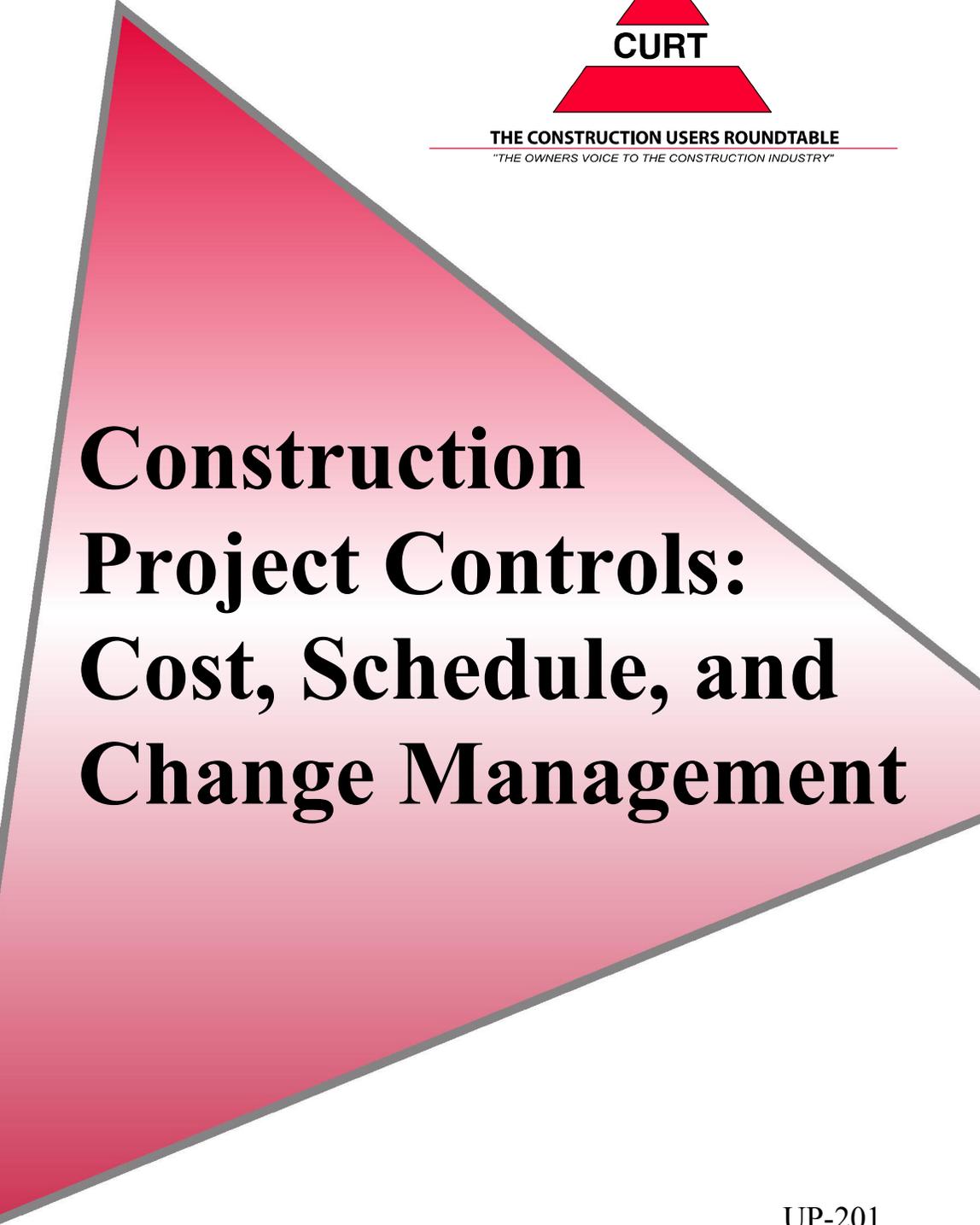


CURT

THE CONSTRUCTION USERS ROUNDTABLE

"THE OWNERS VOICE TO THE CONSTRUCTION INDUSTRY"



Construction Project Controls: Cost, Schedule, and Change Management

UP-201
September 2004

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Notice:

The purpose of this publication is to make available to industry the results of research and common owner practices. The information is provided solely for the individual consideration and education of CURT members and the industry. The publication does not necessarily represent the views of every CURT member company on this topic. The booklet is offered as an informational publication only. CURT intends only to synthesize current thought and trends concerning the topic. Neither CURT nor its committees make any warranty as to the completeness regarding the materials. Readers are encouraged to further research the topic before relying exclusively on these materials. Each CURT member and other readers of these materials are free, acting in its own discretion and its own perception of business self-interest, to reject or adopt the recommendations in whole or in part. Adoption and/or reliance upon these recommendations is strictly voluntary.

The Mission of The Construction Users Roundtable (CURT) is to promote cost effectiveness for owners doing business in the United States by providing aggressive leadership on issues that will significantly improve project engineering, maintenance and construction processes, thereby creating value for the owners.

1. Intent

CURT user practices are developed from individual member practices as presented and discussed at CURT workshops. They are intended for use by CURT member companies.

2. Objective

To improve the predictability of capital project cost and schedule by establishing project controls systems to monitor and predict project outcomes. Effective control systems identify deviations from project plans and commitments early enough to eliminate surprises and allow corrective action.

3. Principles

Project success requires recognition of the following principles:

- ▲ Flexibility to meet changing business goals and objectives is a desired project characteristic.
- ▲ Cost and schedule have a direct relationship. Presuming project plans are being followed, deviations from the planned schedule are indicators of a cost up-trend. Also, cost up-trends tend to be indicators of schedule delays.

4. Scope

A project controls system should be established for each capital project. The scope and detail of the controls system should be based on the size, complexity, sensitivity, and execution strategy of the specific project.

Each project controls system should include:

- ▲ A **Cost Management Process** that estimates, monitors, predicts, and reports project cost.
- ▲ A **Planning and Scheduling Management Process** that plans project activities, monitors completion of those activities, predicts timing of future activities, and reports schedule status.
- ▲ A **Change Management Process** that estimates the impact of change, enables and documents the change decision, and integrates the change into the project scope of work.

(Project Quality is covered separately in CURT **UP 701, “Construction Quality: Achieving Quality on Capital Projects”**.)

5. Corporate Approach (Policy)

Owners should take maximum advantage of contractor project controls systems for both engineering and construction. However, owners should integrate controls systems for projects with multiple contractors.

Owners should provide adequate resources, time, and funding to ensure an integrated project controls system for each project. (Owners should expect to spend between 0.25% to 1.5% of Total Installed Cost to establish and implement an effective project controls system, depending on the complexity of the project and the experience of the assigned staff.)

6. Responsibilities

The owner's Project Manager is accountable to ensure integration and execution of project controls systems. Other members of the Project Team support this effort, including:

- ▲ Purchasing Manager
- ▲ Project Engineer (Planner/Scheduler)
- ▲ Construction Manager
- ▲ Startup Manager

Responsibilities for Key Members of the Project Team	
Project Manager	<ul style="list-style-type: none"> ▲ Leads the Project Team ▲ Ensures that project controls systems are effective and fully integrated for all project entities ▲ Ensures that the change management decision-making process is defined, documented, and understood ▲ Ensures timely decision-making to meet project needs ▲ Evaluates project status reports and forwards them to the business owner ▲ Takes appropriate action to address issues and problems
Purchasing Manager	<ul style="list-style-type: none"> ▲ Ensures that contractor cost and schedule reporting requirements are included in the contract ▲ Ensures that a change management process is documented in each contract
Project Engineer (Planner/Scheduler)	<ul style="list-style-type: none"> ▲ Develops the overall project controls system ▲ Integrates engineering, construction, and start-up controls systems, including: cost, schedule, and change management ▲ Manages the change decision process for engineering design ▲ Receives, analyzes, and integrates cost and schedule reports from engineering design, construction, and startup leadership ▲ Reports status and variation from plan to the Project Manager on periodic basis

Responsibilities for Key Members of the Project Team (continued)	
Construction Manager	<ul style="list-style-type: none"> ▲ Develops construction management controls system ▲ Integrates controls systems from multiple construction contractors ▲ Receives and analyzes contractor cost and schedule reports ▲ Manages proposed change during construction ▲ Reports status and variations from plan to the Project Engineer on a periodic basis
Startup Manager	<ul style="list-style-type: none"> ▲ Develops control systems for startup ▲ Manages proposed change during startup ▲ Reports status and variations from plan to the Project Engineer on a periodic basis

Owners can staff these positions several different ways:

- ▲ Assign direct employees
- ▲ Use contract engineers with specialized expertise
- ▲ Delegate project controls responsibility to a primary contractor

However, no matter how these positions are staffed, the owner remains ultimately accountable to develop, implement, and monitor project controls systems.

7. Timing

Project controls systems are established during project Front-End Planning. They are then implemented and monitored throughout the life of the project, during Design, Procurement, Construction, and Startup.

8. Procedure

Planning and implementation of construction project controls includes the following steps:

- 1. Plan the control systems.**

During the project Front-End Planning, the owner should establish an overall plan to manage cost, schedule, and change during project execution. The form and structure of the project controls plan is influenced largely by the project execution strategy and contract type selected.

For example, a firm-price design-build strategy requires minimal owner involvement because cost and schedule responsibility is consolidated in one contractor.

Conversely, a reimbursable approach with multiple trade contractors will require a high degree of owner involvement to integrate input and information from multiple sources.

Regardless of execution strategy or contract type, the project controls plan should outline and document:

- ▲ Required staffing
- ▲ Roles and responsibilities
- ▲ Cost management work process, including an accounting system that tracks project commitments as well as spending
- ▲ Schedule management system, including computer software
- ▲ Change management system, including the decision-making process
- ▲ Work breakdown structure
- ▲ Required contractor and owner reports

2. Establish the project budget and baseline schedule

The project budget and baseline schedule is determined during the Front-End Planning project phase. These become the control base from which any variation is measured during execution. Typically, these baselines are commitments to the owner organization for cost and schedule project outcomes and are often the basis for project funding.

A process of successive estimating and scheduling is used to develop these control documents. During Front-End Planning a series of estimates and schedules are developed as project scope is more fully defined. These estimates and schedules become more and more detailed, and increasingly accurate, as project knowledge increases.

Estimates and schedules should be structured to match the execution strategy and contracting form established for the project. For example, if a firm price, multiple contractor strategy is selected, the estimates and schedules should be structured so that each contractor's estimated cost and required schedule is clearly understood. Individual contractor schedules should be integrated to show interfaces, interdependencies, and potential interferences.

Owners typically require the estimates and schedules to pass accuracy and risk guidelines before project authorization can occur. The project budget and schedule authorized, become the control baselines used during project Design, Construction, and Startup.

3. Plan the work.

During construction, segments of the work are placed with contractors through the procurement process.

- ▲ Control estimates are used to test the competitiveness of firm-price bids or to establish budgets for reimbursable work.
- ▲ Control schedules are included in the Request for Proposal (RFP) sent to each prequalified contractor, and ultimately are included as a requirement in the contract.
- ▲ The change management process and contractor reporting requirements documented during Front-End Planning are also included in the RFP and then as a requirement in the contract.

Contractors should be prequalified to ensure that they have effective cost, schedule, and change management systems.

4. Control the work.

When construction field work begins, the control estimate and control schedule are used to establish baselines to measure progress and variation. An earned-value system should be established to estimate actual physical progress and to establish a basis for predicting future effort and schedule time required for completion.

It is important to note that cost and schedule control systems provide more than reactive accounting—they also provide timely information for management intervention. Cost overruns and schedule delays are predicted, not just reported. Timely information allows the opportunity to influence scope, crew size, interferences, late deliveries, and other project characteristics to mitigate the overall impact of negative occurrences.

Project controls systems provide timely information for proactive construction management.

a. Cost Management

Project cost is typically reviewed monthly. The cumulative effect of change is tracked and predicted for all firm-price contracts.

Reimbursable cost is predicted by analyzing work progress, amount spent to date, committed cost, and amount predicted to complete. The cost management accounting system summarizes the cost of individual pieces of scope and predicts total construction cost.

Short-duration projects, like shutdowns and turnarounds, may require more frequent analysis and reporting. These projects often predict cost on a weekly, or even daily, basis.

b. Schedule Management

Typically, the schedule is reviewed each week. This is best done at a meeting led by the owner's Construction Manager, where all contractors are represented. Each representative reports schedule progress, delays, and potential interferences.

The owner's Construction Manager enables the coordination of multiple schedules and analyzes schedule progress. Problem areas are addressed and remedies defined to bring schedule progress back toward the plan committed to the business owner.

Again, short-duration projects like shutdowns and turnarounds may require more frequent analysis and reporting. These projects often predict schedule each day, or sometimes each shift.

c. Change Management

Change is inevitable and often desirable. The project change management system should identify and document all variation from the contract drawings and specifications and provide a process for technical approval and project authorization.

The change order documentation should identify not just the cost impact of the change, but also any schedule, quality, and safety considerations. These are key issues to be addressed in the decision-making process.

Proposed change should be dealt with in a timely manner. Once authorized, the change should be incorporated in the project scope of work. Excessive change can add complexity and cost beyond that identified in individual change orders. See CII Research Summary RS158-1, “Quantifying the Cumulative Impact of Change Orders for Electrical and Mechanical Contractors”.

5. Predict final project cost and schedule.

Cost and schedule reviews provide the information required to predict the ultimate construction cost and schedule. The owner's Construction Manager, using the best information available, applies judgment and expertise to predict cost and schedule and identify any variation from the authorized baseline estimate and schedule.

6. Report cost and schedule status and variations from plan.

The owner's Construction Manager periodically reports cost and schedule status to the owner's Project Engineer or Project Manager. This is typically done monthly, but reporting can be more often for accelerated projects. The Construction Manager's report should include:

- ▲ Total predicted construction cost
- ▲ Predicted construction schedule
- ▲ Identified variations from the authorized project cost and schedule
- ▲ Management intervention initiated to mitigate negative cost and schedule impact
- ▲ Assessment of risk associated with attaining the predicted cost and schedule

9. Summary

Owners who proactively manage project cost, schedule, and change experience better project outcomes than those who rely on contractors to meet contract provisions without direct owner involvement.

Project controls systems provide timely information for proactive construction management. Owners who are aware of construction problems can intervene and mitigate negative consequences.

Accurate prediction of construction outcomes enables the business owner to better react to variations from authorized cost and schedule.

10. Reference Documentation

CURT Documentation

- ▲ A-6 Application of Modern Management Systems
- ▲ 1621 The Business Stake in Effective Project Systems
- ▲ 1655 A Message to Owners Who Pay for Major Construction
- ▲ Notes from CURT Project Controls Workshop, April 30, 2004

Construction Industry Institute

- ▲ The Impact of Changes on Construction Cost and Schedule, Apr 90 (RS6-10)
- ▲ Project Change Management, Nov 94 (SP43-1)
- ▲ Model Planning and Controlling System for EPC of Industrial Projects, Apr 87 (RS6-3)
- ▲ Project controls for Construction, Sep 87 (RS6-5)
- ▲ Quantifying the Cumulative Impact of Change Orders for Electrical and Mechanical Contractors, Oct 00 (RS158-1)
- ▲ Quantitative Effects of Project Change, Dec 94 (RS43-2)

Construction User Roundtable Publications

The purpose of developing Construction User Roundtable (CURT) publications is to disseminate recommendations, guidelines, and reports developed by the Construction Users Roundtable. CURT is focused on improving the cost effectiveness of the U.S. construction industry. These publications have been developed from the point of view of owners or users of construction services. Efforts by all segments of the industry, however, are vital if major improvement is to be the result.

This publication is one of a series from committees or study teams addressing a problem area.

Findings and recommendations of The Construction Users Roundtable are included in publication series classified as White Papers (WP), Reports (R), or User Practices (UP). In addition to these classifications, CURT publications are numbered based on the category of the topic:

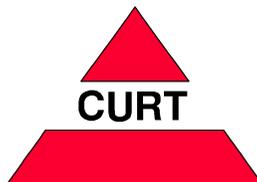
Category	Number Code
Constructability	001 to 099
Contractor Management	101 to 199
Cost	201 to 299
Interface Management	301 to 399
Workforce/Industrial Relations	401 to 499
Material Control	501 to 599
Purchasing	601 to 699
Quality	701 to 799
Safety	801 to 899
Security	901 to 999
Strategy	1001 to 1009
Work Planning and Scheduling	1101 to 1199
Technology/E-Sourcing	1201 to 1299
Special Projects	2001 to 2099

Examples:

WP-1201: A CURT White Paper on Reverse Auction

R-402: A CURT Report on Tripartite Initiatives

UP-801: A CURT User Practice on Construction Safety in Contractor Prequalification



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