

# CSC.04

## Evolving Project Control Practices

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**W**hat will it cost and when will it be finished? How many times has management asked these questions? It's no longer as simple as asking the estimator, cost engineer, or scheduler, as the project control engineer has replaced these traditional roles. A project control team (PC team) is evolving on major projects, consisting of a project controls manager, cost engineers, scheduling engineers, technicians, trend engineers, specialists, and estimators. Moreover, document control and management information systems are being added to the task list of PC team duties.

The PC team involvement on projects can now include planning and scheduling, estimating, value engineering, constructability reviews, cost control, change management, trending, earned value, information systems, reporting, document control, dispute resolution, and financial management. However, the primary project controls mission still remains the same—the PC team must be able to put in place the software, systems, and processes necessary to enable project completion within the approved budget and schedule.

A PC team can be a major project commitment, one that requires total management support to ensure successful implementation. The “no surprises” philosophy is key to earning the trust of management. Thus, the PC team's main concern is avoidance of cost and schedule surprises. To make this happen, the right people and systems must be in place to empower the PC team to alert management early enough to make informed decisions.

The PC team is now being asked to do more, and must determine what tools are needed to support the project controls mission. This paper will discuss the renaissance of the project control team while reviewing “back to basic” ideas and requirements for setting up a project control system. An overview of basic project control elements will be presented with recommendations for organizations, cost-scheduling systems, and tools that can be used on small and large projects. Imagine yourself on a new assignment as the project controls manager. Where do you begin? Note: due to the author's background, the topics covered may be slanted toward program and construction management practices on competitively bid projects.

### BASIC COST AND SCHEDULE CONTROL SYSTEM

The first major step in setting up a project control system is establishing a well-thought-out project management plan. Followed by detailed planning and development of the project's work breakdown structure (WBS), cost code of accounts, preliminary estimate, summary cost report, and a project master schedule. A good starting approach is to create a manual cost system and then move it an integrated project management control system (PMCS). The basic cost and scheduling control system should include these items.

- Project management plan.
- Work breakdown structure.
- Cost code of accounts.
- Preliminary estimate.
- Work packages/control accounts.
- Summary cost report.
- Project master schedule.

### Project Control Organization

The size of the PC team and the corresponding PMCS depends on the magnitude of the project, the budget, and the commitment of management to the cost and scheduling process. What organization is required for a small, medium, or large project? There are key “must have” organizational components and then there are the support options. Small projects are run very lean, with project controls staff covering more than one function. Small projects can usually get by with one person responsible for cost, scheduling and reporting. Medium-sized projects add a project controls manager, cost engineer, scheduler, and part-time estimating support. Large projects maintain a centralized PC team (core group) supporting multiple area project control engineers with other technical staff being added as needed (figure 1).

### Project Control Software

When specifying project control software, consider the project organization, amount of computerization, and desired level of control. The process for choosing “off the shelf” project management software should involve careful review of many products. Whatever is purchased, it has to be set up and maintained with the risk that implementation may take more specialists and con-

sultants than the project can afford. The basic PMCS system consists of standard software modules integrated by the WBS and code of accounts (figure 2).

while also monitoring the schedule’s critical path. Staying with a “back to basics” approach in setting up PMCS will help staff focus on what is currently needed, while providing time to identify options to be added as the project control system matures. What basic systems and procedures are needed to manage a project? Ask the owner and project manager what needs to be reported and why—the answer may be surprising. The PMCS must be simple to maintain and be able to do the following.

**PROJECT MANAGEMENT CONTROL SYSTEM (PMCS)**

An effective PMCS comes from a thorough knowledge of the scope of work; project controls fundamentals, a balanced set of procedures, and the appropriate use of the best available tools. The project control manager must have a good understanding of the contract documents and available tools before any discussions with the project manager about the proposed PMCS. The initial PMCS requirements should be as simple as possible to deploy while still meeting the project’s requirements. Project control emphasis should be placed on early warning techniques to spot deviations in the planned work. The project control system must have the ability to alert project management about problems early enough so corrective action can be taken, thereby saving time and money. Moreover, the system should not overload the PC team to the point of becoming overcommitted and losing effectiveness. The PC team can run the risk of promising too much, getting behind, and falling into the trap of just reporting or reacting to “fire drills.”

- Manage cost and schedule requirements.
- Capture all components of cost from day one.
- Forecast cost to complete on a routine basis.
- Involve entire project community in the project control process.
- Use cost commitments (not just actual payments) measuring performance.
- Link with the project accounting and finance system.
- Identify potential cost/schedule issues early.
- Report cost and schedule variances.
- Compare indirect costs to actual work performed on a continual basis.
- Manage project contingency.
- Measure budget and schedule performance.
- Report cost, status, and progress at different management levels.
- Process changes to the budget in a timely manner.

Most important, the PC team must be in position to constantly look forward and determine the estimated cost to complete

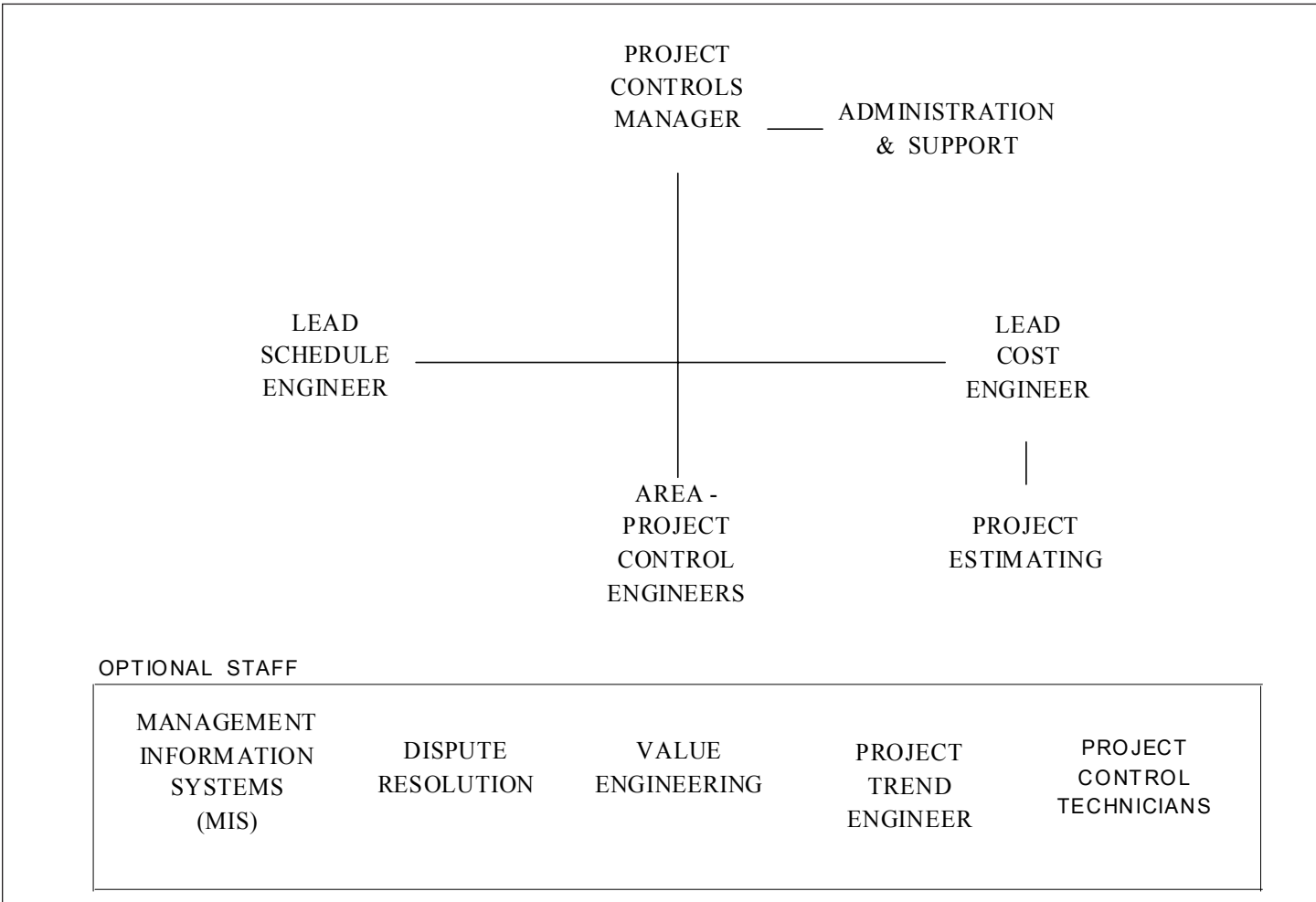


Figure 1—Project Control Organization

**Pulling it All Together**

A fully integrated PMCS does not exist on most projects. Project information is often fragmented and spread around between groups. The accounting department records invoices, but may not be using the right cost codes. The contract and procurement departments know what has been purchased, but may not code commitments as they were budgeted. The project manager understands the project’s scope of work, budget, and schedule, but does not have timely project information to proactively manage the project ... this is the project controls manager’s worst nightmare. With responsibility in so many places and on multiple systems, it can be extremely difficult to manage the project’s budget and schedule performance.

The PC team must be able to cross all of these boundaries and pull it all together. A successful PMCS necessitates getting all players to commit to the project management plan, a standardized cost code of accounts, and the project’s WBS. The project management plan is prepared by the project manager and the control team manager at the beginning of the project, and defines the “rules of engagement” for the interaction of everyone associated with the project. The standardized code of accounts is the tie between project accounting and the cost control system. The WBS forms the backbone of the project control system, allowing multiple software systems to communicate with each other through a common language. The WBS is a top-down logical structure of the project work, usually by geographical or physical area and is derived in conjunction with the project organization.

The PMCS consists of the following elements (figure 3).

- Budgeting and cost management.
- Planning and scheduling.
- Information access and reporting.
- Project technical services.
- Contract administration and procurement.
- Financial systems.

**BUDGETING AND COST MANAGEMENT**

**Work Packages**

The scope of work and initial cost estimate define the emerging project. As the estimate progresses through stages of conceptual through definitive, the project control system has to keep pace, define the work, and control the process. So how is cost and schedule evolution tracked? A proven way to accomplish this is by establishing individual work packages/control accounts, which are now interchangeable terms. Well-defined work packages/control accounts are probably the key to an effective project control system. A difficult but necessary process for management and the PC team at the beginning of the project is breaking down the scope of work into definable and manageable elements of work that can be used to track and measure project performance. Work packages/control accounts are elements of work at the lowest

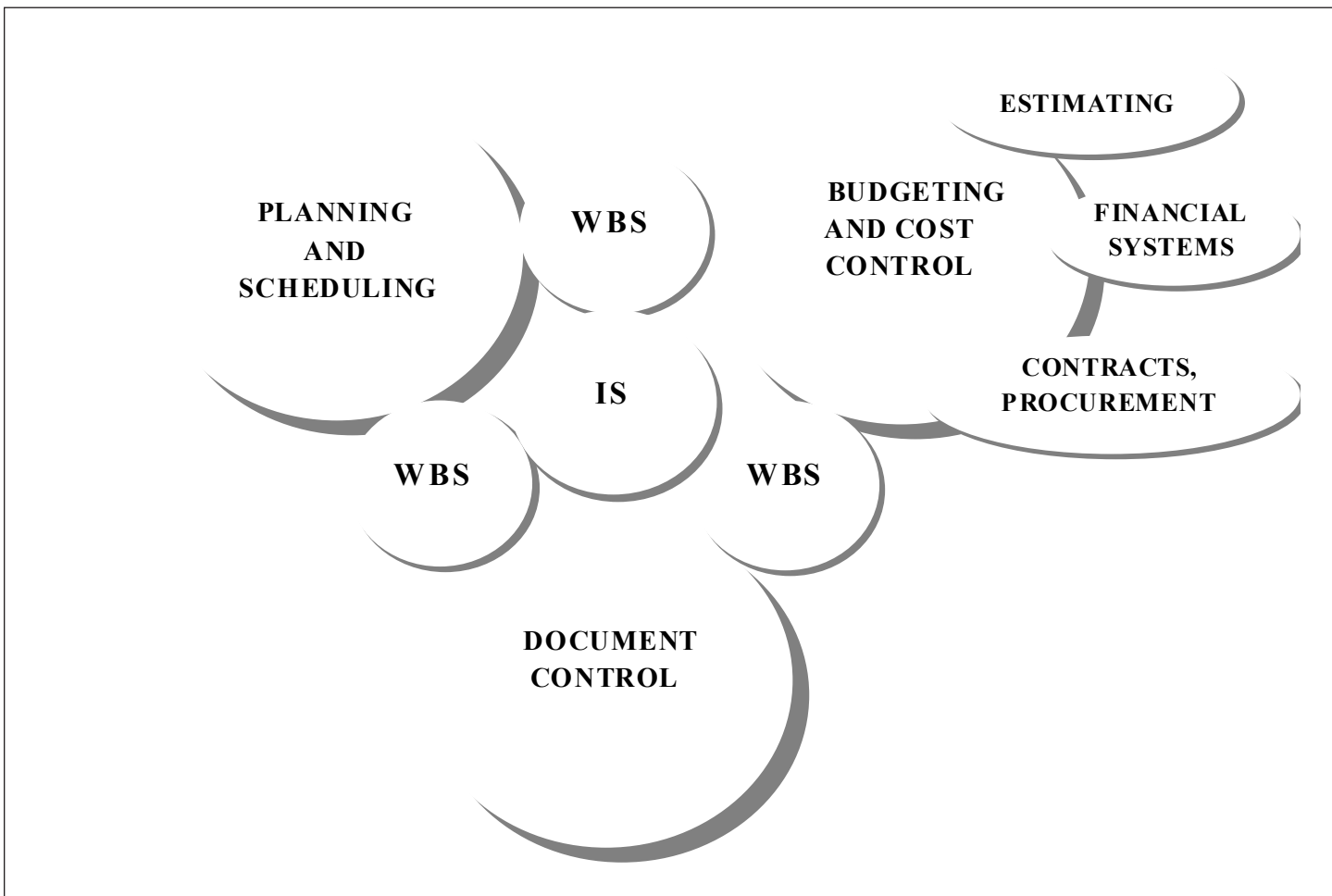


Figure 2—Software Integration Model

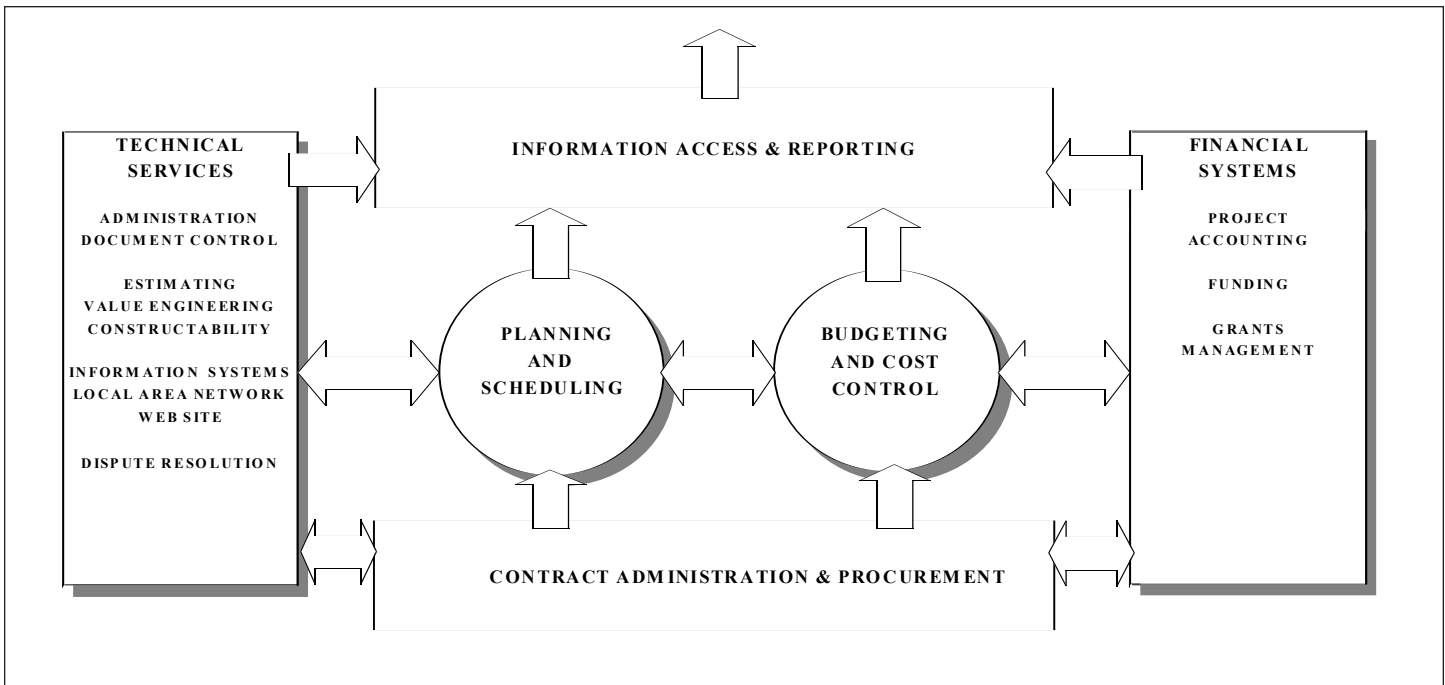


Figure 3—Project Management Control System (PMCS)

responsible level of the WBS describing detail scope, cost, and schedule, and becoming the building blocks for the PMCS. Basically the control account relates to cost and the work package relates to schedule. Earned value management systems may also use the term *cost account plan* (CAP) [1].

### Cost Control Base

The cost control base or “baseline” should be established as early as possible by using the current project estimate. The approved baseline defines the relationship between the scope of work and the cost estimate. To be effective, the control base must be defined in enough detail to support the PMCS and enable informed decisions. The project baseline essentially draws a line in the sand and sets the starting point to measure budget performance. A similar baseline is established with the approved project schedule.

### Trending

Trending is a formal process of highlighting potential cost and schedule issues, and bringing them to the attention of management. Trends are the earliest recognition of project issues that may result in deviations from the approved project scope of work. Trending is a useful management technique for promoting cost consciousness. Trends are subject to change and can either be positive or negative. The importance of trending is its place at the beginning of the change process, allowing management the opportunity to control cost and schedule drivers before they become problems. Trending turns on the project’s headlights for that forward cost look, which is helpful in forecasting the estimated cost at completion.

Important trending considerations include the following.

- Establish a trending procedure to formally track issues.
- Designate a trend engineer as a central point of contact.

- Include approved trends in the forecast cost to complete.
- Review trends with responsible managers on a weekly basis.
- Involve project team members in the trend process.

### Forecasting

Another important goal for the PC team is to forecast what the project may cost. Forecasting is an estimate and prediction of future cost and schedule conditions. It is the science of the educated guess at its best, and is based on information and knowledge available at the time of the forecast. Forecasting uses sound judgment, common sense, experience, and basic cost engineering practices. The forecasting process can take advantage of earned value calculations, pending changes, trends, and check estimates.

A checklist for forecasting should include the following items.

- Funding requirements.
- Current approved budget.
- Commitments.
- Expenditures.
- Estimate to complete.
- Pending changes.
- Work in place.
- Trends.
- Earned value calculations.
- Productivity.
- Rework.
- Escalation.
- Remaining allowances.
- Contingency draw-down.

## Change Management

Changes are an alteration or variation to the scope of work and or the approved schedule. In order to recognize changes and “scope creep,” the PC team must be very familiar with the scope of work and contract documents. The PC team needs to understand how the scope of work has changed, justify what happened, estimate the change, and prepare for negotiations. The change order process can be standardized, and some discipline brought to the process by outlining the steps and defining responsibilities. The completed change order package should include all pertinent documentation for the change. Remember that someone not associated with the project should be able to read the change order package and understand what has happened. The following “six part” change order folder is intended to document the steps in the contract change process [2].

- Finding of fact—this is the initiating document providing justification for issuing a change notice. A rough order of magnitude estimate is prepared at this time.
- Change request—the request for change notice is prepared with a clear definition of the scope of work so the designer/contractor can either prepare a price proposal, or be directed to proceed on force account basis (time and material) until the change is finalized.
- Engineer’s estimate—simultaneous with distribution of the change notice, a detailed independent cost estimate is prepared to be used during the negotiation stage of the change.
- Negotiation plan—the negotiation plan is prepared upon receipt of the designer’s or contractor’s quote and detailed estimate. A comparison is made between labor, materials, and equipment in the engineer’s estimate to those in the price proposal. A strategy to reconcile the differences is developed in the negotiation plan and reviewed with management.
- Record of negotiation—the record of negotiation documents the negotiation and covers the topics of scope, labor, material, and equipment reconciliation between the designer/contractor’s proposal and the engineer’s estimate.
- Change order—concurrent with preparation of the record of negotiation, the contract change order document is prepared. The finalized change order package should include all revised contract drawings and backup documentation.

## PLANNING AND SCHEDULING

The PC team develops the schedule specification requirements for the contract documents. A balance needs to be worked out between having too much or too little schedule control. The size of the project and resources available should be considered. The planning process starts with development of the top-level master schedule, followed by the project level critical path method (CPM) schedule and then detailed control level schedules. The master schedule should be revalidated once the CPM schedule is finalized. Schedules, just like cost reports, are best represented in a hierarchical relationship, where each lower level rolls up into the next higher level (figure 4).

Three types of schedules are produced.

- Level 1, master schedule—the master schedule is the management approved controlling schedule with the plan for the entire project. This top-level schedule summarizes and incorporates all lower level project schedules displayed as a summary bars.
- Level 2, project schedule—the project level schedule is a CPM schedule where the project is planned and statused and earned value performance is measured. Schedule logic establishes a workable plan and sequence of activities to complete the project. The schedule rolls up into and supports the master schedule. It is cost-loaded with the approved budget and becomes the “baseline” schedule for the project.
- Level 3, detail schedules—detail control level schedules are the day-to-day working schedules prepared by the design teams and contractors. The control level schedule allows for detailed daily planning of work in parallel with the project level schedule. Enough work should be planned with this schedule each week to support monthly progress goals.

While preparing schedules, consider the following items.

- Document all assumptions describing how the schedule was prepared.
- Support schedule activity duration with the project estimate.
- Activity logic should be consistent with scope as defined by the work packages.
- Define schedule activities with just enough detail to manage the project.
- Project level activity duration should not be less than one week.
- Avoid overloading the project control system with too much schedule detail.
- Code project level activities to “roll up” into the master schedule.
- Develop “smart” activity coding structures for running special schedules.
- Start with a preliminary master schedule, then build the project level schedule.
- Project level schedules should support progress payments and earned value calculations.
- Resource load the project level schedule to run “what-if” studies.
- Consider building in schedule contingency and planned nonwork weather days.
- Link daily inspection report detail to schedule activities for preparing an as-built schedule.
- Run three-month “rolling schedules” each month using the current schedule.
- Obtain schedule approval as early as possible by approving logic first, followed by cost and resource loading.

## INFORMATION ACCESS AND REPORTING

Everyone associated with the project does not need the same information. Exception reporting allows information to be filtered and summarized for the appropriate audience level. Data is summarized and rolled-up using the project WBS, custom fields and









| <b>PROJECT REPORTING LEVEL</b>  | <b>AUDIENCE</b>   | <b>SCHEDULE</b>   | <b>COST</b>   |
|---|---|---|---|
| <b>1 - MANAGEMENT</b>   | <b>OWNER<br/>PROJECT MANAGER<br/>PARTNERS<br/>FUNDING AGENCY</b>                  | <b>PROGRAM MASTER SCHEDULE<br/>PROGRAM MILESTONES<br/>AREAS OF CONCERN</b>                          | <b>PROJECT COST REPORT<br/>FUNDING STATUS<br/>CONTINGENCY STATUS</b>                    |
|  |  |                    |      |
| <b>2 - PROJECT</b>  | <b>AREA MANAGERS<br/>PROJECT ENGINEERS<br/>DEPARTMENT MGRS.</b>                   | <b>AREA MASTER SCHEDULE<br/>CPM SCHEDULE<br/>THREE MONTH SCHEDULE<br/>CRITICAL ACTIVITY LISTING</b> | <b>DETAIL COST REPORT<br/>CONTRACT STATUS REPORT<br/>CHANGE ORDER LOG<br/>TREND LOG</b> |
|  |  |                    |      |
| <b>3 - CONTROL</b>  | <b>ENGINEERS<br/>DESIGNERS<br/>CONTRACTORS<br/>VENDORS</b>                        | <b>DETAIL CONTROL SCHEDULE<br/>CONTRACT SCHEDULE<br/>WEEKLY WORK SCHEDULE</b>                       | <b>CONTRACT PAYMENT DETAIL<br/>COST ACCOUNT PLAN<br/>WORK PACKAGE</b>                   |

Figure 4—Reporting Levels

Table 1

|   |
|---|
| <p><b>EXECUTIVE SUMMARY</b></p> <ul style="list-style-type: none"> <li>• Monthly highlights</li> <li>• Areas of concern and action</li> <li>• Cost summary</li> <li>• Funding status</li> <li>• Project master schedule</li> </ul> <p><b>PROJECT LEVEL(S)</b></p> <ul style="list-style-type: none"> <li>• Overview</li> <li>• Monthly developments</li> <li>• Plan for upcoming month</li> <li>• Area master schedules</li> <li>• Cost report</li> <li>• Contract status reports</li> <li>• Contract detail reports</li> </ul> <p><b>APPENDIX</b></p> <ul style="list-style-type: none"> <li>• Project photos</li> <li>• Site plan</li> <li>• Project organization</li> <li>• Work breakdown structure</li> <li>• Cost code of accounts</li> <li>• Definitions of terms</li> </ul> |
|---|

code of accounts. Three levels of project reporting are maintained on a project (see figure 4).

- Management level: summarized by major project elements. The audience is the owner and program manager.
- Project level: summarized by detail within major project areas. The audience is the project engineers and area managers.

- Control level: reported at the lowest level of accountability in the WBS and code of accounts. The audience is the engineers, designers, vendors, and contractors.

The monthly project status report (PSR) focuses on areas of concern, cost and schedule issues, and recommendations for action. The PSR should do more than simply record project history. Following the monthly cutoff, the PC team compiles all the project cost, schedule, status and progress information, and prepares the monthly report, as shown in table 1.

**Cost Report**

The detail monthly cost report is the most comprehensive report for the project and is issued separately from the monthly PSR. Various cost reports are prepared for different project management levels (figure 4). Data can be presented in a variety of ways, including cost by program, project area, contract, control account, funding source, owner cost center, contingency status, trends, pending and approved changes, and budget transfers.

Basic cost report columns include these items.

- Original budget: the approved budget for the project, which does not change unless the project changes significantly enough to require a new “baseline” budget.
- Budget transfer: records the authorized movement or shifts between control accounts, as defined by the original budget and tracks transfers in and out of contingency.
- Scope changes: additions or deletions to the original budget by approved changes.

- Current budget: the current updated budget for each control account; takes into account all budget transfers and approved scope changes.
- Committed cost: records cost committed or incurred against control accounts.
- Estimate at completion: estimated cost at completion considers all pending changes, approved trends, “to go” check estimates, and earned value budget performance calculations.
- Actual cost to date: represents the total value of cost expended or incurred by control account at the reporting period.
- Verify that all work packages/control accounts add up to the current budget.
- Measure progress and status against the current schedule.
- Incorporate approved changes.

### PROJECT TECHNICAL SERVICES

#### Schedule Reports

Schedule reporting involves monthly status and progress updates to the current schedule. Once updated, the schedule is compared to the approved baseline schedule, variances noted, and discrepancies reviewed with the designer/contractor. Specialized coding allows the team to prepare critical activity listings, three-month schedules, higher level summary schedules, and special study reports.

Schedule reports prepared each month include the following.

- Program master schedule (level 1).
- Area master schedules (level 2, summary).
- Critical activity listing (level 2, CPM schedule).
- Three month schedules (level 2, CPM schedule).
- Weekly work schedules (level 3, control level schedule).
- Special schedule studies.

#### Earned Value

An earned value management system (EVMS) provides a method to measure budget and schedule performance by determining the value of work actually accomplished. Cost and schedule performance are tracked against the approved baseline and the resulting variances are measured. Earned value provides the PC team with another performance measurement and forecasting tool. However, earned value is still a backward-looking tool based on past performance using derived historical data and should be combined with forward-looking techniques such as trending. The work package/control account is where earned value performance is measured. The cost system tracks actual expenditures and commitments by control accounts and the CPM schedule reports “physical” percent complete by work packages. Earned value cost and schedule performance indices can then be used to calculate estimated total cost at completion [1].

Key considerations for preparing an EVMS include these items.

- Use established WBS, code of accounts, and organizational breakdown structure.
- Define individual work packages/control accounts.
- Recast the project estimate into work packages/control accounts.
- Define schedule activities and milestones supporting work packages/control accounts.
- Assign work package/control accounts to responsible managers.

#### Administration and Document Control

The PC team provides support for the project’s document tracking system. The WBS and code of accounts developed by the PC team provides the basis for coding, tracking, and retrieving all project correspondence. Consistent coding of documents allows the PC team to identify and retrieve project issues for easy reference. Document searches of electronically stored data produce supporting information related to major issues, trends, change orders, and potential disputes.

#### Estimating

The project estimate evolves as the stages of the project move from conceptual through final design. Estimating is an approximation, and the degree of accuracy changes as the project is better defined. Estimates should be prepared within standard estimating formats and have the ability to be recast by the project code of accounts and the WBS. Every estimate should include a summary statement defining the basis of the scope of work and philosophy used to prepare the estimate. Once the estimate is completed, contingency and escalation are added. The current estimate is used to support the cost control baseline.

Contingency is an allowance for unforeseen conditions not defined at the time of the estimate. Contingency is not intended to cover additions to the scope of work, but to cover within-scope items not covered in the estimate. The amount of contingency applied is based on determining the cost to complete, while considering the associated risk involved with completing the work.

Escalation is an estimate allowance to adjust for inflation. An estimate carries a cutoff date that forms the basis for wage rates, material, and equipment cost. Cost escalation is a judgment calculation assigned to future years and is based on consumer price indices, local factors, and experience. Escalation is calculated per year to the midpoint of related scheduling activities.

Factors to remember during preparation of the project estimate are given below.

- Document the basis of how the estimate was developed.
- The estimate format should be consistent with the code of accounts and WBS.
- Document how escalation was determined and applied to the estimate.
- Define how contingency is to be determined, managed, and allocated.

#### Value Engineering and Constructability Reviews

The PC team facilitates value engineering (VE) and constructability reviews during the early stages of the project. VE is the process of checking that the project design concepts will meet requirements for performance, quality, aesthetics, and budget at a

reasonable cost. Formal VE workshops typically involve the project manager, cost engineer, estimator, design team, and other professional consultants. Constructability reviews are usually done in conjunction with VE sessions and provide an organized process to review the contract documents by a very experienced team with the objective of reducing conflicting design information in order to decrease construction changes [2].

### Information Systems

Management information systems (IS) once operated as an independent group on the project, but now interface directly with the PC. Their expertise is required for installation of local area networks, custom databases, and web site communications. The PC team provides a working knowledge of the latest project control systems. Together they provide systems integration involving multiple databases for cost control, accounting, scheduling, contract administration, document control, and custom reports.

### Disputes

Unresolved issues, disputes, and potential claims are a constant risk and concern on competitively bid projects. The PC team should implement “claim proofing” practices early in the project to help mitigate and defend disputes during the project. The main defense is having well-thought-out general conditions and a project management plan. The secondary defense is a document control process that provides access to all the project correspondence. The third defense, is an approved project schedule or “baseline” that can be used to compare the as-planned schedule to the as built schedule. Another useful defense is to track what happened on the project by linking daily inspection reports to activities in the current schedule, thereby providing ongoing documentation for preparation of an as-built schedule. Preparing an as-built schedule is much easier to do as you go, rather than waiting until after the project is finished. The as-built schedule is a powerful tool to have during negotiations. Don’t wait until the end of the project to resolve issues. Process changes in a timely manner during the project to avoid misunderstandings and resolve potential disputes [2].

The PMCS should be able to interface with owner-based accounting systems either directly or indirectly. New enterprise-wide database systems are making their way into project accounting practices by providing a single point of data entry with the goal of saving time and reducing errors. However, the enterprise-wide systems don’t always consider PMCS requirements. The PC team has to establish a working relationship with project accounting as early as possible to define project goals and reporting requirements.

Projects may have multiple grants, funding sources, and partners. This introduces another reporting requirement to track cost by the “color of money,” or different funding sources. Funds management and tracking of expenditures should be considered when setting up the PMCS. The grant process can involve identification of funds for federal grants, state, or local money. Upon approval of the grant agreement, costs are segregated and tracked by cost center.

**T**he rebirth of the cost engineering profession continues to take place. The cost and scheduling engineer is being replaced by the project control engineer within a project control team. The project control team has evolved and is now supporting all aspects of project management and technical services on major programs. The main mission of the project control team has always been to alert management early about potential cost and schedule issues before they become problems—this must remain a priority and kept in focus. As the profession changes, so have the demands on the services being provided. The project control team is continually being asked to do more, and may run the risk of falling into the trap of not having enough time to focus on important tasks, such as forecasting total project cost or completion. It is very easy to overcommit resources since a PC team is usually asked to take on more tasks. The PC team is supported by new software systems and tools that claim to consolidate and make project controls more efficient. However, don’t lose sight of the fact that large complex projects were once completed on time and within schedule using basically manual systems. This paper reviewed some of the basic project control requirements being implemented today. There still are many creative approaches and new software available to manage a project. The tool box for the project controls manager should include the approach of “back to basics and keep it simple” while setting up a project management control system. Options can always be added later.

Companies need to be reminded to take an active role in promoting project control training. In the meantime, professional societies are filling the gap with training programs and certifications. However, we still need to do more by teaching the “how to” basic skills to new project control professionals so they can continue to inform project management about, “What it will cost?” and “When it will be finished?”

## CONTRACT ADMINISTRATION AND PROCUREMENT

Projects can contain several contracts covering design, construction, and a variety of other support services. The WBS and cost code of accounts allows for integration of all contracts into the PMCS. Contract budgets are established and monitored by the PC team. As contracts are awarded, costs are further broken down into measurable line items of work. Invoiced cost is collected at the contract line item level and input into the PMCS. The PC team also provides direct support to contract administration with coordination of submittals, requests for information, correspondence, change orders, payments, and daily reports.

## 2002 AACE International Transactions

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