while the exploratory study described in this report compared against a traditional procured project of similar scope. Nonetheless, the general findings were very similar. Specifically, both studies found that A + B contracting did not increase the cost of the project, and did result in significant reduction in durations. The case study interviews in the Mn/DOT report uncovered the same concerns from project personnel regarding possible increases in administrative costs as the interviews in the exploratory study described in this report. Nevertheless, the quantitative analysis of actual internal costs for the projects examined in the exploratory study did not find evidence of any increase in internal agency costs.

Interviews with Mn/DOT project managers for the three A+B projects revealed some differences of experience and opinion regarding the use of A+B contracts. One project manager stated that the initial dollar amount of the bid (initial construction costs) were lower, one stated that they were higher, and one stated that they were the same as for traditional low-bid projects. All three project managers stated that the final costs of construction, including change orders and I/O payments, would be similar for traditional delivery and for A+B. One project manager did say that contractors are very time sensitive when using A+B with I/O clauses, so it is important to have all environmental abatement, Right-Of-Way acquisition, and utility relocation issues resolved prior to the start of construction.

All three project managers indicated that use of A+B contracts added some complexity to the project management process. In particular, the scheduling of night work by the contractor places demands on Mn/DOT resources needed for inspections, field reviews, and quality monitoring. Utility locations must be verified, conflicts resolved, and plans communicated to the contractor prior to the start of construction. Also, the need to negotiate for time in addition to money resulting from changes during construction adds another responsibility to project management. Lastly, one project manager interviewed stated that many bidders may not understand the award process since they submitted the maximum "B: amount established by the state as part of their bid package.

Two project managers indicated that internal administrative costs were higher for A+B projects because of the need to staff night-work and use overtime for Mn/DOT field personnel performing field reviews, inspections, and material testing. One project manager estimated that internal costs would be similar to other non A+B projects over the long-term, but could be higher during intense periods of work. One project manager stated that the range of internal administrative costs across all project types and contract methods is 6–8 percent, which compares favorably to the ranges for the three A+B projects examined in the case study. The exploratory review of A + B projects did not reveal higher administrative costs, contrary to the perceptions of two of the project managers. The two primary departmental operations affected by the use of A+B contracting are 1) contract administration—because of the need for fast turnarounds on decisions and timely resolution of project issues and 2) field inspections—because of overtime and long shifts necessitated by night work and weekend shifts by contractor crews.

All three project managers agreed that RUC are reduced by using A+B contracts, although one project manager stated that controlled access interstates have limited flexibility in reducing RUCs on a daily basis, but the overall duration of the impact is reduced. One project manager stated that disruptions on third parties along the route (e.g., local businesses and civic entities) were reduced because of shorter project durations, but the other two stated no difference in third party disruptions because access is maintained regardless of contracting method.

When asked if internal agency issues needed to be managed differently for A+B contracts, all three project managers indicated that some different approaches are required. Specifically, there needs to be a greater sense of urgency to resolve issues and more thorough plan reviews and coordination needs to take place prior to the start of construction when using A+B contracts. Related issues such as demolition, environmental remediation, and work sequencing need to be resolved much faster than on typical projects. In short, Mn/DOT cannot afford to go in with as many “unknowns” as they might on a traditional project, and they must get supplemental agreements resolved quickly once construction begins.

The project managers indicated that A+B contracts are best suited for projects with high traffic volumes, projects with limited design complexity and outside factors such as environmental issues, utility conflicts, etc. Unbounded overlays, bituminous overlays, grading projects, mill, and overlays under traffic are projects that fit these descriptions. One project manager stated that he would suggest A+B contracting on any type of project, while another project manager stated that he would not recommend its use in rural areas where detours are available.

Another anecdote regarding the use of I/O clauses involved district-wide policies. It was felt that if some projects had large I/O clauses, other projects in the district without I/O would suffer because contractors would commit resources to the projects where they could earn an incentive or avoid a disincentive. This could be problematic in rural, sparsely populated districts where few contractors are available for competitive bid work.

Interview data from the lane rental project manager suggests that first costs are similar, but final costs may be slightly higher. Night work has an impact on scheduling, but does help reduce RUC. Internal cost differences were thought to be minimally different for lane rental contracts, with incentive payments recognized as the most important cost factor. Lane rental contracting was not considered to be more complex than other forms of contracting. Lane rental was recommended for projects with high traffic volumes.

Research Part 2: Design-build Case Study

ROC-52 Project Overview

ROC-52 is the first best-value design-build highway project of large scale that Mn/DOT has undertaken, and was the largest single highway contract in Mn/DOT history when it was awarded in 2002 for $232 Million. The project's implementation as design-build is governed by the policies established in the Federal Highway Administration's (FHWA) Special Experimental Project Number 14 (SEP-14) for innovative contracting methods and Minnesota design-build procurement legislation. It marks the first time Mn/DOT has used a "best value" approach during the procurement and letting processes for a highway project. As a result, it is of great interest to evaluate different aspects of the project to ascertain how the use of design-build delivery impacted project performance.

The ROC-52 Project spans a distance of approximately eleven miles through the city of Rochester in Olmsted County. At the north end, the project starts at the junction of Highway 52 and 85th Street NW. From 85th Street NW to 65th Street NW, the reconstructed section is rural highway. The urban freeway reconstruction begins at 65th Street and carries through the city to the south end of the project, located at the junction of Highway 52 and U.S. Highway 63. Highway 52 is of critical importance to both the traveling public and the city's several major industries, including the Mayo Medical Center and IBM. The Highway 52 corridor also serves as the primary connecting route between Southeastern Minnesota and the Minneapolis-St. Paul metropolitan area. These factors necessitated that minimal congestion and safe driving conditions be maintained during all phases of the ROC-52 construction.

Prior to the reconstruction, this segment of highway was a four-lane controlled-access freeway, consisting of two through lanes in both directions. The reconstruction project expanded the highway to six lanes, with three through lanes in each direction. Included in the project scope are grading, roadway surfacing, drainage considerations and formation of detention ponds, and construction of roadway structure, such as bridges, noise walls and retaining walls. The improvements also included the installation of traffic signals, lighting, signing, and Intelligent Transportation System (ITS) devices. The project required new construction, reconstruction, or modification of 12 different interchanges or overpasses along the route, as well as construction or reconstruction of 24 permanent bridges. Additional peripheral improvements encompassed by ROC-52 included modification to existing frontage roads, creation of bicycle or pedestrian paths, and some work to a section of Trunk Highway 14 that passes under Highway 52.

Case Study Research Methodology

Investigation of the effectiveness of design-build on the ROC-52 Project required the Iowa State research team to conduct interviews of appropriate project personnel. The insight obtained from these interview sessions forms the basis of this case study. Most of the information gained from the interview process was qualitative in nature, although some interviewees were able to provide numerical data. Interview questions for use in developing the case study are shown in Appendix C.

Prior to the interviews, a set of project-related criteria were identified as a means of comprehensively evaluating a project's performance. The questions presented in the interview were geared to address these different criteria as applicable to ROC-52. Specifically, the research team was interested in learning how the use of design-build, rather than Mn/DOT's traditional system of design-bid-build, may have impacted the project. Ultimately, conclusions can be made about the effectiveness of design-build versus design-bid-build, and recommendations can be made that will enhance the performance of future Mn/DOT design-build projects.

The Minnesota Statewide Transportation Plan developed by Mn/DOT includes a 'Performance Framework and Measures' table which details critical performance criteria for construction. Using the Performance Framework as guide, the following performance parameters have been selected for investigation during the interview sessions: Administrative Costs, Construction Costs, Time, Management Complexity, Disruptions to Third Parties, RUC, Quality of Project, Funding Flexibility, and Innovation. There was also a small set of more general questions asked during the interviews to address perceptions about different types of delivery systems and to determine ways that the administration of ROC-52 could have been improved.

Administrative Costs

The administrative costs on the project were defined as the different types of internal costs Mn/DOT incurred in tracking processes. These include the costs associated with contract administration, inspections, reviews, right-of-way (ROW) acquisition process (not actual land acquisition costs), warranties, and possibly others. Questions considered in the interviews:

- Are there other examples of internal administrative costs on ROC-52 in additional to those already mentioned?
- If ROC-52 had been administered using Mn/DOT's traditional delivery system of design-bid-build, would Mn/DOT's internal costs have been higher, lower, or the same? If different, specifically which types of internal costs would change?
- How did actual processes associated with these administrative costs differ on this design-build project from how they typically would be under projects of traditional delivery?

Construction Costs

Construction costs for the project included first costs, the cost of engineering and design, costs related to changes in scope, environmental remediation and abatement, and management costs. Questions regarding the construction costs:

- How would construction costs have been different if the project had used traditional delivery rather than design-build—higher, lower, or the same? Why?
- Are there other construction costs besides those listed? If there are others, are they attributable to the type of delivery system used on this project?

Time

Time refers to the overall length of time spent in project planning, funding/appropriations, design, construction, and extensions.

- Are there other factors that add to project time?
- Would the length of time spent in each of these project phases have been higher, lower, or the same under the traditional delivery method? How significant would the difference have been?

Management Complexity

The concept of management complexity refers to the relative difficulty of coordinating issues encountered over the course of the project. Management complexity could basically include any management-related aspect of the project, such as executing the procurement phase of the project, planning, establishing scope, evaluating logistical challenges during preconstruction and construction, and troubleshooting unforeseen problems that arose during implementation of the project, etc.

- Was there difficulty understanding the scope or defining the project? If so, would this have been different under the traditional system?
- Was the project easier, more difficult, or equally as difficult to manage due to its status as design-build rather than traditional? Specifically, which areas of the project were more difficult to manage? (procurement processes, utility conflicts, ROW turnover, phasing, etc.)
- What were the logistical concerns with executing the project? Would they have been different under the traditional system?

Disruption to Third Parties

Third parties affected by the project may include businesses, schools, churches, residential neighborhoods, and other establishments or destinations. Effects on community events or seasonal activities were also considered. Other disrupted parties could include railroads, environmental agencies, or local and regional government agencies.

- Are there other specific examples of third parties disrupted by the project? What were the impacts?
- How did ROC-52's design-build delivery method affect the way disruptions to third parties were handled? Did the design-build system improve, hinder, or have no effect on how third-party disruptions were managed or remedied?
- What was the disruption to residents or neighbors? Railroad crossings? Facilities or structures along the route?
- Were there environmental issues on the project? Were there any differences in the way they were dealt with stemming from the use of design-build instead of the traditional system?

Road User Costs

Road user costs refer to the costs incurred by the motoring public resulting from the project. Some examples of RUC include accidents, driver time, and additional vehicle mileage resulting from detours. Most DOTs have a method for determining RUC, and it is a calculation which generally has its greatest merit after a project has been completed. This case study does not attempt to quantify what the RUC will be at project completion, but rather, it speaks to the perceptions of how they may be different as a result of design-build delivery.

- Are there other types of RUC which were specific or unique to the ROC-52 Project?

- Would these costs have been higher, lower, or no different under the traditional system instead of design-build?

Quality of Project
Quality refers to the level of workmanship and the end products' performance versus what is expected by the owner, as well as the amount of post-construction call-backs and required maintenance of the facility. The quality parameter also includes consideration of the processes used to achieve and assure quality on the project.

- How has design-build impacted the overall quality of the project? Are there any specific examples?
- What do you think the long-term effects will be in terms of workmanship, warranty, contractor call-backs, ongoing maintenance, and other quality-related issues?

Funding Flexibility
Consideration of funding flexibility involves the number of appropriation periods spanning the project, capital flows and budget sizes, and issues surrounding appropriations for projects (special) versus appropriations for operations (continuing).

- To what degree does design-build create different options for funding flexibility? For instance, are projects easier to fund than operations? (use of capital budgets versus operating appropriations for design, inspections, etc.)
- Is the impact significant or minimal?

Innovation
Innovation on a project refers to the contractor's use of new or less conventional concepts, methods, or materials on the project. This also includes their flexibility to make design changes and their ability to pursue alternative ideas or techniques.

- How does the design-build system allow for changes to be made on the project?
- Does design-build promote or discourage contractor innovation, and to what extent? What were some specific examples of innovation on the project, if any?
- If applicable, in what areas is innovation made possible? Design? Methods? Sequencing? Other areas?

Additional Questions

- What types of projects or project traits would you look for when considering the use of design-build rather than conventional delivery methods?
- What project characteristics would lead you to consider/recommend design-build? Similarly, what types of characteristics would lead to considering/recommending the traditional design-bid-build method of delivery?
- What internal processes would you recommend that Mn/DOT adopt, change, or eliminate in order to improve the effectiveness or efficiency of design-build projects in the future?

Interview Participants
Obviously, several different entities have had a major role in ROC-52 project. The design-builder for the project is Zumbro River Constructors (ZRC), LLC—a joint venture by Fluor Corporation, Ames Construction, Inc., and Edward Kraemer and Sons, Inc. HDR Corporation has served as Mn/DOT's design-build oversight consultant for the project. Kleinfelder, Inc.

handled materials testing responsibilities as a subcontractor to HDR. URS Corporation also played a significant role in the design of ROC-52 working for the design-builder. Representatives from each of these organizations were interviewed, as were numerous Mn/DOT personnel involved in the project. Interviewees were chosen after receiving input from Terry Ward (Mn/DOT) and Doug Jackson (HDR) during a December 2004 meeting with the ISU research team. Interview sessions were conducted during January and February of 2005.

Interviewees were chosen because they had considerable knowledge of the project and would be able to provide insight and suggestions. In addition, interviews were conducted with several individuals whose involvement in ROC-52 was indirect at either administrative or financial levels.

Understandably, not all interviewees had sufficient information or background to be able to comment on all of the criteria targeted in the interviews. For example, a material testing specialist would not be expected to have considerable insight into issues concerning capital flows or appropriations, although their knowledge of many other project issues is invaluable. Ultimately, those individuals who were selected for interviews were able to speak to a good portion of the criteria of interest for this study.

Case study interviews included:

<u>ROC-52 project personnel</u>
Tim Odell – Deputy Project Manager, ZRC (Ames)
Jim Valyntine – Structures Manager, ZRC (Kraemer)
Sim Brubaker – Field Services Manager, HDR
Craig Glazier – Segment 1 Construction Engineer, HDR
Steve Kilcrease – Deputy Project Manager for Administration, ZRC (Fluor)
Nick Sovell – Construction Manager, HDR
Tanya Houska - Financial Budget Manager, HDR
Doug Jackson – Project Manager, HDR
Tom Wiener – Project Control Manager, HDR
Trinity Houska – Field Engineer, HDR
Jim Eshbaugh – Design Manager, URS
Herb Morgan – Project Manager, ZRC (Fluor)
Dave Robinson – Quality Assurance Materials Manager, Kleinfelder
Nelrae Succio – District 6 Engineer, Mn/DOT
Judy Schmidt – District 6 Administrative Manager, Mn/DOT
Barry Paye – Assistant Segment Engineer, Mn/DOT
Keith Quernemoen – Segment Engineer/Project Controls Engineer, HDR
Terry Ward – ROC-52 Project Manager, Mn/DOT
Karl Anderson – Materials Specialist, Mn/DOT

Administrative personnel
Doug Differt – Deputy Commissioner/Chief Engineer, Mn/DOT
Bob Hofstad – Office of Investment Management, Mn/DOT
Brad Larsen – Office of Investment Management, Mn/DOT
Kevin Kliethermes – Construction and Contract Administration Engineer, FHWA
Kevin Anderson – 494 Design-Build Project Manager, Mn/DOT
Gary Thompson – State Construction Engineer, Mn/DOT
Jon Chiglo – Hwy. 212 Project Manager/ROC-52 Technical Review Committee Chair/ Manager of Design and Materials for ROC-52

Keith Molenaar, Professor of Construction Engineering and Management at the University of Colorado-Boulder and leading researcher of design-build contracting nationwide, served as an advisory consultant on this case study. See Appendix D for a summary of meeting notes from the advisory meeting with Dr. Molenaar.

Findings of the ROC 52 Case Study

One of the objectives of the research project in the original scope statement was to compare "costs" of ROC 52 to costs of traditional projects. This discrete type of analysis proved to be impossible for a number of reasons. There are far too many parameters on a complex construction project to allow for a reasonable comparison, for instance, the elements of the project (soil conditions, number of structures, cut/fill quantities, and many more) vary considerably on every major project. The market conditions (material prices, labor rates, bidding environment, competitive situation) and weather conditions vary greatly on every major project. Lastly, even the definition of "cost" is difficult to quantify, because cost is just one factor of performance. Cost cannot be analyzed without an understanding of risk allocation, quality, schedule, etc. In other words, projects would need to be compared on total performance, not just on construction cost to make any such comparison meaningful. Consultation with national experts on design-build confirmed that the decision to change the scope of the report to a qualitative comparison of performance factors, rather than focus only on cost, was appropriate. The decision has been confirmed by emerging literature published since the start of this research project.

1. Administrative Costs

An important question related to the use of design-build on publicly-funded highway projects is how the use of a different delivery method affects the costs of administration. For the purpose of clarity in the interviews, administrative costs are classified as those costs incurred by the agency to control the project and track certain processes including—but not necessarily limited to—contract administration, design reviews, construction inspections, and right-of-way (ROW) acquisition processes. Excluded from administrative costs are all types of direct construction costs, including first costs, construction change orders, and the cost of engineering and design.

The concept of administrative costs can be perceived as being relatively broad, especially on a project as large as ROC-52 where so many processes involving numerous individuals and organizations are occurring constantly. ROC-52 case study interviewees were asked to identify the costs required to administer the project, in an effort to both help define precisely which costs should be classified administrative costs, as well as to determine any additional administrative costs that were either less obvious or unique to this project. Thus, the first question related to administrative costs asked whether there were other examples of internal administrative costs besides the ones already mentioned.

Additional administrative costs

Of all the ROC-52 personnel interviewed, none had disagreement that costs associated with contract administration, design review, and inspections comprised a large portion of the project's overall administrative costs. In addition, several other sources of administrative costs were suggested. Of the 19 individuals who had the opportunity to respond, at least six specifically identified HDR's role as the project's oversight consultant to be an additional administrative cost. One individual with knowledge of the situation stated that HDR's contract was originally estimated at $16.7 million, but that the actual value may be slightly less than that. Some saw this as an added cost that would not be present on traditionally-delivered Mn/DOT projects, although two stated their belief that Mn/DOT would have assumed approximately the same expense if the oversight responsibilities performed by HDR had been retained by the agency.

The cost to co-locate the collective project teams in the same building was mentioned as an added administrative cost unique to this project. ZRC, Mn/DOT, HDR, and various consultants have located their respective ROC-52 personnel under one roof for the duration of the project. A small office building on Marion Road in southeast Rochester was acquired to house the teams and serve as a base of operations. Most of those who mentioned the cost of this office as an added expenditure also stated their belief that there was value in doing so. One reason this was seen as effective was because of the direct communication it facilitated between members of the different organizations. While it may be relatively easy to identify the cost of co-location in a separate office as an added administrative expense arising from the design-build approach, it is much more difficult to determine the savings derived from it. Co-location made it easier to track down key individuals, arrange meetings, and resolve issues that arose.

Development and execution of the Request for Proposal (RFP) process for best value design-build was cited as an additional administrative cost. The project's status as Mn/DOT's first ever best value design-build highway project may have caused administrative expenses to be greater on ROC-52 than they would be on future projects of the same delivery method. The cost to develop an RFP and contractor qualification procedure tailored to the best value approach was seen as a one-time expense which, once established, would only need minor modifications the next time it is used.

At least three interviewees mentioned document control as an additional or unique cost to ROC-52. HDR staff was involved in the development of a database to which project documents and reports are input, and the database was described as the system that drives Mn/DOT's data collection and document control for the entire project. The cost to develop and manage a new database for this design-build project would not be incurred on traditional Mn/DOT jobs.

Advantages of a "systems" approach

The advantages of a "systems" approach to project management across a variety of contracting methods should not be ignored. The Arizona DOT (11) in their review of best project management practices has identified several areas that could be considered "systems approaches" to the delivery of transportation infrastructure. For example, recommendations include linking project management roles and responsibilities to the strategic objectives of the department, developing internal project management objectives (budgets, schedules, outcomes, etc.) for administrative costs in addition to construction and design costs, and the development of multi-project resource loading programs and quantitative measures for effectively managing internal labor costs. Each of these suggestions indicates systems-level thinking. At the project level, the use of CPM network scheduling to track claims for delay or acceleration should become standard process for many projects, not just design-build or innovative contracting projects. Additionally, activity-based payment to contractors (instead of quantity based payment) should become the standard system for contractual payments. Eliminating the use of unit price quantity payments will relieve Mn/DOT personnel of labor-intensive invoice reviews and quantity checks, freeing up time to work on more value-added activities such as quality assurance, CPM schedule reviews, or new project management systems development.

There were other suggestions regarding administrative costs that existed on this project similar to costs on projects already mentioned, although none of these were mentioned more than once or twice during the series of interviews. Some of these suggestions included the hiring of additional staff to do design reviews, added costs during the right-of-way acquisition process, and preliminary design done by Mn/DOT prior to selection of the design-builder.

Design-build vs. traditional

In design-build, the roles and responsibilities of the designer and constructor are very different than on a traditional project. In design-build, responsibility for design errors, conflicts in the documentation, and ill-specified products rests on the design-builder, and not on the owner (Mn/DOT) or their agent (designer). In addition, the single point responsibility of a design-build contract allows the owner to assign public relations, quality processes, and other project factors to the design-builder if appropriate for the project. Design-build also allows for qualifications based procurement, which can ensure that contractors and designers chosen to propose on the project are qualified to deliver a high quality project. Lastly, use of design-build allows for more variability in risk allocation between the owner and the design-builder based on project characteristics. In general, under a design-build contract, the owner can assign more tasks to the design-builder than they can to the contractor in a traditional delivery system. Also, the owner can allocate appropriate project risks to those parties best able to manage the risk. In other words, design-build allows for more flexibility in assigning tasks and risks that are specific to the project rather than the one-system-fits-all approach of traditional procurement.

The greater question relating to administrative costs is how they compare overall on design-build projects versus traditionally-delivered projects. The question was asked of interviewees: If ROC-52 had been done using the traditional Mn/DOT system of design-bid-build delivery rather than design-build, would internal costs to Mn/DOT have been higher, lower or the same? They were also asked to identify what areas the cost variance could be attributed.

Considerable insight was gained from the responses to this question, although no clear overall consensus was discernable. In fact, the replies from project personnel show a high degree of uncertainty about how administrative costs may vary with different delivery systems. Of the nineteen individuals questioned, five contended fairly strongly that administrative costs were higher on design-build than they would've been under traditional. Two more responses showed either ambiguity or uncertainty while suggesting that administrative costs for this design-build project were higher than they would've been using design-bid-build.

The explanations for why administrative costs may have been higher were numerous. Most of those who perceived administrative figures to be higher cited one or more of the additional costs identified in the previous section, including the co-located office, the oversight contract designated to HDR, and development and implementation of the RFP and contractor selection process. At least three people felt that administrative costs may be higher on ROC-52 simply because of the newness of using the design-build process on Mn/DOT projects. It was also asserted that design-build may require more up-front administrative investment, but that savings are realized in other areas over the life of the project.

In contrast, seven individuals indicated that costs were lower under design-build than they would have been otherwise. Nevertheless, three of the seven responses could be characterized as being somewhat uncertain. Examples of this type of answer were to say that administrative costs were "the same or slightly lower under design-build," or that they were "probably lower."

Two individuals mentioned that a possible reduction in the cost of inspection and testing contributed to a lower overall administrative cost. It was suggested that if the project had been delivered by the traditional Mn/DOT approach, quality processes would've been more costly and required more staffing commitment. Issues surrounding quality control and quality assurance were persistent on ROC-52, and will be discussed in greater detail later in this case study.

Of the remaining five responses, three suggested they were the same and two had no comment. Of the three who said they were the same, two qualified the response by noting that certain costs were higher and certain ones lower, but the resulting overall administrative cost was effectively not different.

Summary

Views varied widely about how the delivery system on ROC-52 affected its overall administrative costs. Almost the entire spectrum of possible responses was present. Those who stated that administrative costs were lower under design-build were equally as common as those who believed they were higher, and the convictions were of varying degrees in both directions. Several people believed they would've been the same under either system.

Numerous administrative costs were identified to be present on ROC-52 that may not have been included if the project had been of traditional delivery. In several cases, however, interviewees contended that the overall figure for project administration was not necessarily greater just because there were certain additional expenses. With some of these costs, the additional money spent during ROC-52 was compensated for by the savings generated in other cost categories. Co-location of the project teams was a prime example of this; while it is an added cost to obtain a facility to house all of the project partners, there can be cost savings in areas both tangible (such as travel time or communication) and intangible (such as efficient problem resolution or greater office productivity gained from a team-based "partnering" environment).

It may be impossible to tell exactly how Mn/DOT's administrative costs for a design-build project would compare if the same project was delivered traditionally. It is clear that there are areas where money has been spent differently on ROC-52 because it is design-build, but no clear consensus emerged from the interview data regarding the administrative costs compared to traditional delivery.

Regarding internal cost comparisons for design-build versus traditional projects, the research team came to the same conclusion as the authors of the Warne report. That is, direct project comparisons are fraught with complications and problems related to dissimilarity of scope, management, project members, contractual obligations, etc. The research team was provided with comprehensive cost data reports for ROC 52 and the Wakota project. Nevertheless, analysis of the cost data for purposes of comparisons of final projected internal costs is problematic because both projects are unfinished, and the projects are in different stages of completion. Therefore, final internal costs cannot be reliably estimated for comparison. The final report of this research project can be amended when both projects are complete in order to perform a comparison of internal cost structures.

One of the reasons there is so much interest in determining administrative cost differences between innovative and traditional contracting is because logic and intuition suggest that the use of innovative contracting will result in increased internal administrative costs for state transportation departments already strapped for cash. Internal administrative costs may differ due to the following:

Reasons internal costs may be LOWER for design-build

- Development of "biddable" versus "buildable" plans requires less detailed design reviews and Mn/DOT development of standards
- Constructor doing more of the public relations work and community coordination
- Constructor doing more of the survey work
- Constructor doing more of the quality control work
- Overall shorter duration

- Contractor innovation may reduce need for Mn/DOT labor in areas where emerging technology is offering less expensive options (e.g. surveying vs. machine controls; stakeless grading vs. bluetopping)

Reasons internal costs may be HIGHER for design-build

- Urgency of reviews required under accelerated schedules
- More overtime or increased staffing needs for Mn/DOT field crews (inspection, compliance, etc.)
- Less familiarity with systems and processed for design-build
- Some existing processes are not suitable for design-build, creating inefficiencies
- Cost of preparing Request for Proposal and more complex procurement process

2. Construction Costs

Construction costs encompass the amount of the original bid, including all engineering and design fees. The expense of changes to the project is also a part of construction costs, although the cost to actually execute change orders is considered an internal administrative cost. Similarly, the amount paid to acquire right-of-way on the project was seen as a construction cost, although the actual effort involved in the acquisition process was classified as administrative. Risk allocation also becomes an important consideration when evaluating construction costs.

The results of the discussions with ROC-52 personnel suggest a high degree of uncertainty about whether using design-build may have caused construction costs to be higher or lower. There were a total of 14 interviewees who commented on the construction cost criteria. Only one individual strongly believed ROC-52 construction costs were higher under design-build than they would've otherwise been, and only two strongly believed they were lower. Of the remaining 11 respondents to this topic, 6 offered a weak or uncertain belief that they are to be lower as a result of design-build—saying they were "probably" lower but indicating there was no way to tell for sure. Two made similarly weak suggestions that they were higher as a result of design-build. Of the final three responses, two said they were the same and the third said it was completely unclear.

As with administrative costs, interviewees were asked if any additional construction costs were present on ROC-52. Few people had any to suggest aside from the ones already mentioned, although there were specific examples of changes required that led to additional expense. The most predominant of these was the environmental remediation associated with structure demolition along the route. These costs were anticipated by Mn/DOT, and were believed to be procured effectively through change orders subsequent to the initial contract letting. Environmental abatement and asbestos removal on 79 buildings within the corridor led to an estimated $1.5 million additive change order expense. However, from Mn/DOT's point of view this has been a great example of successful risk management on ROC-52, as some Mn/DOT leaders estimated bid allowances would have ranged between $3 and 6 million if bidders had been instructed to include these costs in their bids.

Design-build vs. traditional
As with administrative costs, there were differing opinions on how construction costs are impacted by the method of delivery. Although there was not necessarily a strong consensus one way or the other, there were many explanations offered for why construction costs might be either lower or higher as a result of the use of design-build.

Reasons costs may be lower
A pair of reasons was frequently mentioned by interviewees who perceived construction costs to be lower on ROC-52 and on design-build projects in general. First, design-build brings a reduction of change orders, both in number and in the overall dollar amount. Cost growth on ROC-52 has been estimated at approximately 2.6 percent at the time of the interviews. It was stated that the typical Mn/DOT target for cost growth is around 7 percent, and estimated Mn/DOT cost growth on projects from the years 1998 through 2002 was around 9 percent. The comparison of these numbers seems to make the ROC-52 cost growth figure look impressive, and is probably the most convincing indicator to those who believe that the project has saved money over traditional means. The reduction of cost growth was specifically mentioned by at least four of the interviewees.

Second, the ability for schedule acceleration of design-build projects brings savings related to both the time-value of money (e.g. material inflation and interim financing costs) and time-sensitive construction costs such as monthly equipment rentals and weekly fee assignments for temporary facilities, small tool allotments, etc. Some inflationary costs can be avoided because of the shorter duration of design-build projects. Also, the amount of self-financing and margin coverage required by the contractor may be reduced because of the shorter duration and faster stream of payments. Nearly everyone who believed design-build construction costs to be lower mentioned one or both of these perceptions (change order reduction and time-related savings) as contributing factors.

The issue of risk allocation in design-build is a tricky one to make comparisons to the design-bid-build system. It was noted that on ROC-52, however, that at least one area of risk assignment probably helped to reduce cost growth and help lower costs from what they may have been otherwise. Upon parcel acquisition for the project, Mn/DOT was faced with numerous environmental considerations, including 79 existing buildings requiring asbestos removal and 15 more possible areas of environmental contaminations revealed by the environmental impact study. Rather than having the design-builder absorb this risk in their bid, the RFP allowed Mn/DOT to retain the risk and simply pay for the changes. Estimates from interviewees projected the cost savings from this decision to be as much as $4.5 million since most bidders would have included large contingencies for these unknown conditions.

It was suggested that design-build can offer significant cost savings in terms of contractor mobilization costs. Having a single design-build entity able to commit equipment and resources to a single large project may have saved money on the original bid, versus the original alternate plan of ten to fifteen separate job lettings over a span of many more years and likely several different contractors, each incurring mobilization costs.

An interesting area of cost reduction mentioned several times in the interviews involves the production of design packages that are “biddable” versus “buildable.” In design-build, because of the intensity of communication and planning between the design personnel and construction personnel, the level of detail required in design documents is reduced. The reduced number of drawings, details, and documents results in fewer hours of design and drafter time billed. The costs available from reduction in design detail are partly offset by the increased overtime required by the accelerated design schedule, but overall the interviewees seemed to believe cost savings from design were achievable. Several interviewees also commented on the difficulty that some Mn/DOT personnel had in accepting design documents that had less detail than they were accustomed to seeing on traditionally delivered projects.

Another issue related to design is the value of contractor input and the decision speed required of designers. Because of the faster pace of design build, the designer works under firm deadlines because the contract completion date covers both design and construction (unlike traditionally procured jobs). Also, the designers are using contractor input on material availability, efficient means and methods, and budgets to assist the design decisions. These two factors result in more efficient decision-making, with a reduction in the number of non-feasible options considered by the design team.

Reasons costs may be higher

Even though more people believed construction costs may be lower, several suggestions were given as to why they could be higher. Increased risk to the contractor was the most commonly mentioned reason construction costs may be higher. One individual from the contractor side of the project who had considerable past experience in design-build projects said that up-front construction costs are typically five to ten percent higher on design-build. Depending on the cost reduction experienced from the reduction in change orders on the project, the final figure for construction may come in higher if the project is contracted using design-build. He asserted this as one of many reasons why design-build can be advantageous on larger, more complex projects. In other words, first costs could be five to ten percent higher because of increased contractor risk, but savings from reductions in additive change orders may offset these costs.

Several interviewees discussed the processes for attaining quality on a project as one factor that could drive costs higher, particularly on ROC-52. Quality control (QC) on this project was maintained by ZRC, while the quality assurance (QA) responsibilities were retained by Mn/DOT in the form of an oversight consultant, HDR. There were some comments that the contractor added QC staff for the project that constituted an additional overhead expense in the original bid. At least two others saw contractor-QC and owner-QA as something of a duplication of efforts. Perceptions regarding the necessity of this are discussed later in this report, as are the other numerous issues surrounding the actual execution of quality control and quality assurance on ROC-52.

One person pointed out that added cost for the original bid on ROC-52 was for the design-builder’s handling of public relations and community outreach. ZRC handled public relations exclusively and through a single point of contact, which is certainly not typical of traditional projects. This provision could constitute an increase of the bid price compared to traditional delivery, but the value of this approach, as discussed in the disruptions to third parties section, is very high.

Reasons costs may be the same or ambiguous

There was a good deal of hesitation among the ROC-52 personnel interviewed to say construction costs were clearly higher or lower; many of those interviewed, including those who believed either higher or lower, conceded there is just no way to tell for sure. Opinions on how costs vary by the delivery system frequently come down to perceptions about how the systems themselves vary and how costs disparities in certain areas may be compensated for in other areas. Risk was the most often mentioned of these considerations, but there were several others.

Since risk is higher to the contractor on design-build projects, it is expected there is an adjustment in the bid compared to traditional that accounts for the increased exposure. A strength of design-build method is the greater flexibility it allows when allocating risk to the party most suited to accept it. During the planning phase of the project, Mn/DOT identified several key areas of risk and subsequently included related materials and data in the RFP.

The aforementioned environmental issues of asbestos abatement and contaminated sites are examples of how design-build can permit for a more effective risk allocation approach. Other areas of risk including quality and schedule, however, can be placed on the design-builder. The result is that risk is assigned so differently than in design-bid-build projects, first costs of construction and costs of changes are apt to be different. This change in risk assignment makes it difficult to make reasonable comparisons regarding construction costs between the traditional and design-build methods.

Summary

There is no way to say definitively if ROC-52's construction costs would have been higher or lower using a different delivery system. A general consensus, if anything, might be to say that up-front construction costs may have been greater because of the risk involved with the design-build approach, but that the cost for change orders is less. A number of the personnel cited the low rate of cost growth on the project as their primary reason for believing construction costs to be lower. More unclear, however, is how much of this is accounted for by risk considerations in first costs. Mn/DOT's retaining of environmental risk is one area where design-build delivery's risk allocation opportunities were successful, particularly from Mn/DOT's perspective.

The interviews gave dozens of intriguing and seemingly valid points about why choosing design-build could lead to either lower construction costs or higher ones. The most compelling points, however, seem to be the ones that suggest there is no way to tell how the costs for construction differ for the project versus how they would have been under the traditional system. There are enough differences in these contracting methods, most notably with risk allocation, that make it impossible to make a suitable or valid comparison. However, as more projects are completed with design-build procurement and delivery, the costs should decline because of contractor, consultant, and agency familiarity with the process.

3. Time

The discussion about project time impacts from design-build delivery is fairly one-sided when it comes to ROC-52. Perhaps the most widely recognized advantage of design-build, time is a performance parameter which was unanimously acknowledged as one of the primary reasons for its use on the project.

Original projections under design-bid-build had the scope of ROC-52 broken into as many as fifteen separate stages spanning more than eleven years to completion due to district funding restrictions. An aggressive schedule and significant reduction in time was of major importance on the project, driven by feedback received from the community and a joint Economic Impact Study by the City of Rochester and Mn/DOT's District 6. Once design-build materialized as the means for delivering the project, estimated construction time was reduced to five years from project letting in November of 2002 to the RFP required completion date of November 1, 2007. Actual construction time is anticipated to be less than three years.

As expected, all of those contacted for the ROC-52 case study said design-build delivery reduces the time for a project compared to traditional delivery.

Time reduction in design-build

There are several reasons, both apparent and less obvious, why project duration tends to be reduced when design-build delivery is used. The most commonly mentioned reason for why design-build can save time over the traditional process is the ability for design and construction to partially overlap. In design-build, this can effectively be a three-phase process: first, there is a period of design only when preliminary design considerations are addressed; second, preliminary construction activities get underway as some plan details are finalized, a final plan set has been released for construction, and all permits have been secured; third, construction only continues to completion after the plans have been finished (there are plans for what is being built as "release for construction"). Design-build allowed for construction to be ongoing at several locations simultaneously prior to 100% design completion.

Time savings can be realized from the fact that there are certain processes in highway construction which take a significant amount of time but which do not necessarily require a completed plan set. One ROC-52 manager gave the example that there does not need to be a completed and finalized set of plans for work to begin on removal of the existing road or preparation of subgrade for the new one.

Another commonly mentioned explanation for why design-build created time savings on ROC-52 was simply its enabling of a project of its size and scope. The preliminary estimate had the reconstruction of the US-52 corridor taking more than 11 years to complete under traditional practices, but was dramatically reduced to less than 3 years for actual construction. The process of letting the reconstruction as many separate projects rather than a single one would have been schedule prohibitive. Alternative funding vehicles, including Federal Advanced Construction and debt financing, which may not have been available under traditional funding limitations for District 6, made it possible to complete the ROC 52 project under a single design-build contract. ROC-52 simply could not have been funded by District 6 nor built in three to five years, if at all, under Mn/DOT's traditional design-bid-build system.

In the opinion of several of those interviewed, the design-build environment allows the contractor more flexibility to make changes to aspects such as construction scheduling and staging. Design-build is typically considered a method which allows construction specifications to be less prescriptive on how to actually execute processes and encourages builders to think more innovatively to save time and/or money while still meeting performance requirements.

Two managers representing the design-builder noted that the burden to maintain the schedule still lies in the hands of the contractors when scope changes occur, and this is also a factor in minimizing time. Not only do fewer change orders take place but, when they do, contract documents place the responsibility of meeting schedule requirements on the builder. Another individual involved with the design of ROC-52 stated that consultants to the project are also bound by the contractor's aggressive schedule, making the completion of their portion of work more urgent.

Design-build was also said to save time on highway projects because, more than any other contracting method, it promotes contractor involvement before the letting occurs. Once the design-build process was initiated and Request for Qualifications (RFQ) was issued for the project, four teams submitted Statements of Qualifications (SOQ) and all were included in Mn/DOT's "short list" of teams from which proposals would be accepted. After these steps were taken, the four proposing teams became involved in the process in a way that does not occur prior to letting of traditional jobs. Teams submitted Alternative Technical Concepts (ATCs) to the seven member ROC-52 Technical Review Committee for evaluation and acceptance, rejection, or conditional acceptance. The ATCs were incorporated into the final proposals as appropriate, and the Technical review Committee then scored the four teams' proposals.

Getting potential contractors involved earlier meant that Mn/DOT had more time to evaluate and approve innovations and, meanwhile, the contractor could have valuable interaction about the project with the owner. Both sides have a clearer idea of expectations earlier in the process, and this can favorably impact the builders' plan, including their ability to commit equipment and resources, to use innovative technologies to save time and money, and to use project construction methods that allow them to build the project as efficiently as possible. This process likely saved a considerable amount of time on ROC-52. One ATC that Zumbro River Constructors used on the project, the Mechanically Stabilized Earth (MSE) retaining walls, was said by personnel from both design-builder and Mn/DOT to have reduced the schedule by approximately one year.

A couple of managers involved in ROC-52 indicated that the nature of the plans themselves was a source of time savings. As one individual pointed out, design-build offers "more flexibility in the design document deliverable." The distinction between plans being "biddable" on a traditional job versus "buildable" on design-build projects is again a central point. In traditional delivery, the cost of design errors or conflicts is born by the owner. Therefore, the owner invests more in creating a comprehensive and thorough design in order to minimize the risk of design errors. In design-build, the cost of design errors and conflicts is born by the design-builder. Because the designer and builder are working together as a team, communication is more frequent and timely, so design conflicts can be resolved as design and planning progresses, since the cost is born by the design-builder regardless of the time of discovery. Therefore, construction can commence with a substantially reduced amount of design documentation and detail. This rationale is confirmed in our case study. Individuals from the contractor side of the project asserted that projects can be built to the expected level of quality and performance without the level of detail required in a traditional plan set. They believe design-build plans can be completed faster and with less emphasis on details, and still produce a finished product identical to traditional in less time. This is made possible by the intense communication between design personnel and construction personnel during early design phases.

Summary

Time is a performance criterion that is, without question, favorable under design-build. On ROC-52, time savings was a prime motivator for choosing that method of project delivery. All of the project personnel interviewed for this case study agreed that using design-build has facilitated a markedly quicker project, and the reasons for this acceleration are well documented. A considerable portion of the design and construction phases of design-build projects are able to take place simultaneously. Changes occur less frequently and can be reconciled more dynamically, as the risk and accountability for staying on schedule falls squarely on the design-builder. Design-build involves contractors in the process prior to letting, allowing them to explore time-saving options for construction, as evidenced by the ATC process on ROC-52.

From a time and schedule perspective, ROC-52 has been a rousing success. Using design-build along with non-traditional financing on the project can be credited with reducing the projected reconstruction timeline from more than a decade by traditional means down to less than three years. The project is currently on track to be completed in the fall of 2005, ahead of the original bid schedule by more than a year. Even the fact that the project took one year from when it was selected for design-build until the letting is a remarkable achievement. These accomplishments would not have been possible on the ROC-52 without the use of design-build delivery, and demonstrates its considerable power as a time saving tool on large highway construction projects.

4. Management Complexity

As a performance parameter to evaluate design-build, management complexity can encompass a wide array of issues. Managing any portion of the project can potentially bring challenges, whether it is during the stages of planning, procurement, design and engineering, preconstruction, or construction.

Those interviewed for the ROC-52 case study include many of the individuals responsible for managing the day-to-day execution of the project. The objective of this portion of the interviews was to identify what areas of the project brought the highest levels of management complexity. Based on their experiences with ROC-52, individuals were then asked to make comparisons regarding the level of difficulty in managing these roles on design-build projects relative to the traditional DOT delivery system. The responses addressed a range of project areas and issues, and they highlight some of the potential differences associated with managing projects which utilize the design-build method.

A total of nineteen individuals discussed management complexity on ROC-52. Of these, eleven stated that management of the project was at least somewhat more complex than what would be expected of a traditional project of similar scope. The remaining interviewees believed the differences in management complexity to be unclear, ambiguous, or impossible to compare.

Areas of complexity

One of the first and possibly the most fundamental of reasons why several believed design-build projects present a higher level of managerial challenges is simply the newness of the system. This being Mn/DOT's first best-value design-build highway project meant that from the onset of the project, new processes were developed and used. At the start of the project, a new approach to accepting and evaluating proposals for ROC-52 was implemented, and included such new considerations as short-listing teams, instituting the Alternative Technical Concepts process, and using the best-value approach to evaluating the proposals differently than traditional projects. As the project went on, different ways of integrating design and construction, relating to the public, and managing quality were among numerous notable departures from the traditional system. The newness of each of these different methods makes management responsibilities more challenging because, as one interviewee put it, it represents a full "culture shift."

A point of management complexity that was mentioned by individuals from both the contractor and the DOT side of the project was the role and authority of the project managers themselves. Both sides asserted that design-build project managers must be given the authority and trust by their respective agencies to make decisive judgments about issues that arise. By all accounts from those involved, this generally seems to have been handled well on ROC-52. Project managers representing both sides were given the power to make decisions about project issues without requiring escalation to greater levels of management. The belief was expressed more than once that the people in charge at the project level have an ideal combination of specific project knowledge and professional experience and skill, and therefore need to be relied upon to make decisions; in design-build projects where time is such a critical factor, swift and decisive problem resolution is essential to keeping things moving forward.

Along with allowing project mangers the authority to be decisive, several interviewees commented on the importance of actually having an experienced and competent person in that role. The significance of good project management was mentioned by at least three people, each of whom noted that some of the complexity of managing design-build comes from the inability to find project managers with higher levels of experience and skill and the conceptual thinking and teamwork skills required. One individual with previous design-build experience stated that many "regular" project managers who have experience with traditional projects may not necessarily understand the complexity involved in design-build. Again, the statements of those interviewed suggest the project managers on ROC-52 have been highly competent and have performed well.

A very notable complexity with the ROC-52 project relates to DOT staffing needs during and after the project. A project of such a large scale places greater personnel needs on Mn/DOT. Numerous Mn/DOT personnel with high levels of experience and knowledge needed to be realigned to key roles on the project or in support of ROC-52, while others needed to be hired to fill additional project positions or to supplement those who had been moved. As a result, difficulty arises with balancing Mn/DOT's long-term staffing needs with short-term need on ROC-52. Staffing for the regular program of design, construction, and maintenance is still required; positions have needed to be filled both on the project and off. It becomes difficult to determine what future staffing needs will be once the project is complete, and how to integrate project personnel back into regular positions. Some permanent positions are filled by a "placeholder" until the regular employee returns from the project. In other cases, some of Mn/DOT's engineering staff on ROC-52 may not necessarily know where they will be assigned once the project is completed.

A few other suggestions for why management of ROC-52 was more challenging were offered, but may be better categorized as project-specific rather than related to delivery method. Some of these included utility relocation, maintaining emergency routes to the Mayo Clinic and hospitals, construction sequencing, and traffic control. These issues may have been particularly challenging on ROC-52, but it is unclear whether it's because of design-build delivery, or simply because it was a major reconstruction project through an urban corridor.

Ambiguous reasons

The central reason for why many felt uncertain as to whether ROC-52 brought increased management complexity as a design-build project was the difficulty in separating the complexity of the delivery system from the complexity of the project itself. Multiple people expressed the opinion that complexity is more a function of the specific project rather than an issue of traditional versus design-build delivery. The project or projects that would've comprised ROC-52 under the traditional system would have likely shared many of the same complexities, such as large-scale urban reconstruction, complicated staging scenarios, difficult traffic maintenance requirements, as well as many of the same coordination issues with right-of-way, utilities, or environmental concerns. These issues are in no way exclusive to design-build.

Summary

The absence of a single person who believed design-build projects to be simpler to manage than traditional equivalents is a strong indicator that, at least at this point, the design-build process brings more challenges. At least some of the additional complexity must be attributed to the newness of the process, a retooled approach to procurement, greater levels of complexity and integration in scheduling design and construction, and having to change roles and responsibilities on the project. However, the management complexity of a project likely has much to do with the nature of the project itself, in addition to the way it is delivered. The fact that ROC-52 and other such large and complicated projects tend to be the ones that become candidates for design-build delivery should obscure the complexity that some attribute strictly to the delivery method. Overall, ROC-52 was believed to have been somewhat more complicated to manage, partly because it was delivered design-build, and partly because it is a large and challenging project, regardless of the delivery system.

5. Disruptions to Third Parties

The discussion of how a major highway construction project impacts the surrounding people and businesses is of great importance. A project such as ROC-52 obviously cannot occur without having enormous effects on many parts of the community. Businesses, residential neighborhoods, schools, and churches are among the third parties whose routines are subject to disturbances from the construction.

The objective of this performance criterion is to determine how disruptions to third parties may be different, either greater or less, under the design-build system. Of seventeen interviewees who offered a view regarding third party disruptions, fifteen stated that disruptions during the Highway 52 reconstruction were less because of design-build. The remaining two respondents were uncertain or believed disruptions to be no different than they would otherwise have been under traditional contracting practices. No one believed disruptions to the community to be greater under design-build delivery.

Reasons disruptions are less under design-build

The greatest reduction in disruptions to third parties is directly related to the shortened duration of the project. Completing ROC 52 in three years, in lieu of eleven years, creates a much shorter duration of disruptions. Members of the local community seemed overwhelmingly supportive of a greater scope of disruption over a much shorter duration. The shorter duration also resulted in a substantial lessening of economic hardships for businesses along the construction corridor. Mayo Clinic, a major generator of traffic along the corridor, appeared to be very pleased with the reduction in disruption.

Another frequently discussed reason why people believed disruptions to third parties to be less on ROC-52 was the handling of public relations. An incentive-based contract provision gave ZRC a huge PR role, making them the exclusive point of contact for the public over the life of the project. Although a provision of this extent is not typically included in the contract, even for design-build, many of those interviewed considered the way PR was conducted on ROC-52 to be a major success.

On traditional projects, as one person explained, “The DOT or the DOT’s consultant interacts with the public as a go-between with the contractor.” On ROC-52, the design-builder had direct contact with the public, an arrangement that was believed to be advantageous for several reasons. First, the direct interaction eliminates any delay or confusion that occurs from the public-DOT-contractor communication relay. Second, having a single and exclusive

PR point of contact, as ZRC did, greatly reduces any mixed messages or contradictory information that could occur if PR duties were shared in any way. Finally, having direct contact with the public forces the contractor to a different level of accountability. With no buffering organization, the design-builder has direct responsibility to maintain its own good reputation by being responsive to the public's concerns. Several individuals expressed the opinion that the design-builder acts with a greater sense of urgency this way.

The use of multiple media outlets to provide comprehensive and up-to-date travel information was also considered valuable. The contractor made use of local television and radio outlets, as well as a project website, and a "1-800" project phone line as well. The public has been kept current on the status of the project, as well as any ramp closures and detour routes that may affect travel.

Disruptions to third parties were also believed to be reduced greatly by having a shorter overall project lifespan. The period of disruption is much shorter versus what it would have been under the original design-bid-build plan. One individual noted that the public probably perceived any disruptions much more favorably on ROC-52 because their expectations for disruptions were so much worse.

On construction of the project itself, design-build was said to have given the contractor more flexibility to minimize disruptions by making it easier to make changes to plans and processes. Scheduling of construction activities, detour routes, and traffic control were just a few notable areas where changes were made to accommodate the public. Some of the following examples show how this flexibility was used advantageously by the contractor.

Anecdotal examples
Perhaps the best way to illustrate the contractor's ability to minimize disruptions to the community is to consider some specific instances of how this was done on ROC-52. A few of the ROC-52 managers shared actual stories to show how the PR arrangement on the project either prompted or enabled the design-builder to be uncommonly responsive to the public's concerns.

In some cases, the contractor made concessions to local institutions beyond what would be expected on traditional projects. ZRC made what was said to be an atypical effort to accommodate an elementary school near the 6th Street bridge in the central region of the project. ZRC worked closely with the Rochester School District to coordinate its period of closure to minimize the effect to Folwell Elementary School. They altered their schedule to open six to ten months ahead of the original plan, erected a temporary pedestrian bridge, and paid the school district for additional busing needs arising from the construction. Similar concessions were made to the Mayo Clinic to construct and maintain a temporary 2nd Street bridge until the new one was completed.

In another example, on Halloween, parents from the neighborhoods around the 2nd Street and 6th Street overpasses raised concerns about the scheduled 8:00 PM demolition of the two bridges. The parents said that their children would be trick-or-treating after 8 PM in neighborhoods on the other side of Highway 52 and were counting on the bridges to get back home. The contractor responded by delaying the demolition until 10:00 PM that evening to accommodate these families. The contractor's direct interaction and greater accountability to the public was believed to have been a significant factor in their willingness to change the schedule of a demolition event to oblige a relatively small group of residents on Halloween.

In another instance, ZRC's construction work on a frontage road in the corridor prompted a call from a Mayo Clinic doctor who normally worked the late night shift at the hospital and slept at her apartment during the day. Once construction was underway the noise from trucks and equipment were preventing her from sleeping. The contractor's response to the complaint was generous and decisive; they changed the haul routes of the trucks and directed noise away from the doctor's apartment complex. Two of the managers interviewed, including one from the DOT, acknowledged that type of change would not have occurred if Mn/DOT had been handling the PR responsibilities as in traditional projects.

This final example shows the extent to which the contractor has been willing to go to minimize disruptions to the lives of people of the community, altering haul routes to accommodate just one person. In each of these cases, the differences that occur in design-build—particularly how interaction with the public was handled—encouraged the contractor to make a greater effort to reduce disruptions to those affected by ROC-52 construction.

Summary

An overwhelming number of case study participants (15/17) believed that disruptions to third parties were less on ROC-52 as a result of design-build. The other two saw disruptions to be the same under either delivery methods; no one believed third party disruptions to greater on ROC-52. The decision to have the design-builder have complete and singular responsibility for public relations on the project was considered by most to be highly successful. Although not typical on traditional projects, and not necessarily common even to design-build, having incentive-based PR should be considered a worthwhile contract provision. It eliminates the possibility of contradictory information from multiple sources, and expedites the communication process. Moreover, it holds the design-builder more directly accountable to the public than having Mn/DOT relay information or concerns between the public and contractor as on traditional projects.

6. Road User Costs

RUCs are incurred by motorists as a result of construction projects. The determination of RUC puts a value on driver travel time, delays, accidents, additional vehicle mileage from detour routes, and other factors.

The case study interviews addressed qualitative impressions about how design-build impacts RUC. Questions addressed the sources of RUC and how they might be different if the project had utilized the traditional delivery method rather than design-build. Many of the individuals interviewed did not have sufficient knowledge of or did not feel able to comment about RUC. Six people believed RUC to be reduced as a result of design-build; five said they were either the same, or that the impact on RUC from delivery method was unclear.

Reasons road user costs were lower

The primary reason that respondents gave for lower RUC had to do with markedly shorter durations of the project. The logic was that RUCs are function of the amount of time that detours and traffic delays are in-place, and that faster construction schedules reduce the amount of time that road users face delays and detours. Therefore, RUC must be lower.

Another factor mentioned as a reason for lower RUC is the coordination of design, construction, related work (utilities, environmental abatement, etc.) and maintenance of traffic issues. Having a single point of responsibility for all of these activities reduced the chances of miscommunication and “dead spots” in work zones where detours are up but no work is progressing because of miscommunication or lack of task coordination.

Reasons for same or unrelated road user costs

The respondents who indicated that RUC would be the same for design-build and for traditional delivery, and those who said RUCs were unrelated to delivery method, believed that RUC spiked up under design-build because of the increased intensity of activity over a shorter time period and across the entire construction zone. In traditional delivery, you would have RUC for longer durations, but the daily disruptions would be lower, and they would be confined to the segment or phase of work currently under construction in the typical start-to-end sequencing used in traditional delivery. In other words, these respondents believed that the RUC were the same in aggregate, but were experienced over a shorter time in design-build. Several respondents who believed RUC were similar did acknowledge that the traveling public probably **perceives** less disruption because of the speed of construction.

Although not considered a road user cost in a quantitative sense, construction work zones represent the most dangerous places for construction workers and drivers. The shorter project duration reduces the risk exposure of workers and drivers, which is a qualitative factor to be considered in analyzing the performance of design-build.

Summary

There appeared to be some confusion among the interviewees regarding road user costs. The fact that only eleven of the nineteen project interviewees gave clear responses to the question provides some evidence that many of the project participants may not have had a sufficient enough understanding of the concept of road user costs to provide meaningful answers to this question. Also, some of the respondents’ answers appear intended to reflect the perception of road users, while others were intended to address actual road user costs.

Since ROC 52 was constructed using simultaneous construction in three segments, as opposed to sequential end-to-end construction typical of traditional design-bid-build projects, it is probably true that **daily** road user costs were higher on any given day of construction for ROC 52 than they would have been if ROC 52 had been constructed sequentially under design-bid-build. It is also probably true that road user costs are insignificant during the design phase of the traditional delivery, so some portion of the total project life under traditional delivery would have very reduced road user costs compared to design-build. However, it is certainly true that there are significantly fewer days of accumulated road users’ costs on design-build projects.

The case study was not intended to perform a quantitative analysis on daily and total road user costs, so no definitive statements can be issued. Nevertheless, the qualitative data from the case study appears to clearly indicate that the perception of the road users was favorable. In other words, the road users' perception of lower costs is an important aspect to consider in the use of design-build.

7. Quality of Project

Quality as a performance parameter is of great importance to ROC-52. Over the course of the case study interviews, quality emerged as possibly the biggest and most contentious issue during the construction phase of the project. In general, quality refers to workmanship and performance of the final product and how these factors compare to the owner's expectations. A great deal of the discussion about quality was focused on the processes by which it has been achieved on ROC-52. The questions raised about quality during the interviews were not focused on project quality or workmanship, but rather confusion over the processes of quality control and quality assurance.

As the interviews revealed, there is little doubt ROC-52 is a project of good quality. When asked about quality, seven interviewees said quality was better on ROC-52 than they would expect on a traditional project of the same scope. Ten respondents said that quality was either the same as for traditional projects or that a difference in quality could not be based on delivery method. Two respondents were unable to comment on quality issues.

Reasons for better quality

Several reasons were offered for why quality on ROC-52 is superior. Several respondents believed quality to be better on ROC-52 because the contractors tend to put their best and most experienced personnel on the design-build projects. This was said to be true because design-build projects frequently tend to be higher-profile, higher risk, and of greater dollar value. One individual from the contractor side of the project said that design-build contractors need to deliver a quality project and that it was in their best interest to deliver quality to survive and succeed in this side of the industry. Because best-value design-build projects may put a greater emphasis on quality rather than focusing exclusively on the bottom line low bid, it is more important for design-builders to have a reputation for producing quality projects.

Some said that redundancy of quality processes on ROC-52 has helped create a higher quality project. The project was unlike the traditional system where processes to guarantee quality are reserved to the DOT. With the contractor handling quality control responsibilities, and HDR serving as Mn/DOT's oversight consultant responsible for quality assurance, there was a belief by some personnel that twice as many eyes were present to help guarantee material and process specifications were met.

There were a number of people who said that quality was better on the project than would occur under traditional processes, but that the greater quality was attributable to the specific contractor rather than any factor related to delivery method. At least two individuals who represented the other organizations in the case study interviews credited ZRC as the source of better quality on the project, not necessarily because of the system of delivery. In fact, many believed the systems for quality to be problematic or contentious, as discussed in the next sections.

Other explanations for perceived improved quality on ROC-52 were given. One individual involved in quality said that the actual materials used on ROC-52 were superior to most other projects, specifically mentioning higher quality aggregate, sand, and granular material. One said the quality of the plans was better, although this may seem to contradict the general belief that plans for design-build projects need not be as complete or letter-perfect as expected on traditional projects. Another individual referred to the extended testing database as an indicator of better quality on ROC-52; the rate of failed materials tests on ROC-52 compares favorably to most other projects.

Reasons for same or ambiguous quality
Most of the interviewees believed that product quality and workmanship on ROC 52 would have been the same regardless of delivery process used to procure the work. Several comments were offered that product quality has more to do with the capabilities and commitment of the contractor and Mn/DOT field inspectors than with contract method. On ROC 52, the participants generally had praise for both the designer-builder and Mn/DOT/HDR personnel on the project regarding their understanding of and commitment to quality workmanship.

Several participants in the case study interviews also mentioned the rigorous standards in place for road construction when Federal funding is used as well as the well-developed standards of Mn/DOT. These comments were interpreted to mean that both the Federal DOT and Mn/DOT, and their respective research agencies, had accumulated a large body of knowledge regarding what constitutes acceptable material and performance and, therefore, disputes over whether a section of work constituted acceptable quality were virtually non-existent. The existence of these well-defined, clearly communicated standards make quality independent of contract method.

Problem areas in quality processes
As mentioned earlier, most of the problems associated with quality were with process (not product, material, or workmanship) and came as a result of confusion over decision-making authority and responsibilities for quality issues between the design-builder and Mn/DOT/HDR. One example given involved excessive clay in a subgrade fill material. The HDR oversight representative responsible for QA noted the excessive clay and informed the field representative of the design-builder that the fill material was not acceptable. This QA function is appropriate. However, the QA representative then told the design-builder to halt all incoming trucks from the borrow site and stop work on that section of the roadway. This extends beyond the authority of a QA oversight field representative. The remedy of the quality failure is the responsibility of the design-builder, and they have the authority to determine the method of correction. In the case mentioned above, there were several dozen trucks in queue from the borrow site, and returning the material and shutting down work until

a new borrow site was located would have had serious cost and schedule implications for the design-builder. In this situation a different solution to the problem was devised, but not without some difficulties in establishing authority.

Many of the interviewees mentioned that duplication of effort in the quality process led to inefficient resource utilization on the project. No specific examples were given, but the nature of the discussions seemed to imply that there was too much oversight in the field and too much redundancy in the system. Also, the use of prescriptive specifications was inconsistent with design-build quality processes, which focus more on performance outcomes. The use of prescriptive specifications is discussed more in the section on innovation.

Summary

Overall, the participants in the case study interviews believed that most of the problems associated with quality processes were a result of the newness of the design-build process, and that the situation would improve as Mn/DOT personnel and the design-builders became more familiar with design-build delivery. In fact, several respondents commented that the quality process issues improved substantially over the course of the ROC 52 project, and several Mn/DOT personnel commented that many of the lessons learned had been implemented on two subsequent design-build projects in the Twin City metropolitan area.

Design-build procurement allows for contract award on parameters other than low price. This type of change in procurement allows for quality to be considered as a relevant performance parameter, with both positive and negative consequences for the builder if quality requirements are not met. Any procurement system that does not factor in quality of past performance in determining qualification to bid future projects is flawed.

Changes in the quality assurance and quality control process will require some changes in organizational culture. Nevertheless, the move toward contractor responsibility for quality has sound rationale. There are very few industries where the owner is contractually responsible for quality, and placing contractual responsibility for quality on the construction contractor would put transportation projects on similar ground as the commercial building sector of the construction industry along with most other service and manufacturing industries. There will be some growing pains and discomfort with this change, but there is a value in the future from making the change now. The shift to contractor responsibility for QA/QC also fits well with any future use of multi-parameter (A+B+C) contracting letting in the future. As contractors are made increasingly responsible for quality, many of them will use quality reputations and customer satisfaction as an important sales tool in the future**.**

8. Funding Flexibility

Funding issues and related legislative and judicial matters were the most complicated issues to understand in the case study. A majority of respondents stated that they did not have sufficient knowledge of the situation to comment on funding issues involved in the use of design-build. Nevertheless, interviews with District 6 office personnel and DOT leaders in St. Paul proved very beneficial to our understanding of funding issues.

Innovative funding first, then innovative contracting
Perhaps the most recurring theme from the interviews regarding funding issues was the focus on revolutionary change in the approach to financing transportation infrastructure. As one interviewee put it, “You can’t have innovative contracting without innovative funding; they go hand-in-hand.” The cornerstone of the innovative funding program was the 2003 Bond Acceleration Program that pumped four hundred million into construction projects in Minnesota under the Trunk Highway Bonding Authority. The four hundred million in debt financing along with an additional four hundred million in Federal Advanced Construction authority allowed the state to accelerate trunk highway improvements throughout the state. The net result was funding of twelve major highway projects scheduled to be delivered more than sixty years ahead of their original schedules.

Change acceleration to advanced throughout
The nuances of transportation program financing exceed the scope of this report. Nevertheless, some of the consequences of the decision to accelerate construction are the reduction of federal funds for additional projects through 2009. The state of Minnesota has made extensive use of federal advanced funds available under current federal policies. Another consequence is the reduction of cash balances to a projected low point of eighty to ninety million compared to a historic low cash balance of one hundred, seventy-one million. The reduction in cash balances is created by some of the idiosyncrasies of the Federal Advanced Construction (FAC) program. Under the FAC program, expenditures are not reimbursed with federal funds within the normal 3-7 days for conventional federal aid projects. This delay in receipts may put a strain on cash reserves for major projects. Generally, FAC fund reimbursements should be converted to revenues in the same relative period as project expenditures occur. ROC 52, which was let prior to the finalization of the bond acceleration program, however, was intended to be converted over several years and placed a major strain on the Trunk Highway fund balance in the state, reducing the fund by fifty million in FY2004 and another forty-two million in FY2005.

The Warne report specifically points out ROC-52 as one of the projects where innovative funding (i.e., "window of opportunity") issues were a major contributor to the decision to use design-build. Because of the strain on cash flows created by accelerated construction projects such as ROC 52, Mn/DOT developed the Cash Forecasting Information Tool (CFIT), which will enable Mn/DOT to better forecast and analyze the department’s cash flow. Greater sophistication in fund management is one of the ancillary benefits of the use of design-build for ROC 52. Other improvements have been made to accounting, procurement, program and project management systems, and project information and document controls. As a result of the increased sophistication in management, Minnesota became the first state to prescribe maximum monthly draw amounts on an accelerated construction project for transportation (Highway 212, design/build).

In short, speeding up construction under a design-build delivery system will put strain on a department’s cash fund balances, and requires careful analysis of funding options to minimize interest expenses and forecast projected cash balances.

Impact of accelerated construction and debt financing on operations
Several interviewees noted that the transportation demands of the state required a new philosophy about planning, executing, and funding projects. There are, however, many unknowns yet to be worked out regarding how district and central office operations will be affected by the increased use of design-build and other accelerated construction methods.

Many of the projects that lend themselves well to design-build delivery and, thus, to the use of accelerated funding, are found in the metropolitan area. This finding raised a concern among legislators representing areas from outside of Minneapolis and St. Paul that a substantial majority of the trunk highway bond authority proceeds would be spent in the metropolitan area, so they placed language in the enabling legislation creating an expectation that fifty percent of the bond proceeds would be spent outside the metropolitan area. This demand for equity spending puts pressure on DOT leaders to balance pragmatic program needs with political realities. Since design-build delivery represents a blurring of traditional distinctions between operational and capital budgets, the state DOT leaders must continue to educate legislatures, the public, and the construction industry on the use of design-build.

Since more of the traditional internal "operational issues," such as design, quality control, some inspections, public relations, etc. are included in the contract with the design-builder, the capital budgets and operational budgets need to be reconciled. The state is still working out the staffing issues created by this dilemma. Based on current revenues, the construction program in District 6 will be smaller in future years because of the need to pay for the acceleration of ROC 52, and the process for re-entry to operating lines of district personnel who had been moved to project budget lines is uncertain. There is a concern that maintenance and preservation programs in District 6 could suffer as a result of the acceleration of ROC 52. Mn/DOT also has collective bargaining agreements with five separate unions, and there is some animosity over the restructuring of program funding.

Local contractors have some concerns about their ability to compete for large scale projects, and DBE firms appear particularly unaware of how to compete for opportunities in design-build environments. At the other end of the spectrum, the culture at FHWA needs to change as well to bring design-build to its full potential. The increasing use of performance specifications and a move away from the long-established methods and culture at FHWA may be required before the full potential of design-build can be realized. Introducing innovative processes in a conservative culture, such as that typically found at engineering-dominated organizations, can be a long-term process. Special training and development of new protocols will be required. Some interviewees were of the opinion that separate divisions within the federal and state government may be required to perform design-build projects because the process is so foreign to those who have only done projects "the way we've always done things." As one respondent put it, "The guys who built the original interstate system are still around, and they think the old way worked well and don't have a sense of urgency to do anything differently."

Another point raised about funding issues was the certainty of funding that comes from innovative funding options. If ROC 52 had been constructed in phases over eleven years, as originally proposed, the project would have been ongoing over as many as five different legislatures and budget cycles, each one occurring under potentially difficult economic conditions and inflationary cycles. The use of accelerated funding mechanisms reduced the uncertainty of continuing funding and decreased the threat of inflationary pressures on end-phases of the project.

Summary

In summary, the funding issues are complex and some of the staffing issues created by the use of accelerated funding and debt financing have yet to be resolved. The culture change required at several levels to maximize the potential of design-build is slow to develop, but the tremendous opportunities for reduced impacts on the public and dramatically reduced project time make design-build a "must-do" for certain types of projects. The use of innovative funding goes hand-in-hand with innovative contracting, but requires concurrent improvements in cash forecasting systems, internal cost controls, and human resource management issues.

9. Innovation

The respondents were unanimous in their opinion that the use of design-build led to more innovation on the ROC 52 project than would have been possible under traditional delivery. In particular, the method used for submittal, review, and approval of Alternative Technical Concepts (ATC) was particularly beneficial on the ROC 52 project. Several improvements in efficiency and reductions in cost, schedule, or third-part impact were made possible through the introduction of ATCs by the design-builder.

One of the unique and advantageous aspects of the design-build process on ROC-52 was the Alternate Technical Concept (ATC). Initially during the RFP phase, the four teams preparing ROC-52 proposals viewed Mn/DOT's specifications for the project as overly restrictive for the design-build environment. The teams, based on their experience with other design-build projects highway projects, had come to expect specifications which were less prescriptive and more "performance-based." The fundamental difference between prescriptive and performance-based specifications is that the former essentially tells the contractor "how to do it," while the latter allows flexibility and innovation in the way of materials, methods, and systems, as long as required end results are met.

Mn/DOT considered the sentiments of the four proposing teams regarding the lack of innovation allowed under the initial RFP. Mn/DOT's ROC-52 project team looked at how other state transportation agencies had addressed this issue on design-build projects. Typically on these projects, an innovative concept would be presented by a proposing party, reviewed by the owner, and if accepted, the concept would be shared with all proposing teams. Mn/DOT chose to take a different approach to this part of the process, since the belief was held that sharing the accepted innovative concepts between teams removed the incentive and economic advantage for each team to develop them. Instead, teams were permitted to submit new concepts to satisfy the RFP's performance requirements, but these ATCs were kept confidential prior to letting. There were also four project areas Mn/DOT determined to have specific requirements that would not be conducive to ATC submittals—right-of-way, ITS, pavement structure, and aesthetics. ATCs were not considered in these four areas.

The four proposing teams were allowed up to five meetings with Mn/DOT project staff to discuss ideas and obtain feedback. The teams were welcomed to submit ATCs for review, upon which Mn/DOT would decide to accept, conditionally accept, or reject the proposed ATC. Overall, 100 ATCs were received from the four teams. Of these, nine were accepted and thirty-nine were conditionally accepted. The topics covered in the ATC submittals were varied, but the most common were said to include roadway geometrics, walls and bridges, and maintenance of traffic.

Upon awarding ROC-52 to Zumbro River Constructors, a stipend was offered to the three unsuccessful teams for their efforts. As a provision of the stipend, the ATCs contained in the technical proposals of the non-winning teams would become property of Mn/DOT. Mn/DOT could then negotiate with ZRC regarding their use on the project. All three unsuccessful teams accepted the stipend offer, and several of their ATCs were implemented on the project.

ZRC claims to have reduced their bid price by nearly $4 million by being allowed to use ATCs on ROC-52. The most significant ATC in terms of savings was the use of different wall systems, particularly mechanically stabilized earth (MSE) retaining walls, which replaced the more costly and time-consuming cast-in-place cantilevered wall included in the original RFP requirements. This change alone was said by ZRC to have reduced the schedule by one year and generated a cost savings in addition to the $4 million already mentioned. Other successful ATCs allowed for the use of rock-cut material as median fill on the south end of the project, flexible traffic maintenance plans through the entire corridor, and a change in alignment to facilitate construction of the complicated interchange at US Highway 14.

The use of more performance-based specifications is important to the design-build process because it can open the door to innovations that can save time and money. The primary concern may be making sure that the owner's expectations are clear. As one official put it, "the owner may be expecting a Mercedes-Benz, while the contractor sees a Volkswagen." The ATC process used on ROC-52 worked to minimize these types of problems by getting both sides involved in meetings and discussion during the RFP phase, having a structured procedure for approving or conditionally approving the ATCs, and having areas of the project that were off-limits to ATCs. Still, performance-based specifications are appropriate for many situations, and it is important for Mn/DOT officials to realize their high level of importance to the success of projects such as this one. The ability of the contractor to use innovative concepts and have more flexibility is *essential* to design-build projects, and the team seems united in their belief that the ATC process was successful on ROC-52.

In addition to using ATCs to promote innovation, the procurement process used for selection can add value to the project. Each design-build team proposing on the project will have a slightly different approach to the design, construction and management of the project. By using a "best value" selection process, the best ideas can be evaluated quantitatively into the award process. Best value selection could technically be used with any contract type (multi-parameter bidding), but probably lends itself best to design-build because of the ability to incorporate both design and construction innovations into the selection process.

One area of modest frustration expressed by several interviewees had to do with the use of specifications that were deemed to be too prescriptive in nature. Several respondents stated that the full potential for innovation under design-build was thwarted by the inclusion of overly-prescriptive specifications in the bid documents. A greater reliance on performance specifications would allow the design-builder more flexibility to introduce more innovative designs and construction methods into the project.

Along with the change to more performance specifications, some interviewees stated that some personnel in the DOT were reluctant to consider new ways of doing things. They argued that a change in culture within certain parts of the DOT was required if the innovative power of design-build was going to be used to its full potential.

Summary

The case study participants were nearly unanimous in their opinion that the use of design-build led to greater innovation on ROC 52 than would have been possible if the project had been delivered using the traditional contracting method.

Conclusions from ROC 52 Case Study

The unqualified successes on the ROC 52 project include the public relations management function, the reduction in third party disruptions, the use of co-located project teams, the substantial reduction in overall project time, and the introduction of innovative design concepts into the project at early stages of construction planning.

The Warne report (10) obviously bears a high level of significance for the research reported here, since ROC 52 was one of the 21 projects reviewed. Furthermore, the general findings regarding design-build on all of the projects were consistent with the findings of this specific case study on ROC-52. Schedule and funding were major contributors to the decision to the decision to make ROC-52 a design-build project, as they were with other projects in the study. Warne notes that comparisons of first costs of design-build vs. design-bid-build are, at best, very difficult because of numerous factors. However, cost growth rates on design-build are clearly minimized compared to the rates typical of traditional projects.

Many of the processes and themes in design-build implementation that arose on ROC-52 also came up on the other projects. The responsibilities of QC and QA on ROC-52 were handled in the same way as the majority of design-build projects in the Warne study. The ROC-52 project was like several others which offered a stipend to compensate unsuccessful bidders for their efforts, although it was the only one to pay as a percentage (0.2%) of the engineer's estimate rather than the winning bid amount. Overall, Warne's report seems to confirm that the motivations, processes, and results associated with the use of design-build project delivery on highway projects nationwide are consistent with the findings on ROC-52.

The research program as implemented was unable to determine with any certainty whether construction costs and administrative costs were substantially different for ROC 52 under design-build delivery than they would have been under traditional delivery. There are too many variables between projects to allow for a meaningful comparison. Risk allocation, market conditions, weather, and project elements are substantially different for every major project making quantitative comparison problematic. However, it seems clear that Mn/DOT was able to more effectively manage risk through the use of design-build on ROC 52 because there was very little cost growth and the anticipated environmental remediation costs were well managed.

Some of the issues on ROC 52 that suggest a need for improved processes and procedures include the quality assurance/ quality control processes, a greater need for use of performance-based specifications, and a change of perception toward “buildable” sets of documents instead of the biddable documents found on traditional projects, a need for greater awareness of the different processes for design-build for all involved parties (DOT, cities, counties, utilities, permitting agencies, contractors, etc.), and more training and selection of project managers with a goal of improved management of risk and complexity.

If an ongoing comparison of internal costs is desired, more costs will need to be captured by Mn/DOT. For example, overhead costs, facility costs, and senior-level salaries are not allocated to project budgets. To get any sense of “real” administrative costs on a project-by-project basis, the agency will have to identify a method for allocating these centralized costs. In order to facilitate this capability, Mn/DOT should consider adopting new types of internal cost systems and project cost tracking, such as treatment of district personnel issues (temporary assignments, maintenance, etc.), assignment of project financing costs (in present value), and project management protocols for information flow, control, and distribution.

Chapter 7
General Conclusions and Summary of Findings

A+B contracts received the highest effectiveness score for each of the project types, and the differences in mean effectiveness scores were statistically significant in all comparisons of A+B to other contract types except for major corridor realignment/expansion, where design-build mean effectiveness score was not statistically significantly different from A+B. These scoring results suggest that for all project types considered in this study, A+B contracts will create the greatest value when all relevant performance factors are considered. Of course, procurement protocols that do not allow for multi-attribute value consideration (e.g. low-bid awards) will not capture the optimum effectiveness of innovative contract methods.

From these results, it appears that A+B contracts should be considered for all projects, regardless of project type or critical performance factors. However, one of the concerns in using A+B contracts is the higher bid prices ("A" component) and higher internal costs to Mn/DOT. Our case study comparison did reveal higher bid prices compared to traditionally procured projects, but final cost of construction was comparable. However, the internal costs to the agency appear to be lower for A+B projects than for traditional projects. This may be because the intensity of the work is higher, but is offset by the shorter duration of the project. Another explanation is the additional investment in preconstruction coordination and planning that make construction more efficient.

A + B is cost competitive with other types of procurement. Both the exploratory study described in this report and a more thorough analysis by Mn/DOT of all A + B projects in Minnesota between 2000 and 2005 found no cost premium from the use of A + B contracting. Both studies also found significant reductions in project duration.

Often, state DOTs will include a second parameter with A+B bidding. This parameter is referred to as the I/O clause. This clause produces a reward for the contractor that finishes ahead of schedule and a penalty to the contractor that finishes behind schedule. The reward and the penalty is a set amount specified by the state, or an amount specified by agreement between the contractor and state. The purpose of the clause is to promote a completion date ahead of schedule. The I/O clause can be used on a variety of contract types beyond A+B contracts. The performance effectiveness of I/O clauses was not independently reviewed as part of this research project, but the influence of incentive and disincentive language is an important factor to consider when considering contract effectiveness issues. It seems apparent from our study that I/O clauses should be used in conjunction with A + B contracts, especially on projects with high RUCs or critical completion dates.

Another factor to consider in using A+B contracts, either with or without I/O clauses, is the "portfolio effect." It is possible that a contractor will have a portfolio of projects with varying contractual schedule requirements and corresponding incentives (e.g., bonus amount for early completion) and/or disincentives (e.g., amount of liquidated damages per day). Contractors may optimize their portfolio by diverting resources to the projects with the highest incentives, while intentionally accepting the penalty on another project with weak or no disincentive language.

The research team has only anecdotal evidence of this practice in the projects under review, but Mn/DOT should be aware of the possibility and plan contract methods and use of I/O clauses with a better understanding of contractor behavior.

Use of design-build contracting was found to be highly effective for urban projects of high complexity. Similarly to A + B with incentive, the increase in “intensity” could result in higher administrative costs for Mn/DOT, suggesting that design-build contracting is perhaps only warranted for complex, high-visibility, high traffic-volume projects. However, some of the cost increases could be offset by the shifting of traditional Mn/DOT tasks such as public relations, surveying, quality control, etc. to the design-builder. Again, our study was too exploratory and relied upon too few cases to allow us to draw any definitive conclusion. It is important to note that technically, design-build could be used for any project type.

Our study was useful in identifying the best practices for design-build as well as areas for improvement. Many of the best practices discovered in the review of design-build contracting can be transferred to other contracting methods and need not be considered unique to design-build.

For the ROC 52 project, the decision to designate all public relations responsibilities to a single point of contact within the design-builder’s organization was very efficient and beneficial. This practice could be transferred to other contracting methods as appropriate. However, it should be noted that the public relations consultant hired by the design-builder for ROC 52 was very familiar with Mn/DOT procedures, the local community, and the construction process. In addition, the contract with the design-builder contained specific incentive language related to public relations performance. The ability to identify and retain such highly qualified people may vary from location to location and project to project within the state, and the benefit of PR incentives may not be warranted on less visible projects. Nonetheless, assignment of public relations functions to the contractor could conceivably be used in A + B (with or without I/O) lane rental, or traditional contracting methods in addition to design-build projects. Such a process allows for minimization of third party disruptions and faster resolution of public concerns due to the simplification of communication hierarchies and alignment of responsibility, authority, and capability with one “organization.” Regardless of the contract specifics and staffing protocols, the essential lesson to keep in mind is that the best practice is one that promotes direct communication between the individuals responsible for field operations and those directly affected by those operations.

The risk allocation process used by Mn/DOT for ROC 52 was very successful and should be repeated as appropriate on other projects, regardless of the contracting method used. In particular, Mn/DOT should consider retaining the risk on unforeseen environmental conditions, as was done on ROC-52.

Co-location of design-builder (including contractor parties and design parties) with Mn/DOT project personnel and their representatives proved to be very successful and should be continued in the future whenever possible. In addition to the physical co-location, the delegation of decision-making authority and approvals to the project-level within Mn/DOT was a critical factor in improving the administrative processes for design-build contracting. Project-level authority is another "best practice" that can in many ways be transferred to projects using other contracting methods.

The most dramatic performance improvement from the use of design-build comes from time savings, but some of the potential time savings can be lost if complicating owner issues such as environmental remediation, ROW acquisition, and utility relocation are not managed effectively. The best practices identified in our study were to have the owner responsible for these areas of uncertainty. By clearly identifying known conditions and unknown conditions in the Request for Proposal, and also clearly identifying which project partner will be responsible for those conditions, the price proposals will contain less contingency money for uncertainties. In other words, responsibility for unknown conditions assumed by the owner creates an identifiable project risk profile for the design-build proposers, resulting in efficient best-value competition on performance parameters and not on which proposer used the lowest contingencies for unknown circumstances.

Another area where design-build contracting proved effective was in the area of innovation. Allowing designer-builders to bring their best creative efforts in front of Mn/DOT during the proposal process, along with cooperative problem solving during final design and construction, resulted in a number of innovative designs and processes. Many of these innovations can be shared with design professionals for incorporation on projects delivered under more traditional systems. One of the "unseen" benefits of design-build may be the open-system learning that such an approach to projects promotes within Mn/DOT.

One of the areas where some improvement was deemed necessary was in the area of quality processes. There was some confusion on the roles and responsibilities of the design-builder and for Mn/DOT for quality control and quality assurance. The process was resolved as the project progressed, and final project quality was excellent, but there was some confusion and misunderstanding early in the project. The philosophy of Mn/DOT should be to move toward the approach to quality used in most other industries, that of holding the builder responsible for assuring the quality of the project, rather than the owner. Reassigning responsibility for quality will require some change in the culture at Mn/DOT and among design-builders/contractors, but making contractors/design-builders responsible for quality is a trend in the transportation industry that is unlikely to be reversed, since transportation is currently the only industry that places quality control responsibilities on the owner. Subsequent design-build projects starting after our research program had much greater success with the quality program, and this practice should be continued. Continued development of a well trained workforce in the contractor labor force will take some time, as the shift of responsibility is a relatively recent occurrence. Another factor involved in the pace of cultural change regarding quality is the capabilities for state and federal DOTs to incorporate past quality performance or some other quality metric into project procurement processes.

One of the most difficult questions to address is whether total project costs are different for innovative contracts than for traditionally contracted projects. The exploratory nature of our study, along with the variability of project conditions, makes it impossible to state with any certainty whether costs are higher, lower, or similar for projects using innovative contracting. The small number of projects available for our study, as well as the differences between the available projects in terms of scope of work, location, bidding conditions, competitive environment, and I/O language make any comparisons exploratory at best. In addition, any differences discovered from current research may not be long lived because of the newness of innovative contracting. Any differences in administrative costs may suffer from learning curve biases and ill-fitting cost reporting structures. Learning curve bias is created by the newness of the process. For instance, because of unfamiliarity with the process, both the design-builder and Mn/DOT may be over-staffing or understaffing the project. Other areas of potential learning curve bias are the modification of processes, forms, and practices required for the initial design-build projects. Also, lack of familiarity with the process may be leading design-builders to include larger contingencies in their proposals. The costs and inefficiencies created by the need for modification will disappear as more and more design-build projects are completed. More and better information over a longer period of time is needed before any firm statement can be made regarding cost differences for the various forms of innovative contracting compared to traditional methods. However, some of the cost differences can be logically inferred, but the magnitude of the aggregate cost differences, if any, are difficult to quantify without carefully tracking specific costs on large numbers of comparable project types, which may be a practical impossibility in the near term.

For design-build versus traditional contracting, some of the internal cost differences can be identified, but not necessarily measured. For instance, it seems logical that Mn/DOT will incur higher costs for site inspections, quality monitoring, and other activities that are field-based because of the need for overtime and additional staffing compared to traditionally contracted jobs. Conversely, shorter overall project durations would tend to mitigate these field costs, so the net effect may be negligible. Additionally, the use of design-build shifts some costs to the contractor, such as surveying, public relations, and quality control/quality assurance. For A+B contracting with incentive, there may be more overtime for Mn/DOT field crews because of night and weekend work, but a project may be completed more efficiently (for instance, in a single construction season instead of two), reducing costs to field personnel. Currently, there is insufficient data to determine whether the net effect of these cost shifts results in an increase in internal costs, a decrease in internal costs, or no change in internal costs.

In addition to the findings of the research team, the FHWA's SEP-14 initiative for innovative contracting, design-build highway projects requires documentation of lessons learned in an effort to summarize critical experiences on the project and improve effectiveness the process in the future. In response to this requirement, the ROC 52 project team has developed a set of "lessons learned" that are beneficial to identifying the practices to retain and those needing improvement. Lessons Learned for ROC-52 are broken down into a series of four reports covering four phases of the project: Procurement, Post-Design, Construction, and Project Completion. As of the publication of this research report, the phase 1 lessons learned have been released to the public (http://www.dot.state.mn.us/designbuild/hiway52) and are summarized below.

ROC-52 Lessons Learned Report 1
Five major categories of the procurement phase are examined: Project Management, Contract Documents, Proposal Preparation, Proposal Evaluation, and Price Proposal Opening & Award. For each of the sections, the report details the highlights, advantages and disadvantages of the

course of action taken on ROC-52, as well as future recommendations based on the outcomes of this project.

Project Management

Major project management issues addressed in the report included staffing, resource commitments, and decision making. One of the most crucial measures was the development of a ROC-52 "Core Team" to help with decisions and resource commitments during the procurement phase. The Core Team included several senior representatives from Mn/DOT's District 6, the FHWA, and from Mn/DOT's oversight consultant, HDR. Members of the Core Team were functionally independent from pre-existing management assignments and were given authority to make many on-the-spot decisions at the project level. A key recommendation was that this team needs to be highly functional and capable of working well together. Also, the organizations represented by the Core Team need to trust the staff and grant independent authority to make project decisions within the design-build environment.

Contract Documents

To solicit the most qualified teams to manage and execute a complex design-build project like ROC-52, Mn/DOT issued a Request for Qualifications (RFQ). Mn/DOT then received Statements of Qualifications (SOQ) from proposers and evaluated their qualifications in order to establish a "short list" of design-builders from which proposals would be accepted. This was recommended in order to identify the most highly qualified teams, to reduce bid protests, and to minimize the costs of stipends to be paid to the non-winning teams. Use of a single point of contact between Mn/DOT and bidders was recommended due to the consistency of responses to questions that arose. The Request for Proposal (RFP) packages were distributed entirely in read-only, electronic file format, with some portions in hard copy format as well. Key recommendations for the RFP were a clear outline defining requirements and stating information only once to avoid any contradiction. Other important project issues addressed in contract documents were risk management, the use performance-based vs. prescriptive standards, and the development of the Alternative Technical Concept (ATC) process. These topics are discussed elsewhere in this report, and the Lessons Learned recommendations in these areas are consistent with those conclusions.

Proposal Preparation

As, mentioned the proposal process was composed of two phases, RFQ and RFP. This was considered advantageous because it eliminated unqualified proposers and established the short-list; a lone drawback was that it required some duplicated efforts and materials. The advantages of using electronic documents and materials were discussed. The issuing of addenda and clarifications in particular were made more expeditious using electronic communication and documentation. Each proposal maker was given the opportunity to meet with Mn/DOT in up to five one-on-one meetings. Mn/DOT and the proposers were "nearly unanimous" in their support for these meetings; it was a way to both answer questions and concerns clearly and decisively, and also a means to build communication, trust, and partnering between proposing teams and Mn/DOT. The payment of stipends to proposers also was seen as an advantageous decision because it emphasizes Mn/DOT's commitment to the project, it offers the potential to acquire additional ATCs, and helps defray the considerable preparation costs to the proposers.

Proposal Evaluation

The overall goal of Mn/DOT's proposal evaluation process was to select the design-builder that would provide the "Best Value" with respect to price, quality, time, professional project management, and other factors. Mn/DOT required each proposal be split in two components, once package containing the technical proposal and one containing the price proposal. All technical proposals were evaluated first, and price proposals were combined with technical scores upon their completion. The proposal review process was comprehensive and involved a Mn/DOT Technical Review Committee (TRC), technical subcommittees in specific interest areas, consultant technical advisors, and finally, Mn/DOT's Commissioner and Process Oversight Committee. Each of the eight TRC members scored the proposals individually, and scores were averaged equally to arrive at a composite number for each proposal. The technical proposals were evaluated on several pre-determined scoring criteria.

Price Proposal Opening & Award

The technical scores for the proposals were already determined at the time of bid opening; these scores were made public at the bid opening and entered into a project-specific score spreadsheet. Opened bids were then entered into the spreadsheet. ATCs were later opened and their associated bid deduction or addition was entered into the spreadsheet as well. Price was divided by technical score to determine the best value proposal. Official Notice to Proceed was issued to the successful "best value" bidder after execution of the contract, establishing the official project start date.

One of the most important factors to consider when interpreting and reviewing the findings of this research is the overall newness of the design-build process in Minnesota. The change in philosophy, culture, process, and systems required to maximize the benefit of design-build will come slowly. ROC 52, by all available evidence, was a very successful project. However, many of the findings and lessons from ROC 52 will be used to improve future design-build projects. In addition, because the ROC 52 project had such a high degree of innovation in so many different areas, many of the lessons learned can be transferred to other projects, processes, and systems outside of the design-build projects. Learning and development take time, and ROC 52 was a very important, very successful first step in that process. Many of the findings of the research team, and the recommendations that follow, may be attributed to the changes and newness of the process, and not necessarily attributed to the use of design-build *per se*.

Chapter 8
Recommendations

The original scope of this research study was to compare cost effectiveness of innovative and traditional contracting methods. After a review of emerging literature, however, and consultation with leading national authorities on innovative contracting, it became apparent that overall performance effectiveness comparisons were more appropriate than construction cost comparisons, for reasons discussed earlier in this report. Therefore, the research scope shifted to performance comparisons and development of a set of recommendations for Mn/DOT to use in improving innovative contracting processes as well as to determine directions for future research. This section summarizes recommendations generated from the results of this research project.

Recommendations for Design-Build

Developing internal "technology transfer" processes
The Alternative Technical Concept (ATC) process allows Mn/DOT to take greater advantage of the design-builder's innovation and skills, and can result in significant cost savings. In addition, the innovations and ideas gathered under the ATC process can be communicated within Mn/DOT for use on other projects regardless of contracting methods. Mn/DOT should consider developing internal "technology transfer" processes that allow for innovations discovered in design-build projects to be utilized on other projects using traditional design processes.

Considering performance-based specifications
Related to the use of ATCs is the incorporation of more performance-based specifications on design-build projects. Performance specifications promote innovation and institutional learning, which can then be transferred to other projects using prescriptive specifications. On designated projects (typically design-build), performance-based specifications should be considered if Mn/DOT wishes to take advantage of the potential for innovation offered by the design-build method of delivery. The use of performance based specifications is particularly appropriate for federal highway projects, where many of the designs and materials are defined by standards familiar to most designers and contractors in the industry.

Discerning "biddable" and "buildable"
Similar to performance specifications, the level of design detail required on design-build projects should be lower than for traditional projects. Mn/DOT personnel should receive training and education in design-build processes to better understand the distinction between "biddable" and "buildable" plans. A set of plans for a design-build highway project does not necessarily require the traditional level of comprehensiveness in order to be built. The reduced level of design detail is made possible by the intensity and frequency of direct communication between the designers and constructors on a design-build project.

Developing standard practices for defining QA/QC processes
Another area requiring ongoing communication, education and training is in the area of quality processes. Expectations and delegation of responsibilities for quality assurance and quality control processes must be clearly understood by all parties at the onset of construction, and

consequently they must be carried out according to plan. Mn/DOT should develop standard practices for defining QA/QC processes on innovative contracting projects. Mn/DOT and the construction industry should work together to develop qualified individuals in the contractor industry who will be available to take over quality control functions as they are shifted from Mn/DOT to the builder.

Paying stipends
Payment of a stipend to non-winning bidders is recommended for design-build projects. This practice represents an important way for the DOT to send a message to the design-build community that they appreciate the considerable effort of unsuccessful contractors. Compensating the unsuccessful teams for responsive and competitive bids is a way to make sure that several competent teams will go through the demanding process of bid preparation on future design-build projects.

Managing information
Another area of difference between design-build and traditional projects relates to information flow, control and distribution. For design-build, much of the information management and decision-making is decentralized, creating a project-based cost center to handle information flows that might ordinarily be handled through existing protocols within Mn/DOT. The creation, staffing, and capital cost of establishing an information management and document control center should be captured as a project cost.

Recommendations for A + B Contracting

Considering A + B for use on all projects
The results of our study suggest that A + B contracting is effective in determining the optimum balance between cost and schedule, and should be used on any project where Mn/DOT wishes to have contractor input on the most effective balance between speed and cost. The results of the national survey suggest that when multiple, weighted performance criteria are considered, A+B contracting outperforms lane rental, design-build, and traditional contracting on all project types considered in our study.

Using I/O clauses with A + B contracts
When an I/O clause is included with A + B contracts, the contracting and award dynamic changes. Including an I/O clause in an A + B contract is only appropriate when the roadway under construction has high user costs, has a crucial targeted completion date (such as the case of a major sporting event or business opening), or is a high visibility project where public complaints of traffic delay are likely. In other words, the A + B contracting is an ideal choice for choosing among efficient tradeoffs between time and money, but if schedule is critical, an incentive clause should be utilized with A + B contracting. The inclusion of I/O language creates an extra cost condition (either for Mn/DOT or the contractor) that must be weighed against the added benefit of earlier completion resulting in reduced RUCs, worker safety, and public good will.

There are other potential drawbacks to using I/O clauses besides added cost. There is a potential for additional administrative costs to Mn/DOT resulting from increased overtime and weekend shifts of field-based personnel and some costs of expedited reviews. These cost increases may be offset by savings realized from increases in field efficiencies and reductions in overall project duration. The data examined in our study is too preliminary and the number of cases too small to make any definitive statements regarding administrative costs. It seems reasonable to assume that administrative cost variance may be project-specific based on the district staffing levels, project location, overall duration, contractor sequencing of work, and a number of other factors that vary from project to project. Also, the size and certainty of the I/O amount is an important factor in determination of total cost to Mn/DOT.

Developing more thorough preconstruction plans
The use of A + B contracting will require more thorough preconstruction planning on projects where potential disruptions to work flow are likely. Specific project issues requiring attention during preconstruction planning are ROW acquisition, environmental remediation, and utility coordination. All A + B projects with complex task relationships should require the contractor to provide a network schedule, such as a critical path method (CPM) schedule. CPM scheduling allows Mn/DOT and the contractor to identify the real magnitude of delays and how they will or will not impact contractual completion schedules.

Devising special administrative labor categories and budgets
For A+B contracts with I/O, the pre-award work necessary to clear all potential obstacles to seamless scheduling (utility conflicts, environmental issues, design errors, etc.) creates a greater sense of urgency during reviews. The cost control system may need to be modified to capture the increased complexity of pre-award coordination required under A+B contracts.

Recommendations for Innovative Contracting in General

Implementing training
The culture change required to take full advantage of innovative contracting is not limited to Mn/DOT personnel. Changes in philosophy and greater awareness of the different processes required for innovative contracting are needed from all involved parties (Mn/DOT, cities, counties, utilities, permitting agencies, contractors, etc.). A coordinated, joint training program may be beneficial, as well as improved recruitment, selection, and assignment procedures.

Assessing and managing quality
The procurement processes used at Mn/DOT, regardless of contract type employed, must begin to include better evaluation of quality capabilities of the bidders/proposers. The contract language should include clear incentives for high quality work along with negative consequences for poor quality work, including removal from the approved bidders list future Mn/DOT work. In addition to defining procurement and contracting programs for assessing and incentivizing quality, clear definitions of responsibilities should be set out for all projects, regardless of contract type. Responsibilities for testing, oversight, compliance, and reporting need to be well-defined in bid documents and project contracts. Lastly, Mn/DOT and the construction industry

should work closely together to develop training programs in quality to increase the number of individuals in the labor pool who are qualified to manage these tasks.

Considering a project-based management system

Although not directly defined by the findings of the research, Mn/DOT may benefit from adopting a project-based management system for construction of transportation projects. Much of the information of interest regarding innovative contracting relates to internal administrative costs and efficiency of procedures. The research team believes that a move toward a project management model, in lieu of an agency model, for construction projects, will in time provide the type of information necessary for a more thorough understanding of the internal cost and management impacts of innovative contracting.

A project management model for construction would involve decentralization of in-house decision making authority to Mn/DOT project managers, including authority to approve scope changes, payments to vendors, management oversight of internal costs and external expenditures for all Mn/DOT projects. Nevertheless, the degree of decentralization would need to be moderated on a project-by-project basis by the technical complexity of the project and the skills and experience of the project management team. Such a change would require commitment from Mn/DOT executives and coherent communication of project objectives from agency leadership. In addition, a transition to a project management model would require development of project manager training programs, mentoring and professional development for Mn/DOT careers in project management, project management procedures manuals, and a revised cost accounting system. After a sufficient number of projects have been completed under a project management model, Mn/DOT administrators will have historical records that can be used to review administrative costs, prepare internal labor budgets, and work task productivity standards. Administrative project budgets, along with activity-based project accounting systems for Mn/DOT personnel working on multiple projects, will provide the information necessary to make an accurate comparison of the internal cost differences for different contracting and procurement methods.

Under a project management model, each project (regardless of contracting method) would have established objectives for scope, budget, schedule, quality and internal administrative labor costs. In addition to the establishment of objectives, Mn/DOT would need to develop a system for measuring actual performance against the objectives, with project management authority for taking corrective action as needed. In addition to general project management obligations for realizing project objectives, Mn/DOT should utilize project roles and responsibility matrices for project team members, including project managers, technical specialists, unit managers, and other members of a project team.

Evaluating costs

One of the most pressing issues of interest regarding innovative contracting, particularly in the design-build community, is whether design-build is more or less costly than traditionally delivered projects. Answers to this question are beyond our reach at present. Numerous researchers and consultants have tried to address this question in the last three years without success. At this time, there is no systematic method of analysis that allows for control of all project variables that can impact cost. Also, because traditional delivery is based on a low-bid award whereas design-build is frequently awarded on best-value selection criteria, it can be difficult to differentiate “cost” from “value.” Add to these complications the variations in risk allocation on different projects, and the research question regarding cost differences quickly becomes unanswerable. To determine even a relative magnitude of cost difference between design-build and traditional delivery would require identification of a sample of very similar projects for a comparative cost study. Statistical analysis of even a small sample of projects would be problematic because of project dissimilarity in learning curve biases; risk assignments; innovation allowed, location, bidding environment, competitive situation, etc. As the sample size gets larger to provide for better statistical power, these project differences become less manageable. Therefore, traditional two-sample comparison of means research designs become unreliable. For this reason, many researchers have used a qualitative study utilizing a small sample of case studies. Even for a comparative case study, it would be necessary to identify at least two projects of similar design complexity, scope of work (length of paved surface, number of structures, soil work, etc.), and market conditions. Prior to the commencement of work, a separate cost control system would need to be established for both projects, with all Mn/DOT personnel labor and overhead associated with these projects coded to these special control systems, similar to the system described earlier in the project management systems recommendation. Also, all subcontracted payments to vendors for work conducted on behalf of Mn/DOT should be noted in the special control system. The “special” costs not directly associated with design or construction, such as right-of-way acquisition and environmental remediation should be excluded from the project cost control system.

Revising handling of labor tracking and cost-coding

To the extent possible, the labor and cost-coding system should be project-based, with project budgets established and approved by the project manager and his/her superior. Each project cost assigned to the project should be reviewed and approved by the project manager and/or the project staff. A focus group of experienced project managers could determine necessary additions, deletions, or changes to existing cost-accounting codes and categories. Although the experience of the focus group should be a guiding force in establishing different cost codes and categories, some suggestions for new types of internal costs and systems to track seem logical as discussed below.

One of the areas most impacted by the use of innovative contracting is district-level personnel issues such as temporary assignments, holding budget lines open as placeholders for project assignments, shifts in maintenance priorities, etc. The current accounting system may not allow for district personnel to shift their hours easily from project-based tasks to district operational tasks. The project cost control system must be able to track the real cost impact of these staffing issues in order for a cohesive and consistent comparison of design-build projects and traditionally procured projects.

Another area of Mn/DOT cost is in the area of financing. Some consideration should be given to including the cost of debt service (in present value) as a part of project costs, much like a developer or private owner would in a pro forma statement for a project. Similarly, the cost of procurement and “development” through pre-award should be realized as a project cost. Fair comparisons of design-build and traditional projects should include financing and procurement cost differences.

Continuing research
All of the innovative contracting methods in transportation are relatively new. As more experienced is gained, continuing research should be conducted to hone in on best practices for innovative contracting. Research programs aimed at soliciting feedback from contractors, consultants, designers, road users, and the general public would be beneficial to determine the overall performance of innovative contracting. Finally, Mn/DOT should begin examining emerging innovative contracting methods such as design-sequencing and A + B + C contracting for possible use on applicable projects in Minnesota.

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Appendix B

Interview Questions for A + B and Lane Rental Contracts

A team of researchers from Iowa State University have been awarded a contract by Mn/DOT to examine the effectiveness of innovative contracting methods. As part of this study, we are interested in your opinions regarding some of the innovative contracting methods you have used on past projects in your district. Please answer the following questions to the best of your ability, using your education, training, and experience as a DOT engineer as the basis for your opinions. Please remember that we are interested in your opinions rather than actual quantitative data for this phase of the research project.

1) For the A + B projects that you have involved with, how would you compare ***original*** contract terms (cost and schedule) to projects of similar scope that were procured using traditional methods? (e.g. does A + B have higher/lower first cost, shorter/longer ***proposed*** schedule, etc. and if so, by approximately what percentage?).

2) For the A + B projects that you have involved with, how would you compare ***final*** contract terms (cost and schedule) to projects of similar scope that were procured using traditional methods? (e.g. does A + B have higher/higher ***final*** cost, shorter/longer ***actual*** schedule, etc. and if so, by approximately what percentage?).

3) Can you give some examples of issues that resulted in cost or schedule changes from original award on the projects where innovative contracts were used?

4) For the A + B projects that you have been involved with, how would you compare overall ***internal costs*** (inspections, design reviews, compliance reviews, contract administration, supervision, procurement, preliminary design/planning) for Mn/DOT to projects of similar scope that were procured using traditional methods. (e.g. does A + B have higher/lower internal costs, and if so by approximately what percentage?).

5) What categories of internal costs are most impacted by use of A + B contracts?

6) For the A + B projects that you have been involved with, how would you compare overall ***RUC*** to projects of similar scope that were procured using traditional methods. (e.g. does A + B have higher/lower RUC, and if so by approximately what percentage?).

7) For the A + B projects that you have been involved with, how would you compare overall ***third party costs*** (e.g. local businesses and community residents) to projects of similar scope that were procured using traditional methods. (e.g. does A + B have higher/lower third party costs, and if so by approximately what percentage?).

8) What issues (bid review, utility relocation, environmental issues, Rights-of-way, design changes) add complexity to A + B contracting beyond what would normally be anticipated if traditional procurement was used?

9) What type of projects do you think lend themselves to the use of A + B contracting?

Appendix C

Outline of Interview Questions for Mn/DOT ROC-52 Project

Administrative Costs

- Give examples of the types of DOT internal costs to track: reviews, contract administration, inspections, right-of-way acquisition… are there others?
- If ROC-52 had been done using Mn/DOT's traditional system of design-bid-build project delivery, would internal costs to Mn/DOT have been higher, lower, or the same? Can you give examples of what types of internal costs would change?
- How did the processes associated with these internal costs differ on this design-build project versus projects of traditional delivery?

Construction Costs

- Give examples of overall construction costs: first costs, change orders, cost of engineering, cost of design, etc…are there others?
- How would these costs have been different if the project had used a traditional delivery rather than design-build—higher, lower, or the same? Why?

Time

- "Time" refers to the overall length of time spent in project planning, funding (appropriations) design, construction, and extensions… are there other factors that add to project time?
- Would the length of time spent in each of these project phases have been higher, lower, or the same in traditional delivery? Why?

Management Complexity

- Was there difficulty with understanding scope or defining the project? If so, would they have been different under the traditional system?
- Was the project easier, more difficult, or equally as difficult to manage due to its status as design-build rather than traditional? Specifically, what areas of the project were more difficult to manage and why? (Utility conflicts, etc.)
- What were the logistical concerns with executing the project? Would they have been different under the traditional system?

Disruption to Third Parties

- Third parties affected by the project include businesses, churches, schools, and other such establishments or destinations….are there others or specific examples you can share?
- How did design-build impact the way disruptions to third parties were handled? Did D-B improve, hinder, or have no effect on how third-party disruptions were managed or remedied?
- What was the impact/disruption to residents or neighbors? Railroad crossings? Facilities or structures on the route?
- Were there environmental issues on the project? Was there any difference in how they were dealt with stemming from the use of design-build instead of traditional?

Road User Costs

- RUC include accidents, driver time, adverse travel from detours, etc… Are there other types of RUC specific or unique to this project?
- Would these RUC have been higher, lower, or no different had the project been traditional rather than D-B? Why?

Quality of Project

- How has D-B impacted the overall quality on the project?
- What do you think the long-term effects will be in terms of workmanship, warranty, contractor call-backs, ongoing maintenance, etc.

Funding Flexibility

- To what degree does D-B create different options and funding flexibility? For instance, are projects easier to fund than operations (use of capital budgets versus operating appropriations for design, inspections, etc.) Is the impact significant or minimal?

Innovation

- How does the design-build system allow for changes to be made?
- Does design-build promote or discourage contractor innovation, and to what extent? Examples?
- If applicable, in what areas is innovation made possible? Design? Methods? Sequencing? Other areas?

Additional Questions

- What types of projects or project traits would you look for when considering the use of design-build compared to other delivery methods or contracting alternatives?
- What project characteristics lead you to consider/recommend design-build? What project characteristics would lead to considering/recommending traditional delivery?
- What internal processes would you recommend Mn/DOT adopt/change/eliminate in order to improve the efficiency or effectiveness of design-build contracting?

Appendix D

Meeting with Keith Molenaar

Attendees: Keith Molenaar
Nolan Raadt
Kelly Strong
Jimmy Tometich

Date: 10/19/2004
Location: Town Engineering Building, Ames, IA, 50010

In accordance with the contract, the research group met with Dr. Keith Molenaar to further define objectives and gain valuable expert information about the cost effectiveness of alternative contracting techniques. Dr. Molenaar has performed numerous case studies and surveys on both national and state levels on alternative contracting methods. Dr. Molenaar is widely known for his research and publications concerning alternative contracting techniques.

Established in the meeting was the importance of having a good starting point for this research since it is a relatively new and rapidly developing field of study. Dr. Molenaar suggests concentrating on identifying best practices for each delivery method (design-build, A+B, lane rental, and traditional), generating decision support protocols for each delivery method, creating frameworks for comparisons and validation (see attached description), and specifying performance measures for future development. The best practices guides and decision support protocols will be created from a literature search and synthesis. The frameworks for comparison and validation will use previous benchmark surveys of DOT experts, and an in-depth case study. The recommendations for future performance measurements will be determined through in-depth interviews and case study of the Rochester Highway 52 project.

The best practices guide will help identify critical success factors required to maximize the effectiveness of the alternative contracting methods. Dr. Molenaar suggests that similar previous studies concerning information about alternative contracting methods be used on both national and state levels to help develop the team's research database.

With the assistance of Dr. Molenaar, a list of suggested literature was created (see Appendix A). In addition to the literature search, Table 5-1 "Performance Framework and Measures" from the Minnesota Statewide Transportation Plan will be used to help identify relevant success factors for comparison.

After the meeting with Dr. Molenaar, the team was able to further focus on objectives and to obtain information on the latest issues of the cost effectiveness of alternative contracting methods.