EXPERT TECHNICAL COMMITTEE
BAY BRIDGE PROJECT ASSESSMENT MEETING
JANUARY 6-8, 2005

Expert Technical Committee: Stuart Anderson, Texas A&M; David Ashley, University of California – Merced; Keith Molenaar, University of Colorado; Deb Niemeier, University of California – Davis; and Cliff Schexnayder, Arizona State University.

The Expert Technical Committee (ETC) was formed to provide an independent review and assessment of the history and current status of the San Francisco-Oakland Bay Bridge East Span Seismic Retrofit Cost Increases.

The ETC was convened first on December 23, 2004, for an overview of the project by the Results Group, and then again on January 6-8, 2005, to review a draft of the Results Group report "Historical Review of San Francisco-Oakland Bay Bridge East Span Seismic Retrofit Cost Increases" dated January 6, 2005. The questions addressed by the Result's Group were the following:

1. What factors have contributed to the cost increases for the East Span of the San Francisco Oakland Bay Bridge?[1]
2. To what extent have external factors out of control of Caltrans and the State of California contributed to the cost increases?
3. Which cost increases should have been anticipated and what additional practices should have been employed to better estimate costs?
4. To what extent has the Self-Anchored Suspension design chosen by the Bay Area contributed to the cost increases? To what extent did additional decisions by the Bay Area's Metropolitan Transportation Commission contribute to the cost increases?

The ETC reviewed the report verbally with the Results Group on January 6, 2005, and provided written feedback through a letter drafted by Ms. Karin Fish on January 7, 2005.

In the ETC's role of reviewing the Results Group's draft report, members were asked to provide independent expert opinions for each of the four questions as well. The ETC based its assessment on: 1) its collective industry expertise; 2) its collective transportation expertise and its knowledge of research on relevant topics, and 3) the Results Group report and supporting documentation provided to the ETC.

In its assessment, the ETC has chosen to apply a prudency standard. That is, were the actions undertaken and/or the decisions made both reasonable and prudent for a state transportation agency undertaking a similar type of project, given what Caltrans knew, or should have known at the time.

Attachment A provides the summary presentation given by the ETC in response to this request on January 8, 2005. Attachment B provides a table of factors that may have contributed to cost escalation. The table included in Attachment B was used in both the assessment of the Results Group's report and in the independent analysis conducted by the ETC. The table consists of

[1] Note: The November 23, 2004 solicitation for the Results Group report phrased this question differently. The question in the solicitation was "What factors have contributed to cost increases for the Toll Bridge Seismic Retrofit generally and to the San Francisco – Oakland Bay Bridge in particular"?

those factors identified by the Results Group as contributing to costs increases and additional factors identified by the ETC that sometimes also play a role in cost increases based on the existing literature on the subject of cost growth in the design and construction industry. The additional factors identified by the ETC are explained in text following the table. References have also been included.

The content of this document represents the views and opinions of the panel and does not necessarily reflect the official views of the State of California Business, Transportation and Housing Agency.

ATTACHMENT A: SUMMARY PRESENTATION

Expert Technical Committee
Bay Bridge Assessment
January 6-8, 2004

Stuart Anderson, Texas A&M
David Ashley, University of California – Merced
Keith Molenaar, University of Colorado
Deb Niemeier, University of California – Davis
Cliff Schexnayder, Arizona State University

Evaluation Questions

1. What factors have contributed to the cost increases for the East Span of the San Francisco Oakland Bay Bridge?
2. To what extent have external factors out of control of Caltrans and the State of California contributed to the cost increases?
3. Which cost increases should have been anticipated and what additional practices should have been employed to better estimate costs?
4. To what extent has the Self-Anchored Suspension design chosen by the Bay Area contributed to the cost increases? To what extent did additional decisions by the Bay Area’s Metropolitan Transportation Commission contribute to the cost increases?

Overview

- Analysis of Results Group Report
- Addition of Cited Cost Factors from Literature
- Identification of Cost Factors Relevant to this Project
- Evaluation of Events, Decisions, and Processes
- Specific Response to Questions
- Path Forward

General Factors Contributing to Cost Increases

- Engineering and Construction Complexities
- Local Authority/Agency Concerns and Requirements
- Scope Changes
- Market Considerations
- Project Schedule Changes
- Effects of Inflation/Escalation
- Optimistic Estimates
- Poor Estimating (errors and omissions)
- Inconsistent Application of Contingencies
- Delivery/Procurement Approach

General Factors Contributing to Cost Increases

Complexity

- Engineering and Construction Complexities
- Local Authority/Agency Concerns and Requirements
- Scope Changes
- Project Schedule Changes

Market Factors

- Market Considerations
- Effects of Inflation/Escalation

Project Management

- Optimistic Estimates
- Poor Estimating (errors and omissions)
- Inconsistent Application of Contingencies
- Delivery/Procurement Approach

Project Specific Factors Driving SAS Cost Increases

- Project Complexity (Primary)
- Market Conditions (Primary)
- Management Processes (Nominal)

Evaluation

Basis of Evaluation

- Industry Expertise
- Transportation Expertise and Research
- Results Group Report and Supporting Documents

Standard

- We are applying a reasonable and prudent standard for a state transportation agency undertaking a similar type of project.
- What was known or should have been known at the point in time of actions or decisions.

Events-Decisions-Processes

External Events

- Financial Market
- Market Competition
- Price of Steel
- MTC Selection of Design
- Governor Changed Schedule
- Federalization

Decisions

Prudent Decision

- AB 1171 Constraints
- Multiple SAS Contracts
- Delay Bidding Period

Need More Info

- Selection of SAS
- Abandon SAS

Processes

Prudent Processes

- Design
- Estimating
- Risk Management

Need More Info

- Cost Control
- Schedule Control

Design

Examples of Reasonable and Prudent Actions

- Use of Outside Consultants
- Development of Alternatives
- Seismic Peer Review
- Corps of Engineer Review
- Pile Demonstration
- Construction of Mockups

Estimating

Examples of Reasonable and Prudent Actions

- AB 1171 Estimate by Caltrans in conjunction
  - Bechtel, Parsons Brinkerhoff, TY Lin, Moffat Nichol
- Peer Reviews
  - National Constructors (7/97)
  - Bechtel (7/01) (accounted for projected steel estimate)
  - Mock Bids (7/02)
- Value Analysis Studies
- Constructability Reviews

Risk Management

Examples of Reasonable and Prudent Actions

Risk Identification

- Seismic Peer Review
- Constructability Workshops
- Contingencies
- Kimley-Horn Quality Assurance and Risk Report
- Mock Bid
- Booz-Allen Report

Risk Mitigation

- Kimley-Horn Quality Assurance and Risk Report
- Addenda
- Multiple SAS Contracts in Response to Financial Market
- Extended Bidding Period

Cost Control

Critical Elements - *Need More Info*

- Timely Incorporation of Scope Changes in Estimate
- Internal Tracking Mechanisms
- Cost Control Implications on Internal and External Decision Making
- Timely Communication of Estimates
- Timely Linkage of Schedule to Cost

Schedule Control

Critical Elements - *Need More Info*

- Schedule Control Implications on Internal and External Decision Making
- Schedule Updating for Scope Changes
- Timely Communication of Schedules
- Timely Linkage of Schedule to Cost
- Reaction to External Schedule Changes

1. What factors have contributed to the cost increases for the East Span of the San Francisco Oakland Bay Bridge?

Referenced Factors	Results Group Factors	Additional Study
Engineering and Construction Complexities	Introduction/Costs Related to SAS A Different Bridge in SB 60	
Local Authority/Agency Concerns and Requirements	Costs Related to SAS	MTC Recommendations Accounted for in AB1171
Scope Changes	A Different Bridge in SB 60 Costs Related to SAS	Impact of Seismic Safety Peer Review
Project Schedule Changes	Schedule Delays	Impact of Seismic Safety Peer Review
Market Considerations	Federalization Price of Steel	Market Competition (Sole Bidder) Global Market Competition for Resources
Effects of Inflation/Escalation	Price of Steel	Effects of Delay Cement
Optimistic Estimates		Political Pressure Fixed Budget Conformance
Poor Estimating (errors and omissions)	A Different Bridge in SB 60 Costs Related to SAS Low Initial Cost Estimates Project Management Risk Management	Estimating Methods and Process Estimate Communication Project Management Risk Management
Inconsistent Application of Contingencies		Contingency Analysis
Delivery/Procurement Approach	Multiple SAS Contracts Increased Capital Outlay Support Costs Bonding and Insurance	Bonding Contract Implications

1. What factors have contributed to the cost increases for the East Span of the San Francisco Oakland Bay Bridge?

- Project Complexity (Primary)
- Market Conditions (Primary)
- Management Processes (Nominal)

2. To what extent have external factors out of control of Caltrans and the State of California contributed to the cost increases?

Our Evaluation of the Caltrans Processes

Prudent Processes

- Design
- Estimating
- Risk Management

Need More Info

- Cost Control
- Schedule Control

2. To what extent have external factors out of control of Caltrans and the State of California contributed to the cost increases?

Lack of Risk Plan’s Contribution

- Based on our prudency review, Caltrans recognized and actively managed project risk.
  - PMBOK is a credentialing standard but is not generally recognized and has not been adopted as transportation industry standard.
  - In a review of 28 state transportation agencies Caltrans risk management process is not significantly different.

3. Which cost increases should have been anticipated and what additional practices should have been employed to better estimate costs?

Project Complexity (Primary)

- Implications of complexity should have been anticipated and communicated
- Caltrans reasonably relied on external support to identify the complexity issues (TY Lin, Bechtel, Seismic Peer Review, Constructability Workshops)

Market Conditions (Primary)

- The recognition of market risks were reasonable for this industry and Caltrans reasonably relied on external support. (Bechtel (7/01) Cost Review with 5% escalation for steel, Parson Brinckerhoff (7/02) Mock Bid)

3. Which cost increases should have been anticipated and what additional practices should have been employed to better estimate costs?

Role of Timely Cost Estimates

- The role of timely cost estimates is to provide policy and design guidance. Timely cost estimates will not change the actual bids received.

4. To what extent has the Self-Anchored Suspension design chosen by the Bay Area contributed to the cost increases? To what extent did additional decisions by the Bay Area's Metropolitan Transportation Commission contribute to the cost increases?

Responded to on earlier slides.

ATTACHMENT B: TABLE OF FACTORS CONTRIBUTING TO COST GROWTH

1. What factors have contributed to the cost increases for the East Span of the San Francisco Oakland Bay Bridge?
2. To what extent have external factors out of control of Caltrans and the State of California contributed to the cost increases?

Factors Contributing to Cost Growth

(1)	Factors Cited in the Literature as Potential Contributors to Cost Growth (2)	Results Group (3)	Those Factors Considered by the Results Group (4)	Those Factors in Which Additional Study is Required (5)
Project Complexity	Engineering and Construction Complexities	A	Introduction/Costs Related to SAS A Different Bridge in SB 60	
	Local Authority/Agency Concerns and Requirements	P	Costs Related to SAS	MTC Recommendations Accounted for in AB 1171
	Project Schedule Changes	P	Schedule Delays	Impact of Seismic Safety Peer Review
	Scope Changes	P	A Different Bridge in SB 60 Costs Related to SAS	Impact of Seismic Safety Peer Review
Market Conditions	Market Considerations	P	Federalization Price of Steel	Market Competition (Sole Bidder) Global Market Competition for Resources
	Effects of Inflation/Escalation	P	Price of Steel	Effects of Delay Cement
Project Management	Optimistic Estimates	N		Political Pressure Fixed Budget Conformance
	Poor Estimating (errors and omissions)	P	A Different Bridge in SB 60 Costs Related to SAS Low Initial Cost Estimates Project Management Risk Management	Estimating Methods and Process Estimate Communication Project Management Risk Management
	Inconsistent Application of Contingencies	N		Contingency Analysis
	Delivery/Procurement Approach	P	Multiple SAS Contracts Increased Capital Outlay Support Costs Bonding and Insurance	Bonding Contract Implications

Column 3: Assessment of the Results Group's Draft Report (N = Not Addressed, P = Partially Addressed, A = Adequately Addressed)
Column 5: Factor identified by ETC that may have influence on cost growth and requiring additional study with respect to the Bay Bridge Project.

Factors from Literature

Engineering and Construction Complexities caused by the project's location or purpose can make early design work very challenging and lead to errors in internal coordination. Internal coordination errors can include conflicts or problems between the often large number of disciplines frequently involved in the planning and design of a project. Constructability problems that need to be addressed may also be encountered as the project develops. If these issues are not addressed, cost increases are likely to occur (Board 2003, The Big Dig 2003, Booz·Allen 1995, Callahan 1998, Federal-Aid 2003, Hufschmidt 1970, Mass 1999, Touran 1994, Transportation Infrastructure 1997, Transportation Infrastructure 2002).

Local Authority/Agency Concerns and Requirements typically include mitigation of project effects and negotiated scope changes or additions. Actions by the DOT are often required to alleviate perceived negative impacts of construction on the local societal environment as well as the natural environment. Measures may include but are not limited to introducing changes to project design, alignment, and the conduct of construction operations. These steps are often taken to appease local residents, business owners, and environmental groups. The level of required accommodation is often unknown during the early stages of project development. There are many empirical examples of "drastic" measures taken to accommodate local government and citizen concerns as well as national concerns with two of the most notable examples being actions during the Legacy Highway project in Utah and the Big Dig in Massachusetts (Board 2003, Booz·Allen 1995, Callahan 1998, Chang 2002, Daniels 1998, Harbuck 2004, Hudachko 2004, Legacy 2004, Mackie 1998, Mass 1999, Merrow 1981, Merrow 1986, Merrow 1988, Parsons 2002, Schroeder 2000, Touran 1994).

Project Schedule Changes, particularly extensions, caused by budget constraints or design challenges can cause unanticipated cost escalation even when the rate of inflation has been accurately predicted. It is best to think in terms of the time value of money and recognize that there are two components to the issue: 1) the inflation rate; and 2) the timing of the expenditures. Many DOTs have a fixed annual or bi-annual budget and project schedules must often be adjusted to ensure that project funding is available for all projects as needed. Estimators frequently do not know what expenditure timing adjustments will be made (Board 2003, Booz·Allen 1995, Callahan 1998, Hufschmidt 1970, Mass 1999, Semple 1994, Touran 1994).

Scope Changes can lead to underestimation of project costs. Such changes may include modifications in project construction limits, alterations in design and/or dimensions of key project items such as roadways, bridges, or tunnels, adjustments in type, size, or location of intersections, as well as other increases in project elements (Board 2003, Booz·Allen 1995, Callahan 1998, Chang 2002, Harbuck 2004, Hufschmidt 1970, Mackie 1998, Mass 1999, Merrow 1981, Merrow 1986, Merrow 1988, Semple 1994, Touran 1994).

Market Conditions or changes in the macro environment can affect the costs of a project, particularly large projects. Often only large contractors or groups of contractors can work or even obtain bonding for a large project. The size of the project affects competition for a project and the number of bids that a DOT receives for the work.

Typically, the risks associated with large projects are much greater, both for the owner and contractor, which affects project costs. Inaccurate assessment of the market conditions can impact project cost estimating (Summary of Independent Review 2002, Woodrow 2002).

Effects of Inflation/Escalation is a key factor in the underestimation of costs for many projects. The time value of money can adversely affect projects when 1) project estimates are not communicated in year-of-construction costs, 2) the project completion is delayed and therefore the cost is subject to inflation over a longer duration than anticipated and/or 3) the rate of inflation is greater than anticipated in the estimate. The industry has varying views regarding how inflation should be accounted for in the project estimates and in budgets by funding sources. In the case of projects with short development and construction schedules, the effect of inflation is usually minor, however, projects having long development and construction durations can encounter unanticipated inflationary effects. The results of inflation effects are evident in Boston's Big Dig. The original project estimate, which was developed in 1982 and based on the FHWA guidelines in the Interstate Cost Estimate (ICE) manual, did not include inflationary factors relating to the final construction schedule for the project. Inflation is a large portion of the cost overruns experienced on the project (Akinci 1998, Arditi 1985, Board 2003, Booz·Allen 1995, Hufschmidt 1970, Merrow 1988, Pickrell 1990, Pickrell 1992, Touran 1994).

Optimistic Estimates is the demonstrated systematic tendency to be overly-optimistic about key project parameters. Some researchers view this as bias or purposeful underestimation of project costs in order to insure a project remains in the construction program. This underestimation of costs can arise from the DOT estimators' or consultant's identification with the agency's goals for maintaining a construction program. The project process in some states is such that the legislature establishes a project budget by legislative act based on a budget is that is on cost estimates that may be very early in the design process. If subsequent estimates are higher than the legislative budget, the project may be canceled. As a result, engineers and the DOTs may feel pressure to estimate with an optimistic attitude about cost—low (Akinci 1998, Bruzelius1998, Condon 2004, Flyvbjerg 2002, Hufschmidt 1970, Pickrell 1990, Pickrell 1992).

Poor Estimating (errors and omissions) can also lead to project cost underestimation. Estimate documentation must be in a form that can be understood, checked, verified, and corrected. The foundation of a good estimate is the formats, procedures, and processes used to arrive at the cost. Poor estimation includes general errors and omissions from plans and quantities as well as general inadequacies and poor performance in planning and estimating procedures and techniques. Errors can be made not only in the volume of material and services needed for project completion but also in the costs of acquiring such resources (Arditi 1985, Booz·Allen 1995, Chang 2002, Harbuck 2004, Hufschmidt 1970, Merrow 1981, Merrow 1986, Merrow 1988, Pickrell 1990, Pickrell 1992).

Inconsistent Application of Contingencies causes confusion as to exactly what is included in the line items of an estimate and what is covered by contingency amounts. Contingency funds are typically meant to cover a variety of *possible* events and problems that are not specifically identified or to account for a lack of project definition during the preparation of early planning estimates. Misuse and failure to define what costs contingency amounts cover can lead to estimate problems. In many cases it is assumed that contingency amounts can be used to cover added scope and planners seem to forget that the purpose of the contingency amount in the estimate was lack of design definition. DOTs run into problems when the contingency amounts are applied inappropriately (Noor 2004, Ripley 2004, Association 1997).

Delivery/Procurement Approach affects the division of risk between the DOT and the constructors, and when risk is shifted to a party who is unable to control a specific risk project cost will likely increase. The decision regarding which project delivery approach, (design-bid-build, design-build, or build-operate-transfer, etc.) and procurement methodology (low bid, best-value, or qualificationsbased selection), and the packaging of projects (timing of letting, size of project, types of work in project, etc.) affects the transfer of project risks. In addition to the question of risk allocation, lack of experience with a delivery method or procurement approach can also lead to underestimation of project costs. Many DOTs are looking for ways to shorten project schedules in order to quickly deliver much-needed projects to the traveling public, but accelerated schedules are achievable only at a cost. While the end results of applying different procurement approaches should be beneficial, some hard lessons must be learned regarding the proper allocation of risks and what each new method entails, in terms of DOT responsiveness, expectations, and time (Harbuck 2004, New Jersey 1999, Parsons 2002, SAIC 2002).

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