

AACE International Recommended Practice No. 14R-90

**RESPONSIBILITY AND REQUIRED SKILLS FOR A PROJECT
PLANNING AND SCHEDULING PROFESSIONAL**
TCM Framework: 7.2 – Schedule Planning and Development

Acknowledgments:

Edward E. Douglas, III CCC PSP (Author)
Peter R. Bredehoeft, Jr.
Larry R. Dysert, CCC
Earl T. Glenwright, Jr. PE PSP
H. Ernest Hani, PSP
Paul E. Harris, CCE
John K. Hollmann, PE CCE
Kenji P. Hoshino, PSP
Stephen M. Jacobson CCC

Vera A. Lovejoy, CCE PSP
Donald F. McDonald, Jr. PE CCE PSP
Michael R. Nosbisch, CCC PSP
Fredric L. Plotnick, PE
Wesley R. Querns, CCE
Saleh El Shobokshy
Ronald M. Winter, PSP
James G. Zack, Jr.

RESPONSIBILITY AND REQUIRED SKILLS FOR A PROJECT PLANNING AND SCHEDULING PROFESSIONAL

TCM Framework: 7.2 – Schedule Planning and Development



September 19, 2006

INTRODUCTION

This recommended practice is intended to serve the following purposes:

- Describe the roles and responsibilities of a Planning and Scheduling Professional (PSP) during the various phases of project planning and schedule development, management and control.
- Define the *core* skills and knowledge a Planning and Scheduling Professional is required to have in order to be considered a professional practitioner, and in doing so,
- Establish the *core* subjects for AACE International PSP education and certification programs.

Knowledge is understanding gained through experience or study and *skills* are abilities that transform knowledge into use. Core subjects are those whose usage is occasional to frequent and which AACE International considers as being required for planning and scheduling professionals to know and use.

This Recommended Practice (RP) lists the core subjects and provides general performance statements (e.g., "describe", "perform", etc.) in order to represent the level of proficiency expected in each subject area. These statements are guiding examples only, and are presented in a "verb-object" format.

This outline is intended to be a structural foundation for additional planning and scheduling products to be developed by AACE International and will continue to be modified as current practices change.

BACKGROUND

This revision retains most of the content of the previous version and includes information from **RP 11R-88** *Required Skills and Knowledge of Cost Engineering*. It also incorporates those elements of the **Total Cost Management (TCM) Framework** that are deemed applicable for a planning and scheduling professional. It provides organization of the subjects aligned with the **TCM Framework**.

TCM provides an integrated structure and organizes the development of RPs. The AACE International *Constitution and Bylaws* (Section 3) defines Total Cost Management as follows:

"Total Cost Management is that area of engineering practice where engineering judgment and experience are utilized in the application of scientific principles and techniques to problems of business and program planning; cost estimating; economic and financial analysis; cost engineering; program and project management; **planning and scheduling**; cost and schedule performance measurement; and change control."

PURPOSE

The purpose of this Recommended Practice is to:

1. Describe the responsibilities of a project planning and scheduling professional.
2. Incorporate the applicable skills and knowledge for Planning and Scheduling Professionals from **RP 11R-88** and the core subjects required for AACE PSP Certification.
3. Establish a planning and scheduling guideline for training and professional development.
4. Provide ethics subscribed to by planning and scheduling professionals.

This Recommended Practice is organized in three major sections consistent with the traditional planning and scheduling “phases” of project planning, schedule development, and schedule management/control.

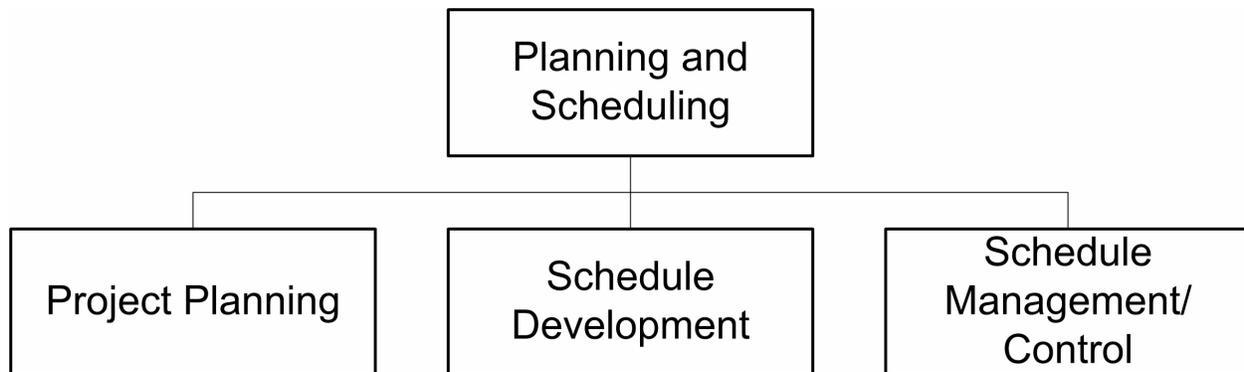


Figure 1. PSP Scope of Knowledge

PURPOSE OF PLANNING AND SCHEDULING

- A. The purpose of project planning is to establish an acceptable course of action ("plan") to execute a project in an effective manner through the review of project scope and objectives.
- B. The purpose of project scheduling is to 1.) Define activities, durations, and relationship logic to implement the project plan, and 2.) Monitor, update, and communicate the schedule to reflect current status and the impact of project changes.
- C. The planning and scheduling professional provides the project management team with the expertise to deliver the project in the most effective manner.

GENERAL CONCEPTS

Project Planning as defined by AACE is, "the determination of a project's objectives with identification of the activities to be performed, methods and resources to be used for accomplishing the tasks, assignment of responsibility and accountability, and establishment of an integrated plan to achieve completion as required" [2].

Project planning consists of:

1. Reviewing the scope of work, client requirements, division of responsibility, project objectives and constraints to develop the strategy for effective project delivery.
2. Identifying major activities to be performed and the preferred sequence in which they are to be accomplished.
3. Developing an integrated plan to effectively execute the scope of work and meet project objectives by identifying cost/schedule areas for the further definition of the scope of work.
4. Coordinating with project management.

Scheduling as defined by AACE is: (A) "The assignment of desired start and finish times to each activity in the project within the overall time cycle required for completion according to the plan [2]." (B) "Process of

converting a general or outline plan for a project into a time-based schedule based on available resources and time constraints [3].” Another clarification of the term scheduling is: “Scheduling is the ordering of the activities within a plan utilizing additional discretionary logic restraints and constraints ... based upon the discretion of the project manager ... and including adjustments to activity-specific and total resource usage that may be directed [12].”

Furthermore a Schedule is defined by AACE as: (A) “A description of when each activity in a project can be accomplished and must be finished so as to be completed timely. The simplest of schedules depict in a bar chart format the start and finish of activities of a given duration. More complex schedules, generally in CPM format, include schedule logic and show the critical path and floats associated with each activity. (B) A time-sequence of activities and events that represent and operating timetable. The schedule specifies the relative beginning and ending times of activities and the occurrence of events. A schedule may be represented on a calendar framework or on an elapsed time scale. [3]”

Scheduling is described as two distinct phases: schedule development and schedule management/control.

Schedule development includes the following,

1. Establishing a schedule development process to develop a project schedule that includes the entire project scope of work, client requirements, schedule hierarchy, division of responsibility, schedule review, approval requirements, and distribution.
2. Developing a master project schedule, identifying major milestones to achieve the project completion date.
3. Developing detailed schedules by WBS, and assigning costs, labor, and equipment to each activity to determine progress requirements to meet the project completion date.
4. Obtaining project team schedule review and approval.

Schedule management/control includes the following,

1. Establishing a regular basis for updating the project schedule to ensure the timely reporting of schedule information.
2. Record and assess the effects of project schedule changes.
3. Assessing actual progress versus planned progress to determine trends and variances.
4. Analyzing schedule trends, determining risks and developing options for corrective action.
5. Revising the project plan and project schedule (re-planning and re-baselining) as required.

PLANNING & SCHEDULING PROFESSIONAL’S ROLES AND DUTIES

A. Planning and Scheduling Professional Duties

The Planning and Scheduling Professional’s duties are to assist the project management team in developing, monitoring, and updating an integrated project plan and schedule so that the project may be executed in the most efficient manner possible. This is accomplished by the following,

1. Assisting with the development and implementation of acceptable planning and scheduling techniques and methods.

2. Preparing procedures and guidelines for project planning and related scheduling management and control.
3. Supporting the project team efforts toward the development of the project plan and translating that project plan into the project schedule.
4. Leading development and analysis of project schedules, CPM software implementation, time impact and delay analysis, and review of periodic schedule updates.
5. Monitoring and updating accurate schedule progress toward achieving the desired project completion date and informing the project management team of changes to schedule outcome.
6. Prepare and provide schedule progress reports, trending charts, and schedule analysis. Maintain records of scope changes, trends, and variances that potentially affect schedule performance.
7. Assuring the credibility of the information contained in the schedule.
8. Assisting with the preparation of project time and cost claims.
9. At the completion of the project, assists in developing and recording the project's historical schedule information and "lessons learned", for use on future enterprise projects.

B. Planning and Scheduling Professional Training and Professional Development

1. Maintains a high level of technical expertise through continuing education programs and participation in cost/schedule related professional activities.
2. Provides technical training and guidance to project personnel on planning and scheduling subjects.
3. Develops leadership/team-building skills as well as written and verbal communication skills.
4. Advance their professionalism by participating in and advancing professional organizations dedicated to professional planning and scheduling.

C. Planning and Scheduling Professional Ethics

1. **Ethics:** The Planning and Scheduling Professional (PSP) must be familiar with and subscribe to the AACE International *Canon of Ethics*.

The AACE International **TCM Framework** (Section 11.1), states "at all times, each person in the enterprise must judge the means and the ends against personal and societal values and rules of conduct. In judging, people and organizations must ask questions about the means and ends such as: are they fair, respectful, responsible, honest and honorable? Society sets the framework for this questioning, but individuals and organizations make the judgments and set the rules. Most organizations have ethics programs or rules of conduct. AACE International's *Canon of Ethics*, which if violated by a member, may subject them to expulsion from the Association."¹

2. **Relations with Employers and Clients:** "Members will undertake only those cost engineering (*scheduling*) and cost (*schedule*) management assignments *for which they are qualified*. Members

¹ The introduction to the *Canon of Ethics* reads: "The AACE International member, to uphold and advance the honor and dignity of cost engineering and the cost management profession and in keeping with the high standards of ethical conduct will (1) be honest and impartial and will serve employer, clients, and the public with devotion; (2) strive to increase the competence and prestige of their profession; and (3) apply knowledge and skill to advance human welfare."

will engage or advise their employers or clients to engage specialists whenever their employer's or client's interests are served best by such an arrangement."

PLANNING & SCHEDULING PHASES

A. Project Planning

Project planning begins early and continues as the project moves through the various phases of the project life cycle from project conception through to project completion, and closeout. Rather than a straight-through process, it is best thought of as a planning cycle [13].

Most project management professionals agree that there is a basic five-step process involved in developing a project plan. Essential questions that are answered during project planning:

- **What?** The physical feature and technical objectives (scope).
- **How?** Work breakdown structure (WBS).
- **Who?** Resource commitments and organization breakdown structure (or OBS).
- **When?** Timeline initially and then the schedule later in the planning process.
- **How Much?** Budget estimate.

Based on these questions, the recommended sequence of actions to develop the project plan are as follows,

1. **define the project scope;**
2. **establish the work breakdown structure (WBS);**
3. **identify resources and availability (people and capital assets);**
4. **establish timeline and sequence of deliverables; and**
5. **determine the budget for each component activity, work package, or group of tasks.**

The Planning and Scheduling Professional assists the project manager to accomplish the following,

- facilitate the preparation of the project plan and work breakdown structure (WBS);
- facilitate the estimation of timelines and project phases;
- identify key project results and milestones;
- involve team members in the planning process; and
- involve the client in defining project goals and key results [13].

SCHEDULING PHASES

Scheduling involves two distinct phases: schedule development and schedule management/control. For these phases, project management sources identify the Planning and Scheduling Professional's responsibilities to include the following,

- provide expertise to develop methodologies, techniques and tools for planning and scheduling;
- provide direct support and expert consulting advice to project personnel regarding planning and scheduling;
- ensure that required project planning and scheduling controls are appropriately implemented and maintained; and
- assist the project manager to establish realistic and achievable schedule baselines [13].

B. Schedule Development

The purpose of the schedule development phase is to implement the project schedule by converting the project plan into a logical arrangement and sequence of activities. During the schedule development

phase, the following occur. The project planning activity definitions are refined. Activity durations are confirmed. Activity relationships and sequences detailed, and key milestones or events are confirmed. Resources or costs may be included in the schedule activities.

During the schedule development phase, the Planning and Scheduling Professional will interface with, and obtain input from, project personnel for the development of a project schedule that reflects the defined scope of work. The major output/deliverable from the schedule development phase is the project baseline schedule as documented in the schedule basis document. After schedule development is complete, including a quality review and stakeholder acceptance of the baseline schedule, then scheduling transitions to the next phase of schedule management and control. The schedule development phase is outlined as follows,

- 1. Initiate the schedule development process.**
 - a. schedule model and methods; and
 - b. schedule development process and procedures.

- 2. Obtain input/data for schedule development.**
 - a. stakeholders;
 - b. contract schedule specifications;
 - c. other requirements; and
 - d. output from project planning is input to schedule development
 - I. schedule scope of work;
 - II. project execution approach/methodology;
 - III. work breakdown structure (WBS);
 - IV. project milestones and key events;
 - V. activity definitions; and
 - VI. logical relationships.

- 3. Develop detailed project schedule.**
 - a. quality analysis; and
 - b. constructability analysis.

- 4. Schedule development output/deliverables.**
 - a. baseline schedule;
 - b. cash flow;
 - c. resource histograms; and
 - d. basis of schedule is documented.

C. Schedule Management and Control

The scheduling management and control phase includes the following: Implementing the schedule procedures and processes required to maintain the project schedule during the project execution phase. Accomplishing progress updates, critical path and near critical activity analysis, schedule change management, forecasts and recovery plan, progress reporting, and providing timely output and deliverables to the project team.

During the schedule management phase actual progress is tracked, critical and near critical path activities are monitored, and variances or trends analyzed and reported to the project participants. The Planning and Scheduling Professional will interface with, and obtain input from, project personnel for the progress and tracking of project activities. The Planning and Scheduling Professional assists the project by analyzing effects to the critical path activities; identifying changes to the project that affect schedule; forecasting; and by developing recovery schedules and alternate courses of action. The Planning and Scheduling Professional develops schedule progress reports, analyzes and reports forecasts for all significant project activities. The schedule management and control phase is outlined as follows:

- 1. Implement schedule management and control procedures.**
 - a. Develop methodologies, techniques and tools for scheduling.
 - b. Provide support and advice to project personnel regarding scheduling.
 - c. Ensure project scheduling controls are appropriately implemented and maintained.

- 2. Maintaining the schedule during the project execution phase by:**
 - a. Tracking progress by updating the project schedule on a regular basis to assess actual performance against the plan.
 - b. Assess impacts on the critical path and near-critical activities and report critical work activities to the project manager. A critical work activity is defined in several ways:
 - I. An activity that is not meeting the required rate of production such that the project objectives will be met on or ahead of schedule.
 - II. An activity that requires a resource allocation that is either unattainable or unmanageable.
 - III. An activity whose late completion will delay the timely completion of a project objective.
 - c. Monitor schedule deviations and variances and assist in developing alternative methods for corrective action.
 - d. Perform value analysis upon recommended alternatives to determine cost/benefit tradeoff, and present recommendations to project management.
 - e. Revise the schedule as directed by project management and ensure that schedule changes are communicated to all project team members.

- 3. Schedule coordination and communication.**
 - a. Present and answer questions on project plans and schedules at project meetings.
 - b. Perform analysis to evaluate alternative plans, work-around courses of action, or otherwise amend, plan, schedule and forecast as directed by project management.
 - c. Work in concert with project cost engineers, quantity surveyors, estimators, and material control personnel, to ensure cost and schedule integration.

- 4. Schedule change management.**
 - a. Revise the approved baseline schedule only when a change order indicates a change in scope or duration.
 - b. Keep time-phased copies of the schedule of the work as historical records as the project progresses.
 - c. Provide schedule-related recommendations to the project management team on strategies to recover from project delays.

- 5. Schedule reports and deliverables.**
 - a. Perform schedule analysis and provide periodic reports of schedule content to the project management team.
 - b. Issue status updates and approved revisions of the schedule that reflect work progress and time elapsed.

- 6. Project and schedule closeout.**
 - a. Upon completion of the project, verify that the as-built schedule reflects accurate completion dates for each schedule activity.

PLANNING & SCHEDULING PROFESSIONAL – SCOPE OF KNOWLEDGE

The Planning and Scheduling Professional should be able to describe, discuss, and/or perform the tasks listed in the following elements of this Scope of Knowledge.

I. PROJECT PLANNING.

- A. Input to planning:** Describe the characteristics of good requirements for use in project or asset planning. Explain how requirements for an asset or product might differ from those for a project.
- 1. Stakeholders:** Describe how to identify the stakeholders and be able to discuss the challenges of eliciting the information regarding needs, wants, or expectations from the various stakeholders.
 - 2. Historical data:** Describe the use of historical data in planning.
 - 3. Contract/scheduling specification:**
 - a. Contract types: Explain the advantage and disadvantages of these types of contracts from the owner and contractor viewpoints:
 1. fixed price;
 2. unit price;
 3. cost-plus (with fixed, incentive, or award fees); and
 4. time and materials (T&M).
 - b. Project delivery methods.
 1. design-build;
 2. EPC (engineering-procurement-construction);
 3. design-build-operate; and
 4. variations of the above.
 - c. Risk allocation: Explain how each contract type allocates risks between the contracting parties.
 - d. Supply chain: Explain this concept and how it might affect procurement planning.
 - 4. Value improvement practices:**
 - a. Constructability.

Constructability is used during construction project planning. It involves methods to optimize the design in consideration of the effective performance of construction activities. Alternate materials, unique construction sequencing (i.e., activity logic), and construction technologies are key considerations. The constructability analysis provides planning input related to the means and methods such as field vs. shop fabrication. The constructability analysis of the detailed baseline schedule output provides an analysis that determines that the project can be constructed within the time constraints of the project.
 - b. Manufacturability.

Manufacturability is used during asset planning to optimize product and production system design in consideration of the effective performance of manufacturing and related activities. Alternate materials, manufacturing technologies, and standardization are key considerations (e.g., use common parts for different products).
 - 5. Planning considerations:**
 - a. Stakeholders:
 1. owner/user/operator;
 2. designers/architects/engineers;
 3. contractors/subcontractors/direct hire;
 4. suppliers/vendors;
 5. public agencies; and
 6. public groups.

- b. Resources:
 - 1. people;
 - 2. equipment;
 - 3. technology; and
 - 4. capital.
- c. Project variables:
 - 1. physical environment;
 - 2. project delivery methods;
 - 3. contracting methods;
 - 4. funding;
 - 5. labor agreements; and
 - 6. constructability assessment.
- d. Value engineering analysis:
 - 1. cost;
 - 2. schedule; and
 - 3. quality.

B. Planning process:**1. Scope development:**

- a. Asset scope – describe this as the physical, functional and quality characteristics or design basis of the selected asset investment (functional decomposition).
- b. Project scope – describe this as the scope of work to deliver the project (i.e., project scope – work decomposition).

2. Execution strategy.

- 3. Work breakdown structure (WBS):** Diagram a WBS for a basic scope provided in narrative form to an appropriate level of deliverables.

- 4. Organization breakdown structure (OBS):** Diagram an OBS for a basic scope provided in narrative form.

5. Establishing milestones.**6. Activities definition.****7. Determine logical sequences.****8. Estimate activity durations.****9. Resource allocation.****10. Risk management:** Describe the following general concepts:

- a. risk and uncertainty: Define risk in terms of risk opportunities;
- b. risk factors (or drivers) and risk factor properties;
- c. risk management plan; and
- d. contingency action plans.

- 11. Monte Carlo simulation:** Discuss the use of a Monte Carlo simulation model to assess probable project outcomes.

12. Schedule contingency:

- a. Define schedule contingency and what should be included.

- b. Describe ways schedule contingency can be estimated/established in coordinate with cost control (estimating/budgeting) team members.

C. Planning output/deliverables:

1. **Project plan:** Describe the content of the project execution plan: also known as: project implementation plan, construction execution plan, task order plan, etc.
 2. **Project goals/execution strategy.**
 3. **Scope of work:**
 - a. Project scope: The scope of work to deliver the project (i.e., project scope = work decomposition).
 - b. Asset scope: The physical, functional and quality characteristics or design basis of the selected asset investment (functional decomposition).
 4. **Work breakdown structure (WBS).**
 5. **Organization breakdown structure (OBS).**
 6. **Milestones definition.**
 7. **Activities and work packages definition.**
 8. **Logical sequences of work packages and activities.**
 9. **Activity durations.**
 10. **Resource allocation.**
 11. **Schedule contingency/recovery plans.**
 12. **Cash flow:** Discuss the effects on planning when cash flow is restricted.
- D. Planning and schedule development transition:** Describe the transition between project planning and schedule development. Describe how the project plan is “handed off” and the project schedule is developed during the schedule development phase. The project planning output provides input/data for schedule development.

II. SCHEDULE DEVELOPMENT.

- A. Schedule models and methods:** Compare scheduling models and methods:
1. **Arrow diagram method (ADM):** Using this method also identify critical points.
 2. **Precedence diagram method (PDM):** Using this method include at least on each finish-start, finish-finish, start-finish, and start-start relationships with lags and identify critical path(s).
 3. **Bar chart/Gantt chart:** Explain the difference between this and a logic diagram.
 4. **PERT chart:** Describe the program evaluation & review technique (PERT) method and use.
 5. **Line of balance (LOB):** Describe this method and uses.

6. **Linear scheduling:** Describe this method and uses.
7. **Critical chain:** Describe this method and uses.
8. **CPM schedule algorithm:**
 - a. Calculate the early and late start and finish times, and identify total float.
 - b. Given either an ADM or PDM network with activity durations, early and late start and finish times, and total float, analyze and correctly answer questions based on activity and schedule calculations showing early/late start or finish times of all activities, and total float of these activities.

B. Schedule input:

1. **Milestones and key events.**
2. **Activities definition.**
3. **Activity logic and logic diagrams:**
 - a. Given a series of logic statements, draw a logic diagram.
 - b. Describe the various PDM logical relationships and their effective use: (e.g. FS, SF, FF, FS).
 - c. Leads and lags: Discuss any proper use of leads and lags.
 - d. Describe the difference between hard logic and soft logic.
 - e. Preferential logic: Describe and define.
 - f. Given a soft-logic work package with no strict activity interrelationships, describe ways to schedule this work.
4. **Activity durations:** Describe the process for developing realistic activity durations.
5. **Constraints:** Discuss typical real and mechanical constraints that may be imposed on a schedule.
6. **Project schedule calendars:** Discuss the use of multiple project calendars.
7. **Activity coding:** Describe the use of coding for sorting/selection of activities.
8. **Resource allocation, loading and leveling:**
 - a. Resource allocation: Describe the mechanics of this step.
 - i. Labor and equipment loading.
 - ii. Cost or value loading.
 - b. Resource availability: Discuss ways to assess availability and potential consequences of not making that assessment.
 - c. Resource limits and constraints: Discuss resource limits and constraints that may occur or be imposed.
 - d. Resource leveling or balancing: Describe the process.
 - e. Resource management: Describe how this process is tied closely to cost estimating (e.g., quantification) and schedule development (e.g., resource allocation).
9. **Critical path:** Describe the critical path (longest path) for the schedule. Determine the constraints and potential impacts to critical path, and near critical path work activities. Assess the impact on critical path and near-critical activities and report critical path work activities to the project manager. A critical work activity is defined in several ways:
 - a. An activity that is not meeting the required rate of production such that the project objectives will be met on or ahead of schedule.
 - b. An activity that indicated a required resource allocation that is either unattainable or unmanageable. And,

- c. An activity whose late completion will delay the timely completion of a project objective.

10. Float: Describe the significance of total and free float for the schedule activities.

C. Schedule development output/deliverables:

1. Baseline schedule.

2. Schedule basis: Describe the typical content of schedule basis documentation.

3. Milestones and key events.

4. Work breakdown structure.

5. Resource loading curves/work crew and staffing requirements.

6. Cash flow: Discuss the importance of integrating estimating and scheduling practices.

7. Stakeholders review/feedback.

D. Other scheduling development concepts:

1. Schedule quality analysis.

- a. Schedule specification compliance.
- b. Schedule integrity: Open ended logic, relationships, constructability (means and methods).
- c. Validation: Describe how the quality and completeness of plans can be assessed before implementation and why the process is important. Also explain the value of historical, empirical information.

2. Schedule strategy.

- a. Describe the characteristics and risks of a fast track schedule.
- b. Describe alternate schedule strategies in regards to potential changes and claims that a contractor may apply in developing a network schedule (acceleration, crashing, crunching, etc.).

3. Project control baseline: Describe how to integrate the cost and schedule control baselines. Establishing effective project control interface (e.g., how to measure progress, integrate schedules, etc.) for each type of contract.

4. Schedule hierarchy: Describe the levels of schedule detail and their intended uses.

5. Code of accounts: Describe the characteristics of a good code of account structure and its benefits for both project scheduling and cost control.

6. Contract documents: Explain the importance of the contract in regards to the schedule.

7. Other contracting and procurement concepts:

- a. Schedule of values: Explain this concept in regards to contracts and schedule control for contracted work.
- b. Cost or value loaded schedules: Explain this concept in regards to contracts and schedule control for contracted work.
- c. Front-end loading (FEL): Describe this concept and its benefits in terms of risk management and project control planning.

8. **Programs:** Explain how schedule development might be handled for groups of projects.
9. **Manufacturing/production operations:** Explain how production scheduling differs from project scheduling.

III. SCHEDULE MANAGEMENT AND CONTROL.

A. Project implementation and control plan: Explain the following concepts:

1. **Phases:** Describe the typical stages in respect to project planning and funding authorization and the benefits of an established process.
2. **Project implementation scope statement:** Describe the typical information in this deliverable at project initiation and the importance of business and project team agreement and communicating this information to all stakeholders.
3. **Control accounts:** Describe this concept and its content in relation to WBS and earned value application.
4. **Project control plan and basis:** Describe the typical information in this deliverable at the start of project execution and the importance of integrating, agreeing on and communicating this information to the project team.
5. **Schedule contingency management:**
 - a. Describe the appropriate level of authority for managing schedule contingency.
 - b. Describe typical criteria for its allocation and use of schedule contingency.

B. Schedule performance procedures and processes.

1. **Schedule progress and status procedures.**
 - a. Status schedule: Discuss the various methods and mechanics of statusing and updating a schedule.
 - b. Physical progress: Explain the general concept for the following methods, and, given input information, be able to calculate the following:
 - i. units completed;
 - ii. incremental milestones;
 - iii. weighted or equivalent units completed;
 - iv. resource expenditure and/or resources required;
 - v. remaining duration;
 - vi. percentage completed; and
 - vii. judgment.
2. **Schedule performance assessment:** Explain these general concepts:
 - a. Schedule variance: Describe this concept as an empirical difference between actual and planned performance for any aspect of the control plan.
 - b. Schedule trends: Describe the difference between random and non-random variance and how this might influence subsequent control actions and forecasts.
 - c. Schedule control assessment: Describe practices and methods for assessing and reporting performance (variances and trends) against the following baseline plans:
 - i. Schedule:
 - a) Describe methods to identify variance (e.g., calculate slip, earned value methods, etc.), assess critical path and remaining float.
 - b) Describe performance reporting methods (e.g., schedule plot showing the planned and actual schedule activity status), tables showing a percentage or factor that

expresses the extent that the schedule is ahead or behind at given points in time, lists of activities sorted by early start date or total float, etc.).

- ii. Resources/earned value: Explain the general concept and the importance of a reliable control basis and objective, quantitative physical progress measures.
 - a) Labor: Describe basic earned value methods.
 - b) Material and fabrication: Describe the use of earned value, schedule assessment, material management reports, and so on.

3. Forecasting:

Forecast and forecasting: Describe how the schedule control concepts are applied in the context of work in progress, performance assessment findings, change management, and corrective actions.

4. Schedule change management:

Definition: For project control, schedule change management refers to the process of managing any change to the scope of work and/or any deviation, performance trend or change to an approved or baseline project control plan.

Definition: For asset management, schedule change management refers to the process of managing any change to documented information defining the scope of an asset or the basis of measuring and assessing its performance over its life cycle. Change management helps ensure that requirements always address customer needs.

- a. Trend or variance analysis: Describe how the schedule control concepts are applied in change management.
- b. Time impact analysis: Describe the concept related to schedule change.
- c. Corrective actions: Describe what these are and why they might be needed.
- d. Change control procedures: Describe ways that change management findings and dispositions are recorded, reported, and incorporated in the project control plans.
- e. Manage schedule contingency:
 - i. Describe methods for managing schedule contingency.
 - ii. Describe ways to assess the need for contingency for work in progress.

5. Contract claims and disputes:²

- a. Explain the difference between scope and non-scope changes.
- b. Discuss the concept of changes and change management in respect to contract agreements.
- c. Describe the difference between changes and claims (for scope, compensation, relief, damages, delay, or other disagreements).
- d. Describe major reasons for contract changes including the role of project scope definition.
- e. Describe various types of schedule delay in respect to contract changes and claims (excusable, non-excusable, compensatory, and concurrent).
- f. Describe the potential affects of disputes on project performance.
- g. Discuss and understand the elements of cost in context of contract schedule disputes and claims (bonds, retainage, performance guarantees, liquidated damages, demurrage, legal costs, etc.).

6. Project closeout: Describe the mechanics and challenges of closing out a project in respect to project control systems, data and information.

- a. Historical data: Describe the importance of historical, empirical data and databases to future planning and schedule development.
- b. Empirical data: Data that are collected using direct or indirect observation. The key feature of this definition is observation. Empirical data consist of pieces of information that are recorded

² A Recommended Practice for *Forensic Schedule Analysis* is currently under development by the AACE International Claims and Dispute Resolution Committee as a guideline for these topics.

- through sensory experience; this kind of data is made up of things that can be seen or heard. Observation can be direct, as in the case of witnessing a phenomenon first-hand, or indirect, as in asking someone about his or her mental state (i.e., beliefs, attitudes, or values).
- c. Lessons learned: Describe the importance of accurate data collection and the importance of evaluating the project schedule execution experiences for the benefit of future projects.

PLANNING & SCHEDULING RELATED DEFINITIONS

- AACE International. *Recommended Practice No. 10S-90 Cost Engineering Terminology*. Morgantown, WV: AACE International, 2004.
- AACE International. *(Draft) Glossary of Terms for Planning and Scheduling Professional (PSP) Certification*. Morgantown, WV: AACE International, November 2005.

PLANNING & SCHEDULING PROFESSIONAL – REFERENCES

1. AACE International. *Cost Engineers' Notebook*. Morgantown, WV: AACE International, 2002. (Specific planning and scheduling selections: *Effective Control of Multiple Small Projects; Procedures for Resource Leveling; Introduction to Planning & Scheduling; Preplanning Project Control*).
2. AACE International. *Recommended Practice No. 10S-90 Cost Engineering Terminology*. Morgantown, WV: AACE International, 2004
3. AACE International. *(Draft) Glossary of Terms for Planning and Scheduling Professional (PSP) Certification*. Morgantown, WV: AACE International, November 2005.
4. AACE International. *Recommended Practice No. 11R-88 Required Skills and Knowledge of Cost Engineering*. Morgantown, WV: AACE International, January 2006.
5. Amos, Scott J., Editor. *Skills and Knowledge of Cost Engineering*, 5th ed. Morgantown, WV: AACE International, 2004.
6. Hollmann, John K., Editor. *Total Cost Management Framework: A Process for Applying the Skills and Knowledge of Cost Engineering*, Morgantown, WV: AACE International, 2006.
7. Glavinich, Thomas E. *Construction Planning and Scheduling*, 2nd ed. Arlington, VA: The Associated General Contractors of America (AGC), 2004.
8. Kerzner, Harold. *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*, 8th ed. New York, NY: John Wiley & Sons, Inc., 2003.
9. Lewis, James P. *Fundamentals of Project Management: Using the Power of Technology to Outperform the Competition*, 2nd ed. New York, NY: AMACOM, 2002.
10. O'Brien, James J., and Fredric L. Plotnick. *CPM in Construction Management*, 6th ed. New York, NY: McGraw-Hill Book Company, 2005.
11. Pinnell, Steven S. *How to Get Paid for Construction Changes: Preparation, Resolution Tools and Techniques*. New York, NY: McGraw-Hill, Inc., 1998.
12. Plotnick, Fredric L., *Review Comments for 14R-90 (Rev. 11/1990)*, E-mail to Vera Lovejoy, February 28, 2004
13. Pathfinder, LLC. *Project Management Experts*. Pathfinder, LLC, October 2003. Online. Internet. <www.pathfinderinc.com/experts.html>.
14. Revay, Stephen O. "Scheduling and Monitoring for Successful Projects". *The Revay Report*. Vol 19, No 3. Calgary, AB: Revay and Associates Limited, October 2000.
15. Silverstrini, Remo J. "The Planning Engineer – A Human Element of Planning and Scheduling", *AACE Transactions*, Morgantown, WV: AACE International, 1983.

CONTRIBUTORS

Edward E. Douglas, III CCC PSP (Author)
 Peter R. Bredehoeft, Jr.
 Larry R. Dysert, CCC

Earl T. Glenwright, Jr. PE PSP
H. Ernest Hani, PSP
Paul E. Harris, CCE
John K. Hollmann, PE CCE
Kenji P. Hoshino, PSP
Stephen M. Jacobson, CCC
Vera A. Lovejoy, CCE PSP
Donald F. McDonald, Jr. PE CCE PSP
Michael R. Nosbisch, CCC PSP
Fredric L. Plotnick, PE
Wesley R. Querns, CCE
Saleh El Shobokshy
Ronald M. Winter, PSP
James G. Zack, Jr.