

Construction Management Practices in Canada and Europe



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16. Abstract <p>Construction management is an essential element of transportation project success, and evolving industry roles are creating changes in conventional U.S. construction management practices. The Federal Highway Administration, American Association of State Highway and Transportation Officials, and National Cooperative Highway Research Program sponsored a scanning study of construction management practices used in Canada and Europe for effective project delivery, contract compliance, and quality assurance.</p> <p>The U.S. team observed that the Canadian, European, and U.S. transportation communities face similar political, financial, and resource challenges, but Canadian and European agencies have developed construction management systems that promote more collaboration between the public and private sectors and create stronger long-term partnerships. The international agencies are more willing to delegate traditional highway functions to the private sector when cost and schedule benefits are significant.</p> <p>The team's recommendations for possible implementation in the United States include developing risk assessment and allocation techniques, using qualifications in procurement, piloting early contractor involvement, applying alternate bids and designs in procurement, conducting preproposal meetings, and using appropriate alternative payment methods.</p>					
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Construction Management Practices in Canada and Europe

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FHWA International Technology Exchange Program

The Federal Highway Administration's (FHWA) Technology Exchange Program assesses and evaluates innovative foreign technologies and practices that could significantly benefit U.S. highway transportation systems. This approach allows for advanced technology to be adapted and put into practice much more efficiently without spending scarce research funds to recreate advances already developed by other countries.

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The International Technology Scanning Program has resulted in significant improvements and savings in road program technologies and practices throughout the United States. In some cases, scan studies have facilitated joint research and technology-sharing projects with international counterparts, further conserving resources and advancing the state of the art. Scan studies have also exposed transportation professionals to remarkable advancements and inspired implementation of hundreds of innovations. The result: large savings of research dollars and time, as well as significant improvements in the nation's transportation system.

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Table of Contents

Executive Summaryxi

Background and Motivationxi

Purpose and Scopexi

Observations and Key Findingsxii

Recommendationsxiv

Implementationxiv

Chapter 1: Introduction1

Background and Purpose1

Methodology1

Reader's Guide to the Report2

Chapter 2: Preconstruction Aspects of Construction Management4

Introduction4

General Context4

Staffing5

Project Delivery10

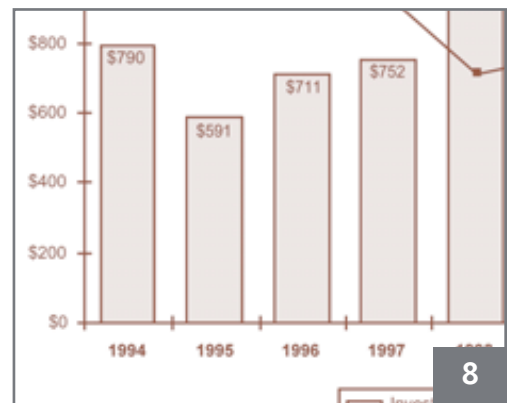
Procurement16

Risk Allocation and Management23

Conclusions29

Chapter 3: Construction Aspects of Construction Management30

Introduction30



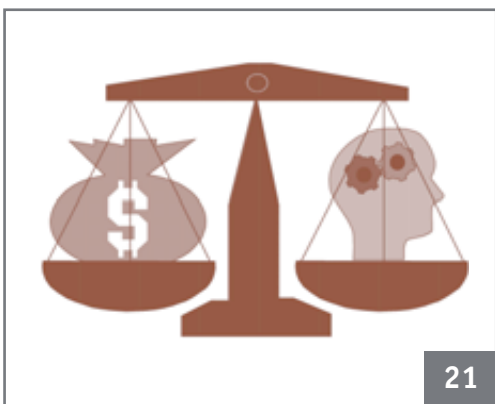
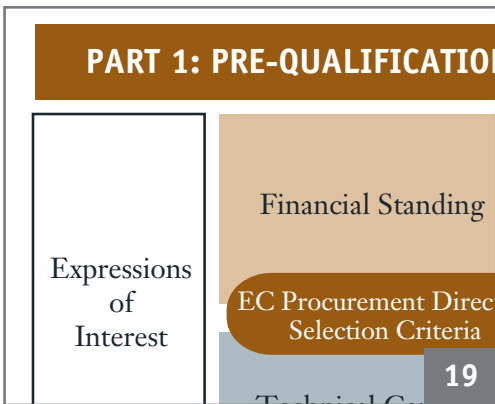
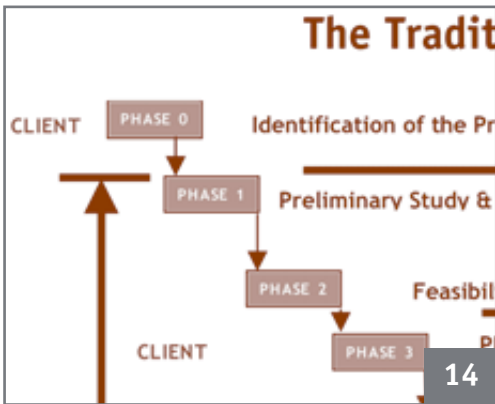
Capital Investment F

IMPROVEMENTS TO PRESENT PROCUREMENT MODELS (DBB, DB & CM) & DESIGN/ENGINEERING CONSULTANT AGREEMENTS

DE IMPLEN INCLUS

DBBF

12



Contract Administration30

Quality Plan Implementation33

Contract Change Processes35

Project Record Keeping37

Third-Party Communications37

Environmental Monitoring38

Project Maintenance Requirements39

Conclusions39

Chapter 4: Postconstruction Aspects of Construction Management40

Introduction40

Maintenance and Warranties40

Process Improvement41

Conclusions42

Chapter 5: Recommendations and Implementations43

Recommendations43

Implementation44

Appendix A: Scan Team Members46

Appendix B: Amplifying Questions49

Appendix C: References51

Appendix D: European Host Representatives52

Figures

Figure 1. U.S. scanning team.1

Figure 2. Reader’s guide to the report.3

Figure 3. Example of staffing issues in the United States.
(Michigan DOT)8

Figure 4. Continuum of project delivery methods from traditional
to alternative.10

Figure 5. Future Finnish project delivery methods.12

Figure 6. The Highways Agency’s traditional project delivery approach.14

Figure 7. The Highways Agency’s ECI project delivery approach as applied
to the A500 Stoke Pathfinder project.14

Figure 8. The Highways Agency procurement process.
(Highways Agency 2003)19

Figure 9. Common attributes of European best-value
procurement procedures.21

Figure 10. Electronic license plate reader system on construction project.33

Figure 11. Public information tools for Upper Forth Crossing
project in Scotland.38

Figure 12. States using warranty evaluation.41

Tables

Table 1. Links to transportation organizations involved in scan.5

Table 2. Context of transportation in host countries.6-7

Table 3. Construction management outsourcing analysis.9

Table 4. Distribution of Bavarian project delivery methods.11

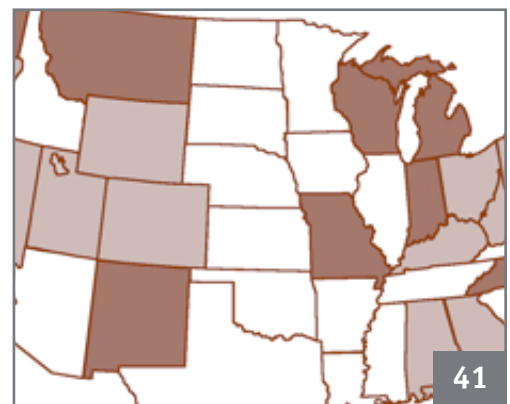
Table 5. Distribution of Dutch project delivery methods.11

Table 6. General risk allocation by country and major delivery method.26

Table 7. Example of risk determination from Dutch Public
Sector Comparator.25

Table 8. Contract cost growth.36

Table 9. Key performance indicators.42



Abbreviations and Acronyms

AASHTO

American Association of State Highway
and Transportation Professionals

BV

Best value

CAT

Capability Assessment Toolkit

CEVP

Cost Estimate Validation Process

CM

Construction management

CP

Corporate performance rating

CPS

Consultant Performance and Selection System

DA

Department agent

DB

Design-build

DBFO

Design-build-finance-operate

DOT

Department of Transportation

DR

Department representative

ECI

Early Contractor Involvement

EOI

Expression of interest

ER

Employer's representative

FHWA

Federal Highway Administration

HA

Highways Agency (United Kingdom)

HARM

Highways Agency Risk Management

ISO

International Organization for Standardization

KPI

Key performance indicator

MAC

Managing agent contractor

NCHRP

National Cooperative Highway Research Program

NHI

National Highway Institute

PFI

Private finance initiative

PM

Project manager

PPP

Public-private partnership

RAQS

Registry Appraisal and Quality System

RFP

Request for proposals

Executive Summary

BACKGROUND AND MOTIVATION

Construction management involves the oversight of risks and resources in the construction of a highway project. Construction management is an essential element of the success of any project, large or small. Traditional construction management processes, such as open bidding, unit-price contracting and agency quality control, have served the U.S. public well in the construction of our national and state highway systems. While these processes provide transparent checks and balances, they do not inherently promote trust among agencies, contractors and their supply chains, and they

inhibit innovation and efficiency. These methods also do little to help manage the highly publicized cost and schedule overruns that have created a lack of public confidence in the industry's ability to perform effectively. To compound these issues, many highway agencies are realizing a reduction in staffing while facing increasing infrastructure

- ✓ Construction management is an essential element of the success of any project.
- ✓ Evolving industry roles are creating changes in conventional U.S. construction management practices.
- ✓ The international highway community has developed practices in what the United States would consider an alternative procurement and contracting environment.

demands. U.S. highway agencies and their industry partners are beginning to rethink fundamental design and construction management principles.

Evolving industry roles and the adoption of alternative project delivery methods are creating changes in the conventional construction management practices that public agencies use to ensure appropriate project delivery, contract compliance, and quality assurance. The Federal government and state transportation agencies are developing policies and procedures to address these evolving delivery methods. Critical components of these new methods include the changing relationships among public agencies, contractors, private engineering firms, including risk allocation processes, quality

control/quality assurance, and general contract administration procedures. Some evolving delivery methods include the use of nonconventional procedures such as design-build contracts, public-private arrangements, maintenance and warranty requirements, and use of third-party consultants to perform contract management.

The international highway community has developed construction management procedures in what the United States would consider an alternative procurement and contracting environment. Recognizing the similarities and benefits that could result from an examination of international construction management procedures, a diverse team of experts was assembled to research, document, and promote the implementation of international best practices that might benefit U.S. industry.

The scan team has gained a fresh perspective on how the U.S. highway industry can function in a new spirit of partnership and alignment toward customer-focused goals. We are offering a challenge to public and private highway construction professionals to change current construction management practices that create adversarial relationships. We must create new practices and contractual measures that promote trust, build teamwork, and align all participants toward customer-focused objectives of quality, safety, and dependable transportation facilities. We must also learn to analyze risks more effectively and allocate these risks to the party that can manage them most effectively. These changes must occur if we are to meet customer demands.

Purpose and Scope

In May 2004, a U.S. team traveled to Canada and Europe to learn from their significant experience by conducting a scan of construction management practices for effective project delivery, contract compliance, and quality assurance. The purpose of the scan was to review and document international policies, practices, and technologies for potential application in the United States. The team conducted meetings with government agencies, academia, and private sector organizations involved in construction management efforts, and visited sites where alternative technologies and practices were being applied. The study consisted of a combination of meetings with highway agencies and practitioners, and site visits. The scan team

visited or conducted meetings with international organizations from the following locations:

- Toronto, Canada
- Munich, Germany
- Cologne, Germany
- Manchester, England
- Edinburgh, Scotland
- Glasgow, Scotland
- The Hague, Netherlands
- Helsinki, Finland

Observations and Key Findings

The following observations and key findings provide a basis for the recommendations of this study. The European and U.S. transportation communities are quite similar in terms of the political, financial, and resource challenges they face. However, key procurement and construction management techniques found on this study promote better alignment among project team members and with their customers. The U.S. scan team discovered a more spirited effort of long-term partnership and collaboration between the public and private

- ✓ The European and U.S. transportation communities are quite similar in terms of the political, financial, and resource challenges they face.
- ✓ The U.S. scan team discovered a more spirited effort of long-term partnership and collaboration between the public and private sectors.

sectors and more customer awareness among the industry members than in the United States. Specifically, the Canadian and European agencies have developed construction management systems that promote the alignment of team goals through the use of integrated risk analysis techniques that support the strategic application of alternative delivery methods.

These concepts are seen throughout the project life cycle, from procurement systems that set the framework for success to contract payment systems that support alignment and trust. The agencies are more willing to delegate traditional highway functions to the private sector where project delivery systems have produced significant benefits in cost and schedule without sacrificing quality. All of these project delivery, procurement, and construction management techniques have resulted in a closer partnership between public and private entities.

Similar Transportation Needs

Canadian and European transportation systems have growing capital project needs, as well as backlogs of maintenance needs. International highway agencies face operating an aging infrastructure under tight funding constraints and increasing environmental challenges with leaner public

staffing resources. These challenges are not unlike those State and Federal agencies face in the United States. In many instances, the international agencies have developed or are developing innovative solutions to these problems. The highway agencies and their industry partners have become more aware of their customer needs and have developed a philosophy of network management to meet these needs. The Highways Agency in England perhaps states its objectives best through the key performance indicators (KPIs) it attempts to measure for each project and service provider:

- Client satisfaction with the product
- Client satisfaction with the service
- Predictability of time
- Predictability of cost
- Safety
- Process improvement (defects)

Construction Management Methods that Promote Alignment of Team Goals

Although traditional construction management methods under design-bid-build delivery ensure competition in bidding and minimize the transfer of risk to the private sector, they can often result in an adversarial, or even litigious, relationship between the public and private sectors. Some international agencies use alternative construction management techniques that may limit competition and transfer more risk to the private sector when compared to traditional U.S. methods, but they believe that their techniques are more efficient, more sustainable, and/or deliver better value to customers in the long term through the creation of partnerships with the industry that incentivize contractors and the supply chain to focus on outcomes of customer-oriented goals.

Integrated Use of Risk Analysis Techniques

The international community has an awareness of risk analysis and allocation techniques not present in all of our U.S. highway agencies. The HA in England has developed HARM to model the uncertainties of estimates for cost and time to ensure robust and realistic budgets for publicly financed projects. The Ministry of Transport, Public Works, and Water Management in the Netherlands has developed the Public Sector Comparator and the Public-Private Comparator to assist with these same decisions. Both agencies have dedicated staff members that assist project teams in identifying and quantifying project risk using probabilistic techniques, and then choosing delivery and contracting strategies that can best control and mitigate these risks.

Strategic Use of Alternative Delivery Methods

The agencies visited on this scan all used a balanced approach to project delivery methods. The scan team witnessed the entire spectrum of traditional and alternative

methods, including design-bid-build, design-build, design-build-operate, and a variety of public-private partnerships. The team also found a number of new methods that allocate more risk to the private sector and/or create more motivation for total life cycle maintenance and operation solutions from the private sector. Of particular interest to the team is the HA's ECI delivery method in which design and construction professionals are selected early in the project development process through a qualifications-based selection. They then develop an open book target pricing system during design development in conjunction with the HA.

Procurement Systems that Set Framework for Success

While the traditional U.S. low-bid procurement system is employed abroad, the majority of countries visited on this scan use a best-value procurement system as their standard procedure. Procurements based solely on qualifications (without a bid price) are also in use in compliance with European procurement directives. Best-value methods use factors in addition to price for the selection of teams. These additional factors include team qualifications, past performance, design alternatives, and a number of other items based on the needs of a particular project. The Ministry of Transportation in Ontario, Canada, has developed a RAQS to rate contractors on past performance. These ratings are

used to adjust prequalification ratings for bidding purposes. England's HA recently developed a CAT in which it scores company management practices and combines this score with past performance to select designers and contractors in a purely qualifications-based selection for all major projects. An overriding

- ✓ The majority of countries visited on this scan use a best-value procurement system as standard procedure.
- ✓ Procurement systems start the project team on the road to success, and payment methods complete the cycle.

objective of these procurement systems is to create trust and long-term partnerships between the agencies and the industry. In addition, by receiving competitive proposals that are evaluated on factors such as quality or traffic management plans, the owner can align the procurement with the project and customer goals at the earliest stages.

Contract Payment Methods that Support Alignment and Trust

Procurement systems start the project team on the road to success, and payment methods complete the cycle by creating incentives to meet customers' needs. Unit-price contracts used in the United States allocate the risk for quantity variations appropriately, but they miss opportunities to provide

incentives for early completion of project milestones or to minimize impact to the traveling public. Lump-sum payments are being used abroad to create milestone incentives for project completion. The Scottish Executive does not use unit prices for contractor payment, but rather creates a series of completion milestones for which it makes lump-sum payments. The agency believes this minimizes its administrative burden and incentivizes the contractor to complete the milestones efficiently. Both the HA in England and the Ministry of Transport, Public Works, and Water Management in the Netherlands use congestion pricing incentives/disincentives for payment on privately financed projects that impact the traveling public. The congestion payment mechanisms are in direct alignment with the customer-focused goals repeated throughout this study.

Delegation of Traditional Highway Agency Functions to Promote Efficiency

The private sector partners of the international highway agencies involved in this scan conduct many construction management tasks traditionally done by State highway agencies in the United States. The motivation for this transfer of roles stems from a reduction in agency staff and/or a belief that the contractors can perform these tasks more efficiently. For example, the use of milestone and lump-sum payments allows contractors to invoice for completed work with less verification required by the owner than in traditional U.S. contracts. Notably, more quality management is done by the contractor abroad than in the United States. The agencies rely on contractor-designed quality management systems that are in accordance with the procedures they submit in the project proposal. Under these systems, a third party audits the contractors. The use of best-value procurement and past performance in selection allows the agencies to take on more of a quality audit role during construction. All of the countries participating in this scan noted the use of International Organization for Standardization (ISO) certification as an important element of more dependence on contractor quality management.

A Philosophy of Network Management

The need to maximize the efficiency of aging highway infrastructure coupled with a steady reduction in staff have driven a number of the international highway agencies toward a philosophy of network management. With this philosophy, the contracting agency's primary focus is the efficient operation of the transportation system through packaging and managing project delivery strategies that provide for optimal performance. Many of the host countries have turned to the private sector for delivery functions that formerly were self-performed, such as planning, design, construction management, operations, and maintenance. These contracting agencies now rely on the private industry to provide all of the necessary technical support and contract management ability. As a result, the contracting agency

focus has shifted from contract compliance for individual services to management of the network by integrated service contracts.

For example, the English HA previously experienced problems with the traditional design-bid-build project delivery system. This included cost overruns averaging 35 percent, schedule delays, cutthroat competition precipitating adversarial relationships, and the inefficient use of the industry's expertise for constructibility and innovation. Recognizing that many of these issues were inherent in the traditional project delivery system, the HA established a multiyear plan to change its method of managing the transportation network and delivering projects through a variety of strategies, including design-build contracts, managing agent contracts, early contractor involvement, and design-build-finance-operate contracts.

Greater Partnership Between Public and Private Entities

The project delivery and construction management methods the team observed on this scan have led to a more spirited effort of long-term partnership and collaboration between the public and private sectors. The agencies are very conscious of how their procurement and construction management methods affect their design and construction professionals and supply chain. By working toward longer-term partnerships, the agencies have worked with the private sector to better understand customers' needs. The strategic application of delivery methods that promote life cycle solutions, the use of qualifications and past performance in procurement, and the delegation of traditional highway agency construction management functions to the private sector all have contributed to a closer relationship between the public and private sectors in a sustainable manner.

Recommendations

The construction management scan team was composed of Federal, State, local, industry, and academic members with more than 100 years of combined experience in the design and construction of highway projects in the United States. Through this focused research study, the team has gained a fresh perspective on how the U.S. highway industry can change to achieve more productive partnerships and alignment toward customer-focused goals. The team's recommendations offer a challenge to highway construction professionals to change current construction management practices that create adversarial relationships. The team's recommendations are listed below and fully explained in Chapter 5.

- Align team goals to customer goals.
- Develop risk assessment and allocation techniques.
- Strategically apply alternative delivery methods.
- Enhance qualification-rating processes.
- Use qualifications in procurement.
- Pilot early contractor involvement.
- Apply alternate bids/designs in procurement.
- Conduct preproposal meetings.

- Apply more contractor quality management.
- Use appropriate alternative payment methods.
- Work toward warranties and life cycle responsibility.

Implementation

The scan team is committed to implementing its recommendations with the industry in the coming months and years. The Federal, State, industry, and academic members of the team are actively transferring the lessons learned in this scan to the U.S. highway industry. Three critical tools to realize the team's recommendations are listed below and full explained in Chapter 5.

- Expert technical group
- Pilot studies
- Conferences and focused workshops

The Introduction

BACKGROUND AND PURPOSE

Construction management is a critical element for the successful completion of any highway construction project. Construction management procedures are rapidly changing in the United States. Alternative procurement systems and contracting procedures for project delivery have become part of the U.S. highway construction program. These delivery methods include the use of nonconventional procedures such as design-build contracts, public-private arrangements, maintenance and warranty requirements, and use of third-party consultants to perform contract management.

These new project delivery methods will require changes in the conventional construction management practices that public agencies use to ensure appropriate project delivery, contract compliance, and quality assurance. The Federal government and State transportation agencies are developing policies and

✓ New project delivery methods will require changes in conventional construction management practices.

procedures to address these evolving delivery methods. Critical components of these new methods include the changing relationships among public agencies, contractors, and private engineering firms, including risk allocation processes, quality control/quality assurance, and general contract administration procedures.

The international highway community has developed construction management procedures in an environment of what the United States would consider alternative procurement and contracting procedures. Recognizing the similarities and benefits that could result from an examination of international construction management procedures, a diverse team of experts was assembled to research, document, and promote the implementation of international best practices that might benefit U.S. industry.

In May 2004, a U.S. team traveled to Canada and Europe to conduct a scan of construction management practices for effective project delivery, contract compliance, and quality assurance. The purpose of the scan was to review and

document international policies, practices, and technologies for potential application in the United States. The team conducted meetings with government agencies, academia, and private sector organizations involved in construction management efforts, and visited sites where alternative technologies and practices were being applied. The Federal Highway Administration (FHWA) and the American Association of State and Highway Transportation Officials (AASHTO) jointly sponsored this study with the National Cooperative Highway Research Program (NCHRP).

Methodology

The construction management scan was selected by the Transportation Research Board's NCHRP Panel 20-36 from a number of competing proposals for the 2004 funding cycle. Upon acceptance of the proposal, two scanning study cochairs were named representing the funding agencies: Steven DeWitt, director of construction for the North Carolina Department of Transportation (DOT), and Gerald Yakowenko, contract administration engineer for FHWA's Office of Program Administration. They joined public and private sector representatives from a cross-section of the industry. Team members are shown in figure 1 and their affiliations are listed on the following page. Complete contact information and biographical sketches for the scan team members are in Appendix A.



Figure 1. U.S. scanning team.

The next step was to conduct a desk scan to select the most appropriate countries for the scan team to study. The objective of the study was to maximize the time spent by the panel reviewing its topics of interest. This desk scan employed a three-tiered methodology of 1) literature review, 2) e-mail surveys, and 3) synthesis. This methodology provided for data collection from government agencies, professional organizations, and experts abroad who are most advanced in the scan

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topic. The desk scan was very revealing. A number of countries have unique transportation agency roles and responsibilities that could provide insight into the future roles of stakeholders in the U.S. highway industry. A number of countries also are breaking new ground in the area of contract administration and quality compliance. The desk scan also revealed numerous U.S., Canadian, and European contacts who provided interviews to help select the final countries to visit. For a copy of the *2003 Construction Management Desk Scan*, contact the FHWA Office of International Programs at international@fhwa.dot.gov or <http://www.international.fhwa.dot.gov>.

The results of the desk scan were presented to the U.S. scanning team at a meeting in Washington, DC, to select the host countries. In addition, the team used the meeting to finalize a panel overview document, which was sent to the host countries to prepare them for the U.S. delegation. The panel overview explained the background and scope of the study, sponsorship, team composition, topics of interest, and tentative itinerary.

Before conducting the scanning study, the team prepared a comprehensive list of amplifying questions to further define the panel overview and sent it to the host countries. Some of the host countries responded to these questions in writing before the scanning study, while others used the questions to organize their presentations. The team attempted to craft the questions precisely enough to not miss any information that it anticipated, yet open-ended enough that new ideas the team had not envisioned could be brought to light by the host countries. The team was successful in its assembly of the questions, as documented throughout this report. Appendix B contains the amplifying questions sent to the host countries.

The delegation traveled to Canada and Europe from May 13 to 30, 2004. The team's study consisted of a combination of meetings with highway agencies and practitioners, and site visits. The scan team visited or conducted meeting with international organizations from the following:

- Toronto, Canada
- Munich, Germany
- Cologne, Germany
- Manchester, England
- Edinburgh, Scotland
- Glasgow, Scotland
- The Hague, Netherlands
- Helsinki, Finland

Reader's Guide to the Report

The report combines definitions and case study examples of construction management techniques in Europe with critical analysis of the applicability of these techniques to U.S. contracting. When possible, parallel examples from the United States are provided to amplify those techniques that are directly applicable. The report is organized into preconstruction, construction, and postconstruction aspects of construction management.

2004 Construction Management Scan

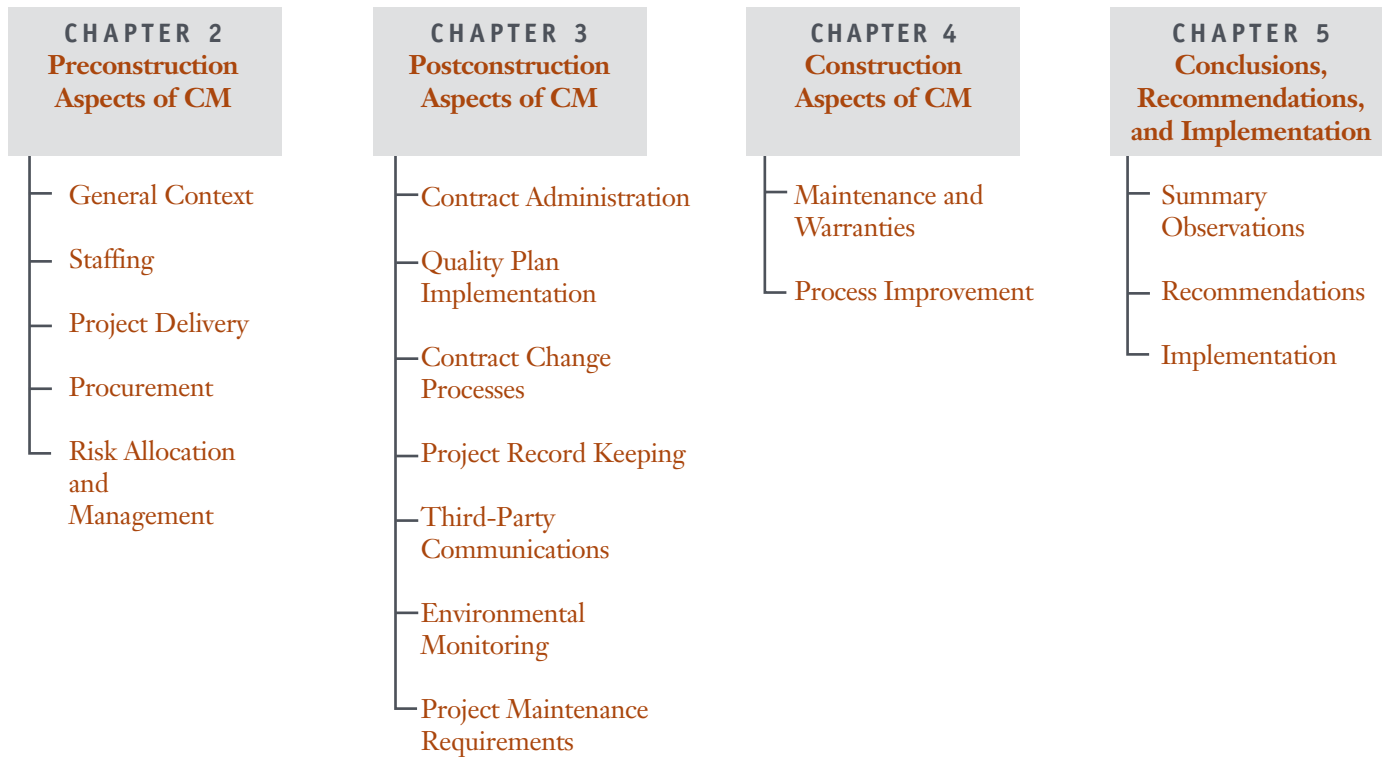


Figure 2. *Reader's guide to the report.*

Preconstruction Aspects of Construction Management

INTRODUCTION

Construction management involves the oversight of the physical construction of a highway project. While the majority of construction management activities occur during the construction phase, a successful construction management process begins long before contracts are executed and physical work begins. The framework for construction management success begins in the planning and design phases. It is at this point when staffing issues are addressed, project delivery methods are chosen, procurement processes are defined, and risk allocation and management strategies are determined.

- ✓ Construction management is an essential element of successful highway construction.
- ✓ New project delivery methods are forcing changes in conventional construction management practices.

These construction management planning issues allow for successful construction management to occurring during the construction execution stage. This purpose of this chapter is to present the findings from the international case studies on the preconstruction aspects of construction management. This chapter begins with a description of the general context of transportation in the countries involved in the scan to provide a better understanding of why some of their construction management practices exist. The remaining sections of this chapter detail the most important aspects of preconstruction planning for construction management. A discussion of staffing finds that many U.S. construction management functions traditionally performed by highway agencies are being performed by private sector partners abroad. Project delivery is the next point of discussion, and the scan team found a strategic application of multiple project delivery methods by international agencies, as opposed to the traditional one-size-fits-all

approach in the United States. Procurement turned out to be a major topic with all countries. The scan team found that international transportation organizations use many factors in addition to price when selecting contractors. The chapter concludes with observations on risk allocation and management. Examples of sophisticated risk analysis tools are presented and could have immediate application in the United States.

General Context

The general context of construction management involves the key aspects of how transportation construction management is positioned within the political, economic, and technological structure of a country. To adequately discuss international construction management procedures, it is important to understand such items as owner structure, market structure, market competition, contractor associations, funding structure, and the roles and responsibilities of the other primary stakeholders in the transportation life cycle in each country. Table 1 provides a link to the Web site of each transportation organization the scan team studied. Table 2 provides a summary of the various countries' characteristics that relate to construction management.

Although the environments vary, as seen in table 2, the international countries are surprisingly similar to the United States. All of the countries have a free market economy. Most have similar central government structures for funding, setting policy, and planning. All of the countries rely on private contractors for construction of capital facilities. The scan team also quickly realized that the drivers for change in Europe are similar to those in the United States. The most significant drivers of change confronting Europe include the following:

- Growing infrastructure needs
- Inadequate public funds
- Insufficient and diminishing staff
- Lack of innovation in addressing project needs
- Slow product delivery and delays
- Adversarial relationships

COUNTRY	LINKS TO TRANSPORTATION ORGANIZATIONS
Canada	Ontario Ministry of Transportation http://www.mto.gov.on.ca/english/index.html
Germany	German Ministry of Transport, Building, and Housing http://www.bmubw.de/ Bavarian Ministry of the Interior—Building, Highways, and Bridges http://www.stmi.bayern.de/english/highways Strassen NRW http://www.strassen.nrw.de/siteinfo/about.en.html
England	Highways Agency of the Department for Transport http://www.highways.gov.uk and http://www.dft.gov.uk
Scotland	Scottish Executive Enterprise, Transport, and Lifelong Learning Department http://www.scotland.gsi.gov.uk/About/Departments/ETLLD
The Netherlands	Ministry of Transport, Public Works, and Water Management (Rijkswaterstaat) http://www.verkeerenwaterstaat.nl and www.rijkswaterstaat.nl
Finland	Finnish Road Administration http://www.finnra.fi/index.htm

Table 1. *Links to transportation organizations involved in scan.*

- Cost overruns
- Claims-oriented environments
- Perceived lack of maintenance efficiency
- New European Union directives
- User frustration

Some notable differences that exist between the United States and a number of the host countries merit discussion. The level at which the central government participates in the development of specifications and designs varies. Germany exhibits the most control over plans and specifications in traditionally delivered projects, while England or Scotland may give the most latitude to the industry in this area. In the area of public-private partnership (PPP) projects, England has the most aggressive program with a target of 25 percent of the 10-year plan works dedicated to PPPs. It yields much of the design work to the private sector on its nonpublic projects, working to published standards or agreed-on deviations from these standards. With the exception of Scotland, all of the other countries have relatively little experience with private finance initiative/public-private partnership (PFI/PPP) projects. All of the other countries have relatively little experience with PPP projects.

The current U.S. system varies, but might be most closely related to the German or Dutch system of design and construction. The most significant difference between the host countries and the United States is the other countries' allocation of maintenance operations to the private sector. Germany most closely resembles the United States in that it maintains its

highway networks through government employees. The rest of the countries rely on the private sector for essentially all highway maintenance. This is accomplished through a series of term maintenance agreements in which routine maintenance and repair is done in accordance with performance contracts.

Staffing

Staffing and workforce issues affect agencies' ability to deliver and maintain transportation infrastructure. Agencies must maintain a high-quality staff to accomplish goals. U.S. agencies have traditionally maintained design and construction administration staff in-house to ensure quality and consistency. As U.S. transportation agencies shift from a new construction mode of operation to one of system preservation, much of the planning, design, and construction work is being outsourced, reducing the hands-on opportunities attractive to engineers and technicians.¹ Maintaining a high-quality staff is not only an issue for the highway agencies, it is also an issue for consulting firms that work with the highways agencies. The international agencies and consultants on the scan were asked about how they maintain quality staff, both in-house and with consultants, to meet agency goals and customer needs.

The international highway agencies are experiencing staffing issues similar to those found in the United States, and are dealing with it in several ways. No one solution exists for the amount of work outsourced to the private sector versus the work kept in-house. Table 3 (see page 9) provides a summary outsourcing analysis from the agencies

¹ For more information on staffing issues in the United States and abroad, see *European Practices in Transportation Workforce Development*, International Technology Program, Federal Highway Administration, Washington DC, June 2003.

	ONTARIO MINISTRY OF TRANSPORTATION	GERMANY	ENGLAND
Primary Funding	<ul style="list-style-type: none"> ■ About 95 percent of the funding is provided by the individual provinces, with 5 percent assistance from the Canadian government. 	<ul style="list-style-type: none"> ■ Funding is provided by the central government for 16 states (Länders). 	<ul style="list-style-type: none"> ■ Funding is provided by the central government and private funds through the Private Finance Initiative.
Owner Structure	<ul style="list-style-type: none"> ■ Provincial highway program ■ Ontario does not have a national highway system similar to the U.S. system. 	<ul style="list-style-type: none"> ■ States administer construction and maintenance activities for federal interstates and highways on behalf of the federal government. 	<ul style="list-style-type: none"> ■ The central government administers design and construction of the core network through the Highways Agency, which reports to the Secretary of State for Transport.
Market Structure	<ul style="list-style-type: none"> ■ Free market. ■ About 50 firms have road construction capabilities. ■ There are about 100 construction contracts per year with an average size of \$5 million to \$10 million and large projects of \$50 million. 	<ul style="list-style-type: none"> ■ Member of the European Union. ■ Free market. ■ About 3,500 firms have road construction capabilities. 	<ul style="list-style-type: none"> ■ Member of the European Union. ■ Free market. ■ About 25 to 30 major firms have road construction capabilities in addition to the smaller contractors.
Roles and responsibilities of the primary stakeholders in the transportation life cycle	<ul style="list-style-type: none"> ■ The provincial government finances and owns the transportation system with the exception of a new privatized road. ■ The ministry's role is primarily asset management, standard setting, and contract management. ■ Consultants are employed for design, testing, and construction management. ■ Construction contractors are an approximately equal split of both union and nonunion. 	<ul style="list-style-type: none"> ■ The federal government finances and owns the transportation system, interstates and federal highways, with the exception of a few tolls. State roads belong to the Länders, and link roads belong to administrative districts. ■ The states set construction specifications and supervise construction. ■ The states operate and maintain the network with the exception of tolls. 	<ul style="list-style-type: none"> ■ The central government finances and owns most of the transportation system with the exception of tolls and shadow tolls. ■ The central government sets the bidding parameters, and the agency sets construction specifications and supervises with consultant support construction of design-build contracts and PPPs. ■ The private sector maintains the roads through a series of term maintenance contracts and PPPs.

Table 2. Context of transportation in host countries.

SCOTLAND	THE NETHERLANDS	FINLAND
<ul style="list-style-type: none"> ■ Funding is provided by the central government for the national trunk road network with some private funds through PFI/PPP. 	<ul style="list-style-type: none"> ■ Funding is provided by the central government for the national highways. 	<ul style="list-style-type: none"> ■ Funding is based mainly on appropriations allocated in the annual state budget.
<ul style="list-style-type: none"> ■ The central government administers design and construction through the Department of Enterprise, Transport, and Lifelong Learning, which reports to the Scottish Executive. 	<ul style="list-style-type: none"> ■ The central government administers design and construction through the Ministry of Transport, Public Works, and Water Management. 	<ul style="list-style-type: none"> ■ The central government administers design and construction through the Finnish Road Administration, which reports to the Ministry of Transport and Communications.
<ul style="list-style-type: none"> ■ Member of the European Union. ■ Free market. ■ About 10 construction contractors typically work on major projects. 	<ul style="list-style-type: none"> ■ Member of the European Union. ■ Free market. ■ Contractors range from a few (five or six), large, internationally operating ones to about 6,000 small ones. 	<ul style="list-style-type: none"> ■ Member of the European Union. ■ Free market. ■ Five to six large national contractors and numerous smaller contractors.
<ul style="list-style-type: none"> ■ The central government finances and owns 3,500 kilometers of trunk roads, and 32 local authorities own about 50,000 kilometers of local roads. ■ The central government sets construction specifications and supervises construction of trunk roads using private sector or local authority agents. ■ The Scottish Executive oversees policy and legislation relating to Scotland's four toll bridges and two toll roads. 	<ul style="list-style-type: none"> ■ The central government finances and owns most of the roads in the state transportation system. ■ The central government sets construction specifications and supervises construction. ■ Use of PPPs is very small (less than 3 percent of state roads), with the state setting the policy on these roads and the use primarily being on major roads and tunnels with tolls or shadow tolls. ■ The private sector maintains the roads through a series of term maintenance contracts. 	<ul style="list-style-type: none"> ■ The central government finances and owns most of the transportation system with authority distributed to nine regions. ■ The central government sets construction specifications and supervises construction, with the exception of design-build contracts and a small number of PPPs. ■ The private sector maintains the roads through a series of term maintenance contracts and a small number of PPPs. ■ Private sector consultants are employed for testing, oversight, and spot-checking.

Construction management staffing has become a significant issue in U.S. highway agencies. State highway agencies are being required to build more with fewer staff. Historically, agencies have maintained design and construction administration staff in-house to ensure quality design and construction. However, increasing industry demand for engineers and technicians, more competition for workers, a large number of retirements, the need for broader skill sets, and different expectations of young engineers are making it difficult for some agencies to maintain an appropriate staffing level. For example, State DOT full-time employment has dropped 5.3 percent while budgets have increased 56 percent (FHWA 2003). Figure 3 shows a case study from the Michigan DOT. From 1974 to 1994, the agency’s full-time equivalent engineering staff dropped from about 5,200 to 3,200. At the same time, its expenditures more than doubled. While the Michigan example is somewhat extreme, U.S. highway agencies generally are being challenged to maintain appropriate staffing levels to meet their customers’ needs.

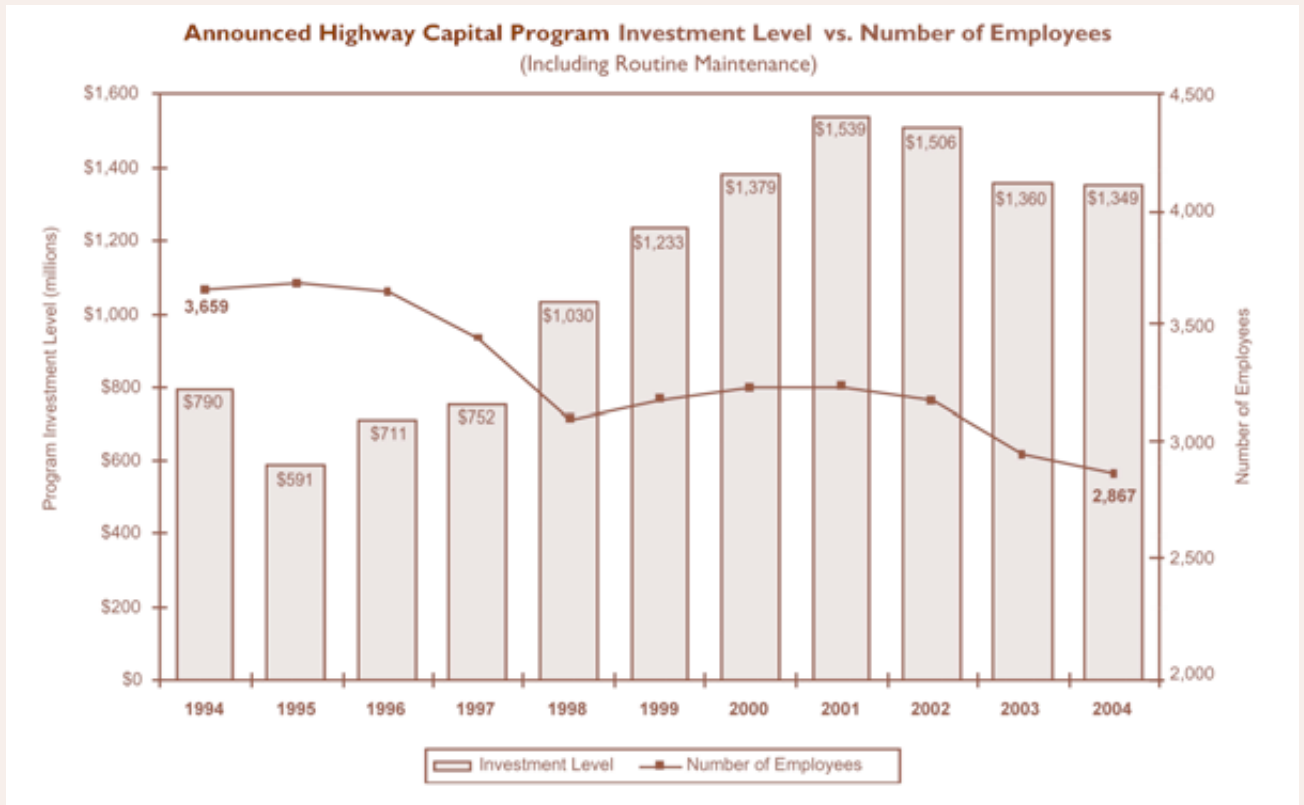


Figure 3. Example of staffing issues in the United States. (Michigan DOT)

involved in this scan. The first column of the table lists planning, design, and construction activities, which traditionally have been done with agency staff in the United States. The remaining columns list the approximate amount of work outsourced to the private sector. The percentages are only estimates provided by the international highway agency interviewees, but they provide a good reflection of the overall use of in-house staff versus consultants.

As seen in table 3, some international agencies are quite similar to U.S. highway agencies in their use of private sector consultants, while others have almost completely outsourced traditional highway agency functions. Germany and the Netherlands are most like the United States in their approach to design and construction staffing. They maintain a higher

level of in-house engineers to perform design and construction administration. The Bavarian highway agency in Munich, Germany, performs about 30 percent of its design for interstates in-house and about 70 percent for federal highways and state roads. No consultants are used for any aspect of project delivery, except for areas with highly specialized designs or extremely unique or difficult components. Germany also maintains its system with state staff, but it is the only country that still performs that function. The Netherlands is being downsized by almost 20 percent, primarily through retirements and phasing out of positions, but it recognizes the need to maintain expertise and involvement in the technical aspects of the program. It is maintaining areas of expertise in specialized areas such as bridges and tunnels. Finland has a relatively

Table 3. Construction management outsourcing analysis.

OUTSOURCING ACTIVITY	ONTARIO	GERMANY	ENGLAND ²	SCOTLAND	THE NETHERLANDS	FINLAND
Design	80-90%	30-100% ³	100%	100% ⁴	70% ⁵	100%
Testing	100%	50%	100%	100% ⁶	100%	100%
Construction	100%	100%	100%	100%	100%	100%
Construction Contract Administration	95%	0%	90%	100%	50%	0%
Maintenance	100%	0% ⁷	100% ⁸	100%	100%	100%

small agency staff, but it prefers to maintain construction management functions in-house. Finland has a goal of less government involvement in transportation projects in the future and is working on procurement strategies and longer-term agreements with consultants to support a reduction in staff from its current size of about 1,000 employees.

England and Scotland are perhaps the most different from the United States in their use of in-house staff. The Private Finance Initiative of 1991 and a series of other issues have led the Highways Agency in England to outsource 95 percent of its expenditures. It has only a small engineering staff in-house, and has changed from the role of providing engineering functions to overseeing them. The agency considers itself a network operator rather than a provider of engineering services. The scan team observed that the Highways Agency anticipates and is comfortable with losing technical expertise over time while focusing more on director/management expertise. Likewise, Scotland uses consultants or local authority agents for almost its entire planning, design, and construction needs.

✓ All of the international highway organizations involved in this research are experiencing a reduction in internal staff.

The Scottish Executive Transport Group oversees the country's entire highway operation with just over 50 engineering and 50 administrative employees.⁹ Before 1990, the Scottish Executive did more engineering in-house, but it has been transferring roles and responsibilities to the private sector in an effort to reduce staff. The Transport Group's staff is responsible for

management, maintenance, design and construction, standards, and procuring, accounting, and evaluating the delivery of projects and contractor/consultant performance.

Recently, Ontario has been moving toward the English and Scottish models. The Ministry of Transportation made a decision to outsource its operations in 1996. This decision was driven by an economic analysis. The government determined that the private sector could conduct the ministry's functions much more economically. The goal of this outsourcing was to gain a 5 percent savings. Officials stated that they have witnessed a 12 percent cost savings in these functions from 1996 to 2004 because of outsourcing. They still maintain a staff of about 2,400.

Generally, all of the international highway organizations involved in this scan are experiencing a reduction in internal staff and an increase in the use of consultants. Even the Netherlands and Germany, which as stated previously most resemble the United States in their approach to staffing, are changing. At the time of this report, the Dutch were reorganizing the transportation department to focus more on its core business, which they define as network management. This includes a change in staffing. New staff members will be incorporated, part of the present staff will be trained, and some will have to find new opportunities in other organizations. Rijkswaterstaat will downsize from about 11,000 employees in 2004 to about 8,000 in 2008. In Bavaria, staff declined about 18 percent (about 1,350 persons) between 1994 and 2004 to 7,000 at two motorway (interstate) head offices, 23 district road offices, and 42 motorway and 91 road maintenance depots. Bavaria continues to witness a staff reduction through fluctuation (meaning the agency is taking on fewer staff than

² 95 percent of the Highways Agency's expenditures go to private firms.

³ Road design totals 40 percent (the design finished before bidding, such as traffic analyses, dimensioning of road and traffic-joints, number of lanes, etc.), construction design 30 percent (the design after bid, such as preliminary calculation of statics, masses, costs, etc.), geotechnical survey 100 percent, final plans and quantities of construction 100 percent, statics testing/structural analysis 90 percent.

⁴ No design is done with government staff. Designers are also retained to monitor construction onsite.

⁵ By 2007, the Netherlands expects to do only 2 percent of design.

⁶ Contractor verifies testing through a client representative. Third-party United Kingdom Certified Testing (UKAST) contractors do this task.

⁷ In some Länders, maintenance activities are accomplished through a combination of the transportation agency and contractors with agency oversight.

⁸ Both maintenance operations and management of maintenance are outsourced.

⁹ Development of technical standards is funded by the Department for Transport and carried out by England for Scotland, Wales, and Northern Ireland, who participate in a review function.

it is losing through retirement). The agency also is experimenting with reforming the road administration to meet the challenges of the future. Bavaria has established a task force for implementing the A-Model, described in this chapter. Per directives from the German government, the agency is focusing this task force on delivering, operating, and maintaining the highway network. The task force is designed to operate like a typical business in the private sector with strategic planning, performance measurements, and audited financial statements. Administrative and operative centers are designed to generate a profit or essentially operate as nonprofit within budget, and have primary objectives to motivate staff, encourage innovation, and be result oriented and customer focused. While this is only an experiment, the team observed that Germany, like the other countries involved in this scan, is using the private sector more for functions traditionally done by highway agency staff in the United States.

The scan team was also interested in how international highways agencies maintain high-quality staff, both internally and in their consultants, to achieve their agency goals. Internally, the agencies have training programs similar to those of U.S. agencies. The Bavarian highway agency requires one week of continuing education per year. Technicians attend technical training courses annually. The U.K. Highways Agency uses mentoring programs for new entrants and promotions, as well as informal annual training requirements and refresher seminars to maintain a trained staff. In addition, the Highways Agency uses industry workshops and surveys to obtain feedback from the private sector and determine areas for staff and/or policy and procedure improvement, thereby letting its partners help determine the education and training needed. The Scottish Executive uses mentoring programs as well as informal annual training requirements to maintain a trained staff with effective management skills rather than technical experience and expertise, although it values its intelligent client role. The Scottish Executive obtains feedback from the private sector with informal discussions rather than formal surveys like the English Highways Agency. The Dutch are implementing an extensive training program for the new contract delivery programs that includes mentoring and in-house training. They have what most U.S. agencies would consider traditional technical training and seminars.

The international agencies involved in this scan are experiencing staffing challenges similar to those found in the United States. All of the agencies have experienced downsizing in staff over the past 10 years and an increased use of consultants for traditional construction management activities. For in-house staff, the agencies use training methods similar to those found in the United States. For consultants and industry partners, the agencies use a variety of what U.S. agencies might consider nontraditional project delivery, procurement, and quality assurance processes.

Project Delivery

All of the international agencies involved in this scan strive to use a balanced approach to project delivery. The scan team witnessed the entire spectrum of traditional and alternative methods, including design-bid-build, design-build, design-build-operate, and a variety of public-private partnerships. The team also observed a number of new methods that allocate more risk to the private sector and/or create more motivation for total life cycle maintenance and operation solutions from the private sector.

The purpose of this section is to describe the international project delivery methods found on this scan, specifically as they impact construction management methods. A brief discussion of delivery methods for each country is provided. One particularly interesting delivery method, the Highways Agency's Early Contractor Involvement method, is described in more detail because the scan team believes it is an innovation in project delivery that could promote better construction management practices. The project delivery methods are discussed in order, beginning with those that most resemble the traditional U.S. delivery method, including design-bid-build delivery with agency design and inspection, low-bid procurement, and unit-price contracts, as depicted in figure 4. For a more detailed description of project delivery methods in Europe, see *Contract Administration: Technology and Practice in Europe* (FHWA-PL-02-016).

Germany

German project delivery methods are the most similar to those found in the United States. Germany primarily uses a traditional design-bid-build system with a low-bid procurement,

GERMANY CANADA THE NETHERLANDS FINLAND SCOTLAND ENGLAND

Design-Bid-Build Delivery
Agency Design & Inspection
Low-Bid Procurement
Unit-Price Contracts

Design-Bid and PPP Delivery
Consultant Design & Inspection
Best-Value & Quality-Based Procurement
Lump-Sum & Incentive Contracts

Figure 4. Continuum of project delivery methods from traditional to alternative.

but it has a system to allow for alternate designs/proposals to be submitted at the same time as contract bid submissions (discussed later in this chapter). Design-build using source selection is used on a very limited basis for unique and special circumstances or in emergency situations. Germany generally maintains its facilities with public sector employees.

Germany plans to use two PPP systems—termed “Model A” and “Model F”—on federal roads within the next few years. Model A, expected to be implemented by 2006, will be used for improving existing facilities. Under this scenario, the contractor/grantee will be selected on a price, quality, and time basis, and will be responsible for design/detail, construction, financing, maintenance, and warranty. The owner/grantor will collect tolls and establish toll rates for heavy goods vehicles. The toll actually paid in the section the contractor is responsible for will be transferred to the contractor. However, the owner will not guarantee a specific traffic volume, so the contractor will carry the toll risk. In addition and in compensation for the missing car toll, the owner will provide a start-up fee. The contractor in Bavaria has an option to get maintenance work done by the owner (via the existing motorway (interstate) maintenance depots) on a time- and materials-calculated basis.

The first projects of Model F have been implemented. This method will be used for new routes in charging all kinds of vehicles. Model F is essentially the same as Model A, but the contractor will have more risk by being fully responsible for facility operation, maintenance, and toll collection for about 30 years. The PPP models will be used as pilot projects to fill in gaps in transportation networks and financing. The contractor will design, build, finance, and operate the project, and the owner will “pay” for the work by granting a concession.

For state roads in Bavaria, another PPP system will be implemented within the next few years. This model will be used on smaller but extensive projects to fill in gaps in the state road network more quickly than could be done by funding with regular budgetary means. The contractor will build and finance the project, but the owner will pay for the work over a 20-to-25-year term out of regular transportation funds because tolls or similar fees would not be practical. In this model, the owner will maintain the facility after completion, but the contractor will be responsible for repairs for 20 to 25 years. The idea is to minimize costs of construction and repair by joint responsibility.

Canada

The Ontario Ministry of Transportation project delivery methods closely resemble those used in the United States, except that much more of the design and management is outsourced, as described in the previous section. The primary delivery method is design-bid-build. The Ministry of Transportation has experimented with design-build delivery, but it found that design-build contracts for projects under \$20 million are too labor intensive for the owner at the request-for-proposal (RFP) stage, given its lean staffing. Although the development of

complete construction documents before procurement is a longer process, the agency believes it better fits its organizational structure. It recently completed outsourcing 100 percent of its maintenance functions. Also, Ontario has entered the embarked-upon project delivery through public-private partnerships (PPP), most notably on the \$1 billion, 69-kilometer 407ETR Highway. This has many unique features unlike any other PPP highway project in the world, and the PPP formed for this project set a new precedent in risk sharing in the building and operation of highway infrastructure in Ontario. The agency did not discuss the project with the scan team because it is not considered a significant delivery method for future projects.

An outlook for the Bavarian distribution of project delivery methods is provided in table 4. The design-bid-build method will continue to predominate for the next few years, with a slight increase in the use of concessions. The use of design-build and performance-based maintenance project delivery is not anticipated.

The Netherlands

The traditional project delivery method in the Netherlands is a design-bid-build system. Design is developed by a governmental engineering department, and construction is completed by contractors under the supervision of an engineering department. This system was standardized and functioned for about 25 years. The Netherlands, however, is making a major shift toward design-build in the next 4 years, as shown in table 5. The primary reason for this shift is a philosophy of risk shifting to the private sector. The government is also

DELIVERY TYPE	BAVARIA 2004	BAVARIA 2007
Design-bid-build	95—98%	92—95%
Design-build	0%	0%
Performance-based maintenance contracts	0%	0%
Concessions	0%	3%
PPP/DBFM	2—5%	2—5%

Table 4. Distribution of Bavarian project delivery methods.

DELIVERY TYPE	2004	2007
Design-bid-build	67%	2%
Design-build	5%	90%
Performance-based maintenance contracts	25%	100%
Concessions	0%	0%
PPP/DBFM	3%	>3%

Table 5. Distribution of Dutch project delivery methods.

downsizing Dutch public sector engineering staff in an effort to be more efficient. The Dutch have used design-build-finance-maintain and other forms of PPPs for two completed projects, but they have experienced high costs in construction, while maintenance and management of maintenance with traffic management may have become too fragmented. They plan to outsource their maintenance functions completely through performance contracts, as table 5 shows.

Finland

The Finnish Road Administration uses various forms of project delivery in the procurement of capital investments. The most common form of project delivery has been the traditional design-bid-build method, which accounted for about 75 percent of all projects by quantity and about 35 percent based on the total expenditure in 2002. Contract development has advanced toward more integrated methods, such as use of the design-build project delivery method, which accounted for about 25 percent of all projects by quantity and about 65 percent of the total expenditure in 2002. Similar to the United States, construction management at-fee and at-risk project delivery methods are seldom used.

In the future, new Finnish procurement methods will include more inclusive agreements with longer service periods and broader and more inclusive content, as shown in figure 5.

Quality standards will be subjected to end product specifications (functional or performance requirements), and will also include more outcome-based criteria. The agreements will make contractors or service providers responsible for quality control. This, in effect, will compel service providers to be responsible for production, monitoring, reporting, and overall quality requirements.

Scotland

All Scottish transportation projects are delivered with lump-sum contracts using design-bid-build, design-build, design-build-finance-operate, and public-private partnerships (e.g., toll road companies). About 70 percent of the program is delivered using the design-build method, which began in 1990. In some cases, the local authorities perform design and procurement functions for coordination purposes if competent staff is available. For projects under €5 million, Scotland primarily uses the design-bid-build process, with a lump-sum bid, and provides 100 percent plans to the prospective bidders for lump-sum project delivery. For projects over €5 million, Scotland uses several design-build processes and provides specimen/conceptual plans supported by statutory consents to prospective bidders developed by private consultants working for the Scottish Executive.

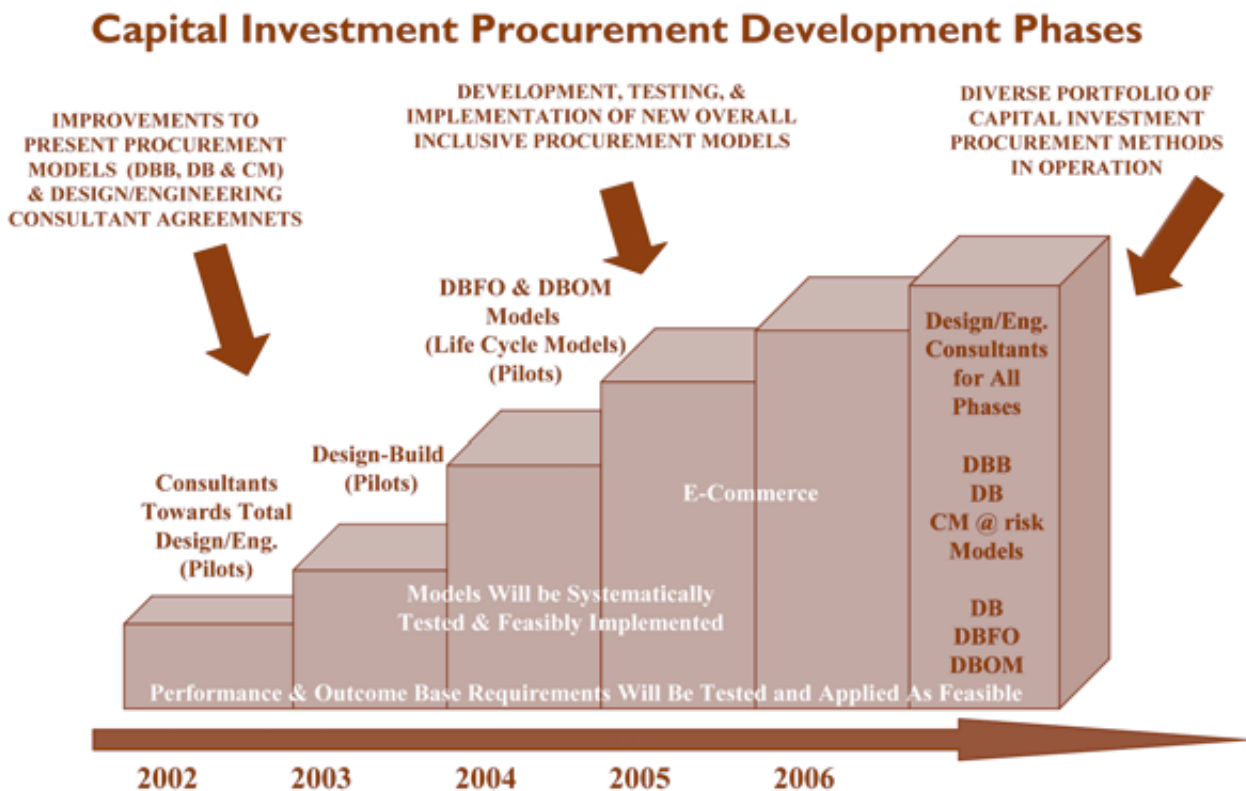


Figure 5. Future Finnish project delivery methods.

Since 1990, Scotland has shifted from traditional unit price design-bid-build to design-build. The owner's primary objective for changing project delivery methods was to transfer risk and responsibility to the contractor because of poor results of past contracts resulting in 30 percent price creep, compared with 9.5 percent for lump-sum bid contracts and 4 percent for design-build projects. Scotland is very satisfied with this shift to lump-sum and design-build delivery.

England

The Highways Agency's (HA) project delivery philosophy is the most different from the U.S. philosophy. It has made drastic changes from the traditional design-bid-build method of project delivery, which was its primary delivery mechanism until the early 1990s. The agency delivers the overwhelming majority of its services through third parties, in particular through contractors, maintaining agents, and consultants. It now uses longer-term agreements in project delivery that create partnership and life cycle-based solutions for its customers.

Highways Agency strategically applies a variety of project delivery methods that create partnership and life cycle-based solutions for its customers. Each of the basic delivery methods can vary because of funding sources, time of contract award, and other procurement or contract issues. The following are the five basic project delivery methods in use:

- **Design-build (DB)** contracts on current major improvement projects
- **Early design-build and Early Contractor Involvement (ECI)** as extensions of design-build on the most recent major improvement projects
- **Design-build-finance-operate (DBFO)** projects with payment mechanisms linked to the level of service to road users for selected contracts
- **Framework**¹⁰ contracts introduced for regional works projects and design services
- **Managing agent contractor (MAC)**¹¹ contracts for maintenance contracts implemented, including the first single point supply

The Highways Agency explains the impetus for this change in its publication *Delivering Best Value Solutions and Services—Highways Agency Procurement Strategy* (Highways Agency, 2001a):

A succession of major studies during the 1990s highlighted the inefficiencies of traditional methods of procuring and managing major projects, in particular the problems created by awarding contracts solely on the basis of lowest price. Experience has shown that this does not provide value for money in either the final cost of construction or the through life and operational costs. Relations over this

period between the construction industry and government departments were also often typically characterized by conflict and distrust, which contributed to poor performance particularly in the control of costs.

It is clear that change needs to be led by owners and they must demand better value and improved performance from suppliers. In return, owners must demonstrate that they will act as good employers and will procure work in a way that allows best value to be delivered and provides fair rewards for good performance. The Clients' (or owners') Charter plan operated by the Confederation of Construction Clients will be an important tool for owners to demonstrate their commitment to best practice.

A discussion of the implications for each of the Highways Agency's project delivery methods is not practical in this report, but many of the details are covered in *Contract Administration: Technology and Practice in Europe* (FHWA-PL-02-016), a report on the 2001 contract administration scan.¹² However, the scan team found the Highways Agency's Early Contractor Involvement (ECI) project delivery method of particular interest. The details of this method are not covered in the contract administration scan report because ECI was not yet developed in 2001.

The premise of the ECI delivery method is that traditional methods create the team much too late in the project development. Even in design-build delivery, the Highways Agency estimates that the design is at least 80 percent constrained and there is little scope for innovation and consideration of constructibility, including health and safety planning. In the ECI delivery system, design and construction professionals are selected early in the project development process through a qualifications-based selection process. They then develop an open book target pricing system in conjunction with the Highways Agency. A graphical depiction of the traditional versus the ECI delivery process is provided in figures 6 and 7 (see page 14).

The scan team visited the pilot for the ECI contract, the A500 Stoke Pathfinder project. It was named the Pathfinder project because it was a pilot project to test the early design-build process. A description of the ECI delivery, which has evolved from the early design-build process, is provided in the *Highways Agency Procurement Strategy* (Highways Agency, 2001a) and reprinted below:

Design and Build—Early D&B

The HA has delivered most major projects since the mid-1990s using design and build (D&B) contracts with most risks transferred to achieve greater cost certainty. The scope for contractor innovation has been limited

¹⁰ The framework contract is an arrangement that allows a purchaser to package its procurement requirements and select one or several suppliers to meet specific task(s) or order(s) over a period of time.

¹¹ In a managing agent contract, the managing agent is responsible for carrying out all design work, asset inspections, network maintenance management, and supervision of the term maintenance contractors. The term maintenance contractors are responsible for all routine, cyclical, and winter maintenance, and small capital maintenance and improvement works.

¹² The report can be viewed at <http://international.fhwa.dot.gov/contractadmin/contractadmin>.

because they have not been appointed until after the statutory planning stages that establish many constraints. In addition, improved price certainty has been sought by transferring risks, without giving full recognition to a contractor's ability to assess and manage the risks. This

approach does not always support partnership working if commercial pressures come to the fore. Improved value for money can be achieved by allocating risks appropriately, and price certainty delivered by managing the risks in partnership, supported by incentives.

The Traditional Approach

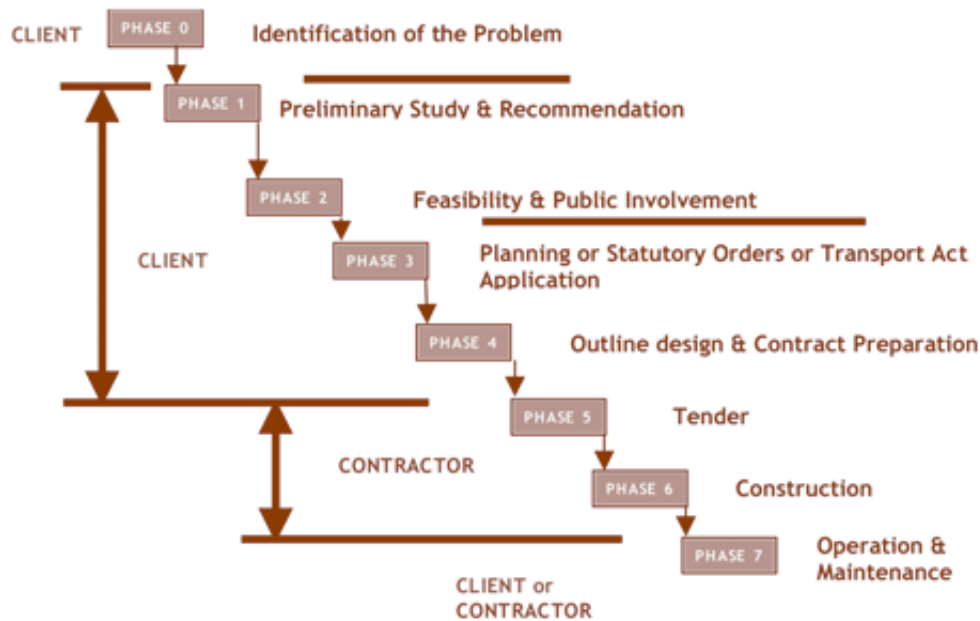


Figure 6. The Highways Agency's traditional project delivery approach.

Early Contractor Involvement

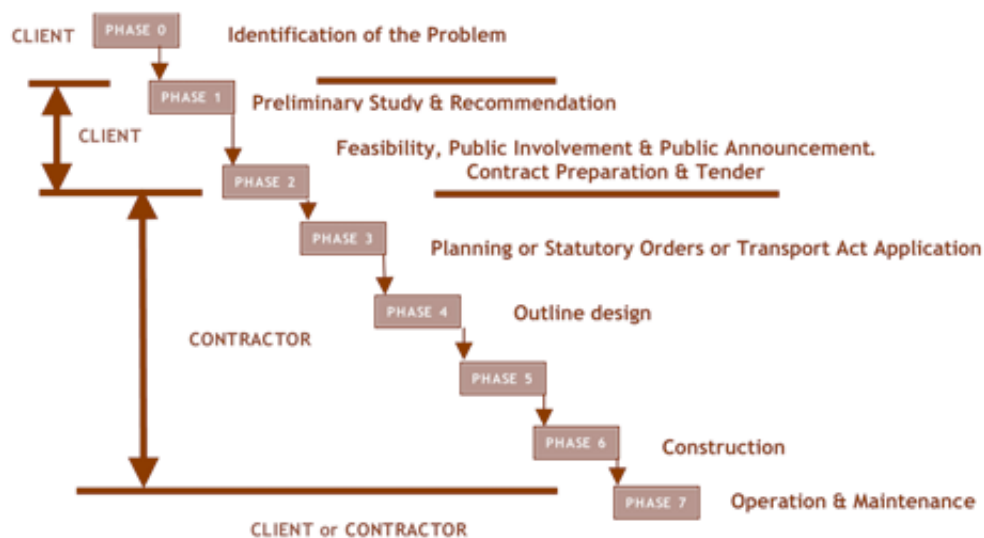


Figure 7. The Highways Agency's ECI project delivery approach as applied to the A500 Stoke Pathfinder project.

The earlier selection of a contractor offers considerable scope for better value, but it is important to get the right timing. The earlier it is, the more scope there is for the contractor to contribute expertise and innovation, but the time period to construction should not be too long. There would be a risk that if a contractor were appointed too early they would not be motivated to contribute their best staff. The long period before construction could also make it difficult to maintain enthusiasm and to retain key staff.

The use of project partnering arrangements on the HA's major projects in recent years has been beneficial in achieving mutual objectives for the particular projects. However, the procurement of major projects on an individual project basis means that the partnerships and the invested knowledge and experience of team members, can be lost to the client if there is no continuity of work. The lack of continuity also makes it difficult for suppliers to plan their resources and does not encourage the training and development of the workforce. This could be resolved by applying long-term relationships to the delivery of major projects.

Actions on Design and Build:

- For publicly funded major projects, the HA will normally use a new form of D&B contract, known as "early D&B," where the contractor is involved much earlier in the planning process. The contractor will be appointed as soon as possible after identification of the preferred route and well before the statutory stages which normally involve a public inquiry.
- The contractor selection process will be based largely on quality,

with the HA seeking to identify a supplier that has all of the right skills and who is considered most capable of working in partnership, to identify the optimal solution and to deliver it as efficiently and safely as possible.

- Suppliers will need to demonstrate good supply chain management practices as set out in this document. In particular, the relationship between the contractor and their designer will be very important and the HA will require designers to be adequately incentivized to deliver optimal solutions.
- The burden of tendering will be kept to a minimum by avoiding the need, as far as possible, for detailed design work during the tender stage.
- Pricing will be based on key cost components and a process to establish a target cost when the design is finalized. Target costs will be incentivized in a way that encourages continual improvement throughout the development of the project.
- Risk schedules will be developed with offerors as part of the quality assessment process and also to identify a fair allocation of risks to the parties best able to manage them.
- The HA will develop ways of entering into longer-term relationships with contractors on the delivery of major

projects to achieve the benefits which are being achieved on new maintenance contracts and framework arrangements. Options that will be examined will include frameworks and the packaging of projects into long-term programs.

The scan team found that the early design-build delivery method used in the Pathfinder project and the ECI process

✓ **Early Contractor Involvement (ECI) project delivery involves choosing a design-builder by best-value selection at the earliest stages of the project and pricing of the project through a target pricing mechanism rather than a lump sum.**

described above have substantially evolved from 2001 when the Pathfinder project started and the procurement strategy was published. The primary evolutions stem from a new procurement method called the Capability Assessment Toolkit (CAT), which is described in the next

section, and the application of target pricing instead of lump-sum pricing.

In the new ECI target pricing contract, HA tenders the project with only feasibility plans and selects a contractor/consultant through a purely qualifications-based procurement

U.S. PARALLEL STRATEGIC USE OF ALTERNATIVE DELIVERY METHODS

The Federal Highway Administration's National Highway Institute is developing a course on Alternative Contracting (Course No. 134058). Below is a short description of the course. More information is available at <http://www.nhi.fhwa.dot.gov/>.

COURSE OBJECTIVE

The estimated 2-day training course will teach participants how to select the appropriate projects for alternative project delivery strategies, choose the correct alternative contract provisions, and recognize the legal and programmatic implications associated with these techniques. The course design will be flexible, allowing the requesting agency to customize the presentation for increased emphasis on topics of interest to the agency.

The target audience will include FHWA, State, and local highway agency employees, consulting engineers, and design and construction engineers who work in project development, contract administration, and the management of highway construction.

The course is expected to cover some or all of the following topics:

Module I—Introduction

- Traditional contracting concepts
- Drivers for use of alternative methods
- Risk allocation, legal, and administrative issues
- Implementation

Module II—Project Delivery Systems

- Construction management (CM) at risk and agency-CM
- Design-build (and variations—operate-maintain, -warranty)
- Indefinite quantity/indefinite delivery
- Design sequencing
- Public-private partnerships (PPP)

Module III—Procurement Systems

- Cost+time bidding (A+B)
- Multiparameter bidding (A+B+C)
- One-/two-step best value (BV)
- Alternate designs
- Alternate bids
- Additive alternates
- Lump-sum bidding
- Negotiated or qualifications-based selection (for construction)
- Bid averaging
- Reverse auction bidding

process to complete the delivery team. When the contractor/consultant is hired, the project has an approved budget price. Through additional planning and design, the delivery team establishes a work estimate that becomes the contract target price. The target price is then fixed as the baseline price for the project from that point forward. Various mechanisms throughout the design and construction project allow the contractor/consultant to share in savings from this target price and participate in losses if an overrun is realized, thereby creating a pain/gain relationship. This policy is designed to motivate the contractor to assist with the most economical delivery option for the advance works not included in the contract target price.

Procurement

The European host countries' procurement processes vary significantly from those found in the United States, and these variances help promote construction management techniques that align project team goals with customer needs. In addition to low-bid procurement, the scan team found widespread use of qualifications and/or past performance in procurement, use of best value (price plus nonprice factors) in procurement, and the use of alternative bids in procurement. While the procurement process occurs before construction management in the project cycle, the scan team found that it is an integral part of construction management success. All of the host countries allow nonprice factors to be incorporated into contractor selection. These nonprice factors are used to align team goals with project goals and ultimately customer requirements. All of the countries, except the Netherlands, have the ability to use some form of past performance in the procurement. They noted that these processes are critical to the success of their construction management programs.

Use of Qualifications and/or Past Performance in Procurement

U.S. highway agencies are accustomed to using prequalification processes for contractors on an annual basis, but these processes are usually quite general and not typically used on a project-by-project basis. In contrast, all of the international organizations studied in this scan have the option to

- ✓ Contractors' ability to participate in the future will be affected by past work, either directly through a past performance rating or indirectly through an assessment of their qualifications and capabilities.
- ✓ The drawback is that the use of past performance in procurement can limit competition.

assess qualifications and/or past performance in procurement in some manner on each project. All of the countries cited their procurement processes as a critical element of success in their construction management systems. When discussing construction management issues of quality assurance/quality control, contract change

processes, environmental monitoring, etc., they frequently stated that contractors have incentives to perform these practices well because they know it will affect their ability to participate in future work, either directly through a past performance rating or indirectly through an assessment of their qualifications and capabilities. The Netherlands is the only country restricted by jurisdiction from using past performance criteria for selection, but it does use an assessment of qualifications in its procurements.

Although quality-minded contractors gain an advantage, the drawback to using qualifications and/or past performance in procurement is that it can limit competition. Traditional U.S. procurement is accomplished through an open bidding system, which provides opportunity for companies to compete for public dollars. Our highway system has been built, in most part, by relatively small contractors in a very competitive environment. Contractors win a project by being the low bidder, not through exceptional performance on past projects or possessing capabilities in line with a particular project's needs. The process can be very different internationally. The Highways Agency perhaps states this fact most succinctly in the Highways Agency Procurement Strategy (Highways Agency, 2001a):

Partnership approach based on long-term relationships

The HA has entered project partnering arrangements with its suppliers on major projects for a number of years. These have been successful and beneficial through the agreement of cooperative working arrangements to deliver mutually agreed common objectives. The HA is now seeking to develop longer-term partnerships with suppliers which allow successful teams to be retained and maximum use made of developed skills and invested knowledge.

Long-term relationships allow the supply chain to be involved in the development and planning of work programs and to deliver them more efficiently and safely. They also facilitate the recruitment and retention of the skilled resources needed to deliver the programs.

Selecting and Working with Suppliers

Issue

The new procurement strategy will result in a tendency towards fewer, better quality suppliers appointed on a long-term basis. It will be vital that the best suppliers are employed. There needs to be a clear understanding of what aspects of quality add real value to the service delivery and the requirements and procedures need to be consistent and transparent to suppliers.

Objectives

To ensure that the HA identifies and employs suppliers that can work in partnership to deliver best value services and solutions, and to incentivize good performance by fair rewards.

To select suppliers on the basis of the optimal combination of quality and price which for any particular service or project will achieve the delivery of best value.

To maintain a supplier base that is competitive and sustainable, and which is motivated to seek work from the HA and to achieve continual improvement.

The Highways Agency procurement strategy is perhaps the most different from those found in the United States, but it does provide an example of how international transportation organizations are striving to align project team goals with customer needs. The scan team found that Germany and the Netherlands have procurement systems that resemble those of the most progressive U.S. DOTs and the Federal sector. Scotland and Finland use qualifications in procurement because of their extensive use of design-build contracting. The Ministry of Transportation in Ontario has developed an innovative system that it uses to incorporate past performance and qualifications into procurement of both contractors and construction administration consultants.

Germany and the Netherlands use prequalification and past performance in procurement the least. Germany has no formal or annual prequalification processes, but the owner is very knowledgeable about its routine contractors' experience and abilities. However, the owner will informally request prequalification information with references before awarding difficult or large projects if it is not familiar with a contractor's experience. The references are contacted, experience/ability informally verified, and if acceptable to the owner, the project is awarded. Owners will also deny future bidding privileges if a contractor fails to perform or is not in general compliance with state policies and procedures.

The Dutch do prequalify contractors on a project basis, but they do not take past performance into account because they are restricted by law from doing so. Noncomplex projects are and will continue to be awarded to the bidder of the lowest price after an open call for offers. For more complicated projects, a prequalification (short listing) is done after an open call. The prequalification is based on competence, but generally not on ideas for the project. After the prequalification, the selection is done on the basis of price and either a preliminary quality plan and/or a design in the case of design-build work.

In Scotland, design-bid-build work is treated differently from design-build work. For design-bid-build work, all contractors must submit a standard prequalification questionnaire to be evaluated by the owner and be eligible to receive tender requests. For design-build work, all prospective bidders must submit a response questionnaire on a project-by-project basis, and the project is then awarded on a best-value basis as discussed later in this chapter. This is similar to most

States using design-build in the U.S. system, but some States—such as New Jersey, Ohio, and Pennsylvania—have procured design-build on a low-bid basis.

The Ontario Ministry of Transportation in Canada has developed a system to prequalify consultants and contractors called the Registry, Appraisal, and Qualification System (RAQS). The ministry uses an annual contractor prequalification system that is similar to many U.S. systems, but it is a little more reliant on past performance. All contractors are prequalified on a basis of financial status, performance appraisals, and infrac-

✓ The Ontario Ministry of Transportation in Canada has developed a system to prequalify consultants and contractors called the Registry, Appraisal, and Qualification System (RAQS).

tion reports at the end of each project (no interims), which establish an overall performance rating. The rating is maintained on a 3-year rolling average. All contractors must have a financial rating, which is based on assets and cash. Contractor's financial

statements are checked annually and audited on a random basis. Contractors can bid only up to their available financial rating, which is a function of financial rating, penalty adjustments, and work on hand in all jurisdictions and the private sector. Penalty adjustments are made for poor performance through an infraction process and contractor performance rating system.¹³

The Ministry of Transportation's use of consultants to perform construction administration is also relevant to this report. These consultants are selected on a combination of price, performance, and quality—20 percent, 50 percent, and 30 percent, respectively. The system developed for conducting this assessment is called the Consultant Performance and Selection System (CPSS), which develops a corporate performance rating (CPR). The following is a description of consultant selection taken from the *Consultant Performance and Selection System Procedures Guide* (Ontario Ministry of Transportation, 2003)¹⁴:

Introduction

Past performance is measured by a consultant's Corporate Performance Rating (CPR), which is the weighted-average of a consultant's appraisals over the last three years.

- Effective January 1, 2001, the ministry modified its consultant selection procedures to take past performance into account at the Expression of Interest (EOI) and at the Request for Proposals/Quotation (RFP/RFQ) stages. The objective is to improve quality of engineering and related services received and thereby reduce road user

¹³ The ministry's use of RAQS has enhanced its prequalification process and allowed it to completely eliminate performance bonding requirements for all construction contracts—saving about \$2 million per year (Minchin and Smith 1999).

¹⁴ See the RAQS Web site at <https://www.raqsa.mto.gov.on.ca/> (viewed July 2004).

costs and infrastructure life cycle costs. The revised consultant selection system is referred to as the Consultant Performance and Selection System (CPSS).

Corporate Performance Rating (CPR)

- Past performance is measured by a consultant's Corporate Performance Rating (CPR), which is the weighted-average of a consultant's appraisals over the last three years.
- Appraisals for all types of capital project consultant assignments are included to calculate corporate CPR for each consultant. The CPR of a consultant firm is calculated by the following equation:

$$\text{CPR} = \frac{3(\text{Avg. Yr. 1}) + 2(\text{Avg. Yr. 2}) + 1(\text{Avg. Yr. 3})}{6}$$

Avg. Yr. 1 = Average of all appraisals within the most recent 12 months

Avg. Yr. 2 = Average of all appraisals in 12 months prior to Year 1

Avg. Yr. 3 = Average of all appraisals in 12 months prior to Year 2

- The following applies for calculating CPR:
 - When a consultant assignment is completed, an appraisal will be completed for the prime consultant only. A prime consultant is defined as the party who has signed the legal agreement with the ministry. Appraisals will not apply to sub-consultants.
 - In the case of consortiums or legal partnerships, one overall performance appraisal rating for the assignment will be completed. This rating will apply to each

member of the consortium or partnership.

- The ministry's Registration, Appraisal and Qualification System (RAQS) automatically calculates CPR on a quarterly basis, for each consultant, using past performance appraisals (e.g., January 1, April 1, July 1 and October 1).
- Only "approved" performance appraisals are included in the CPR calculation. An appraisal is "approved" if the consultant signs off the Performance Appraisal Form or does not respond within the 30-day time limit (to request a formal review). In case of a request by a consultant for a formal review, the appraisal is not considered approved until the completion of the regional manager review stage or the Qualification Committee review stage, depending on how far the consultant chooses to proceed with the review.

CPSS Application at the Request for Proposals (RFP) Stage

- The RFP submissions, CPR and prices are scored out of 100 points max for each.
- The highest RFP score, the highest CPR and the lowest price each are assigned a score of 100 and the other values are pro-rated lower.
- Weights of 30 percent, 50 percent and 20 percent are applied to the RFP, CPR and price scores respectively and the scores are converted.
- The weighted RFP, past performance (CPR) and price scores are added, and the total is used to rank the applicants. The highest Total Weighted Score wins the assignment.

An example of the application of CPSS at the RFP stage is illustrated in the table below:

FIRM	RTP TECH. SCORE	SCORE OUT OF 100	WGHT. SCORE (30%)	PERF. RATING (CPR)	SCORE OUT OF 100	WGHT. SCORE (50%)	PRICE	SCORE OUT OF 100	WGHT. SCORE (20%)	TOTAL SCORE	RANK
A	635	100	30.0	3.6	94.7	47.4	78000	73.1	14.6	92.0	1
B	505	79.5	23.9	3.0	78.9	39.5	57000	100	20.0	83.4	4
C	552	86.9	26.1	3.2	84.2	42.1	69250	82.3	16.5	84.7	3
D	575	90.6	27.2	2.9	76.3	38.2	99130	57.5	11.5	76.9	5
E	545	85.8	25.7	3.8	100	50.0	94000	60.6	12.1	87.8	2

If the Total Scores for two or more consultants are tied, the consultant with the lowest price wins the assignment.

The Highways Agency is the most different from the United States in its use of qualifications and past performance in procurement, as demonstrated in the statements from its procurement strategy at the beginning of this section. It has the most structured approach to assessing and updating contractor performance ratings. It is the Highways Agency's intent to work only with selected contractors. They maintain a "long list" or general prequalification of contractors, and then selectively produce a project-specific "short list" to distribute work to multiple contractors in the marketplace to maintain a healthy level of competition. As seen in figure 8, companies are prequalified to the long list on the basis of financial standing and technical capability. For purposes of the short list, each company is assigned a "vendor rating" on the basis of its capability, past performance, and other strategic data. The Highways Agency Supply Chain Management Team considers issues such as current backlog and the possibility of over-dominance or over-reliance in the marketplace when making the short-list decisions.

To assist in a qualifications-based procurement, the Highways Agency has recently developed the Capability Assessment Toolkit (CAT). In essence, CAT is a system for contractors to assess their own capabilities, which are combined with a past-performance rating to develop a qualification-based score for procurement. CAT is a very structured qualifications assessment tool developed in consultation with the industry. The following is taken from the Highways Agency's description of CAT (Highways Agency, 2003)¹⁵:

Implementing the Procurement Strategy

As part of the ongoing implementation of the Procurement Strategy, the CAT has been developed by the Agency's Supply Chain Management Team to:

- Improve the consistency, transparency and robustness of the selection of offerors.
- Facilitate a program of supplier development aimed at improving the effectiveness of our suppliers.

The CAT has been developed in consultation with the construction industry and incorporates feedback gained from across the Agency's procurement practices.

The New Approach to Selecting Offerors

Under the new approach, offeror selection will be a high-level company assessment that will exclude detailed project issues. The aim will be to allow the best and most appropriate suppliers the most selection opportunities.

How Does the CAT Fit into the Procurement Process?

The new process will use standard selection criteria to pre-qualify suppliers (step 1) and then capability, past performance and strategic overview information to arrive at a tender list (step 2).

This process has been designed to reward the most capable and best performing suppliers, while maintaining competition in our supply base. It systematically increases the likelihood of success, by ensuring that the best and most appropriate suppliers are placed on the Agency's offeror lists. The process is consistent and transparent and allows suppliers to develop realistic and relevant improvement plans that respond to the feedback that they receive.

Data obtained from the CAT will initially be used in major highway procurement exercises, but will be applied to other work categories in due course.

The new two step process will be used to select suppliers for tender lists following receipt of expressions of interest.

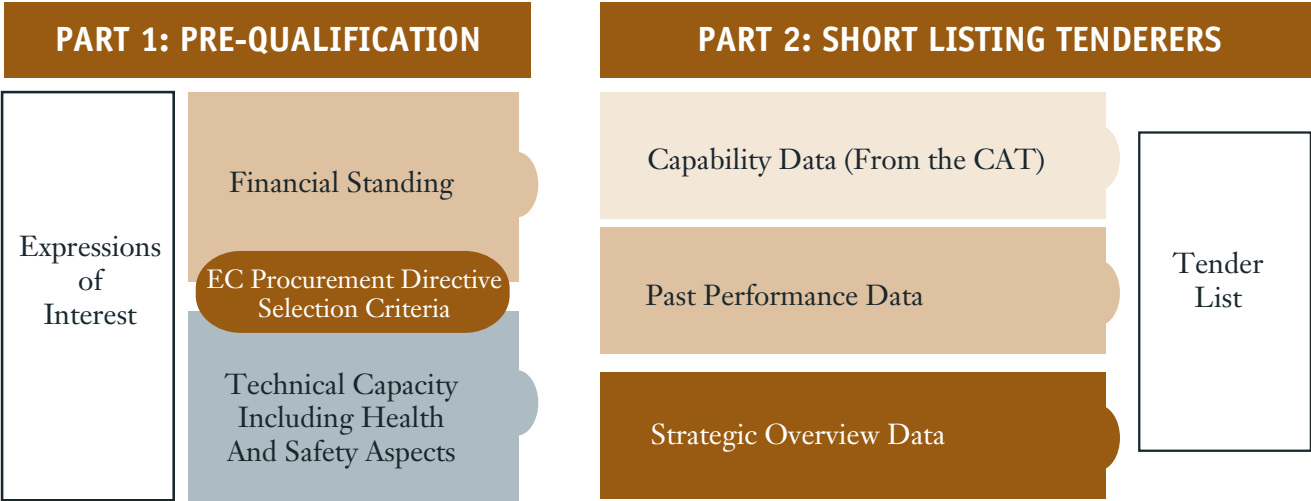


Figure 8. The Highways Agency procurement process. (Highways Agency, 2003)

¹⁵ The entire report can be viewed at <http://www.highways.gov.uk/business/procure/cat/index.htm>.

Step 1 Prequalification

During this step, suppliers expressing an interest are assessed as to their financial and economic standing and their technical capacity, including a strong focus on health and safety issues. Suppliers must exceed acceptability thresholds to prequalify.

Step 2 Short-Listing

A single set of validated capability scores will be held for each company on the Agency's procurement database. The scores will relate to the entire company and will normally be valid for a period of 12 months.

The validated capability scores will be used together with past performance and strategic overview information to arrive at the tender list.

This approach will:

- Reduce the time and cost of selecting offeror lists
- Reduce the number of repetitive actions that are part of the current process
- Increase consistency and transparency

Structure of the CAT

The CAT has been developed using the well-established principles that underpin a number business excellence models. The CAT considers what it is that companies need to do to be effective. It is structured as follows:

A Capability Attributes

1. Direction and leadership
2. Strategy and planning
3. People
4. Partnering
5. Processes
6. Internal resources

B Capability Indicators

For each attribute, three indicators describe features of the capability that could be demonstrated.

C Capability Level Descriptions

For each of the indicators there are five levels of capability, 0 to 4.

The documentation making up the toolkit (CAT) is in two main parts:

- Supplier self-score handbook
- Self-score framework of 18 sheets (1 per indicator) comprising:
 - Self-score proformas on front of page
 - Next steps proformas on reverse

The CAT process

The capability assessment process has two distinct stages:

- Supplier self-score
- Validation by client CAT practitioners

Self-Score Stage

Companies are asked to score themselves using a CAT self-score framework and guidelines and return those scores to the Agency's Supply Chain Management Team.

Validation Stage

A team of fully trained and briefed client CAT practitioners will spend time with the companies to validate the self-scores. The validated scores will be held on the Agency's procurement database and will be used in conjunction with past performance and strategic overview information to determine tender lists.

The U.S. transportation industry can benefit greatly from these examples of incorporating qualifications and past performance in procurement. While techniques in use by the international organizations involved in this scan may be prohibited by law in many States, the U.S. transportation industry can benefit from the experience of these organizations as we look to the future. The use of qualifications and past performance in procurement may allow the United States to improve current construction management techniques. There is opportunity for more efficiency, better team alignment and partnering, and products that better meet our customers' expectations. Changing to procurement systems like those discussed in this section will take an integrated effort between agencies and practitioners. The change will also take time to occur so that accurate data on past performance can be generated and professionals can align their business practices with agencies' overarching procurement goals.

Use of Best-Value Procurement

The use of best-value procurement was prevalent in all of the countries using design-build project delivery. A number of countries also use best-value procurement on traditional design-bid-build delivery. A best-value procurement process involves awarding a project on the basis of price and other key factors—not on the basis of cost alone. The other key factors should enhance the long-term performance and value of construction. Best-value procurement can use the qualifications and past performance elements discussed in the previous section, as well as allow for the proposal of management plans (safety, traffic, environmental, etc.) or technical solutions/designs that enhance the project.

Finland, England, and Scotland use best-value procurement almost exclusively. Germany and Ontario generally award construction contracts on the basis of low price, but they do have the options to use best-value procurement when project characteristics merit its use (e.g., design-build delivery, more technically complex projects, or when only a small number of contractors are available). The Netherlands uses best value more frequently than Ontario and Germany. The Netherlands uses it for all design-build projects and also on selected design-bid-build projects, particularly in conjunction with those projects in which it shortlists contracts.

Contractor prequalification/use of past performance information is not common in most State highway agencies. A number of States, however, have embarked on pilot programs, some of which use past performance data in procurement. In 2002, the AASHTO Subcommittee on Construction Contract Administration Task Force conducted a questionnaire on State DOT approaches for dealing with unsatisfactory contractor performance (time and quality). (See <http://www.fhwa.dot.gov/programadmin/contracts/>.) The results of this questionnaire show that the use of prequalification and past performance is fairly prevalent:

Question 7) How does the State use contract performance evaluation data (other than contract progress, for example: quality of materials, quality of the constructed product, quality of traffic control facilities, timely submittal of documentation, cooperation, safety compliance, public coordination, etc.)?

7a. Performance evaluations directly lead to an adjustment of prequalification capacity rating with the completion of every contract (explanations suggested)—7 (FL, GA, IA, IL, ME, MO, NE).

7b. Performance evaluations indirectly lead to an adjustment of prequalification capacity rating only when consistent or below-average performance is noted over several contracts—18 (CA, IN, KS, MI, MO, ND, NH, NJ, NV, OH, OR, PA, SD, UT, VA, WA, WV, WY).

7c. Removal from the prequalification list—15 (AL, IA, IL, IN, MO, NC, ND, NE, NH, OH, OR, PA, UT, VT,VA).

Question 9) Does your State have a contractor prequalification process?

Yes—34 (AL, AR, CO, CT, FL, GA, HI, IA, IL, IN, KS, MA, ME, MI, NC, ND, NJ, NE, NM, NV, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, VT, WA, WV, WY).

May be used on individual projects—(MD, MS).

The results of the survey show that a fair number of States do allow past performance to affect future work and that the majority do use some type of prequalification process. Only a few States, however, use contractor prequalification on individual projects as seen so prevalently in the international organizations. Missouri and Florida have developed contractor rating systems that parallel those found abroad. Information on their programs is available from the following Web sites:

MISSOURI

Rules of Department of Transportation, Division 10—Missouri Highway and Transportation Commission, Chapter 10—Contractor Performance Rating to Determine Responsibility, <http://www.sos.state.mo.us/adrules/csr/current/7csr/7c10-10.pdf>

FLORIDA

Construction Project Administration Manual, Performance Ratings, Section 13.1—Contractor’s Past Performance Rating, http://www.dot.state.fl.us/construction/manuals/cpam/CPAM70000000/New%20Clean%20Chapters/ch13s1_clean%20_Harper_.pdf



Figure 9. Common attributes of European best-value procurement procedures.

The goal of National Cooperative Highway Research Program (NCHRP) Project 10-61 was to recommend a best-value procurement method for U.S. highway construction. The resulting report outlines a comprehensive process that transportation agencies can use to create best-value methods in their individual States. The research effort investigated best-value concepts in use in the construction industry, evaluated their relative effectiveness, and recommended a best-value system or systems that may be used in conjunction with a traditional design-bid-build delivery system for highway construction. The recommendations parallel the best-value systems discovered in this international scanning effort.

The research products include the following:

- A common definition and conceptual framework for the use of best-value procurement methods for highway construction projects.
- A best-value procurement system that allows for flexibility in the choice of parameters and award methods.
- An implementation plan that includes a project screening system for selecting candidate projects, and a step-by-step process for selecting appropriate parameters, criteria, and award algorithms.
- Recommendations on models to use for legislation and procurement regulations.
- A compendium of case studies for best-value procurement in the highway construction industry.
- A training tool to assist agencies with implementation.

The results of NCHRP 10-61 are available at <http://www4.trb.org/trb/crp.nsf>.

The mechanics of the best-value processes varied by country, but all of the processes shared common characteristics. As shown in figure 9, the goal of a best-value selection is to balance cost with noncost factors to achieve long-term performance and value of construction for the public. All of the systems employ a two-envelope bidding (or proposal) system. The contractor submits a price proposal in a separate envelope from the technical (or qualifications) proposal. The technical envelope is always assessed (or scored) before the price proposal is opened. Opening the price proposal occurs only after the assessment of the technical proposal to ensure that the price proposal will not influence the assessment of the technical offer.

The criteria assessed in the technical proposal varied on a project-by-project basis throughout the host countries. Value can be added to projects through two general categories: 1) contractor qualifications or 2) contractor enhancements to the project. Contract qualifications are assessed through criteria such those discussed above. Contractor enhancements vary greatly, but can include time-related issues, design enhancements, traffic management plans, safety plans, environmental mitigation, etc. The owners choose these best-value parameters and create evaluation criteria from them on a project-by-project basis.

A key to success in best-value procurement involves the transparency of evaluation plans. Procurement documents must clearly convey how the evaluation criteria will be scored and how the cost and technical proposal will be combined. Transparent criteria and scoring methods convey to the contractors how they will be evaluated and what they should focus on in their proposals. These processes must be transparent to the proposers so that they know how to weight costs and efforts in their proposals. Procurement

documents must clearly convey the owner's project goals if the owner is to receive the best proposals.

The manner in which tradeoff analysis is conducted between the price and technical proposals varies by country and by project within each country. Some examples only employ two criteria of price and qualifications or past performance. If the lowest price comes from the highest technical rating, then the project is awarded to the lowest bidder. If the lowest bidder does not have the highest technical rating, then the agency performs a tradeoff analysis to determine if the higher technical scores provide the public with better long-term value. If it can be determined that better value is achieved from one of the higher technical offers, then the award is made to someone other than the lowest bidder.

The use of best-value procurement is very similar to the use of qualification and past performance in procurement. The international organizations examined in this scan deemed the procurement procedures to be essential elements in the success of their construction management programs. Best-value procurement, when employed thoughtfully and correctly, can undoubtedly help achieve alignment between project team goals and customer needs.

Use of Alternative Bids and Preproposal Meetings in Procurement

In contrast to the majority of U.S. design-bid-build projects, the scan team discovered widespread use in the countries visited of alternative bids proposed by contractors and design-builders. Innovations in design and construction management are being captured in the procurement phase—not as contractor-initiated change proposals after the contract is awarded. Confidential preproposal meetings are often conducted in conjunction with the use of

alternative bids to clarify concepts while maintaining competition. The scan team believes that more use of these two mechanisms will improve construction management procedures in the United States.

As previously stated, the German project delivery and procurement systems most resemble those in the United States. Even though Germany primarily uses a low-bid system, it does allow for alternate designs/proposals to be submitted at the same time as the contract bid submissions. Alternate proposals are evaluated on the basis of price, time, quality, functionality, and life cycle costs. Accepted alternates

✓ Confidential preproposal meetings are often conducted in conjunction with the use of alternative bids to clarify concepts while maintaining competition.

may be awarded even when higher than other base bid submissions, if determined prudent to the owner.

Scotland's project delivery and procurement practices are much more progressive than those found in the United States. Contractors may propose alternative designs meeting equivalent outcome requirements. The contractor assumes the risk for these changes. The Scottish Executive will promote variations to the statutory consents, but if additional right-of-way is needed, the contractor must acquire the additional property and transfer it to the Scottish Executive. When there are multiple jurisdictions involved in the project, the responsible agency must approve the changes. Scotland uses consultants to review technical competency of alternative proposals.

When using alternative bidding procedures, contractors or design-builders often need to ask the highway agency questions. Officials in the Netherlands, England, and Scotland discussed the importance of allowing for confidential discussions with bidders/proposers during the procurement process. They conduct these discussions in preproposal meetings. It is important that the proposers know that their design alternates will not be rejected. The alternatives are not necessarily accepted in these meetings because they cannot be fully reviewed, but proposers can discuss the ideas with the owners and know that their alternatives will not be rejected outright following bid submission.

Scotland's preproposal meeting is representative of what was found in this study. Scotland conducts confidential preproposal meetings with each short-listed bidder to validate compliance with contract requirements and/or indicate acceptance of alternate designs, which prevents nonresponsive proposals. This process is beneficial to both the owner and the contractor because they can correct any obvious errors or noncompliant proposal items before the bid, when it is the least costly to do.

Confidential meetings are imperative when discussing design alternates. Proposers must be confident that their ideas will not be shared with other teams, or they will lose any competitive edge from their innovation. This is different from

U.S. PARALLEL ALTERNATIVE PAVEMENT BIDS/DESIGNS

A number of U.S. highway agencies have developed procedures for allowing alternative bids and designs. Pavement and bridge structures are the two most common applications.

ALTERNATIVE PAVEMENT BIDS

A number of states are allowing competition on pavement types through the solicitation of alternative bids, including Louisiana, Maryland, Michigan, Missouri, Ohio, and Texas. Louisiana has developed and published the process listed below.

Louisiana Department of Transportation and Development *Agency Process for Alternate Design and Alternate Bid of Pavements*
<http://www.ltrc.lsu.edu/pdf/TRB2004-001293.pdf>

ALTERNATIVE BRIDGE BIDS

PennDOT has been using a "contractor furnished/alternate structure design" program since the early 1980s. This program has resulted in many innovations in both prestressed concrete and fabricated structural steel bridges over the past 20 years.

U.S. PARALLEL PREPROPOSAL MEETINGS

The use of design-build delivery on large projects in the United States has necessitated the creation of a process for preproposal meetings. Design-builders are often required to develop substantial designs in their proposals and need some assurance that their designs will not be rejected. "Alternative technical concept" review/approval procedures have been used effectively on large design-build projects to stimulate innovation and savings.

More information is available at the Web site of the AASHTO Joint Task Force on Design-Build. See Section 5.1 of the *Report on Current Design-Build Practices for Transportation Projects* at http://design.transportation.org/db_report.html. The Design-Build Contracting Final Rule also has provisions to allow alternative technical concepts in Federal 23 CFR 636.209. It can be viewed at <http://design.transportation.org/doc/DBrelatedCFR.htm#Sec.%20636.209>.

the process of written requests for information and issuance of addenda used in the United States. The meetings can be binding or nonbinding for both parties and are used to promote discussion with the team.

The use of alternative bids/designs and preproposal meetings sets a stage for efficient construction management

procedures. These mechanisms allow for team alignment to be developed early and project goals to be communicated. The international organizations involved in this scan view alternative bids/designs and preproposal meetings as integral components of their comprehensive construction management system.

Risk Allocation and Management

Risk allocation and management integrally affect the construction management process. Risks must be properly allocated to the team members who can best manage them. Contract clauses and construction management processes that create onerous risks for either the contractor or the agency will cause substantial project cost increases or even project failures. For proper alignment of team goals, risks must be allocated and managed with an open and equitable philosophy. Transportation agencies should strive to make project risks transparent to help ensure project success. Project team members should work together to mitigate or manage major risk items in a spirit of partnership and alignment toward customer needs.

The scan team explored risk allocation and risk management processes in the control of work on projects, including the relationships/responsibilities of the owner, consultants, testing services, prime contractor, and suppliers. Specifically, the international transportation organizations were asked how they identify and address risk in the construction process to ensure that legal and financial responsibilities are assigned to the appropriate party. The organizations were also asked how they manage high-risk issues (utility coordination, right-of-way procurement, environmental permitting, etc.) to eliminate or reduce their impacts.

The team found a variety of risk allocation and management strategies that directly related to the project delivery methods used in each country. As discussed in the project delivery section of this chapter, Germany and Ontario are the most similar to the United States in their delivery methods. Accordingly, they are also the most similar in their allocation of project risk to the contractor. England and Scotland allocate risks most aggressively to the private sector, but they also use project delivery methods such as ECI, design-build, consultant design and inspection, best-value procurement, and incentive contracts that allow contractors to best manage the risks. Table 6 (see page 26) provides a summary of the general risk allocation approach used in each country. Of course, unique project requirements may change the risk allocation strategy on any one project, but table 6 represents the overarching risk allocation philosophy of each country.

Risk allocation for design-bid-build contracts used in Germany, Ontario, and the Netherlands is similar to that found in traditional U.S. contracts. The agency retains the majority of risk involved with design, third-party coordination, and undiscovered work. The contractor is primarily responsible for risks encountered after design is complete and before maintenance begins. The contractor takes the risk for construction

permits, civil for temporary structures, and variation in costs of bid unit prices.

Risk allocation for design-build and design-build-finance-operate contracts is significantly different from traditional contracts. In these contracts, design-builders are allocated risks that occur during the course of design because they are directly in control of these risks as design is their responsibility. As shown in table 6, design of permanent civil structures is their responsibility, as is traffic control design. The agencies are also more willing to allocate or share third-party coordination responsibilities with design-builders because they have more control over when these elements need to be scheduled as a result of their design decisions. Because design-bid contracts typically use lump-sum pricing agreements, the contractor assumes the risk for overrun and underrun of anticipated material quantities.

The philosophy of the ECI contract is to promote team coordination early in the project development process. This philosophy is demonstrated through the large number of shared risk items. A shared risk implies that some portion of a risk is allocated to each party. For example, the Highways Agency assumes the major, or critical, risks involved with archeological finds, utility relocation, and changes in subsurface conditions. The risks for minor archeological finds, utility relocations, and changes in subsurface conditions are allocated to the contractor. Even the risk for cost overruns and underruns is shared in the ECI contract through the target pricing mechanism described previously in this chapter.

Some items vary by a country's general risk philosophy rather than by delivery method. These items include hazardous materials in the right-of-way, changes in subsurface conditions, maintenance of existing facilities during construction, and warranty issues. Scotland is notably aggressive in assigning these risks. U.S. highway agencies have generally determined that maintaining these risks will result in the lowest cost over the long term. By maintaining these risks, contractors should provide lower bids. Scotland most notably assigns these risks to the contractor in the belief that the efficiency of incentivized management of the problem by the contractor is more significant in determining costs and delays than the emergence of the risk itself. Contractors must bid contingencies for these risks in their prices, but the owner is assured of a fixed cost. The allocation of inflation costs for volatile products (e.g., fuel, cement, asphalt, etc.) and variances in insurance costs differed from country to country, much as it varies among U.S. highway agencies.

The scan team discovered an awareness of risk management not present in all U.S. highway agencies. England and the Netherlands discussed systematic tools they have developed to identify, analyze, and allocate project risk appropriately. The Ministry of Transport, Public Works, and Water Management in the Netherlands has developed the Public Sector Comparator and the Public-Private Comparator to help it select delivery methods and allocate contract risk

Risk Management

- ✓ The Netherlands has developed the Public Sector Comparator and the Public-Private Comparator.
- ✓ The Highways Agency has developed the Highways Agency Risk Management (HARM) tool.

in the early stages of project development. The Highways Agency has developed the Highways Agency Risk Management (HARM) tool. Both of these agencies dedicate staff to assist project teams in identifying and quantifying project risk using probabilistic techniques. They apply

the results to the selection of project delivery methods and appropriate allocation of project risks.

The PPP Knowledge Centre in the Netherlands has developed a Public Sector Comparator and a Public-Private Comparator. The comparators are financial modeling tools that allow for a comparison of delivery systems and total project cost of the project life cycle. The objectives of the comparators are to 1) provide insight on the total costs, income, and risks over the project life, and 2) create a benchmark to make a comparison with the final public-private partnership proposals.

The Public Sector Comparator presents a structured format to project delivery selection and risk allocation, which involves five modules:

- Module 1—Inception report
- Module 2—Crude Public Sector Comparator
- Module 3—Risk analysis
- Module 4—Supplementary financial considerations and sensitivity analysis
- Module 5—Final report

The system describes a process for the decisionmakers and gives insights from past application of the tool. The tool also provides sample checklists and guidance. One such checklist involves project risks. Table 7 is a list of project risks generated from the risk checklist and provided as an example in the comparator manual.

Upon completion of the risk analysis, any supplemental financial considerations are made and a sensitivity analysis is conducted. The sensitivity analysis is based on the modeling of cost and uncertainty in the risks and can be generated several ways, depending on the time and cost the agency wishes to invest. The Public-Private Comparator offers a more detailed discussion of the risk quantification and sensitivity analysis process. The following steps are offered in the Public-Private Comparator section on risk valuation:

- A. Develop a list of the risks.
- B. Categorize the risks.
- C. Determine the global risk allocation and make a selection of the most important risks.
- D. Estimate the size, impact, and probability of the risks.

Table 7. Example of risk determination from Dutch Public Sector Comparator.

RISK	RISK DESCRIPTION	EXAMPLE
Risk of unfavorable results of bidding process	Risk of unfavorable results bidding process	Few bidders, therefore high prices
Design risk	Probability of gaps in the design	Inadequate lighting
Risk of unfavorable ground and soil conditions	Probability of unfavorable ground and soil conditions	Archaeological finding
Risk of extra costs during realization phase	Probability of large accident	Damage to works
Risk of extra costs during realization phase	Probability of flooding	Inundation of works
Risk of extra costs during realization phase	Probability of protest demonstrations	Environmental protests that interrupt the works
Technical risk	Probability of problems with piling	Ground conditions differ from trial results
Risk of extra costs during exploitation phase	Probability of supplementary security requirements	Law requiring additional safety measures
Risk of extra costs during exploitation phase	Replacement investment sooner than planned	Faster deterioration of asphalt road surface

Table 6. General risk allocation by country and major delivery method.

RISK ISSUE	GERMANY	ONTARIO	THE NETHERLANDS
	DESIGN-BID-BUILD	DESIGN-BID-BUILD	DESIGN-BID-BUILD
Traffic Control Design	Owner	Owner	Contractor
Erosion Control Design, Permanent and Temporary	Owner	Owner	Contractor
ROW Acquisition	Owner	Owner	Owner
Environmental Permits	Owner	Owner	Owner
Construction Operations Permits and Clearances	Contractor	Contractor	Contractor
Hazardous Materials in ROW	Owner	Owner	Owner
Archeological Finds in ROW	Owner	Owner	Owner
Utility Relocation in ROW	Owner	Owner	Owner
Change in Subsurface Soils and Conditions (Minor and Major)	Owner	Owner	Owner
Third-Party Incidents Before Interim or Final Acceptance	Contractor	Contractor	Owner
Third-Party Incidents After Any Acceptance	Owner	Owner	Owner
Third-Party Communications on Project Activities	Shared ¹⁶	Not Asked	Owner
Maintenance of Existing Facility, Pavement, etc.	Shared	Shared ¹⁷	Owner
Maintenance During Winter, Nonwork Months	Owner	Owner	Owner
Civil for Permanent Structures	Owner	Owner	Owner
Civil for Temporary Structures	Contractor	Contractor	Contractor
Inflation for Volatile Products	Contractor ¹⁸	Not Asked	Owner
Variances in Quantities	Shared	Not Asked	Owner
Major Subsurface Unknowns	Owner	Not Asked	Not Asked
Work Associated with RR	Not Asked	Not Asked	Owner
Variances in Insurance Cost	Contractor	Not Asked	Contractor
Reparis/Warranty	Contractor	Not Asked	Owner
Latent Defects	Contractor	Not Asked	Owner

¹⁶ Third-party communications responsibility varies slightly with project type and project location.

¹⁷ Minor maintenance is performed by the contractor and major unplanned maintenance is performed by the ministry.

¹⁸ Germany allows for variation in the price of cement and steel on large-scale projects. In that circumstance, risk is shared.

THE NETHERLANDS	FINLAND	SCOTLAND	ENGLAND	ENGLAND
DESIGN-BUILD	DESIGN-BUILD	DESIGN-BUILD	EARLY CONTRACTOR INVOLVEMENT	DESIGN-BUILD FINANCE-OPERATE
Contractor	Contractor	Contractor	Contractor	Contractor
Contractor	Contractor	Contractor	Contractor	Contractor
Owner	Owner	Owner	Owner	Owner
Owner	Owner	Owner	Shared	Owner
Contractor	Contractor	Contractor	Contractor	Contractor
Owner	Owner	Contractor	Owner	Contractor
Owner	Owner	Owner	Shared	Contractor
Owner	Owner	Shared	Shared	Shared
Owner	Owner	Contractor	Shared	Contractor
Owner	Contractor	Contractor	Contractor	Contractor
Owner	Owner	Owner	Shared	Contractor
Shared	Owner	Shared	Contractor	Contractor
Contractor	Owner	Contractor	Shared	Contractor
Contractor	Owner	Contractor	Shared	Contractor
Contractor	Contractor	Contractor	Contractor	Contractor
Contractor	Contractor	Contractor	Contractor	Contractor
Contractor	Contractor	Contractor ¹⁹	Shared	Contractor
Contractor	Contractor	Contractor	Shared	Contractor
Not Asked	Not Asked	Owner ²⁰	Owner ²¹	Not Asked
Contractor	Contractor	Shared ²²	Not Asked	Not Asked
Contractor	Contractor	Contractor	Shared	Contractor
Contractor	Contractor	Contractor	Contractor	Contractor
Contractor	Contractor	Not Asked	Contractor	Contractor

¹⁹ Unless term contract of 5 or more years where inflation index is used.

²⁰ Major subsurface unknowns (e.g., those that render the original proposals physically impossible such as the discovery an abandoned mine) are bid on a unit-price basis once they are discovered.

²¹ Archeological risks are shared with DBFO responsible for minor discoveries and HA responsible for major discoveries.

²² Advance work by owner and coordination by contractor.

- E. Assess the interrelationships (and correlations) of the risks you have defined.
- F. Develop a risk matrix.
- G. Determine the probability distribution.
- H. Study any possible correlations.
- I. Calculate the value of the risks.
- J. Present the results.

The Highways Agency in England also takes a risk-based approach to project delivery and contracting. In recent years, it has developed HARM, which involves dedicated staff to assist project teams in identifying, quantifying, mitigating, and allocating risks appropriately early in the project life cycle. The team assesses risk in much the same manner as described above. Although the Highways Agency did not share a manual for HARM, it has a clear statement of fair risk allocation in its *Highways Agency Procurement Strategy* (Highways Agency, 2001a):

Fair allocation of risks

The HA has sought to improve the certainty of final construction project costs on certain contracts by the transfer of most risks to the contractor. This has been successful in improving cost and time certainty but it may not necessarily deliver best value as it comes at the price of a risk premium. A fair allocation of risks requires that risks are identified prior to the establishment of a contract. In addition, offerors need to be able to assess the potential consequence of a risk and to be able to include an appropriate risk

✓ In theory, best value is achieved by the owner paying for appropriate risk management measures together with the costs of dealing with the consequences of only those risks that actually occur.

allowance in the price bid. It is unlikely that a client will get best value if offerors have had to rely on guesswork if they have had inadequate information or if they will not be in a position to manage the risk. The outcome will be that the offerors will either

U.S. PARALLEL DESIGN-BUILD RISK ALLOCATION

As design-build project delivery continues to increase in the United States, so too does the awareness of appropriate risk allocation on these projects. The AASHTO Joint Task Force on Design-Build views this as a critical element of success for design-build projects. More information is available at Web site of the AASHTO Joint Task Force on Design-Build. See Section 10—Risk Allocation in the *Report on Current Design-Build Practices for Transportation Projects* at http://design.transportation.org/db_report.html. The Design-Build Contracting Final Rule also discusses the importance of risk allocation and management. See HWA DB Final Rule 23 CFR 636.114 and 115 at <http://a257.g.akamaitech.net/7/257/2422/14mar20010800/edocket.access.gpo.gov/2002/pdf/02-30428.pdf>.

guess too high or too low, neither of which scenarios will result in best value. The client will either pay too much or the quality of the product or service may be threatened by commercial pressure.

In theory, best value is achieved by the owner paying for appropriate risk management measures together with the costs of dealing with the consequences of only those risks that actually occur. However, the contractor and the supply chain are more likely to contribute to the effective and efficient management of risks if they have fair and reasonable incentives. The judgment required by a client is how much to pay for the transfer of a risk, and at what level it is judged better value to retain the risk and to pay any consequential costs. The HA will accept risks where suppliers are prepared to work in partnership to manage the risks and control the consequences.

The Highways Agency’s statement on fair allocation of risks mirrors the philosophy of the majority of countries. The value-for-money HARM process is an attempt to

U.S. PARALLEL WASHINGTON STATE DOT COST ESTIMATE VALIDATION PROCESS

To provide the public with better cost estimates and transportation engineers with more accurate predictions of project uncertainty, the Washington State DOT has developed a Cost Estimate Validation Process (CEVP®). CEVP is an intense workshop in which a team of top engineers and risk managers from local and national private firms and public agencies examine a transportation project and review project details with WSDOT engineers. Many participants have had extensive first-hand experience in large project programming and delivery.

The CEVP workshop team uses systematic project review and risk assessment methods to identify and describe cost and schedule risks, and evaluate the quality of the information at hand. The process examines, from the very beginning, how risks can be lowered and cost vulnerabilities can be managed or reduced. A dividend of CEVP is the promotion of activities that will improve final cost and schedule results. For more information on the CEVP process, go to <http://www.wsdot.wa.gov/projects/cevp/default.htm>.

operationalize this philosophy. Although the other countries share the philosophy of appropriate risk allocation, they do not all have resources such as dedicated staff, scientific risk assessment processes and tools, and delivery mechanisms that allow for the implementation of this philosophy. The Netherlands and England understand the need for the integrated approach to risk management and, although they are not completely standardized in their practices, they have a greater awareness and more strategic approach than typically found in the United States.

Conclusions

This chapter stresses the importance of the preconstruction aspect of construction management in project success. The scan team found that the international organizations involved in this scan rely on the private sector for many construction management functions traditionally performed by U.S. highway agencies. Project delivery is applied strategically and supports appropriate construction management methods. Procurement turned out to be a major topic with all countries. The scan team found that international transportation organizations use many factors in addition to price when selecting contractors. Finally, the team found sophisticated risk management strategies that tied all of the preconstruction aspects of construction management together. The scan team's summary observation is that the application of construction management methods begins before construction, and this is the time to begin aligning team goals with the customer's needs and requirements.

Construction Aspects of Construction Management

INTRODUCTION

Construction management involves the oversight of the physical construction of a highway project. Before any earth is moved or any pavement is constructed, contracts are written to define the roles and responsibilities of the parties involved. During construction, records are maintained to document quality and ensure contract compliance. Inspections are conducted immediately after construction is complete and at the end of the contract warranty period. For every project that is physically constructed, a project is built on paper through the construction management process.

The scan team found that international highway organizations tend to delegate many traditional highway agency functions to the private sector to promote efficiency and satisfy the client's requirements. The private sector partners of the international highways agencies involved in this scan do many of the construction management tasks traditionally done by State highway agencies in the United States. In conjunction with this delegation, contract payment methods are used that support alignment and trust. Quality plan implementation methods also support this delegation and alignment of goals. These construction management methods lead to long-term partnerships and collaboration between the public and private sectors.

The purpose of this chapter is to present the findings and observations from the international case studies on the construction aspects of construction management. This chapter begins with a description of construction administration, which discusses the management of construction contracts including responsibilities of administrations, progress tracking,

payment, and final project closeout issues. Quality plan implementation is discussed with an emphasis on how international organizations ensure high design and construction quality of the finished product. Managing the change process is extremely important to construction management success, and techniques used to substantiate the cost of changes and minimize changes are discussed. The next topic in the chapter is day-to-day record keeping for items such as progressive inspection, testing, progress payments, project closeout, and final audit. The final topics discussed are environmental monitoring and project maintenance requirements during construction.

Contract Administration

Contract administration involves the organization of day-to-day responsibilities for management of construction contracts, including the responsibility/authority level of contract administrators, tracking of project progress, project payment determination, project stoppage issues, and project closeout processes. The scan team found that although contract administration procedures varied by country and project delivery method, they could be used to align team goals and support partnership and trust. The team's primary findings on contract administration stem from 1) the delegation of traditional contract administration procedures to consultants, 2) contractor reporting of progress, and 3) innovation in payment methods that make construction administration more efficient while promoting team trust and alignment.

Contract Administration Roles and Responsibilities

Germany's contract administration methods most closely resemble those in the United States. Germany relies on public sector staff to track progress and authorize payments. Since the majority of its work is procured with 100 percent of the design complete at the time of award, it can rely on unit-price bids and direct monitoring of quantities to assess progress and make payments. Germany generally does not use consultants for contract administration.

Finland and the Netherlands are also similar to the United States in their contract administration procedures. They main-

- ✓ Payment methods support alignment and trust.
- ✓ Quality plan implementation supports alignment of goals.
- ✓ Construction management methods support long-term partnerships and collaboration.

tain significant public sector staffs to administer construction contracts, but as described in the Staffing section of Chapter 2, they are moving toward more consultant involvement in contract administration. They are also moving toward more design-build project delivery, as discussed in the Project Delivery section of Chapter 2. Today's practice is a mix of the traditional approach and the design-build approach with contract administration by public sector staff. Traditionally, intensive supervision was present on the construction site, making day-to-day reports. However, these countries have goals to move away from 100 percent in-house construction administration in the next 5 to 10 years, particularly as it pertains to nontraditional project delivery.

Ontario, Scotland, and England differ most from the United States in contract administration because of their use of consultants for traditional administration and their use of alternative delivery methods, which require nontraditional contract administration methods. The Ministry of Transportation in Ontario uses consultants for contract administration, as discussed in the Staffing and Procurement sections of Chapter 2. The consultant is responsible for determining compliance with the specifications. The contract administration consultants are hired at the same time as the contractor. They are viewed as an extension of the owner's staff, but they are subjected to rigorous performance reviews to ensure performance.

The Scottish Executive also uses a consultant to provide oversight and management of the contract. The consultant is referred to the employer's representative (ER). The ER monitors contractor compliance with the approved quality control plan. The ER also reviews technical proposals submitted by the contractor, and certifies achievement of milestones used for progress payments. The Scottish Executive also assigns an in-house project manager (PM). The PM is responsible for authorizing changes and managing risks retained by the Scottish Executive.

The Highways Agency uses consultants exclusively to perform contract administration tasks. For example, there are 14 management agent contracts (MACs) for the operation and maintenance of all roadways within an assigned geographic

✓ **Contract administration roles and responsibilities vary substantially, depending on staffing resources and project delivery methods.**

area. The consultants assume the traditional role of a U.S. State highway agency for contract administration, but they are private sector firms. They oversee all projects not considered major projects (less than £5 million). The MACs are long-term network management contracts of about 5 to 7 years. The Highways Agency uses a consultant as a department agent (DA) to oversee all major projects (more than £5 million). The consultant is selected early in the project development phase and assists in the fund bidding process and tender evaluation of the contractor's proposals.

The Highways Agency also establishes a department representative (DR) for major PPP/PFI projects who is the operational works contact for the DA.

As described above, contract administration roles and responsibilities vary substantially, depending on staffing resources and project delivery methods. Consultants are used almost exclusively in the role of contract administrators by England, Scotland, and Ontario and to a lesser extent by Finland and the Netherlands. The procurement of consultants for contract administration tasks occurs early in the project in England, but not until the time of bidding in Ontario.

Progress Reporting and Payment Methods

The scan team was interested in exploring methods of measuring work progress and the basis for determining the payment amounts. The team was particularly interested in how dollar amounts are determined when calculating acceleration costs,

Measurement of Progress

- ✓ Plan quantity
- ✓ Incremental milestones
- ✓ Ultimate completion

Payment Methods

- ✓ Unit price
- ✓ Lump sum

liquidated damages, incentives, and disincentives. The team discovered that contractors self-monitor progress and agencies take an audit role more often abroad than they do in the United States. The team also found a series of innovative payment techniques

that streamline the reporting and payment process, such as milestone and lump-sum payments. The methods are being used to align the team to project goals.

The scan team found a full spectrum of progress reporting methods, including measurement of progress by detailed plan quantities, incremental milestones, or ultimate completion of work. These progress measurements were tied directly to the payment methods. In all of these cases, the contractor did more self-monitoring of progress than we see in the United States. The owners do audit these progress payments carefully, and the use of milestone or lump-sum payments makes monitoring of contractor progress much easier.

In Ontario, the contractor is responsible for submitting invoices for completed portions of work. Many items are plan quantity or lump-sum items. Examples include all electrical items by lump sum, structures by lump sum, and grading by plan quantity. Contractors are experimenting with hot mix asphalt by tonne. The traditional method of monitoring progress in the Netherlands is to have the owner determine progress after measuring the work in the field. In the Netherlands' approach to design-build and its increasing use of consultants on traditional projects, the contractor has to report on his own progress. Progress has to be checked on an internal but independent quality system. Payments are made based on the contractor's reports and controls of his quality system on different levels (system, process, products, etc.). In Scotland, payments are made on a vertical and horizontal measurement basis

Design-build in the United States primarily uses lump-sum and milestone payments rather than the traditional unit-price payment method. Since many of the individual quantities are not known at the time of award in a design-build project, unit-price payments are not feasible. The agency and design-builders agree on a milestone payment system (or schedule of values) early in the project, and use this system to monitor progress and make payments throughout the project. For more information, see Section 7.1 of the AASHTO Joint Task Force on Design-Build *Report on Current Design-Build Practices for Transportation Projects* at http://design.transportation.org/db_report_7.html.

Lump-sum methods are also in use for design-bid-build delivery. The Florida DOT has developed lump-sum project guidelines for traditional contracts, available at <http://www.dot.state.fl.us/rddesign/updates/files/v1chap22.pdf>.

for achievement of project milestones corresponding to a schedule of prices provided by contractor.

For measured items in England, the contractor submits measurements of the portion of works completed, and the contract administration consultant verifies that portion. The contractor is responsible for tracking work completion and providing a certification of compliance upon completion of the work. The consultant (DA) audits progress on PPP/PFI projects for the Highways Agency. Possible remedies for nonperformance range from noncompliance reports to warning notices.

The scan team found that incentive and disincentive methods vary substantially by country, but they generally are based on time or congestion. Liquidated damages for late completion and incentive payments for early completion typically are not used in Germany. Liquidated damages are used in the Netherlands, Finland, and Scotland, but the interviewees said that they were not employed very often and they typically do not use incentives for early completion. Incentive payments for early completion are used more frequently in Ontario. As a rule for time incentives, contractors capture about 75 percent of the available incentives. The Ontario Ministry of Transportation is satisfied with that percentage because it believes that meets the goal of setting an incentive to meet time requirements. The ministry establishes incentive payments based on what it believes will be required to accomplish its objectives. The ministry has developed detailed models for road user delay costs.

DBFO projects rely more heavily on incentive/disincentive payments. In Scottish DBFO contracts, the pressure is considerable to complete the project on time because the Scottish Executive does not make full payments until the roadway is complete and ready for use. In the case of the GSO/M77 project, which the team visited, it was reported that the consortium's financial group established a liquidated damage of £1 million per month to ensure the contractor completes the project on time. For DBFO projects in England, the Highways Agency bases payment on more recent contracts on levels of congestion and safety, but it bases payment on previous contracts on shadow tolls (based on traffic flow figures).

This creates an incentive system for payment.²³ However, the project must meet basic condition requirements before the payment is determined. The contractor proposed the data collection process to measure congestion and safety, and the Highways Agency established the payment schedule. If speed and traffic volume meet certain conditions, a bonus is possible. Congestion (based jointly on speed and volume) is 95 percent of payment, and safety (reduction of personal injury rate) is 5 percent.

Subcontracting

The scan team explored approaches relating to limitations on subcontracting, such as self-performance requirements by the prime contractor, maximum, and subcontracting. The team found very few restrictions on subcontracting in the countries studied.

Many U.S. highway agencies have a minimum percentage of work that the prime contractor must perform itself. This gives the owner confidence that the prime contractor will be in charge of quality and finances, rather than subcontracting all of the work. In Ontario, prime contractors must self-perform 40 percent of the original contract value, with some exceptions for specialty items. Germany requires the prime contractor to perform 30 percent of the work on Federal projects, and 70 percent of the work it is capable of performing. The Netherlands has no subcontracting limitations as we are accustomed to in the United States, but it does require in-house skills during procurement of subcontractors and some subcontractors need approval (particularly those involving high-tech skills). Scotland, Finland, and England have no subcontracting limitations. They generally do not see prime contractors attempt to subcontract the entire project, so they do not view it as a problem. Scotland did state that the prime contractor cannot subcontract the project management portion of the project.

Germany is the only country that maintains direct approval of subcontractors. The other countries rely on the prime contractor's internal selection system. They also rely on the fact that the prime contractor will be evaluated for performance

²³ For more information on congestion-based payments in the Highways Agency, see *Contract Administration: Technology and Practice in Europe* at <http://international.fhwa.dot.gov/contractadmin/contractadmin>.



Figure 10. *Electronic license plate reader system on construction project.*

Arizona DOT implemented a form of incentives/disincentives for congestion in its State Route 68 design-build project. ADOT used a contractual provision that required the design-builder to measure speed consistency and performance through the 20.9-kilometer (13-mile) construction work zone. The contract provided for a \$400,000 travel time budget item that was drawn against if the target travel time average was exceeded. Contractual incentives and disincentives were implemented for performance above or below the contractual standard.

The design-builder elected to deploy an electronic license plate reader system developed by Computer Recognition Systems, a British company. This system used a camera and a light source to capture license plate images of passing vehicles. The license plate number was taken from the picture by image recognition software, encrypted, and sent to the central computer at the contractor's office through a high-speed data connection. A second camera at the end of the project took a second picture, encrypted that license plate number, and sent it to the central computer. The central computer attempted to match up license plates that entered and exited the construction project limits.

The travel time incentive program was not very visible to the traveling public, but it is still enjoying the benefits. Because of this contractual provision, the contractor made great efforts to limit the delay to people traveling the corridor. The contractor made sure to limit the number of flagging stations throughout the project and scheduled work in such a way that it reduced impacts on the public.

For more information, go to <http://www.tfbrc.gov/pubrds/02may/01.htm>.

based on the work of its subcontractors. They rely on the past performance and prequalification systems described in Chapter 2. Ontario, for example, has no required approval/prequalification of the subcontractors, but some of the major subcontractors are prequalified as a function of being in the rating pool as prime contractors and prime contractors are being evaluated on the work their subcontractors perform.

Quality Plan Implementation

The traditional design-bid-build delivery system in the United States has generated construction specifications with detailed quality control requirements. Quality assurance historically has

- ✓ The scan team found that quality control and quality management plans are developed primarily by the contractor.
- ✓ Reliance on International Organization for Standardization (ISO) methods is heavy.

been performed by State highway agency staff. Only recently have contractors been allowed to develop their own quality control plans. The scan team explored how international organizations develop and execute formal quality control plans, and specifically who is responsible

for the plans. The primary method used to assure that materials meet contract requirements was also explored. The scan

team found that quality control and quality management plans are being developed primarily by the contractor. There is a heavy reliance on International Organization for Standardization (ISO) methods, and contractors can be rated on their quality management plans before project award or through postproject reviews. Most countries pointed to their use of qualifications and past performance in procurement as remedies for dealing with substandard work.

Quality Plan Development

The scan team found that quality control and quality management plans are developed primarily by the contractor. All countries except Germany noted that contractors have a significant level of input into the quality plan development. In Germany, the owner specifies the required quality control in the contract in a similar fashion to the majority of U.S. highway agencies. All of the other countries require ISO 9000 (or 9001) certification, and contractors must develop the project quality plans in conjunction with their companies' certified quality procedures.

Ontario has evolved toward use of more contractor quality control since the 1990s and, as previously noted, also relies on consultants for administering quality assurance. The evolution has involved prioritization and increasing responsibility of the contractors. Initially, Ontario required specific quality control plans for each contract, which was described in a

comprehensive specification. However, this was very labor intensive to develop and review. Later, Ontario evolved to a generic quality control plan and required an appendix to address specific project requirements. Now it requires contractors to have a quality control (contract compliance) plan for prequalification.

In the Netherlands, and similarly in Finland, the contractor is responsible for developing its own quality plan in accordance with its ISO-certified processes. Only the table of contents is prescribed in the contract documents. Each contractor submits a quality control plan. The quality plan of the selected contractor needs approval by Rijkswaterstaat before the design or building process starts. Contractors are responsible for showing how the completed work meets the quality levels (prove the quality). Daily records are available for review, as well as other project quality documentation. Copies of the documentation are provided upon completion of the work.

The Scottish Executive has the contractor propose its quality plans in the procurement of its design-build projects. The Scottish Executive provides a specimen design that includes the basic footprint for the project. The contractor is selected on the basis of the quality of the proposal meeting a prespecified threshold, the lowest price, and an evaluation of how the time taken for construction impacts the public. Contractors are required to be ISO certified. They must develop and comply with an established quality control plan. They also require the subcontractors and suppliers to provide an accepted quality control plan. The contractor's designer also observes the work and certifies that the completed work complies with the design requirements.

Contractors in England are also required to be ISO certified. They are required to use both an internal business quality assessment process and to establish a project-specific quality control process. The Highways Agency uses the Capability Assessment Tool (see Chapter 2) rating, which is based on the technical and financial capabilities and previous experience for each contractor. The DA can observe all quality control activities and documentation prepared by the contractor. The DA does not duplicate the testing. The contractor provides a certificate of completion to the DA that documents that the work is acceptable and meets design requirements.

Materials Testing

Materials testing generally follows the contractor's proposed quality plan and uses a variety of methods, including acceptance (assurance) tests completed as work progresses or as end result measurements to assure that materials meet contract requirements. Germany has the most prescriptive testing procedures, while England and Scotland have the most end result-based procedures.

In Germany, the State periodically observes contractors' quality control activities. The quality control activities are specified in the bidding documents. Suppliers must certify their products. A contractor must supply a complete set of documentation of its testing and certification to the State.

U.S. PARALLEL CONTRACTOR QUALITY MANAGEMENT

PENNDOT MATERIAL LAB ISO CERTIFICATION PROGRAM

The Pennsylvania Department of Transportation obtained ISO 9000 certification of its materials testing laboratory in April 2002, followed by the construction unit of Engineering District 10 in June 2002. Several maintenance units at district engineering offices have attained ISO 14001 certification, and all districts expect to be certified by the end of 2005. These achievements are the first steps to raise the awareness of certification and quality in the industry. PENNDOT is now considering certifying other areas, such as additional district construction and design units, and is also looking at certifying the asphalt pavement supply line process. PENNDOT hopes to expand this quality initiative across all partners to incorporate more accountability and capability to produce a high-quality end product.

For more information on PennDOT's ISO certification program, visit <http://www.dot.state.pa.us/PENNDOT/news.nsf/0/6c4bbcf3a0b9026f85256c1a0>.

Also, the contractor generally must warrant the work for 5 years. If defects are identified, the contractor must perform an investigation to determine the cause and generally is responsible for any defects.

Ontario uses a combination of end result and acceptance tests as work proceeds. Acceptance is based on a contractor's quality control tests. Most tests are performed during the process rather than on the completed work. Generally, quality assurance test results are not immediately shared with the contractor. Officials said this is to avoid contractors depending on quality assurance test results to control their process. The Ministry of Transportation in Ontario uses a private lab to perform quality assurance testing. The ministry tenders for lab services by at least two test labs per provincial region. These are 3-year tenders to provide continuity. The

U.S. PARALLEL DESIGN-BUILD RISK ALLOCATION

NCHRP 10-58(02)

The National Cooperative Highway Research Program is conducting a study on using contractor-performed tests in quality assurance (NCHRP 10-58(02)). The objective of the study is to develop procedures to assist State DOTs in effectively using contractor-performed tests in the quality-assurance process. The final report is due in 2006.

For more information on the project, go to [http://www4.trb.org/trb/crp.nsf/All+Projects/NCHRP+10-58\(02\)](http://www4.trb.org/trb/crp.nsf/All+Projects/NCHRP+10-58(02))

contractors also use qualified labs for the quality control tests. A reference lab is available if differences in test results exceed an established threshold.

In the Netherlands and Finland, contractors are primarily responsible for ensuring that the materials meet the required quality levels, and they provide certifications and test results. Tests are conducted as work progresses. All work is subject to owner review, but separate tests normally are not conducted. The set of checks by the owner consists of a mixture of system checks, process checks, and product checks. Most tests are standardized and the contractor has to use the standards. Most standards are legally enforceable. A mix of acceptance tests can be implemented, mostly during the work progress.

In Scotland and England, the contractor performs the required tests at the frequency required by the tender documents and documents the results. The documentation is available for review by the PM or ER in Scotland and the DA or DR in England. Any nonconforming results or work must be reported on a noncompliance report.

Remedies for Nonconformance and Substandard Work

When asked about the remedies for nonconforming work (not meeting a standard) and substandard (unsatisfactory) work, most of the countries pointed to their use of qualifications and past performance in procurement (see Chapter 2). However, a few specific examples for dealing with these items in the course of the project were cited, the primary method being to withhold payment.

Ontario uses a combination of contract reductions for price adjustment based on quality, and contract administrator-determined reductions for nonconforming work. The ministry reserves the right to have unsatisfactory work removed. All work in Ontario has a 1-year warranty, but officials said this is not often invoked.

In Germany, the construction supervisor observes work, noting and documenting deficiencies. The work is determined to be acceptable before payments are made. Payment deductions and charges for abatement are allowed up to the extent of complete new construction.

In the Netherlands and in Finland, the contractor is responsible for rebuilding the work to bring it into conformance. Negative price adjustments are possible, but rarely used. Instead, these agencies prefer to rely on their extensive use of quality criteria in their prequalification and procurement programs.

In Scotland, nonconformities are reported on nonconformance reports and must be addressed before project completion. The Scottish Executive does not dictate how contractors must correct deficiencies, but it assures that the deficiencies are addressed. The Highways Agency system is similar for design-build projects, with the contractors' incentive being to maintain their KPI score so they will be offered future work. For DBFO projects, the emphasis is on proactively addressing all concerns early in a partnering environment. The funding

companies will get involved quickly if the DA indicates performance issues are occurring. The Highways Agency also has a formal system of actions, notifications, and remedies.

Contract Change Processes

Given the complexity of designing and constructing a highway project, contract changes are virtually inevitable. Managing the capital construction of highway projects requires the coordination of a multitude of human, organizational, technical, and natural resources. Quite often, the engineering and construction complexities of such projects are overshadowed by economic, societal, and political challenges. The scan team was particularly interested in the international agencies' requirements and methods for identifying, quantifying, and documenting contract change impacts on time, costs, and quality of work. The innovative methods to manage change that the team found were presented in the discussion of project delivery methods, procurement methods, and payment methods. Otherwise, the contract change processes were found to be quite similar to those seen in the United States, with some differences in the level of authority for changes and the use of consultants for administration.

Cost of Changes

All of the countries stated that their goal is to minimize contract change. Much of the motivation for implementing the innovative project delivery methods in England, Scotland, and

The scan team was interested in methods for identifying, quantifying, and documenting contract change impacts on the following:

- ✓ Time
- ✓ Costs
- ✓ Quality of work

the Netherlands (see Chapter 2) stems from a need to control contract change and cost growth. The policy of the Highways Agency is to avoid initiating any changes after contract award. If this becomes necessary, the Highways

Agency will pay additional costs for the changed situation. Finland also has a policy to avoid any changes that will result in a change in the cost or completion date, and the scheduled completion date typically is not negotiable.

The scan team asked all of the country representatives to approximate contract cost growth as a percent of total awarded contract value. Table 8 (see page 36) provides approximate average cost growth percentages from contract award through project completion. These values are explained in more detail on the next page.

The Ministry of Transportation in Ontario had the most accurate measures of cost growth and also quantified the reasons for this growth. Total contract increases range from 9 to 18 percent, with an average of 10 to 12 percent. This includes 5 to 10 percent for changed conditions, 3 to 5 percent for overruns due to errors in estimated quantities, and 1 to 3 percent for material and time bonuses and price indexing (0.3 percent due to price adjustment clauses).

Table 8. Contract cost growth.

COUNTRY	APPROXIMATE COST GROWTH FROM CONTRACT AWARD TO PROJECT COMPLETION
Ontario	+10-12%
Germany	+15%
England	+0-27%
Scotland	+4%*
The Netherlands	+10%
Finland	+5%

** for design-build delivery*

The other countries provide more approximate values for cost growth. Germany provided different values for Bavaria and North Rhine-Westphalia. In Bavaria, the final contract cost is normally within 90 to 110 percent. Ranges from 80 to 200 percent have been experienced. In North Rhine-Westphalia, final costs grew an average of about 15 percent. In Scotland, the tendency-to-overrun figure is plus 4 percent, underpinned by the Scottish Executive ensuring that changes are minimal, if any, to avoid changes. In the traditional Dutch contracts, the average contract growth was about 10 percent. Not enough statistical information is available on the new contracts, and the Dutch have found that the numbers vary. Finnish contracts generally are completed on the established date. The average growth is 0 to 5 percent. England witnessed very poor performance in its traditional design-bid-build contracts, with average growth of up to 27 percent. The new design-build and ECI contracts have yielded very little growth, but officials did not provide a definitive average cost increase.

Costs for these changes are substantiated in much the same manner as in the United States. Germany uses unit-price contracts almost exclusively, so when a change is needed, the State uses unit prices or hourly wage agreements. Germany uses lump-sum agreements when necessary. An increase or decrease in unit prices is negotiated when quantities increase or decrease beyond 10 percent of the estimated value. In Ontario, the contractor submits costs, and the construction administration consultant estimates a cost independently and determines fair payment. In the Netherlands, the contractor is required to propose any change order costs for the agency to review. The agency has a large database of costs and numerous technical experts. In addition, the contractor is responsible for establishing the basis of prices for the projects in its price proposal, which is used to review change order costs. When change orders are unavoidable in Scotland, the cost is negotiated between the PM and the contractor. The ER theoretically has some authority for authorizing minor changes, but in practice the PM for the Scottish Executive approves all changes.

Similarly in England, the change is negotiated between the DA within delegated limits and the contractor.

Value Engineering Change Proposals

Quite often, innovations can be realized during construction to improve the quality of a project. The scan team explored the methods available internationally to allow the contractor to change construction concepts during design or construction for the betterment of the project. The team found that all of the countries have mechanisms that allow for change proposals after award in traditional design-bid-build projects in much the same manner that they are allowed in the United States. It also found that changes after award in design-build projects are the right of the design-builder as it develops the design, but these changes must conform to the owner's original request and design-builder's proposed design.

Change proposals in traditional contracts internationally follow the same process used in the United States. All countries involved in this scan allow these change proposals. In Ontario, for example, contractors are allowed to propose changes after the award of contract and present associated costs. These are analyzed by the design consultant for technical merit. The contract administration consultant evaluates them for cost impacts. For normal changes, prices are based on contract unit prices, adjusted unit prices, agreed lump sum, or force account. The Ministry of Transportation will then evaluate the proposals for scope changes and have the final approval. The ministry has formal cost reduction incentive provisions for post award changes. Savings are shared equally after deductions for each party's costs. The Canadian system is representative of what was found in the other countries.

In design-build contracts, the design-builder is still completing the final design after award. The contract allows the design-builder to make changes to its design, but only if these changes meet the agency's request for proposal requirements and the design-builder's proposed scope. If the scope of a change does not meet these original contract documents, the design-builder must follow a similar process for proposing changes as described above for the traditional process. In Scotland, for example, the design-builder's proposal must meet the design requirements established by the Scottish Executive. The contractor provides the final design and is free to make any changes as long as they meet the minimum design required and does not deviate from the accepted proposal. If the Scottish Executive allows a change to a standard less than the specimen design, it shares the savings, but it strives to not make any changes. In the Netherlands, the design-build contract specifications are much more performance oriented. This means that construction concepts may be changed, but only if they meet these performance requirements and only if only the rules of the contractor's quality system are followed. All changes have to be reported, and any conceptual changes have to be approved by the government.

Change Management

The countries studied all attempt to manage change at the lowest level possible to keep the process efficient. In Ontario, for example, the majority of changes are handled at the project level. Of the major issues, 75 to 85 percent are resolved at the regional level, 15 to 20 percent are handled by headquarters, and about 1 to 5 percent go to the legal system (lawyers, arbitrators, courts, etc.). The highest-level engineer outsourced is at project manager level, and \$30,000 is the highest level of approval that an outsourced person can be involved in. In one instance in Germany, increases of up to 25 percent of the original contract amount may be approved autonomously (up to €200,000). Increases beyond these thresholds must be approved by the superior office, the construction division.

The Dutch and Finnish change approval process is very stringent. In traditional Dutch contracts, the supervisor at the project prepares a contract change. This supervisor has authority for small, prescribed matters. Substantial changes are approved by an agency official, most likely a member of the regional director's staff. Sometimes senior project managers are granted special authority for changes, but it requires special appointment. Contract changes always have to be prepared by two agency officials. Finland also has a stringent change process. It elevates from the field any changes outside of the original project scope because the agency is held to a fixed budget. This may contribute to Finland's low average cost growth.

Project Record Keeping

A highway construction project really involves two projects, the one physically built in the field and the one built on paper to document the physical project. The scan team was interested in any innovative practices for managing documentation requirements, including the parties responsible for progressive inspection, testing, progress payments, project closeout, and final audit. Much of the documentation process has been described in the previous sections of this chapter, specifically in the contract administration, quality plan, and change process sections. This section specifically focuses on how countries capture trends in documentation to make their systems more effective, and how they use information technology to make their processes more efficient.

Again, it should be noted that project record keeping is affected by the project delivery system. In traditional project delivery, record keeping is mainly the responsibility of the agency, although more of the traditional record keeping responsibility is placed on the contractor internationally than in the United States. In design-build and DBFO projects, the philosophy is to require the contractor to have quality management programs covering all aspects of the project. Within that program, the inspection to determine compatibility with the contract documents is accomplished and certified by the contractor and the DB designer. Third-party certified labs often conduct the testing. In addition, the agency periodi-

cally will verify procedures and review results. The contractor retains all records for sampling and testing, and submits copies to the agencies. The agencies will also often have an independent consultant onsite that monitors the contractor's quality management plan.

The countries all noted some process to capture trends in project documentation with an eye toward process improvement. Periodic meetings with the project team and industry associations were specifically noted by Ontario and in one instance in Germany. England tracks requested changes/innovations to its standards and specifications electronically and periodically reviews these submissions for trends to inform updates.

The United States appears to be ahead of the countries studied in this scan on the use of information technology (e.g., Internet, electronic databases, handheld devices for inspection, etc.). Although most of the international government transportation organizations stated that they have the capability to retain records electronically, the team did not witness systems that were substantially better than those found in the United States. In fact, officials in a number of countries said that most of their field records are still kept on paper. The DBFO projects that the team visited did have database systems that allowed all team members to share test reports in real time. The large size and longer durations of these projects and sole-source aspects of the project delivery allow for a greater investment in information technology infrastructure.

Third-Party Communications

Utilities, railroads, local agencies, and other third parties can greatly affect the outcome of a highway construction project. These third parties are impacted by the construction, but they often are not benefiting from it and have no financial ties to the project. In fact, they may be negatively affected by the project. Coordination of third parties and third-party communications are typically a shared responsibility of the agency and the contractor, depending on the phase of project development. The scan team found that the international transportation organizations are acutely aware of the need for good public relations, but they vary in methods to achieve results. The team also discovered that several countries have legislation that governs payments for utility relocations.

The public must be kept informed before, during, and after construction. The responsibility for public information varied slightly from country to country. The agency takes primary responsibility for public information in Ontario, Germany, the Netherlands, and Finland. The contractor takes primary responsibility for public information in England and Scotland.

Scotland showed the scan team the most aggressive public information strategies. The Scottish Executive believes in informing the public early in the project environmental phase and continuing throughout the project's development using a multimedia approach. On major projects, the Scottish

Executive will actually conduct intense public meetings in which video simulations and models are used to inform the public. In addition, a project-specific Web site allows for continuous updates to the public. Traffic simulations are conducted to qualify the benefits of the project and provide the public with an idea of the future traffic patterns. Figure 11 shows a Web site depicting future construction traffic detours and a public information meeting for the Upper Forth Crossing in Scotland.

The Netherlands also has an aggressive public information strategy. On all large infrastructure works, a strategic communication plan is prepared with a matrix of communication tools, including press releases (radio, television, newspaper), periodic press tours, brochures, dedicated Web site, dedicated phone line, meetings with the local authority and community groups, and on large projects, an information center. An action plan is developed to implement the strategic communication plan. The regional communications director has major responsibility for this function. The project manager (only if trained in public relations) and contractor have lesser roles, and everything they do must be preapproved for method and content.

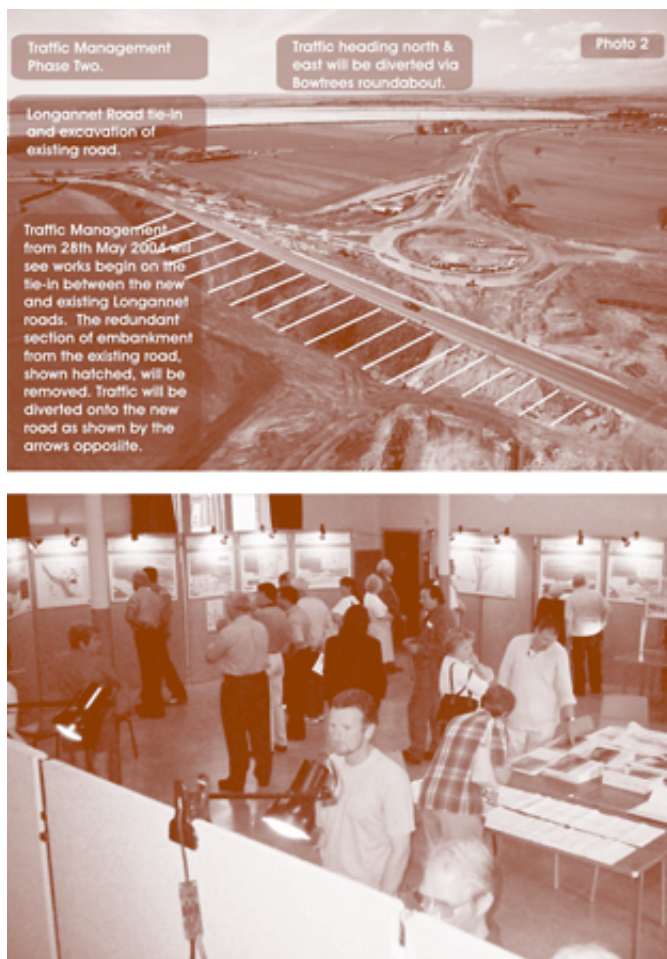


Figure 11. Public information tools for Upper Forth Crossing project in Scotland.

Philosophies differed on coordination and payment for utility relocations. Scotland and the Netherlands pay the total cost of utility relocation, while the Canadian government pays utility companies 50 to 100 percent of all utility relocation costs, depending on the age of the utility being relocated. More specifically in Scotland, laws have been adopted recently that require utility owners to comply with the plans they provide to the contractor. This permits the contractor to seek monetary settlement if the utility company fails to execute the relocation shown in the plans.

Finally, there was consistency in the belief that contractors should be given additional payments and time extensions for delays caused by third parties on traditional design-bid-build contracts, with the exception of Scottish design-bid-build contracts using a lump sum. On the design-build and DBFO contracts, some of these risks were assigned solely to the contractor.

Environmental Monitoring

Environmental issues can arise in both planning and construction. In the United States, contractors do not typically play a role in the environmental process during planning, but they are directly involved with environmental issues during construction such as noise, vibration, dust, and water quality. The scan team explored the role of the contractor in the environmental process to discover innovative ways to lessen the impact on the environment. The scan team found that contractors are not involved in the environmental planning/permitting process, with the exception of the first phase of ECI contracts in England. The team also found that most countries specify the environmental monitoring and compliance during construction in the contract, but generally avoid method specifications. Contractors are encouraged to enhance the contract requirements through their proposed quality management plans.

Contractors did not play a part in the environmental permitting process in any country except England. The Highways Agency retains the option to have the contractor become involved in environmental planning through its statutory public consultation process. Up to this point, the contractor assists only as a consultant to help the Highways Agency navigate the environmental process. Once the environmental and consultation planning process is completed, the ECI contractor will move into a contract with the Highways Agency for detailed design and construction.

Environmental requirements during construction generally are defined through detailed contract method requirements in Germany and Ontario. In Germany, the construction contract contains corresponding protective measures aimed at avoiding negative environmental impacts. Impacts that had not been recognized are delegated to the contractor via an addendum to the construction contract. In Ontario, the ministry and the environmental agencies have standard models that are included in the contracts. Government agencies do monitor, but mainly as a reaction to complaints.

Environmental requirements during construction generally are defined through both contract provisions and contractor quality control plans in England, Scotland, and the Netherlands. In England, the contractor typically has a full-time environmental liaison person onsite daily to see that all

- ✓ Environmental requirements during construction are defined through method specifications.
- ✓ ISO 14000 certification often is required in quality control plans.

activities are being conducted in compliance with the project environmental plan. The Scottish Executive will have global environmental requirements in the contract requirements, including noise and water quality.

The contractor will have a quality management plan for the environmental aspects. In addition, the contractor's quality management plan for the environment will outline the specific aspects of monitoring and corrective action. An individual or individuals in the contractor's organization are assigned to conduct the environmental monitoring and reporting during construction.

Project Maintenance Requirements

Contractors consistently are responsible for project maintenance during construction, including the contractor's and owner's responsibilities for existing or adjacent facilities. This responsibility includes routine maintenance in England and Scotland. In Ontario, the contractor is responsible for maintenance activities during the normal construction season (April through October) within the limits of construction. The agency may accept part of a project, which will relieve the contractor of maintenance responsibilities. The remaining time, the agency's maintenance contractor is responsible. Germany only assigns responsibility for repairs caused by construction to the contractor. Insurance typically is required for damage to adjacent facilities.

Conclusions

As discussed in this chapter, international highway organizations delegate many traditional highway agency functions to the private sector to promote efficiency and satisfaction of the client's requirements. In conjunction with this delegation, contract payment methods are used to support alignment and trust. Quality plan implementation methods also support this delegation and alignment of goals.

The scan team found that contractors frequently report their own progress and that agencies take more of an audit role than a measurement role. Milestone and lump-sum payments support these progress reporting methods. There are fewer requirements on the amount and types of subcontractors abroad. The scan team found the quality control and quality management plans frequently are developed by the contractor. Reliance on ISO certification

is heavy, and contractors can be rated on their quality management plans before project award or through postproject reviews. Most countries pointed to their use of qualifications and past performance in procurement as remedies for dealing with substandard work. While the team did not find many innovative information technologies for record keeping, it did find good use of information technologies in public information efforts. Finally, the scan team found that contractor quality certification standards and project quality plans are being used to supplement contractually mandated environmental monitoring processes.

Postconstruction Aspects of Construction Management

INTRODUCTION

The construction management process is not finished when the project opens to traffic. Agencies, and in some cases their industry partners, are responsible for operating and maintaining the facilities long after the construction contract is complete. International highway organizations have a different philosophy on warranties than those in the United States. Warranties of 5 years and longer are not uncommon in the countries studied on this scan. Agencies and their industry partners must also continuously consider how to improve their construction management methods.

This chapter discusses postconstruction aspects of construction management. It describes the typical involvement of

- ✓ Many countries employ long-term warranties.
- ✓ There were numerous examples of design-build-operate-maintain contracts in various forms.
- ✓ The team found examples of international agencies working closely with their industry partners to implement construction management innovations.

the construction contractor with the maintenance and operation of facilities it constructed. It also discusses how new knowledge is captured during the construction management process and how it is used to improve the process on future projects. The scan team found warranties of 1 to 7 years being used for various aspects of construction, and numerous examples of design-build-

operate-maintain contracts. The team also found that the international agencies work closely with their industry partners to implement construction management innovations that can save time and money and help meet customer needs.

Maintenance and Warranties

The typical involvement of the construction contractor with the maintenance and operation of facilities it constructed

varies substantially with the project delivery method. As stated in Chapter 2, England, Scotland, Finland, the Netherlands, and Ontario all have used some type of design-build-operate-maintain project delivery method. In these cases, the contractor is responsible for maintaining the project to predetermined performance levels. Warranties are not required on these projects. This section of the report will discuss primarily maintenance and warranty issues on traditional design-bid-build and design-build projects, as these have the most relevance to U.S. highway construction management.

In Germany and Ontario, the construction contractor does not get involved in maintenance. The construction contractor's responsibility is similar to that in the United States with the exception of warranties. Ontario requires a 1-year warranty on all aspects of the project. Germany requires longer warranty periods of 5 years for soil and earthwork, 5 years for bridges and drainage systems, and 1 to 3 years for pavements.

The Highways Agency in England uses different maintenance and operational requirements for various contract types. For the design-build-finance-operate contracts and other long-term contracts, the contractor provides operational and maintenance services for the full length of the 30-to-50-year contract. The contractor designs and constructs the project with the full knowledge that he will have to operate and maintain the infrastructure for the full term of the contract. At the termination of DBFO contracts, criteria require a level of guaranteed workmanship, and Euro products have to be tested and certified. On the other hand, the preferred new method of contracting for design and construction services—the ECI contract—does not provide for traditional operational and maintenance services. These contracts include a general workmanship and materials warranty. The team members of the A500 contract indicated that at the completion of construction, the contractor is responsible for a 2-year general workmanship and materials warranty. In addition, the contractor is also responsible for any design or construction defects directly attributable to the contractor's failure to exercise reasonable care in design and construction for 12 years after the contract is executed.

Like England, the Netherlands uses different maintenance and warranty requirements for various contract types. For design-build contracts (and variations of design-build known as D&C, E&C contracts in which both design and construction services are provided), the Netherlands requires a 7-year warranty for the surface course of asphaltic concrete pavements.

✓ At the end of a DBFO project, the HA criteria require a level of guaranteed workmanship, and Euro products have to be tested and certified.

This is a performance warranty for raveling and skid resistance. A 3-year warranty is also required for expansion joints for structures, pavement markings, and landscaping plants such as trees. The Netherlands indicated that warranties

have not always been effective in the past. Historically, Dutch law has been liberally interpreted in the contractor's favor to release the contractor from any liability unless the agency can prove that the defective workmanship or materials are directly attributable to the contractor. Under the newer design-and-build contracts discussed above, the agency believes that any pavement defects occurring in the first 7 years after construction will be the responsibility of the contractor. Officials said that the Netherlands is considering more pilot projects with bonded warranties because of success with these warranties in the railroad sector.

Although the term "warranty" is not used in Scotland, the Scottish Executive requires contractors to be responsible for all defects during a 5-year maintenance period after construction is complete. A retainage is used to ensure the correction for defects, but some contractors opt to submit a bond in lieu of having retainage held. For pavements, the design life is 40 years. The agency runs a deflectograph in years 3 and 4 to determine performance trends, and again in year 5 for acceptance and/or remediation. Warranty bonds are not used. The agency does not want to invoke a bond only to get the defects corrected. Since past performance is considered in determining the list of invited bidders, disputes could affect a contractor's ability to tender on future projects.

The Finnish Road Administration often requires a 5-to-7-year warranty for all workmanship and materials, with the exception of pavements, which have 2-year warranties. However, the specific warranties for a given project may vary with the scope of the project. Warranties of 5 to 7 years have been used on pavements, 2 years on lighting and other electrical devices, and 1 year on plantings and landscaping items.

Process Improvement

This report has provided numerous examples of continuous improvement processes for construction management processes. The international organizations shared their newest innovations in construction management and the team learned the processes of capturing the new knowledge that generated

U.S. PARALLEL ASPHALT PAVEMENT WARRANTIES

Warranties are not new to the United States. From 1890 to 1921, Warren Brothers Paving owned a patent on hot mix asphalt (HMA). Warren Brothers provided a warranty for its products that lasted up to 15 years. The warranties covered both materials and workmanship. After 1921, the Warren Brothers' patent expired. The asphalt market was opened up to competition and the warranty program was discontinued.

In the 1950s, the U.S. government formalized its participation in the highway construction program. Warranties were not allowed because they were considered maintenance, and the Federal government could participate only in construction. In 1988, a Transportation Research Board study produced *Circular 38—Innovative Contracting Practices*, which described the possible application of warranties to highways. FHWA Special Experimental Project 14, put in place in 1990, allowed for the evaluation of warranties and other alternative contracting methods on Federally funded highway projects. In 1995, FHWA mainstreamed most alternative contracting methods, including warranties, and many State and local agencies began to evaluate the use of warranties on their own. Figure 12 depicts the States in which FHWA had approved warranty projects in 1999.

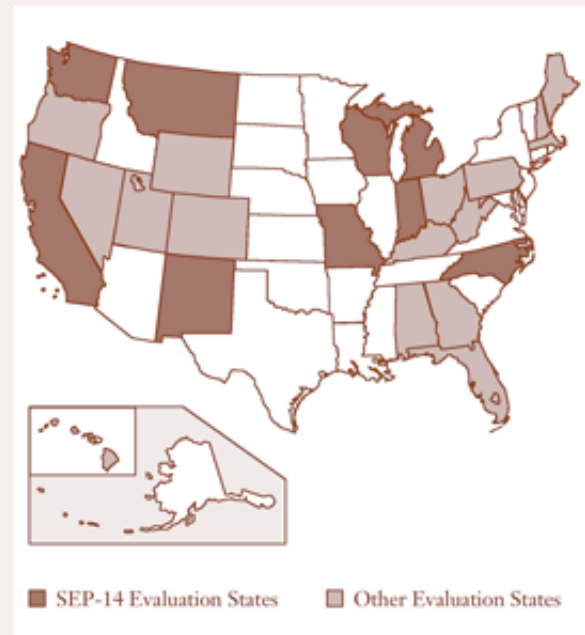


Figure 12. States using warranty evaluation.

them. A few of the most notable process improvement examples previously described in this report include the following:

- England’s ECI contracts that provide incentives for new innovations (Chapter 2)
- England’s CAT evaluation process that requires continuous improvement from its supply chain (Chapter 2)
- Ontario’s RAQS evaluation process that captures past performance and measures improvements (Chapter 2)
- ISO certification processes that provide the framework for continuous improvement (Chapter 3)

All of these examples were developed in close consultation with industry partners. Officials in each country shared specific examples of how they obtain feedback to ensure the knowledge gets back into the project development system. Ontario has a very formal process. With its contractor administration consultant, it holds monthly meetings to discuss ratings and progress. One final rating is provided for each contractor at the end of the project. For multiyear projects, discussions are held, but no ratings are done. Postconstruction meetings are held between the engineering consultant and construction contractor at the end of every project. A construction report is prepared for each project and circulated within the ministry. The ministry is also starting to invite the design consultant to construction site meetings.

Germany receives feedback through a team concept. It develops projects using a designated team assigned to the project from beginning to end. These teams are multifaceted, and consider the lessons learned from construction in future project development. German construction officials meet regularly with the country’s contractors’ association to address conflicts and resolve industry issues.

The Highways Agency in England conducts joint reviews with the Office of Government Commerce at various phases of the project development process to gather lessons learned and provide feedback to the overall transportation delivery program. The schedule of reviews is determined by a risk assessment of the project scope.

ENGLAND	FINLAND
<ul style="list-style-type: none"> ■ Characteristics of the specific product ■ Service being delivered ■ Predictability of time ■ Predictability of cost ■ Safety ■ Defects 	<ul style="list-style-type: none"> ■ Impacts to road users and society ■ Performance-based criteria (currently being developed as part of the strategy) ■ Level of service, outcome, and performance-based criteria ■ Adherence to technical specifications ■ Adherence to material specifications

Table 9. Key performance indicators.

Postconstruction reviews are conducted informally in Scotland, but if the final contract amount exceeds the bid by 15 percent or more, a more detailed review is done to explain overruns. The Scottish Executive also conducts several meetings with tendering contractors to ensure that their approach is in compliance with the owner’s needs. Whether the approach meets the criteria in the request for tender or is an alternate design, the submission must meet the basic criteria established by the agency. These meetings essentially have eliminated tenders being rejected for noncompliance with the owner’s requirements.

For processes to be improved, they must be measured. All of the countries measure time and cost growth, and Ontario tracks these in earnest, as discussed in Chapter 3. While the Highways Agency traditionally has tracked cost and schedule growth on its projects, the lump sum-based ECI contracts provide even stronger economic incentives for the contractor to complete the work on time and on schedule. Also, the DBFO contract, by its nature, rewards contractors for innovation, risk taking, performance measurements, and budget attainment. By awarding the project to a DBFO company based on a quality/concept selection process and having the DBFO company identify the target costs, contract cost growth and time growth should be at a minimum. If the owner can refrain from initiating change orders, the DBFO company is measured against the standards it established for itself through the certification process.

Both England and Finland have more global key performance indicators that they measure to attain their goals of the future. Table 9 provides a list of these indicators.

These key performance indicators are relatively new, so the agencies did not have historic data to share with the scan team at the time of the site visits. However, the potential for the measurement of process improvement is obvious.

Past performance assessment of individual contractors is discussed in Chapter 2, but a summary of the measurement techniques is merited here. The Netherlands is prohibited from using past performance in procurement. Ontario and England have the most mature past performance measurement systems. Ontario uses its RAQS system for both consultants and contractors. England uses its CAT system, which is relatively new. Details on these systems are in Chapter 2.

Conclusions

Postconstruction aspects of construction management are important to maintaining long-term success. The international organizations the scan team met with are striving to incorporate long-term construction management solutions through the use of warranties and innovative contracts that include substantial maintenance agreements. The team discovered numerous examples of innovations stemming from rigorous process improvement. U.S. highway agencies may benefit from employing these innovative techniques or process improvement techniques that generated them.

Recommendations and Implementation

RECOMMENDATIONS

The construction management scan team was composed of Federal, State, local, industry, and academic members with more than 100 years of combined experience in the design and construction of highway projects in the United States. Through this focused research study, the team has gained a fresh perspective on how the U.S. highway industry can change to achieve more productive partnerships and alignment toward customer-focused goals. The recommendations of the team offer a challenge to highway construction professionals to change construction management practices that create adversarial relationships.

Align Team Goals to Customer Goals

Develop procurement, contract provisions, and construction management methods that better align the goals of the customer, owner, and contractors. The industry must move to integrated teams that are formed early and focus on customer goals throughout the project development and construction life cycle. The process must begin with disciplined risk assessment and strategic project delivery decisions. These early decisions need to be supported through procurement and construction management techniques that support and incentivize the teams in achieving customer goals.

Develop Risk Assessment and Allocation Techniques

Develop more effective risk assessment processes that begin at the scoping process and continue through the construction management process. These processes should determine risks and assign them to the party best able to manage them. The Highways Agency Risk Management (HARM) tool, the Public Sector Comparator, and the Public-Private Comparator can be used as models for developing disciplined risk assessment and allocation techniques in the United States.

Strategically Apply Alternative Delivery Methods

Choose delivery methods that better align goals and allocate risk properly. The U.S. highway industry must evolve from the

traditional one-size-fits-all project delivery method. A renewed focus should be given to alternative delivery methods that promote early industry involvement and life cycle design solutions to maximize the entire project team's input in meeting customer needs.

Enhance Qualification Rating Processes

The team recommends development and implementation of consistent quality rating processes to facilitate quality-based selection. A number of U.S. States have begun to collect and track contractor qualification rating information. The mature processes in Ontario and Europe took many years to develop. A concerted effort among different agencies with a long-term implementation plan will be required if the process is to be as successful in the United States as it has been abroad.

Recommendations

- ✓ Align team goals to customer goals.
- ✓ Develop risk assessment and allocation techniques.
- ✓ Strategically apply alternative delivery methods.
- ✓ Pilot early contractor involvement.
- ✓ Enhance qualification rating processes.
- ✓ Use qualifications in procurement.
- ✓ Apply alternate bids/designs in procurement.
- ✓ Conduct preproposal meetings.
- ✓ Apply more contractor quality management.
- ✓ Use appropriate alternative payment methods.
- ✓ Work toward warranties and life cycle responsibility.

Use Qualifications in Procurement

The team recommends greater use of best-value procurement, including considerations for price, qualifications, time, and technical approach. Many construction management techniques discovered on this scan work because agencies are able to track perform-

ance from one project to the next. The use of qualifications in procurement will encourage long-term relationships and the associated efficiencies that can be realized from these partnerships.

Pilot Early Contractor Involvement

Test a system of contractor qualification-based selection to deliver a project from the planning and/or environmental process through construction using a target price contract. The early contractor involvement process is a wholesale change from the current way of doing business in the United States, and it will take a longer-term strategic plan to test and implement the system. The system could deliver enormous rewards, but it must be developed with industry support, tested, and documented if it is to be successful. The system should be tested in a pilot study setting and the results should be disseminated widely.

Apply Alternate Bids/Designs in Procurement

The team recommends more use of alternate bids in a low-bid environment, provided the bidders are being evaluated on a fair and transparent basis. Alternative bidding procedures can potentially achieve better value for the money through the competition of innovative ideas in procurement. Alternative bidding processes can be established for design-bid-build, design-build, and other delivery methods observed on this scan.

Conduct Preproposal Meetings

When design alternates are being considered, conduct confidential preproposal meetings to allow proposers to validate acceptability for innovative concepts. This process is being used already on a limited basis in large design-build projects in the United States. These processes should be extended and refined for application to all methods of project delivery. Guidelines for discussions must be created with industry input and followed in practice to ensure that there is no impropriety in selection.

Apply More Contractor Quality Management

Use more contractor quality management systems with reliance on agency assurance. Contractor-initiated quality plans can be competed during procurement and written into each project contract. On design-build contracts, provide designer assurance of critical construction components. Consider using quality management process certifications when appropriate. This competition in quality management will lead to innovative solutions for quality management issues, but it will take consistent owner auditing and noncompliance procedures.

Use Appropriate Alternative Payment Methods

Use alternative payment methods such as contractor invoicing, milestone payments, and lump-sum payments to align team goals and/or promote efficiency. A variety of methods should be available for different project types and customer goals. These alternative payment methods must be developed with industry to ensure that they do not limit competition.

Work Toward Warranties and Life Cycle Responsibility

Consider appropriate long-term warranties on critical

components of appropriate projects to deliver better products, allow for more innovation, and eliminate redundant quality processes. Qualify items within the contractor's control. All team members must have an understanding of the life cycle needs of customers, and these contract provisions can assist in the understanding and realization of these needs.

Implementation

The scan team is committed to implementing its recommendations with the industry in the coming months and years. Three critical tools to realize the team's recommendations are described below.

Expert Technical Group

An expert technical group consisting of AASHTO and FHWA representatives will be formed to prioritize implementation

Implementation

- ✓ Expert technical group
- ✓ Pilot studies
- ✓ Conferences and focused workshops

steps, coordinate with various industry associations, designate lead States for implementation, and assist these States in developing guidelines, training programs, presentations, and information exchange programs. Funding commit-

ments for this group have not yet been secured, but FHWA anticipates that this will be a multiyear effort.

Pilot Studies

Many of the innovative recommendations will require pilot studies in the United States. These pilot studies must be developed in conjunction with appropriate stakeholders and the results documented and disseminated if we are to learn from our experiences and promote appropriate change. Team members plan to pilot a number of these recommendations, but more participation is required.

Conferences and Focused Workshops

The team plans to disseminate this information at Transportation Research Board and AASHTO conferences. The team is also organizing focused workshops on the topics. For more information on these conferences and workshops, go to <http://construction.colorado.edu/cmscan>, or contact the team members listed in Appendix A.



APPENDICES

- Appendix A—Scan Team Members
- Appendix B—Amplifying Questions
- Appendix C—References
- Appendix D—European Host Representatives

Appendix A Scan Team Members

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Team Biographies

Steven DeWitt, P.E., (AASHTO cochair) is the director of construction for the North Carolina Department of Transportation (NC DOT) in Raleigh, NC. He is responsible for all construction management activities for the NC DOT. This includes all aspects of contract administration, project inspection, construction workforce issues, quality control programs, innovative and/or alternative contracting methods, project lettings, contractor claims, constructibility and value engineering reviews, and utility relocation processes. DeWitt has served with the NC DOT for more than 19 years in construction management-related positions. He has a bachelor's degree in civil engineering from the University of North Carolina at Charlotte. He is a licensed professional engineer in North Carolina. He serves in leadership roles on construction-related committees with the Transportation Research Board and the American Association of State Highway and Transportation Officials.

Gerald Yakowenko, P.E., (FHWA cochair) is a contract administration engineer with FHWA in Washington, DC. Yakowenko is responsible for developing and interpreting FHWA's policy for federally funded construction contracts. In addition, he provides technical and programmatic assistance to State DOTs for alternative contracting practices, such as design-build and multiparameter bidding contracts. Throughout his 24-year career with FHWA, he has been involved with construction contracting issues. He is a 1977 graduate of Lehigh University with a bachelor's degree in civil engineering. He is a licensed professional engineer in Missouri. Yakowenko is a member of the American Society of Civil Engineers, the American Association of State Highway and Transportation Officials Subcommittee on Construction, and the Transportation Research Board Committee A2F05—Construction Management.

Keith R. Molenaar, Ph.D., (report facilitator) is an assistant professor with the Construction Engineering and Management Program in the Department of Civil, Environmental, and Architectural Engineering at the University of Colorado at Boulder. His research focuses on alternative delivery strategies for the construction of infrastructure and constructed facilities. His responsibilities include coordinating a collaborative research effort aimed at exploring alternative delivery methods, analyzing project performance, and disseminating research results to owners, designers, constructors, and students. Previously, Molenaar was a faculty member at the Georgia Institute of Technology, where he was group leader of the Construction Research Center's Procurement and Project Delivery research initiative. Molenaar has a bachelor's degree in architectural engineering, and master's and doctoral degrees in civil engineering from the University of Colorado at Boulder. Molenaar is a member of the American Society of Civil Engineers, Design-Build Institute of America, and Construction Management Association of America.

Thomas R. Bohuslav, P.E., is the director of the Construction Division of the Texas Department of Transportation (TxDOT). He is responsible for developing and issuing statewide policy and procedures for all construction contracting. He also ensures that all materials used in construction and maintenance are uniformly tested for quality. He oversees TxDOT's responsibilities for pavement management and design, and the business opportunity programs, including the U.S. Department of Transportation Disadvantaged Business Enterprise, the State Historically Underutilized Business, and the Small Business Enterprise programs. Bohuslav has served with TxDOT for more than 22 years. He is a graduate of Texas Tech University with a bachelor's degree in civil engineering. He is a licensed professional engineer in Texas and serves as vice chair of the American Association of State Highway and Transportation Officials Subcommittee on Construction.

Tucker Ferguson, P.E., is a senior civil engineer manager for the Pennsylvania Department of Transportation (PennDOT) in Harrisburg, PA. He is responsible for the administrative operations of Pennsylvania's construction program, which includes contractor prequalification and evaluation, labor compliance, and Disadvantaged Business Enterprise regulation monitoring. He also oversees work order and payment processing, specification development, alternative contracting, construction documentation systems, and construction inspection and management. Ferguson, who has served more than 13 years with PennDOT, is now the chief of the Bureau of Construction and Materials' Contract Management Division. Tucker also has served in PennDOT's Bureau of Maintenance and Operations and Bureau of Highway Safety and Traffic Engineering, and as a design engineer and construction inspector in the private sector. He has a bachelor's degree in civil engineering technology from the University of Pittsburgh at Johnstown. He is a registered professional engineer in Pennsylvania, and serves on several AASHTO technical committees.

Eugene (Gene) Hoelker, P.E., is the construction and contract administration engineer on the Construction and Project Management Team at the FHWA Resource Center in Olympia Fields, IL. Hoelker serves as a national technical resource for FHWA, State, and transportation industry representatives in the areas of construction operations, contract administration, alternative contracting, construction inspection and oversight, specifications, materials acceptance, and highway maintenance. Previously, Hoelker had project development, design, and construction responsibilities with FHWA in North Dakota, Indiana, Oregon, and Wisconsin. He also served in the Construction and Maintenance Division in Washington, DC, and as the construction and materials engineer with the former FHWA Regional Office in Illinois. Hoelker has a bachelor's degree in civil engineering from the University of Wisconsin-Platteville, and has completed advanced studies in materials engineering at Purdue University in Indiana. He is a licensed professional engineer

in Indiana, and serves on the AASHTO Subcommittee on Construction and the AASHTO Subcommittee on Maintenance.

Greg L. Schiess, P.E., is the pavement management and materials engineer for the FHWA Florida Division in Tallahassee, FL. He is responsible for promoting and implementing sound principles for pavement management, design, and construction; and acceptance and testing of materials both internally among Florida Division personnel and externally with the Florida Department of Transportation (FDOT), State and local officials, and industry representatives. Schiess has served FHWA for more than 29 years in the areas of highway design, construction, and materials. His most recent work dealt with improving FDOT's design-build program and hot mix asphalt specifications using the contractor's data for acceptance, and developing pavement warranties. Schiess has a bachelor's degree in civil engineering from the University of Wisconsin-Platteville and is a licensed professional engineer in Wisconsin.

John M. Smythe, P.E., is the State construction engineer for the Iowa Department of Transportation in Ames, IA. Smythe is responsible for administering the statewide highway construction program, including establishing construction policies and practices, developing contract requirements, and deploying technical training for field construction staff. His emphasis areas include establishing contractor project quality control responsibilities, implementing a shared worker program for cross utilization of construction and maintenance personnel, developing a training academy for required training for Iowa DOT staff, measuring and improving the quality of construction plans, and streamlining construction data collection and record keeping. Smythe has worked for the Iowa DOT for more than 30 years, and has more than 25 years in various construction positions. He has a bachelor's degree in civil engineering from the University of Wisconsin-Platteville. He is a licensed engineer in Iowa, and is active in several Iowa DOT/contractor/FHWA-sponsored quality management initiatives.

James E. Triplett, P.E., is majority owner and chief executive officer of United Contractors (a bridge-building corporation), U.S. Constructors (a road-building corporation), and Triplett-King & Associates (a consulting engineering corporation), which operate primarily in the Carolinas and Virginia. He provides general direction for the operation of the organizations in the highway industry, including planning, design, construction, and inspection/testing services. As president of United, Triplett focuses most of his efforts on bridge construction, especially design-build and fast-track projects. Before joining United in 1992, he designed bridges and other structures in the Virginia and North Carolina offices of Ralph Whitehead Associates, and ultimately developed the firm's construction engineering services program. Triplett has a bachelor's degree in civil engineering from Clemson University. Along with being

a licensed general contractor, he is also a licensed professional engineer in South Carolina, North Carolina, and Virginia. Triplett is a member of Chi Epsilon Society and the American Society of Civil Engineers. He serves on the board of directors for Carolinas Associated General Contractors, on the SCDOT/CAGC Cooperative Committee, and as chairman of the SCDOT/CAGC Bridge Subcommittee.

Richard E. Wagman is chairman and chief executive officer of G.A. & F.C. Wagman, Inc., a general contracting firm engaged in heavy and highway construction in Pennsylvania, Maryland, and Delaware. He is responsible for the administrative and operational operations of the company, as well as the company's industry relations, public affairs, and lobbying. He has a bachelor's degree in business administration from Georgetown University and pursued a master's in business administration at Drexel University. Wagman has been involved in a number of alternate design and design-build projects. Wagman serves as senior vice chairman of the American Road & Transportation Builders Association (ARTBA) and is scheduled to become chairman of that organization in September 2004. ARTBA, as representative of transportation contractors and designers, is vitally concerned with design-build, best value, privatization, warranties, and other alternative procurement systems and contract procedures for transportation project delivery. Throughout his career, Wagman has been active in industry issues at both the national and State levels through his involvement in various transportation construction associations. He is a member and former chairman of the ARTBA delegation to the AASHTO-AGC-ARTBA Joint Committee. Other ARTBA positions have included northeast regional vice chairman, chairman of the Long-Range Planning Committee, and president of the Contractors Division. Wagman serves on the boards of the Associated Pennsylvania Constructors and the Maryland Highway Constructors Association, and is a past president of both organizations.

Appendix B Amplifying Questions

Introduction

The following questions provide detail on the topics of interest outlined in the panel overview of January 2003. We hope that these questions can serve as a framework for the discussions for our visit in May. Wherever possible, we ask that you answer the questions directly or provide examples of successes and failures in the topical area. Example contracts or contract language from successful projects will also be helpful. While we are certainly interested in your largest and most innovative projects, policies, and procedures, we are also interested in your routine practices, as we may gain new ideas for U.S. agencies from these as well.

Preconstruction Aspects of Construction Management

General Context

1. Generally describe the key aspects of how transportation construction management is positioned within the political, economic, and technological structure of your country. Please comment on items such as owner structure, market structure, market competition, contractor associations, funding structure, and the roles and responsibilities of the other primary stakeholders in the transportation life cycle.

Staffing

2. Describe how staffing and workforce issues in your agency affect the construction management of projects.
 - a. How do you ensure that a high-quality staff is present to accomplish agency goals?
 - b. To what extent are you using consultants in the management of program design, construction inspection, and material testing?

Project Delivery

3. Describe the primary project delivery method in your country. In the United States, we primarily use design-bid-build delivery, in which a complete project design is

used to procure a contractor through a low-bid process under a unit-price contract.

- a. What is the approximate percentage of use by dollar volumes for the following project delivery methods: design-bid-build, design-build, performance-based contracting, concessions with long-term agreements and operational periods, public-private partnerships, others (please describe).

Procurement

4. Describe how your procurement or bidding methods support the construction management process throughout the project life cycle.
 - a. Do you prequalify contractors or use past contractor evaluations in the decisionmaking process of future bidding privileges? If so, describe the process and selection factors.
 - b. Do you select contractors on the basis of low bid or a combination of cost and other factors? If so, describe the process and selection factors.

Risk Allocation and Management

5. Briefly describe your risk allocation and risk management process in the control of work on projects, including the relationships/responsibilities of the owner, consultants, testing services, prime contractor, and suppliers.
 - a. What do you do to identify and address risk in the construction process to ensure that legal and financial responsibilities are assigned to the appropriate party?
 - b. How do you manage high-risk issues (utility coordination, right-of-way procurement, environmental permitting, etc.) to eliminate/reduce their impacts?

Construction Aspects of Construction Management

Contract Administration

6. Describe the organization of day-to-day responsibilities for management of construction contracts, including the

responsibility/authority level of contract administrators, tracking of project progress, project payment determination, project stoppage issues, and project closeout processes.

- a. What is the basis for determining the dollar amount when calculating acceleration costs, liquidated damages, incentives, disincentives (e.g., agency construction management costs, road user costs, delay costs, detour costs, private inconvenience costs, etc.)?
- b. What methods are used to allow the contractor to change construction concepts during design or construction for the betterment of the project?
- c. Are there limitations on subcontracting, such as self-performance requirements by the prime contractor, maximum subcontracting, tiered subcontract issues, etc.?

Quality Plan Implementation

7. How does your country ensure high design and construction quality of the finished product?
 - a. Are contractors responsible for developing and executing formal quality control plans or does the owner specify the plans in the contract? If so, please describe the advantages and disadvantages of the process.
 - b. Describe the primary method used to assure that materials meet contract requirements. Are acceptance (assurance) tests completed as work progresses, or end result?
 - c. When quality standards are not met, what remedies are used for substandard work? How do you differentiate between nonconforming (not meeting a standard) and unsatisfactory work?

Contract Change Processes

8. Describe the requirements and methods for identifying, quantifying, and documenting contract change impacts on time, costs, and quality of work.
 - a. What is the approximate average contract growth for your projects (as a percentage of total project construction cost)? How do you calculate this percentage and what are the primary causes for this growth?
 - b. How does the contracting agency substantiate the cost of change order work?
 - c. How are contract changes managed to eliminate/reduce their impacts?
 - d. Describe process and the levels of authority for approving changes.

Project Record Keeping

9. Provide an overview of your project documentation requirements, including the parties responsible, for progressive inspection, testing, progress payments, project closeout, and final audit.
 - a. Provide examples of how you capture trends to help improve your processes.

- b. Please describe the use of information technology in your system (e.g., use of the Internet, electronic databases, handheld devices for inspection, etc.).

Third-Party Communications

10. Describe your processes for public information and third-party communication, including public construction updates and coordination of third-party construction (utility relocation, local agency improvements, rail crossings, etc.).
 - a. What methods do you employ for notifying the public of construction activities?
 - b. How do you determine contractor time extensions and additional payments due to third-party delays? Do you seek reimbursement from the third parties for delays, and if so, how successful are you?

Environmental Monitoring

11. Describe the process for dealing with environmental issues that arise during construction, including noise, vibration, dust, and water quality.
 - a. What role does the contractor play in environmental permitting processes?
 - b. How are project environmental requirements defined? Are end result standards established, or method requirements specified in the contract?

Project Maintenance Requirements

12. Describe the responsibilities of project maintenance during construction, including the contractor's and owner's responsibilities for existing or adjacent facilities.

Postconstruction Aspects of Construction Management

Maintenance and Warranties

13. Describe the typical involvement of the construction contractor with the maintenance and operation of facilities it constructed.
 - a. Do you use project warranties? If so, please describe typical products warranted, warranty periods, and corrective actions required.

Process Improvement

14. Describe how new knowledge is captured during the construction management process and how it is used to improve the process on future projects.
 - a. What process measurements and performance indicators are used to evaluate and improve your construction management process (e.g., contract cost growth, contract time growth, etc.)?
 - b. What aspects of contractor performance are measured and how are they used on future projects?
 - c. Have you found any innovative methods for incorporating private sector knowledge and suggestions into your construction management processes?

Appendix C

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