AACE INTERNATIONAL

PLANNING AND SCHEDULING PROFESSIONAL CERTIFICATION

STUDY GUIDE

2ND EDITION

PSP

A Product of the Education Board of AACE® International

Planning and Scheduling Professional (PSP) Certification Study Guide

AACE
INTERNATIONAL

2019

Planning and Scheduling Professional (PSP)
Certification Study Guide
Second Edition

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A Special Publication
of
AACE International – The Authority for Total Cost Management

Planning and Scheduling Professional (PSP) Certification Study Guide

Second Edition

2019

A continuing project of the AACE International Education Board

Please see **Acknowledgements** on the next page

Acknowledgments

The 2018-2019 AACE International Education Board is grateful to the AACE International members who have assisted in the development of this *PSP Certification Study Guide*, including:

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Marina Sominsky, PSP
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PREFACE

AACE International's **Planning and Scheduling Professional (PSP) Certification Study Guide** was developed to accomplish two purposes similar to that of the **CCP Certification Study Guide**. First, it aids professionals wishing to achieve AACE International's specialty certification in Planning and Scheduling. Second, the **PSP Certification Study Guide** summarizes various topics considered central to the planning and scheduling profession, as outlined in **AACE International Recommended Practice 14R-90***, Responsibility and Required Skills for a Planning and Scheduling Professional*, along with the current edition of the **Skills and Knowledge of Cost Engineering**.

The **PSP Certification Study Guide** should be a beneficial and useful publication for all planning and scheduling professionals. It primarily serves the needs of planning and scheduling professionals who are preparing to take AACE International's PSP certification examination. This publication is intentionally concise and does not delve deeply into any subject, yet it broadly touches upon all topics within the required skills and knowledge of a planning and scheduling professional. This text is not intended to be a source of detailed planning and scheduling knowledge, nor does it substitute for the minimum experience necessary to qualify to sit for and pass the PSP certification exam. That is, the reader will not find deep development of planning and scheduling concepts in this manual, since listed references are already available to provide all necessary details. Rather, it introduces required knowledge and skills for potential PSP certificants.

Much of the information contained in this **PSP Certification Study Guide** parallels and amplifies information presented in **Skills and Knowledge of Cost Engineering** and the **CCP Certification Study Guide.** These publications can be used together for study of fundamental cost engineering, as well as essential planning and scheduling. They also include sample problems related to the subject matter.

The **PSP Certification Study Guide** incorporates terms and phrases that are generic to the profession, and some are specific to AACE International. Terms and phrases used in industry and technical software may not always agree precisely with one's previous understanding, or how the terms are used in a specific organization or industry. One should consult the list of terms found in Appendix C and the terminology definitions in the latest edition of **AACE International Recommended Practice 10S-90**, *Cost Engineering Terminology*, to learn the definitions as applied in the exam. AACE International's **Recommended Practices** can be obtained from AACE International's web site at web.aacei.org.

The AACE Education Board will continue to improve this publication, revising and improving it as needed to support the PSP exam, enhancing its value as described above. Recommended changes and updates are highly welcome and should please be forwarded to the AACE International Education Board at edchair@aacei.org.

Please see **Introduction to PSP Certification Study Guide** on the next page

Introduction to PSP Certification Study Guide

AACE International's **PSP Certification Study Guide** enables users to understand the scope of the PSP Certification Examination and prepare for it. It does not provide fundamental education in the basics of planning and scheduling. Whoever uses this guide should already possess the minimum PSP education and work experience as required to sit for the PSP certification exam. The guide informs PSP applicants of subjects that the exam tests, poses representative questions and problems, and lists useful references for detailed study.

This text uses a typical engineering-procurement-construction (EPC) project as the basis for presenting knowledge and concepts integral to planning and scheduling. Further, it uses the term "project" in its generic form while recognizing the knowledge and skills can apply to multiple projects or a "program." However, these concepts, tools, and techniques are applicable to the majority of industries that rely on planning and scheduling professionals to effectively manage work. This includes aerospace, agriculture, telecommunications, ship building, software development, resource planning and management, manufacturing, and others.

In addition to the EPC model for construction, process and industrial operations have been incorporated into the development of the **PSP Certification Study Guide**. Other major themes include:

- The planning process extends from conceptual through delivery phases.
- Planning includes design and engineering development.
- The change management process is considered throughout all phases.
- Stakeholders' interests are presented with emphasis on considerations and constraints.
- Human issues are presented with emphasis on health, welfare, safety, and environment.

The study guide is organized according to *Scope of Knowledge* (see figure 1), and the taxonomy lists the knowledge areas that may be tested.

The **PSP Certification Study Guide** begins by discussing the PSP Certification Examination Structure. The guide discusses the topics outlined in Figure 1 by identifying the following:

- Introduction and Learning Objectives
- Related Sections
- Terms to Know
- Key Points for Review
- Summary
- Sample Questions

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The **PSP Certification Study Guide** is divided into two main chapters (Planning and Scheduling) and two sections in both of those chapters:

- Planning.
    - ✓ Planning development.
    - ✓ Planning product.

- Scheduling.
    - ✓ Schedule development.
    - ✓ Schedule maintenance and reporting.
- Complex problem.
- Appendix.
    - ✓ Recommended references and resources.
    - ✓ PSP certification glossary.
    - ✓ Sample application.
- Answers to questions and complex problem.

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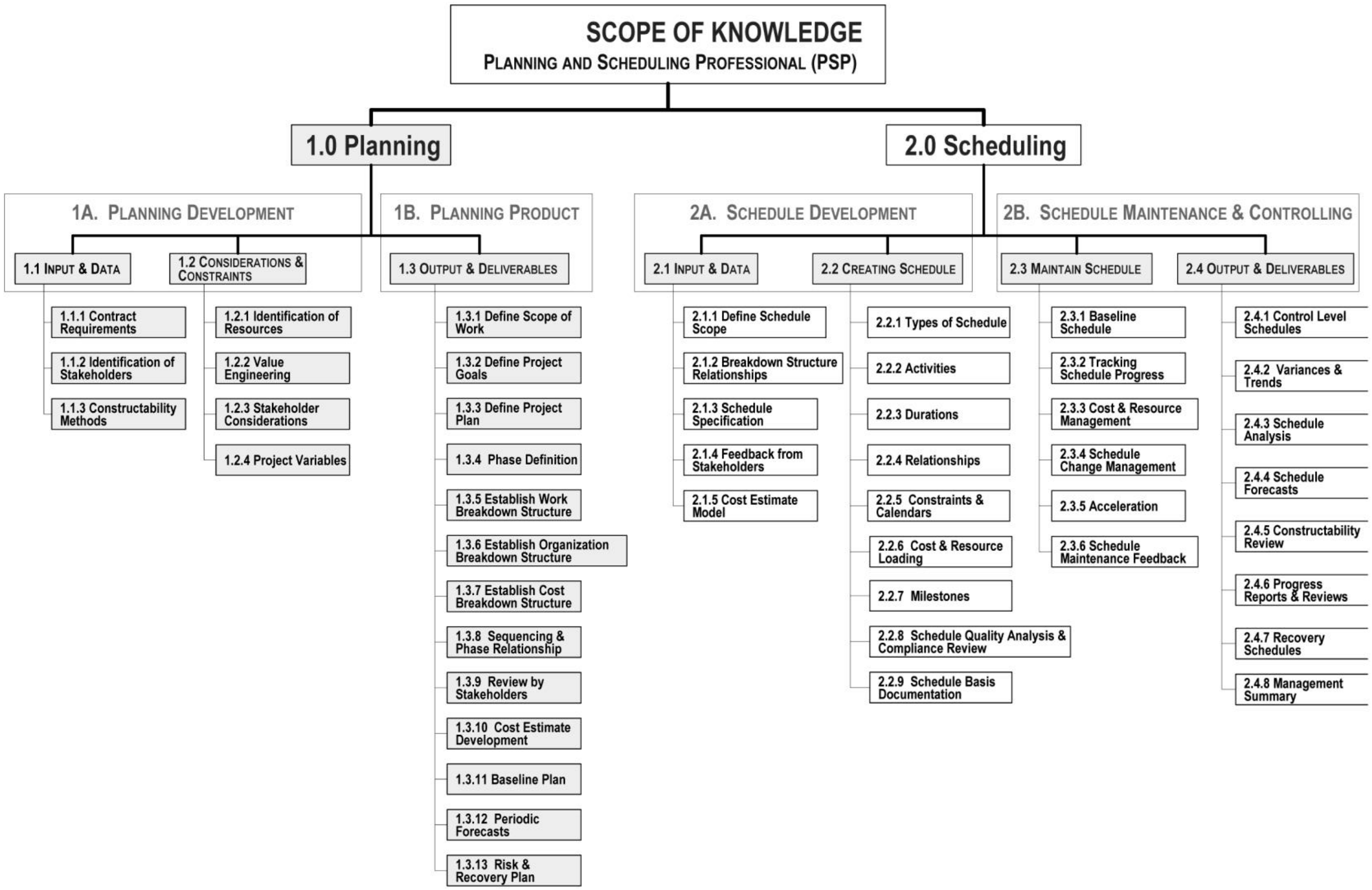

Figure 1—Scope of Knowledge, Planning and Scheduling Professional (PSP)

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Certification Policies, Procedures and Examination Structure

The most current information regarding AACE certification is posted on our website at web.aacei.org, under the Certification tab.

A summary of the steps to become AACE certified is that the candidate must do the following:

1. Meet the minimum eligibility requirements (it is the responsibility of the candidate to ensure they can meet the eligibility requirements prior to registering for the examination).
2. Upload all verification documentation and other required documents to http://web.aacei.org/certification.
3. Register and pay for the (certification) exam.
4. Schedule an exam at AACE's testing center partner after receiving clearance from Headquarters within 6 months of clearance.
5. Successfully pass a written examination as determined by the AACE International Certification Board.

All AACE certification examinations are conducted through computer-based testing at testing centers worldwide.

Our website contains all the necessary information for becoming certified, including exam and scheduling tutorials, exam specific toolbox – containing helpful documents and guides, and the recommended study materials to assist in preparing for the certification examination. Please visit our website at web.aacei.org for all your certification questions and needs.

All certification related questions should be directed to certification@aacei.org or 1-304-296-8444.

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PSP Certification Requirements and Process

Eligibility

For the most current information regarding PSP eligibility requirements, visit the AACE website at web.aacei.org under the Certification tab. It is also important to be aware of the certification policies and procedures regarding certification registration, payment, and examination scheduling, which can also be found on the AACE website.

Examination Format

The exam is delivered through computer-based testing (CBT) and consists of multiple choice questions and an essay-style question. The examination is closed book. Programmable or per-programmed calculators (including those with financial functions) are also permitted.

For the latest information regarding the PSP exam or recommended study materials, visit the AACE website at web.aacei.org, under the Certification tab.

Preparing for the PSP Certification Examination

Generally speaking, a candidate's education and professional experience are the primary sources that prepare the individual for the examination. However, there are other ways to prepare for the examination:

- Study the ***PSP Study Guide***.
- Study the reference materials referenced in Appendix B of this manual.
- Learn the planning and scheduling terms found in Appendix C of this manual, in conjunction with **AACE International Recommended Practice 10S-90**, *Cost Engineering Terminology*.
- Access relevant online learning opportunities through AACE International's website.
- Attend the PSP review seminar conducted at the AACE International Annual Meeting
- Attend review sessions or seminars at AACE International Sections and Regions.
- Attend AACE International Section monthly meetings at least whenever the discussion includes planning and scheduling topics.

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PSP Certification Examination Structure

Introduction

To be certified as a Planning & Scheduling Professional (PSP), a candidate must meet the minimum eligibility requirements and successfully pass a written examination as determined by the AACE International Certification Board. This study guide provides the information needed to prepare for the PSP examination. All current information regarding PSP certification can be found on the AACE website at web.aacei.org, under the certification tab.

Basis of the Examination

The purpose of any professional certification or licensing program is to provide a mechanism to formally evaluate the individual's knowledge and skill in a subject against widely accepted standards. Public recognition of the professional's capabilities in the defined skill area may result. Certification as a Planning and Scheduling Professional (PSP) recognizes certificate holders who have demonstrated their experience and expertise in planning and scheduling. Planning and scheduling are respectively defined as:

- **Planning** – The identification of the project objectives and the orderly activities necessary to complete the project (the thinking part) and not to be confused with scheduling; the process by which the duration of the project task is applied to the plan. It involves answering the questions:
  1. What must be done in the future to reach the project objective?
  2. How it will be done?
  3. Who will do it?
  4. When it will be done?

- **Scheduling** – (1) 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 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. (2) A time sequence of activities and events that represent an operating timetable. The schedule specifies the relative beginning and ending times of activities and the occurrence times of events. A schedule may be presented on a calendar framework or on an elapsed time scale.

These definitions of planning and scheduling provide the underlying basis for the AACE International certification examination. The examination tests professional proficiency across these areas. The candidate is directed to study from the Primary References in Appendix B.

Planning and scheduling is a dynamic profession affected by advances in philosophies, methodologies, and technology. Professional planners and schedulers are expected to keep abreast of advances in these three realms.

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In summary, the definition of a planner and scheduler and the **Skills and Knowledge of Cost Engineering** (Planning and Scheduling chapters) determine the scope of the PSP certification examination. In recognition of this, the examination addresses:

- Minimum knowledge covered by the basic skills documents; and
- Advanced knowledge based upon planning and scheduling experience.

Examination Structure

The PSP exam is delivered through computer-based testing (CBT) and consists of multiple-choice questions and a written exercise.

1. **MULTIPLE CHOICE QUESTIONS**: The exam is delivered through computer-based testing (CBT)* and is comprised of multiple-choice and complex, scenario questions. The topics covered in the exam are: *basic planning & scheduling skills and knowledge, communication competency, practical exercises, and planning & scheduling applications.*
2. **MEMO ASSIGNMENT**: The memo assignment provides a scenario and will require the candidate to demonstrate both communication skills and insight regarding a challenging PSP workplace scenario. The memo will be written in the text box provided onscreen and should demonstrate a candidate's ability to organize thought and communicate effectively. The memo will need to be addressed properly, include a purpose statement, describe the potential impact of any described problem or issue, propose a clear actionable solution with supporting rationale and include a closing statement.

The exam is closed book. Candidates are permitted to bring any style of calculator, including programmable calculators, to use during the exam. Candidates will have a maximum of 5 hours to complete the exam.

The examination is not based upon use or knowledge of specific software, but rather embodies the knowledge and experience of a PSP practitioner using such tools. All materials provided during the examination, including work paper, must be turned in upon completion of the examination.

Recognizing that there are many industries and fields within the profession—engineering, construction, manufacturing, process facilities, mining, utilities, transportation, aerospace, environment and government—candidates can expect questions from any of these practices. The exam takes into account the fact that no one can be expected to be conversant in all practice areas through its multiple-option format and extensive use of questions of general applicability.

Understanding and Using the Sample Questions Provided in the PSP Study Guide

The **PSP Study Guide** includes many sample questions with answers. These questions should be answered to ensure you know which areas might need additional preparation on your part. The questions are found at the end of each subchapter.

PSP Study Guide questions have been developed specifically for those preparing for the examination and are similar in content and context to the actual exam questions. All of the questions on the PSP Certification Examination, except the writing requirement, are multiple-choice questions. Each has four possible answers with one correct solution, whereas the questions in this ***Study Guide*** include other forms of questions.

Questions in the ***PSP Study Guide*** are in the following formats:

- Multiple choice questions, similar to what you might find on the certification examination.
- Fill-in-the-blank questions. These questions are intended to provide relevant thinking exercises to support preparation for the examination.
- A complex problem. The intent of this question-set is to enable the student to prepare for complex question section of the examination. The complex question sample is found in Appendix A.

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Test Your PSP Knowledge

As a good gauge of PSP knowledge gained by using this study guide, the candidate is encouraged to start by answering the following pre-test questions. Answers should be recorded, and when studies are complete, the candidate will answer the same questions again. A close comparison of the results, before and after study, will show the knowledge gained and what gaps may remain prior to sitting for the exam.

1. What is planning?
2. Why is planning important?
3. What is scheduling?
4. Why is scheduling important?
5. What is a work breakdown structure (WBS) and how is it used?
6. What is a CPM schedule?
7. What are a planning and scheduling professional's general duties and responsibilities?
8. What are the different types of schedule activities and how are they used?
9. Who are the stakeholders who use and work with plans and schedules?
10. What does a forward and backward pass schedule calculation provide?
11. What types of schedule logic and constraints are normally used and why are they important?
12. What is the difference between ADM and PDM schedules and how do they differ?
13. What are schedule levels and why used?
14. What makes for a successful plan?
15. What makes for a successful schedule?
16. Why do plans and schedules fail?
17. Define basic steps in CPM schedule model development.
18. What does modeling of resource utilization in the schedule provide?
19. Define schedule calendars and their use.
20. How are schedules updated for progress?
21. How should changes and delays be incorporated into a schedule model?
22. What is involved in shortening the overall duration of or compressing a schedule?
23. What is analyzed when defining a schedule recovery plan?
24. What is important to document as the plan and schedule basis?
25. What are planning and scheduling deliverables during the life cycle of a project?

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Please see **Chapter 1.0—Planning** on page 11

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Chapter 1.0 - Planning

Introduction

The Planning chapter provides an organized outline to assist in understanding the means, methods and tools necessary in the planning process. This chapter includes:

- Planning Development.
  - Planning Input and Data.
  - Planning Considerations and Constraints.
- Planning Product.
  - Planning Output and Deliverables.

Each section identifies the concepts associated with particular planning phases.

- **Planning is conceptual.**
- **Planning is dynamic.**
- **Planning is both cyclical and iterative.**

The planning process is repeated with each phase of work effort and development throughout the project's life cycle. As scope is developed, information becomes more detailed, and the plan and schedule are more detailed, as well. This iterative review, development, and modification cycle is constant throughout the life of the project.

The scope of the planning process must be appropriate to the phase of work. The elements of a plan developed in the planning process must be equally weighted to achieve a balanced and usable product.

When conditions change for the plan or any of its elements, the planner should re-examine and update it as necessary. The plan for one phase is the key to developing a plan for the next phase, as well as for the project as a whole.

Project planning begins early and continues as the project moves through phases of the project's life cycle, from conception through to completion, and closeout. Rather than a serial process, it is best thought of as a planning cycle. Effective implementation of a plan results in the ability to produce a credible schedule.

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

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Based on these questions, the recommended sequence of actions to develop a project plan is:

1. Define project scope.
2. Establish a work breakdown structure (WBS).
3. Identify resources and availability (people and capital assets).
4. Establish timeline and sequence of deliverables.
5. Determine a budget for each component activity, work package, or group of tasks.

A planning and scheduling professional (PSP) assists the project manager to accomplish the following:

- Facilitate preparation of the project plan and work breakdown structure (WBS).
- Facilitate estimation of timelines and project phases.
- Identify key project results and milestones.
- Involve team members in planning process; and involve the client in defining project goals and key results.

Learning Objectives

- Understand fundamental concepts of the planning process and its terminology.
- Recognize that the planning process is a dynamic process repeated throughout each phase of a program or project life cycle.
- Scaling of the planning process must be appropriate and equally weighted to each phase of work to achieve a balanced and usable product.
- When conditions change, the planning process and deliverables should be examined and updated as necessary. The plan for one phase of a project offers a pattern for developing the plan or next phase of the project as well as the project as a whole.
- Effective implementation of a plan results in a schedule.

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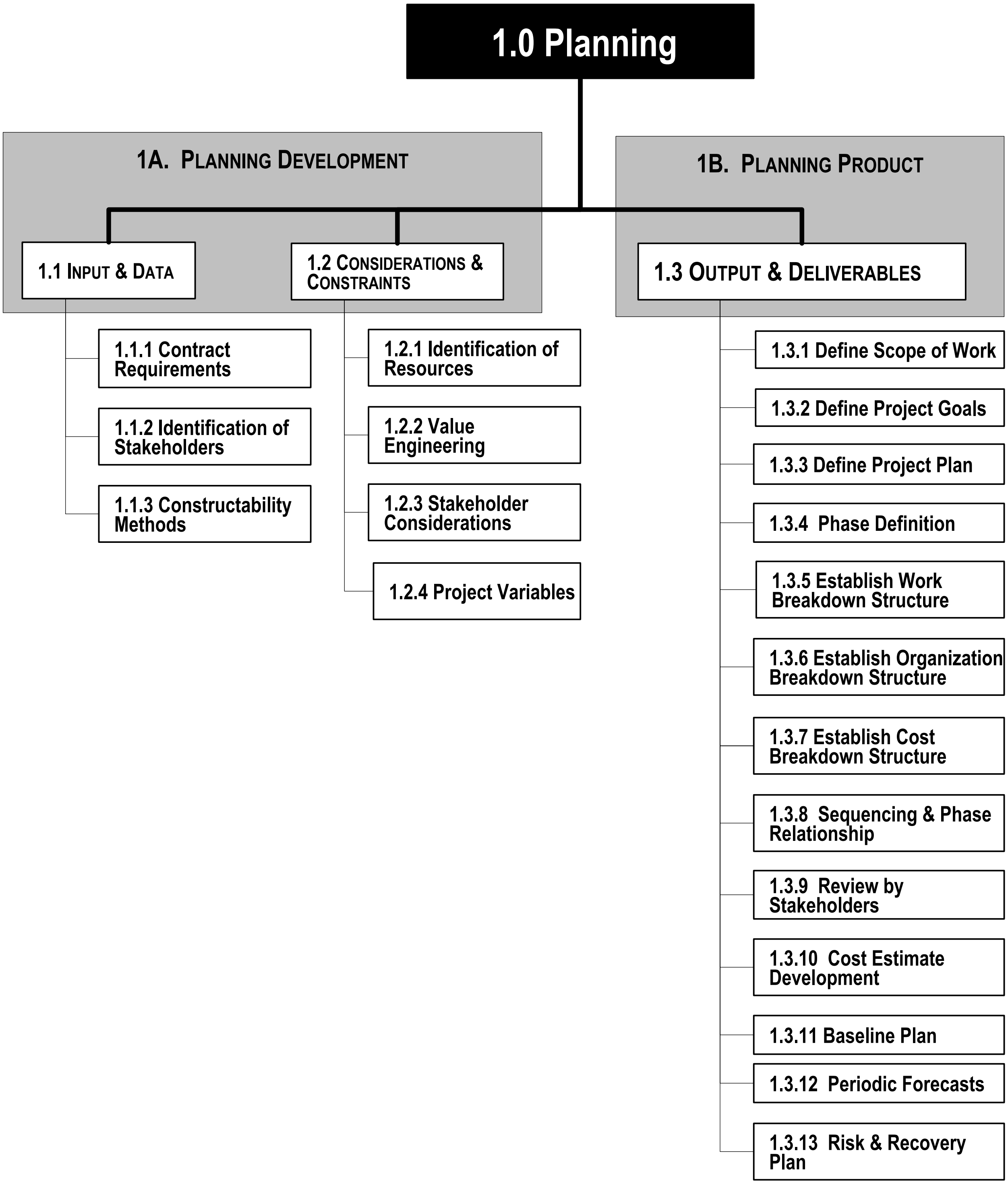

Figure 2—Planning Elements of PSP

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Please see **Section 1A—Planning Development** on page 15

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Section 1A – Planning Development

An owner or developer, whether a public entity or a private individual or organization, first perceives a need for an industrial process, building, or facility. From this initial effort, project planning begins. In some organizations, this process may be undertaken by outside experts performing contract work for the owner or developer.

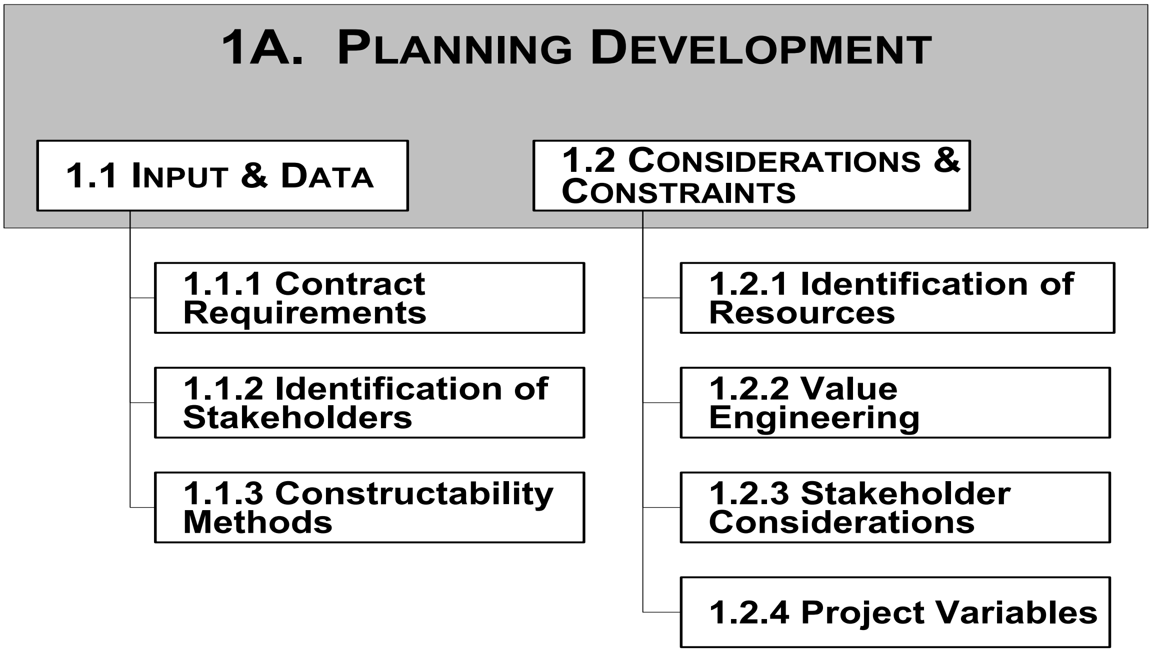

Figure 3—Planning Development

Important participants in any planning development team are those who have developed expertise in the planning process and abilities to conceptually schedule work. These conceptual planning and scheduling capabilities are needed in both the planning and construction cycles. The most important elements that these professionals bring to the planning development phase include:

- Input and Data.
- Considerations and Constraints.

The models for input and data include consideration of contract requirements, the end product, and constructability. Initially important is identification of the stakeholders who will be involved throughout the life of the project.

The planning process includes identification of considerations and constraints of resources and project variables. With the owner's scope identified, consideration of engineering or technical variables is reviewed in a cyclical process. The process identifies the alternatives that the various stakeholders must review, so that appropriate decisions optimally satisfy the interests of the parties and the goals of the project.

One of the most important responsibilities for planners is recognition and communication of the cyclical and iterative nature of the planning process. Additionally, open-mindedness throughout the planning and development process leads to identification of the most appropriate concepts for project completion and success.

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Please see **Subchapter 1.1 Input and Data** on page 17

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Subchapter 1.1 Input and Data

The Input and Data Subchapter represents the initial process of identifying the requirements, both individual and specific elements necessary to understand and implement the planning phase of the project.

The Input and Data subchapter consists of the following sections:

- Contract Requirements.
- Identification of Stakeholders.
- Constructability Methods.

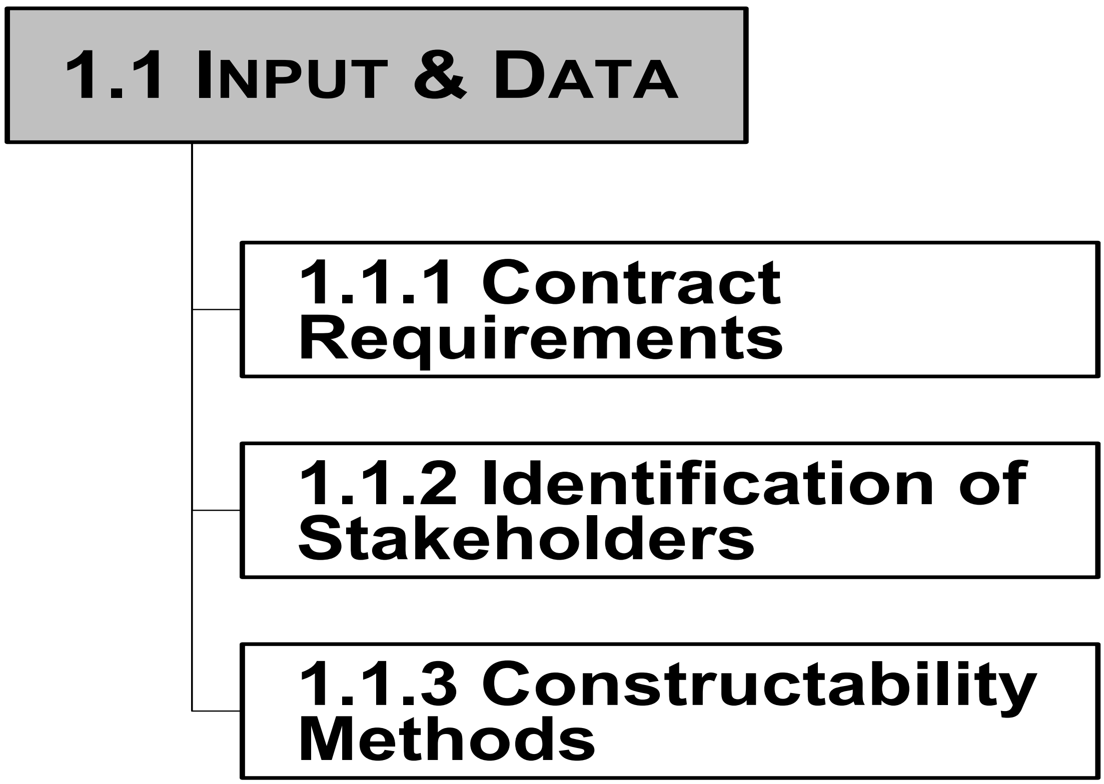

Figure 4—Planning Input and Data

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Please see **1.1.1 Contract Requirements** on page 19

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1.1.1 Contract Requirements

Introduction and Learning Objectives

Understand contracts and their relationship to the planning process used by the project team.
The primary focus of the project team during the planning phase is to understand the total scope of the contract documents. It is important that all project team members know and understand contract terms, conditions, requirements, and their relationship to the work.

The requirements for a program normally come from the governing contract documents. They define the scope and type of processes and procedures to be used. They explicitly or implicitly define the minimum planning and scheduling requirements.

Note that the term "contract documents" applies equally as well to projects that have evolved to the draft contract stage or to an endeavor that has yet to evolve to a contract, if a contract should result. In the latter case, a planning and scheduling specification, an organization's practices, or experience alone will govern how to proceed.

Related Sections

- Stakeholders: 1.1.2 – Identification of Stakeholders, 1.2.3 – Stakeholder Considerations, 1.3.9 – Review by Stakeholders, 2.1.4 – Feedback from Stakeholders, 2.3.6 – Schedule Maintenance Feedback
- Specifications: 2.1.3 - Schedule Specification
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Goals and Phases: 1.3.2 - Define Project Goals, 1.3.3 – Define Project Plan, 1.3.4 -Phase Definition
- Schedule Types: 2.2.1 – Schedule Types, 2.3.1 – Baseline Schedule, 2.4.1 – Control Level Schedules, 2.4.7 – Recovery Schedules
- Durations, Constraints and Calendars: Section 2.2.3 – Durations, Section 2.2.5 – Constraints and Calendars
- Milestones: 2.2.7 - Milestones
- Change Management: 2.3.4 - Schedule Change Management, 2.3.5 - Acceleration
- Reporting: 2.4.6 - Progress Reports and Reviews

Terms to Know

Basic types of contracts:

- Fixed price.
- Unit price.
- Cost plus (with fixed, incentive, or award fees).
- Time and materials (T and M).
- Guaranteed maximum price (GMP).

Common delivery methods:

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- Design-build.
- Design-bid-build.
- EPC (Engineering-procurement-construction).
- Design-build-operate.
- Variations of any above.

Changes and change management.
Planning, scheduling and reporting requirements:

- Notice to proceed (NTP).
- Milestones.
- Phases.
- Resources.
- Costing.
- Substantial completion.
- Project completion.

Value engineering (VE).
Constructability.

Key Points for Review

1. Contract types.
2. Delivery methods.
    a. Development and coordination of contract component elements:
    b. Specifications.
    c. Plans.
    d. Special requirements, e.g. permits.
    e. Contract formulation.
3. Change management.
4. General and special conditions:
    a. Labor.
    b. Weather.
    c. Equipment.
    d. Material.
    e. Environment.
    f. Regional constraints.
    g. Any other project-specific variables and requirements.

Summary

The key components include understanding the importance of development and implementing effective planning related to the contract documents. This includes terms and conditions that influence the outcome of a planning process.

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Sample Questions for Section 1.1:

1. The traditional governmental contracting process in the US is:

   A. Design, build, and operate.
   B. Design, bid, build.
   C. EPC.
   D. Design, build.

2. Critical delivery dates are referred to as:

   A. Milestones.
   B. Phases.
   C. Substantial.
   D. Flags.

3. Which of the following documents is most likely to be of the LEAST value to a planner-scheduler when planning a contractor's baseline critical path schedule for the construction of a high rise building on a remote South Pacific resort island for a private developer? The contractor has been awarded the contract.

   A. Specifications as found in the contract document.
   B. The local government's report on future resort projects on the island.
   C. International Building Codes—as referenced in the contract document.
   D. A project-specific geotechnical report.

4. When a planner-scheduler is collecting information about the project during the initial planning cycle, which information is of GREATEST value?

   A. Contract schedule specifications.
   B. The contractor's pre-bid site visit meeting minutes and notes.
   C. The contractor's changes clause.
   D. A detailed scope of work statement.

5. Describe the difference between contract types and delivery methods.

6. Describe what milestones are.

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Solutions to Sample Questions for Section 1.1.1

1. B. Design, bid, build

2. A. Milestones

3. B. The local government's report on future resort projects on the island.

4. D. A detailed scope of work statement.

5. Contracts define the financial terms of a relationship between an owner and a contractor, while the delivery method describes the method of management the contractor will use to perform the work.

6. Milestones are interim completion dates that are either contract driven or contractor self-imposed to measure progress or trigger subsequent work activities. Their achievement may earn progress payments for the contractor.

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1.1.2 – Identification of Stakeholders

Introduction and Learning Objectives

Identify and define stakeholders and their interests. Understand stakeholder decisions and their impacts and effects on the project.

On a project there are typically many different stakeholders, and each has different goals and objectives. These goals and objectives influence the development of the plan and the behavior of the team implementing that plan.

Stakeholder interests may be positive or negative when viewed against the planning process. Obtaining consensus among the stakeholders during the planning process is a key to success.

Related Sections

- Contracts: 1.1.1 – Contract Requirements
- Stakeholders: 1.2.3 - Stakeholders Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders, 2.3.6 - Schedule Maintenance Feedback
- Variables: 1.2.4 – Project Variables
- Scope of Work: Sections: 1.3.1 – Define Scope of Work, 2.1.1 – Define Schedule Scope
- Goals and Plans : Sections: 1.3.2 - Define Project Goals, 1.3.3 - Define Project Plan
- Estimates: Sections: 1.3.10 – Cost Estimate Development, 2.1.5 – Cost Estimate Model
- Risk and Recovery: 1.3.13 - Risk and Recovery Plan, 2.4.7 - Recovery Schedules
- Reports: Sections: 2.2.6 – Schedule Quality Review and Compliance Review, 2.4.6 – Progress Reports and Reviews, 2.4.8 – Management Summary

Terms to Know

Types of stakeholders:

- Public agency:
  - ✓ Federal.
  - ✓ State.
  - ✓ Local.
  - ✓ Special purpose entity;
    - ➢ School or university.
    - ➢ Utility district.
    - ➢ Special legislative, e.g., Tennessee Valley Authority (TVA).
- Private entities:
  - ✓ Owner.
  - ✓ Developer.
  - ✓ Individuals.
  - ✓ Social or political organizations.
  - ✓ Individuals and special interest groups.
  - ✓ Public agencies and private enterprises.

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- Engineer-architects.
- Contractors.
- Subcontractors.
- Consultants.
- Vendors.
- General public:
  - ✓ Land owner.
  - ✓ Activist.
  - ✓ Investor.
  - ✓ Concerned citizen.

Key Points for Review

1. Stakeholders' rights and responsibilities.
2. Influence of stakeholders.
3. Concerns of the stakeholders.
4. Conflict resolution among stakeholders.
5. Document coordination and resolution.
6. Project cost risk associated with stakeholder decisions.
7. Project schedule and risk associated with stakeholder decisions.

Summary

All stakeholders on a project have an effect on the outcome of the planning process. Stakeholders ultimately determine planning process success or failure. Stakeholders have a continuing influence throughout the life of the program and may positively or negatively impact the cost or schedule. An individual should be able to understand how the goals and objectives of different stakeholders affect the planning process and schedule development.

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Sample Questions for Section 1.1.2

1. Project architects are:
    - A. Stakeholders
    - B. Developers
    - C. Activists
    - D. Special interest groups

2. Which is NOT normally considered a stakeholder on a *Greenfield* chemical plant project?
    - A. Shop owners in an enclosed mall three miles downwind of the project.
    - B. The owner's project banker's engineer.
    - C. A third-tier electrical subcontractor.
    - D. The employee-owned contractor.

3. All project stakeholders provide input data and information during the initial planning process to set the overall project duration?
    - A. Absolutely true.
    - B. Absolutely false.
    - C. Only by analyzing the contract can one determine if a change in duration is allowed.
    - D. Only the project owner client may set the overall duration, and this is often driven by marketing and business considerations.

4. Name the three levels of government or public agencies in the US.

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Solutions to Sample Questions for Section 1.1.2

1. A. Stakeholders

2. A. Shop owners on an enclosed mall three miles downwind of the project.

3. B. Absolutely false.

4. Federal, state and local.

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1.1.3 Constructability Methods

Introduction and Learning Objectives

Understand the purpose and effect of constructability analysis on project planning. Constructability is defined to be "the optimum use of construction knowledge and experience in planning, engineering, procurement, and field operations to achieve overall project objectives (Construction Industry Institute, CII).

The constructability analysis process should begin during initial planning phases and continue throughout the entire planning cycle and into the implementation phase of the project. Constructability analysis during the planning process examines the methods and cost of installed equipment and materials, technology, site conditions, resources, and related infrastructure.

The benefit of the constructability analysis process is to reduce both time and cost impact to a project. Constructability analysis is often done throughout the life-cycle of a project in order to optimize cost, plan, and schedule while mitigating risk. It is most critical during the earliest stages of the project.

Related Sections

- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Value Engineering: 1.2.2 Value Engineering
- Variables and Constraints: 1.2.4 - Project Variables, 2.2.5 Constraints and Calendars
- Scope of Work: 1.3.1 – Define Scope of Work, 2.1.1 – Define Schedule Scope
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Baseline: 1.3.11 – Baseline Plan, 2.3.1 – Baseline Schedule
- Risk: 1.3.13 - Risk and Recovery Plan
- Documentation: 2.2.9 – Schedule Basis Documentations
- Constructability: 2.4.5 - Constructability Review

Terms to Know

Constructability

Methods of constructability:

- Modularization.
- Pre-fabrication.

Pre-assembly.

- Design-build.
- Material alternatives.
- Means and methods analysis.
- Design alternatives and constraints.
- Health, safety and environmental (HSE) impacts.

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Costing constructability:

- Time.
- Labor.
- Transportation.
- Storage.
- Site access.
- Governmental requirements.
  - ✓ Permitting.
  - ✓ Accessibility.
  - ✓ Inspections and compliance.

Key Points for Review

1. Constructability analysis.
2. Constructability process and methodologies.
3. Constructability alternatives and evaluation.
4. Constraints.
5. Variables.

Summary

The key to performing constructability analysis during the project planning phase is determining the most effective and efficient methods to construct the facility. It is important that this process be performed early in the planning to allow alternatives to be considered and incorporated into the design.

An integral part of constructability analysis is a determination that what has been designed is reasonably “buildable.”

By determining, evaluating, and selecting the most appropriate alternative method, construction time and costs are minimized to provide a positive contribution to the outcome of a program or project.

Sample Questions for Section 1.1.3

1. Which should not be a reason why superintendent and subcontractors are included during planning phase?
   A. They have more immediate "buy-in" to project plan.
   B. Planning phase is a theoretical exercise and their input is not needed until the execution phase.
   C. Accuracy of a resultant plan is improved through "brainstorming."
   D. Management expectations regarding plan are transmitted to the team (alignment).

2. Constructability, in terms of schedule modeling, is best defined as:
   A. Understanding how the contractor's plan defines overall project duration.
   B. Understanding how the owner's arbitrary completion milestones will drive resource utilization.
   C. How the contract specifies all aspects and phasing of work.
   D. The input data necessary to understand the various means and methods alternatives to accomplish and execute a project.

3. Constructability takes into account all but:
   A. Location, logistics, and resource availability analysis.
   B. The average price of general labor in the area.
   C. Quality inspections and compliance.
   D. Labor productivity studies from previous similar projects in the area.

4. True or False: During a constructability analysis, the availability of specified materials is determined?

5. True or False: A constructability analysis is only performed during the initial planning stage of design?

6. What are some different methods of constructability enhancement?

7. What is the purpose of a constructability analysis?

8. When is the optimum time to perform constructability analysis?

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Solutions to Sample Questions for Section 1.1.3

1. B. Planning phase is a theoretical exercise, and their input is not needed until execution phase.

2. D. The input data necessary to understand the various means and methods alternatives to accomplish and execute a project.

3. C. Quality inspections and compliance.

4. True

5. False

6. Modularization, pre-fabrication, pre-assembly.

7. Reduce time and cost to construct a project.

8. Constructability can be performed throughout the project, but the most favorable impact is from constructor input during the planning phase to best enable a constructible design.

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Subchapter 1.2 Considerations and Constraints

In developing a plan for a project there are many considerations and constraints that require identification and evaluation.

The Considerations and Constraints Subchapter consists of the following sections:

- Identification of Resources.
- Value Engineering.
- Stakeholder Considerations.
- Project Variables.

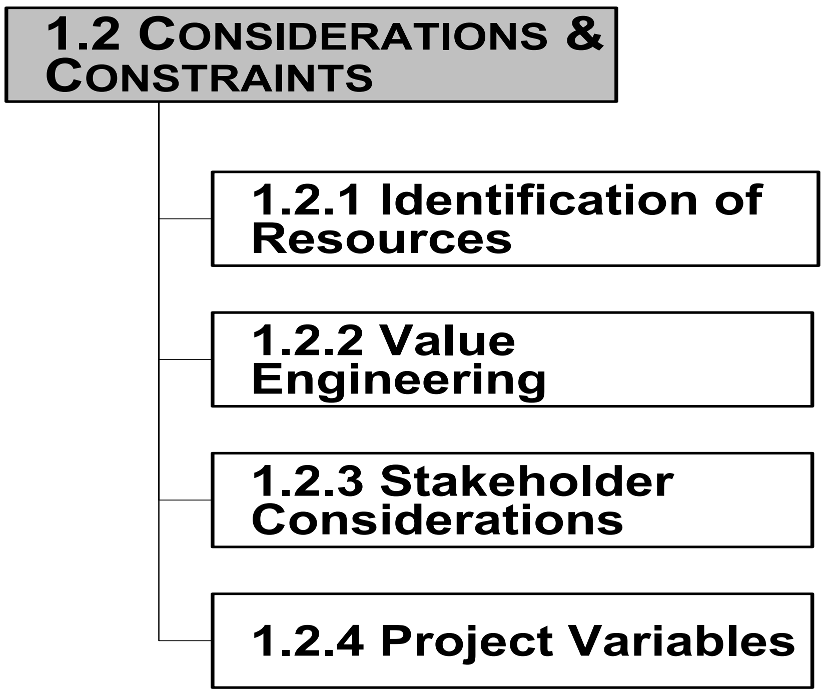

Figure 5—Planning Considerations and Constraints

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Please see **1.2.1 Identification of Resources** on page 33

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1.2.1 Identification of Resources

Introduction and Learning Objectives

Understand the impact that resource considerations and constraints have on a project. Resources are critical to the planning effort and, if not fully considered, may result in adverse impact to the program or project.

Planners must identify driving or key resources in relation to the priorities of the project. In short, resources are all assets that are used to accomplish the specified work during the life-cycle of a project. More specifically, resources are those assets whose application—numbers and durations—are formally entered and tracked on the schedule.

Related Sections

- Constructability: 1.1.3 - Constructability Methods, 2.4.5 - Constructability Review
- Project Variables: 1.2.4 - Project Variables, 2.2.5 - Constraints and Calendars
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Breakdown Structures: 1.3.5 – Establish Work Breakdown Structure, 1.3.6 – Establish Organization Breakdown Structure, 1.3.7 – Establish Cost Breakdown Structure, 2.1.2 – Breakdown Structure Relationships
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Resources: 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Constraints: 2.2.5 – Constraints and Calendars

Terms to Know

Categories of resources:

- Labor.
    - ✓ Management.
    - ✓ Technical.
    - ✓ Supervisory.
    - ✓ Craft.
    - ✓ Subcontract.
- Equipment.
    - ✓ Construction equipment.
    - ✓ Engineered (installed) equipment.
- Material.
    - ✓ Type.
    - ✓ Availability.
    - ✓ Deliverables.
    - ✓ Timing and phasing (need-by dates and logistics).
    - ✓ Installation.
    - ✓ Protection.

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- o Human.
    - ✓ Skill level.
    - ✓ Social values.
    - ✓ Cultural impacts.
    - ✓ Performance issues.
- o Technology.

Data sources:

- o Historical database.
    - ✓ Type of program or project.
    - ✓ Location.
    - ✓ Prevailing conditions.
- o Program or project specific data.
    - ✓ Site survey.
    - ✓ Local resource studies.
    - ✓ Logistics and transportation.

Key Points for Review

1. Categories of resources:
    a) Labor resource categories and their affect on project planning. These include:
        - o Availability
        - o Cost
        - o Skill (including productivity) and training level

    b) Construction equipment.
    c) Engineered equipment.
    d) Financing and economics.

2. Consideration and evaluation of performance and productivity issues are an integral part of the planning process. Often only viewed as a labor production issue, *all* resources and execution schemes should be considered during the planning process.

3. Understanding human, social, and cultural considerations and constraints plays an important role during the planning process. These issues should be identified, evaluated, and reconciled against the project plan.

Summary

Multiple resource variables affect a project. During the planning process, considerations and constraints are key elements of a project.

There are many considerations to evaluate when looking into resource planning and their effect on projects.

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Sample Questions for Section 1.2.1

1. During the planning process for a capital project, which is NOT a consideration?
    A. Religious holidays.
    B. Local country language.
    C. Education and skill level of local craft labor.
    D. None of the above.

2. Material resource considerations include all except:
    A. Availability
    B. Installation
    C. Crew skills
    D. Timing of delivery

3. Which of the following is NOT a constraining resource?
    A. Labor availability
    B. Scheduling software
    C. Material delivery
    D. Craft skill levels

4. True or False: On construction projects, labor and equipment are considered limitless resources?

5. True or False: The physical constraints of a jobsite can impose a limit on the amount of simultaneous equipment usage?

6. List three types of resources.

7. Describe how resources can influence a project.

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Solutions to Sample Questions for Section 1.2.1

1. D. None of the above.

2. C. Crew skills.

3. B. Scheduling software.

4. False

5. True

6. Labor, equipment and materials.

7. Resources can influence a project due to availability, labor skill level, and social aspects.

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1.2.2 Value Engineering

Introduction and Learning Objectives

Understand value engineering (VE) and its impact on cost, schedule, and quality of materials and equipment during the planning process. Value engineering provides functional and project alternatives.

In its relationship to the planning process, value engineering must consider all stakeholders' needs and requirements, prioritize required functions, and evaluate their cost and schedule impact. VE will optimize life-cycle performance by guiding selection of materials and installed equipment to maximize their functionality and quality while minimizing their costs.

Value engineering is a separate but related process to constructability analysis. Value engineering is a strategic planning process while constructability begins later in the planning process, usually lasts through the execution phase, and optimizes construction processes. VE occurs during design; value analysis (VA) occurs after design, often by contractor analysis and recommendation. Together VE and VA comprise value management. VE focuses on maximizing value, which can be formulated as the sum of design item functionality and quality, per unit cost. Constructability focuses on efficient and effective construction techniques by which to best install designed elements. In a sense, constructability, which impacts cost, is but one factor within the array of material and equipment concerns addressed by VE or VA.

Related Sections

- Contracts: 1.1.1 – Contract Requirements
- Stakeholders: 1.1.2 – Identification of Stakeholders, 1.2.3 – Stakeholders Considerations, 2.1.4 – Feedback from Stakeholders, 2.3.6 – Schedule Maintenance Feedback
- Constructability: 1.1.3 - Constructability Methods, 2.4.5 - Constructability Review
- Variables: 1.2.4 – Project Variables
- Scope of Work: 1.3.1 – Define Scope of Work, 2.1.1 – Define Schedule Scope
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Risk: 1.3.13 – Risk and Recovery Plan, 2.4.7 – Recovery Plan

Terms to Know

Value engineering (VE).
Cost effectiveness.
Materials selection.
Functional ability.
Constructability.
Design schedule.

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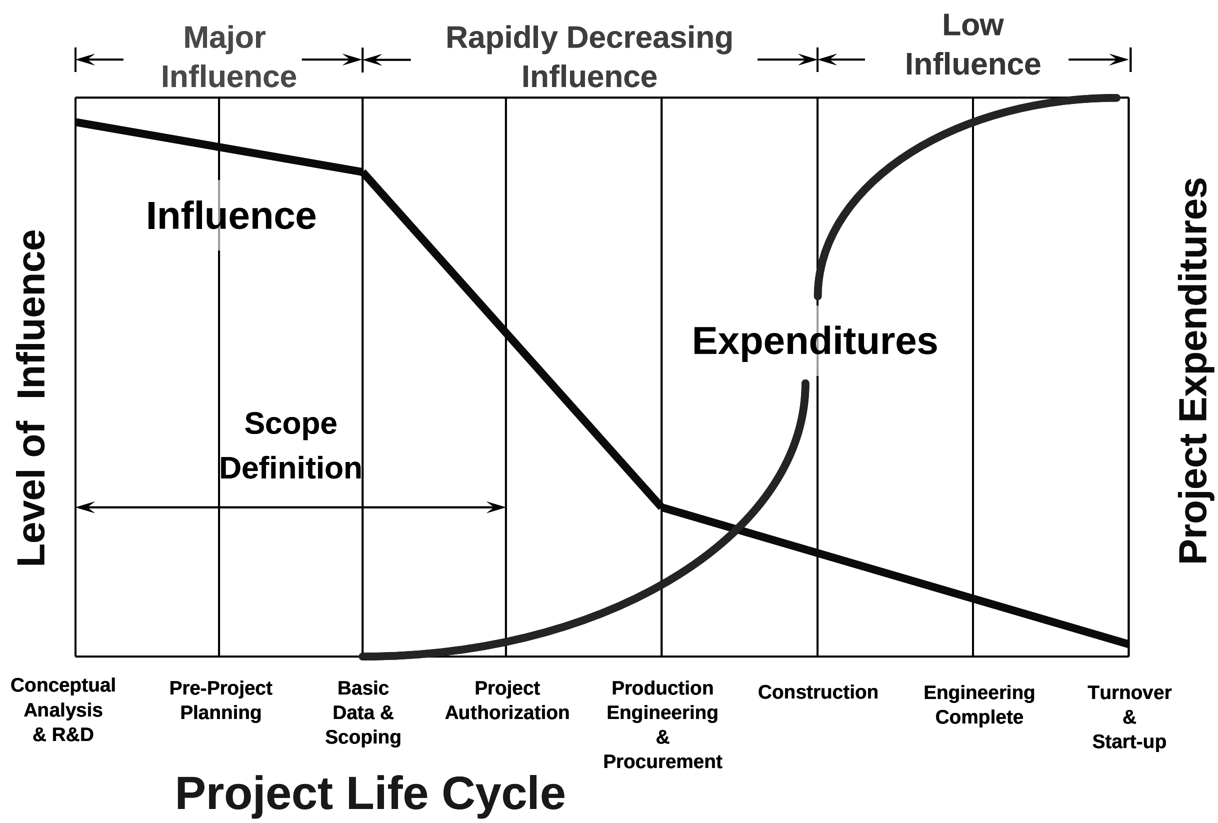

Figure 6—Cost Influence Curve

Key Points for Review

1. Six phases of the value engineering process are:
    a) Information
    b) Function analysis
    c) Creativity
    d) Evaluation
    e) Development
    f) Presentation

2. Stakeholders' inputs include:
    a) Needs and requirements
    b) Functional prioritization
    c) Alternative selection
    d) Cost evaluation
    e) Schedule impacts

Summary

Value engineering impacts the ability of the project team to optimize cost, schedule and quality of materials and equipment to enhance the life-cycle performance of a program.

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Sample Questions for Section 1.2.2

1. Implemented VE provides the contractor with the following, except:

    A. Improved product and service
    B. Cost and price savings
    C. Labor costs
    D. Time savings

2. Among the six phases of the VE process are all except:

    A. Information
    B. Development
    C. Presentation
    D. Scheduling

3. True or False: The VE process starts with the submittal of bid price?

4. True or False: The information phase of VE occurs during design development?

5. Describe the VE process, especially as it relates to the planning and scheduling process.

6. List the six phases of VE.

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Solutions to Sample Questions for Section 1.2.2

1. C. Labor costs

2. D. Scheduling

3. False

4. True

5. VE provides functional and project alternatives that are part of the strategic planning process.

6. Information, function analysis, creativity, evaluation, development, and evaluation.

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1.2.3 Stakeholder Considerations

Introduction and Learning Objectives

Understand stakeholders' considerations and constraints. Any party that has an interest (stake) in the endeavor or project is a stakeholder. Stakeholders may directly or indirectly affect or become involved in the day-to-day management and execution of work.

Stakeholder considerations and constraints must be identified, evaluated, and reconciled to allow the planning process to proceed. Stakeholders large and small will have a significant impact on the success or failure of a project.

Related Sections

- Contracts: 1.1.1 – Contract Requirements
- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.3.9 - Review by Stakeholders 2.1.4 - Feedback from Stakeholders, 2.2.8 – Schedule Quality Analysis and Compliance Review
- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Variables and Constraints: 1.2.4 - Project Variables, 2.2.5 – Constraints and Calendars
- Breakdown Structures: 1.3.5 – Establish Work Breakdown Structure, 1.3.6 – Establish Cost Breakdown Structure, 1.3.7 – Establish Organization Breakdown Structure, 2.1.2 – Breakdown Structure Relationships
- Cot Estimate: 1.3.10 – Develop Cost Estimate, 2.1.5 – Cost Estimate Model
- Milestones: 2.2.7 - Milestones

Terms to Know

Owner
Suppliers
Contractors
Public agencies
Designers
Public groups
Third parties
Non-governmental organizations (NGO's)

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Key Points for Review

1. Fiscal and cash flow constraints.
2. Timeframe:
    a. Phase
    b. Milestone
    c. Completion
    d. Operations
3. Resource availability.
4. Labor agreements.
5. Designer, contractor, and supplier workload.

Summary

The considerations and constraints of the stakeholders must be determined, evaluated and resolved.

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Sample Questions for Section 1.2.3

1. Which of the following documents is probably of LEAST value when planning a contractor's baseline critical path schedule for construction of a high-rise building on a remote South Pacific resort island for a private developer? The contract has been awarded.
   A. Specifications – as found in the contract document.
   B. The local government's report on future resort projects on the island.
   C. International Building Codes – as referenced in the contract document.
   D. A project-specific geotechnical report.

2. Which of the following is NOT normally considered a project stakeholder?
   A. Project supplier to a subcontractor.
   B. Client or owner.
   C. Project consultant or engineer.
   D. Non-governmental organizations (NGOs)
   E. Local news media

3. What should one do with stakeholder considerations?

4. What are some examples of considerations that should be evaluated?

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Solutions to Sample Questions for Section 1.2.3

1. B. The local government's report on future resort projects on the island.

2. E. Local news media.

3. Determined, evaluated, and resolved.

4. Cash flow, timeframe, resource availability, contractor or designer workload.

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1.2.4 Project Variables

Introduction and Learning Objectives
Understand project variables that affect the planning process and the associated risks, which might extend the proposed project timeline.
Among the constrained variables that should be considered and evaluated are the physical environment, contractor methods, funding, labor agreements, and delivery methods.

Variables can be broad or narrow in nature and should stand alone. A project variable is an event, element, or feature that will have an impact on the project plan. The variable can have a positive or negative effect on the project.

Related Sections

- Constructability: 1.1.3 - Constructability Methods, 2.4.5 - Constructability Review
- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Goals and Plans - Sections: 1.3.2 – Define Project Goals, 1.3.3 – Define Project Plan
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Forecasts, Variance, and Trends: 1.3.12 – Periodic Forecasts, 2.2.5 – Constraints and Calendars, 2.4.2 – Variances and Trends, 2.4.4 – Schedule Forecasts
- Risk: 1.3.13 – Risk and Recovery Plan

Terms to Know
Project Size:

- Funding methods
- Scope

Site and local considerations:

- Resources (labor, material, equipment, etc.)
- Location
  - ✓ Urban
  - ✓ Rural
  - ✓ Remote
- Project Type
  - ✓ Undeveloped
  - ✓ Reuse
  - ✓ Renovation
- Local environment and climatic conditions

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Delivery methods:

- Design-bid-build
- Design-build
- EPC (engineering-procurement-construction)
- Design-build-operate
- Variations of above

Infrastructure:

- Access
- Utility availability
- Easements

Labor agreements

Productivity:

- Labor
- Equipment

Risk and risk analysis

Key Points for Review

1. Identification, evaluation, and selection of project variables are critical to optimizing the project planning process.

2. The size of a project is based on an evaluation of current and projected needs of the end user and the intended life-cycle of the facility. These, in turn, determine the scope and funding methods addressed during the planning process.

3. New and untried processes and procedures should be identified during the planning process to determine the most effective method to use.

4. The project will determine a location's logistics requirements and their effects on the plan.

5. Productivity should be estimated within the constraints of labor agreements and other factors during the planning process. Their relationship to the delivery method and contract type will influence plan development.

Summary

Each project has influential variables such as available resources, site conditions and constraints, financial and economic considerations, local laws and regulations. These variables and their associated risks must be identified, evaluated, and resolved or mitigated to the best ability of the team. As the planning process proceeds, the nature of the variables may change. Therefore, when a variable changes, planning dynamics change and must be re-evaluated. Some variables are not reconcilable in the best interest of all stakeholders, thus resulting in potential unresolved conflict.

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Sample Questions for Section 1.2.4

1. All assumptions made by the planning team _______________.

   A. Become a part of the formal contract documents
   B. Are typically documented in the contractor's pre-bid site visit meeting minutes and notes
   C. Should be documented and clearly communicated to the appropriate parties
   D. Directly influence labor productivity assumptions and, thus, the planned activity durations that derive from those productivity assumptions.

2. List five common project variables.

3. How do project variables affect a project?

4. True or False: The project size may require additional constraints on the project?

5. True or False: Local climatological conditions may result in a restricted work schedule for various construction activities?

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Solutions to Sample Questions for Section 1.2.4

1. C. Should be documented and clearly communicated to the appropriate parties.

2. Project size, site location, project delivery methods, productivity, and infrastructure.

3. Project variables can have either a positive or negative influence on a project. It is the project team's responsibility to identify and mitigate the negative aspects of project variables and use the positive aspects of variables.

4. True

5. True

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Section 1B Planning Product

Outputs and deliverables of the planning process constitute the planning product. Inherent within plan production are two important elements:

- Development during the conceptual planning process; and,
- Implementation of the conceptual plan. This results in document development that defines process installation or end-product installation.

The planner-scheduler is an important team member in both of these major phases of the cycle. Successful development of the products, which comprise the end products of the planning process, is most likely when planner-schedulers are involved early and throughout planning.

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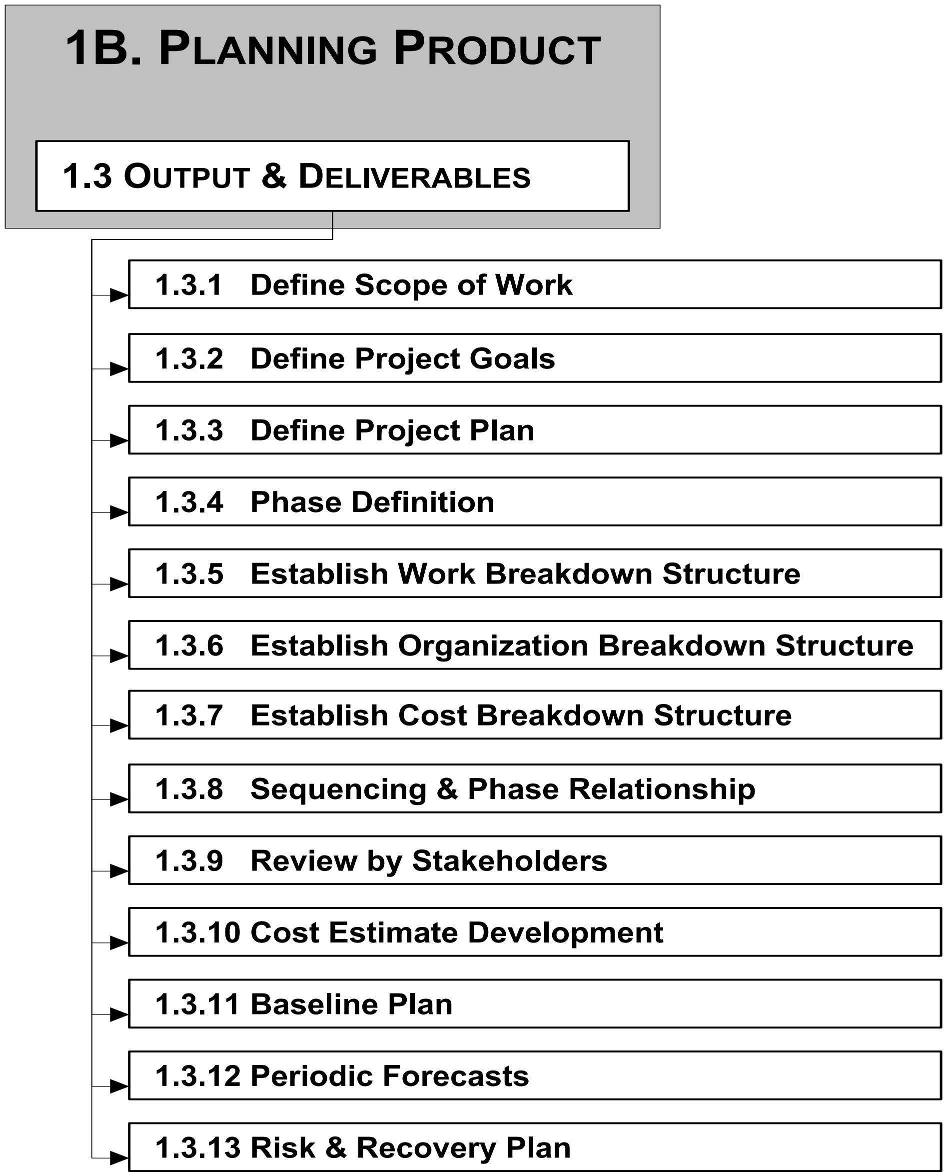

Figure 7—Planning Product

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Subchapter 1.3 Planning Output and Deliverables

As the project plan develops, several major elements require identification, evaluation, and selection of the optimum alternative. Choosing that alternative initiates the implementation process, which transfers the output of the planning effort to the scheduling phase of a program or project.

The planning team develops these tangible products. They include the appropriate effort to:

- Define scope of work.
- Define project goals.
- Establish work breakdown structure.
- Establish organization breakdown structure.
- Consider cost benefit structure.
- Define project plan.
- Define phase.
- Sequence and phase relationships.
- Develop cost estimate.
- Develop baseline plan.
- Develop periodic forecasts.
- Consider risk and recovery plans.

Each of these planning product units is essential to the planning team product being complete and effective. Only when fully developed do they lead to a successful plan.

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Please **see 1.3.1 Define Scope of Work** on page 53

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1.3.1 Define Scope of Work

Introduction and Learning Objectives

Understand how the scope of work is developed within the planning process.

At the conceptual stage of a project, the scope of work is a narrative description. As the program or project evolves during the planning stage, the scope of work is refined and expanded to reflect current goals and requirements. In later stages of planning, the level of detail continues to be enhanced and results in detailed drawings and specifications of the work.

The scope of work is identified and expressed as an achievable product. A program or project scope of work is specific, and it is usually broader than an objective. As the planning process progresses, the scope of work becomes better understood and is more specifically defined.

As a project participant, each stakeholder may have different perceptions of the established scope of work. Reconciliation of differing perceptions is required to ensure stakeholder satisfaction and project efficiency and effectiveness.

Related Sections

- Contracts: 1.1.1 - Contract Requirements, 2.1.3 – Schedule Specification
- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholders Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders
- Variables: 1.2.4 - Project Variables, 2.2.5 – Constraints and Calendars, 2.2.7 - Milestones
- Goals and Plans: 1.3.2 – Define Project Goals, 1.3.3 – Define Project Plan
- Phase and Sequencing - Sections: 1.3.4 – Phase Definition, 1.3.8 – Sequencing and Phase Relationships
- Breakdown Structures: 1.3.5 – Establish Work Breakdown Structure, 1.3.6 – Establish Cost Breakdown Structure, 1.3.5 – Establish Organization Breakdown Structure, 2.1.2 – Breakdown Structure Relationships
- Estimate – Section 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Baseline: 1.3.11 – Baseline Plan, 2.2.9 – Schedule Basis Documentation, 2.3.1 – Baseline Schedule
- Risk: 1.3.13 – Risk and Recovery Plan
- Activities: 2.2.2 – Activities, 2.2.3 - Durations
- Schedules: 2.2.1 – Types of Schedules, 2.2.8 – Schedule Quality Analysis and Compliance Review, 2.2.9 – Schedule Basis Documentation, 2.3.1 – Baseline Schedule, 2.4.1 – Control Level Schedule

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Terms to Know

Targets and objectives.

Scope of work:
- Asset.
- Function.
- Program and project.

Execution strategy.

Work packages:
- Engineering and design.
- Contract.
- Construction.

Considerations and constraints:
- Deliverables.
- Milestones.
- Variables.

Key Points for Review

1. The client-owner is responsible for defining the conceptual scope of work. The scope of work evolves to identify elements of the plan and should be approved by the client-owner.

2. Development of the work packages is the end product of the planning phase of the program. The scope of work provides the relationship between the execution strategy, and the considerations and constraints that serve and support the contractual requirement.

3. The client-owner is responsible for developing contracts and specifications that reflect the definable scope of work.

Summary

Understand the purpose and development that the scope of work requires as an initial planning task. It provides the client-owner's conceptual statement of the project goal, which is further refined and expanded upon as the planning process progresses.

The scope of work provides a basis from which the baseline plan for performance measurement is developed during the scheduling phase of the program.

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Sample Questions for Section 1.3.1

1. When reporting progress and completion forecasts to the client's management, a schedule that is organized by the projects work breakdown structure (WBS) structure provides ______________.

    A. A useful reporting tool that meets the client's project team special needs.
    B. An "early finish" constraint with a 20 day negative lag on the last activity.
    C. A "late start" constraint on the first activity with a 20 day negative lag.
    D. A "late finish" constraint on the last activity.

2. When gathering data to document activity progress and observed trends, the activity's reported percent complete _______________.

    A. Is all that is necessary to forecast remaining duration for that activity?
    B. Is used as part of the 6/10 rule to determine the remaining duration for that activity.
    C. Must be analyzed in conjunction with all observed activity data (actual start dates, trends, etc.) to estimate the remaining duration for the activity.
    D. Provides sufficient information necessary to determine the activity's earned value.

3. True or False: Contract deliverables are defined in the scope of work?

4. True or False: Drawings and specifications augment the written scope of work narrative?

5. What does the scope of work influence during the planning process?

6. Who is responsible to develop the conceptual scope of work?

7. Define the differences between an asset or functional scope of work and the project scope of work.

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Solutions to Sample Questions for Section 1.3.1

1. D. A "late finish" constraint on the last activity.

2. C. Must analyze in conjunction with all observed activity data (actual start dates, trends, etc.) to determine an estimated remaining duration for the activity.

3. True

4. True

5. Scope of work influences the execution strategy, development of work packages, project goals and objectives, and milestones.

6. The owner is responsible for the conceptual scope of work.

7. An asset or functional scope of work defines the process for which the facility is constructed, while the project scope of work defines the scope of work to be physically constructed.

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1.3.2 Define Project Goals

Introduction and Learning Objectives
Understand how project goals are developed and determine activities within the planning process.

A project goal is a concept that is identified and expressed as an achievable end product. Project goals are broader and are less specific than objectives.

A project may have multiple goals and objectives. Each stakeholder may have different perceptions of established goals, which require reconciliation to ensure goals alignment.

Related Sections:

- Contracts: 1.1.1 Contract Requirements, 2.1.3 – Schedule Specification
- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholders Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Project Plan: 1.3.3 - Define Project Plan
- Phase: 1.3.4 - Phase Definition
- Breakdown Structures: 1.3.5 – Establish Work Breakdown Structure, 1.3.6 – Establish Cost Breakdown Structure, 1.3.7 – Establish Organization Breakdown Structure, 2.1.2 – Breakdown Structure Relationships
- Sequence: 1.3.8 - Sequencing and Phase Relationship, 2.2.4 - Relationships
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Baseline: 1.3.11 – Baseline Plan, 2.2.9 – Schedule Basis Documentation, 2.3.1 – Baseline Schedule
- Risk: 1.3.13 – Risk and Recovery Plan
- Constraints: 2.2.5 – Constraints and Calendars
- Milestones: 2.2.7 - Milestones

Terms to Know
Goals.
Contractual obligations:

- Milestones.
- Deliverables.

Targets and objectives.
Baseline.

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Key Points for Review

1. The client-owner is responsible for identifying project goals. These goals are used to identify elements of the plan and may be used capture progress during the project implementation.

2. The goals may be either contractual or non-contractual depending on the nature of the program or project.

3. The client-owner is responsible to develop contracts that reflect definable and achievable goals.

Summary

Every program or project must have established achievable goals in order to be successful. The client-owner initially establishes conceptual goals, and the team is responsible for identifying, reviewing and recommending incremental goals upon which stakeholders act.

The contract may only represent definable, achievable goals.

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Sample Questions for Section 1.3.2

1. What is a project goal?

2. Can a project have multiple goals?

3. Can each stakeholder have a different view of what the project goal may be?

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Solutions to Sample Questions for Section 1.3.2

1. A project goal is a concept that is identified and expressed as an achievable project and product. The goal may or may not be a contractually specified requirement.

2. Yes

3. Yes

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1.3.3 Define Project Plan

Introduction and Learning Objectives

Understand the project plan as the roadmap of action for the project team. Current stakeholders should concur with the project plan. An essential concept is the integration of all plan elements with the work breakdown structure (WBS). The project plan is dynamic, cyclical, and iterative.

The project plan, when it becomes the baseline plan, serves as the benchmark against which progress, quality, and performance measurements are evaluated and reported.

The project plan is a fixed document, unless modifications or changes to the scope of work cause significant changes to the scope of work, thus requiring a new plan. Any revised project plan should be agreed upon by stakeholders to the extent that those stakeholders have a contractual basis to provide such input. However, non-contractual stakeholder input must be carefully and appropriately considered, too.

Once the project plan is identified, an initial schedule risk assessment and analysis determines the risks associated with meeting deadlines identified in the project plan.

Related Sections:

- Contracts: 1.1.1 - Contract Requirements, 2.1.3 – Schedule Specification
- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholders Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders, 2.2.8 – Schedule Quality Analysis and Compliance Review, 2.3.6 – Schedule Maintenance Feedback
- Scope of Work- Sections: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Goals: 1.3.2 - Define Project Goals
- Phase: 1.3.4 - Phase Definition
- Sequence: 1.3.8 - Sequencing and Phase Relationship
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Baseline: 1.3.11 - Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Forecasts: 1.3.12 - Periodic Forecasts, 2.4.4 - Schedule Forecasts
- Risk: 1.3.13 – Risk and Recovery Plan, 2.4.7 – Recovery Plans
- Schedules: 2.1.3 – Schedule Specification, 2.2.1 – Types of Schedules, 2.2.9 – Schedule Basis Documentation, 2.4.1 – Control Level Schedule
- Sequence: 2.2.4 – Relationships
- Constraints: 2.2.5 – Constraints and Calendars
- Milestones: 2.2.7 - Milestones
- Change Management – Section 2.3.4 Schedule Change Management, 2.3.5 – Acceleration, 2.4.7 – Recovery Schedules

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Terms to Know

Project plan.
Baseline:

- Schedule.
- Budget and cost.
- Forecasts.
- Periodic reporting.

Change and change management.
Measurements.
Phase.
Sequence.
Risk.

Key Points for Review

1. The scope of work that is identified during the planning process includes the methods and means to develop the project plan and enables the project to move forward.

2. An organization's policies and procedures, along with the project's policies and procedures, impact the development, review, and approval of a baseline plan.

3. A baseline plan should not be altered unless significant change occurs and is agreed upon the stakeholders. Changing the baseline is a major issue. Change should be restricted to circumstances when it is absolutely essential, as when continuing the previous baseline leads to inaccurate analysis. One should usually be especially wary of changing the baseline late in the project cycle, when the benefit of change is less.

Summary

The project plan is the final output of the planning process for a project. The project plan evolves into the baseline plan. The baseline plan provides the framework for all measurement evaluation.

The project plan is dynamic, cyclical and iterative. When significant changes occur, a revised project plan will be required and re-approved. The revised project plan or revised baseline plan will then serve as the new baseline for measurement going forward. The plan should be evaluated and analyzed periodically to identify the schedule risks to achieving the plan.

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Sample Questions for Section 1.3.3

1. What is the purpose of a project plan?

2. Once the project plan becomes the baseline plan, how is it used?

3. When does the project plan get modified?

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Solutions to Sample Questions for Section 1.3.3

1. A project plan provides a roadmap for the project team during the planning process. The project plan is the basis for the baseline plan.

2. The baseline plan becomes the benchmark for performance and reporting.

3. The project plan is modified when there are significant changes to the scope of work. The new plan should be agreed upon by the stakeholders.

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1.3.4 Phase Definition

Introduction and Learning Objectives
Understand the process for determining the project phases within the scope of work. As the scope of work is refined, the identification or breakdown of the project scope into various phases may likewise be expanded to fit the project.

A phase is a significant period of time or grouping of related activities within a project. A phase may encompass several stages of planning and work.

Phase definition is the initial identification and outlining of phase relationship and sequence planning, as defined by the scope of work. Further, since planning is an iterative and phased process, the scope definition will improve over time.

Phase definition can permit the initial development of cost estimates and control level schedules, and risks can be determined and analyzed for each phase.

Related Sections:

- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Goals and Plans – Sections 1.3.2 – Define Project Goals, 1.3.3 – Define Project Plan
- Breakdown Structures: 1.3.5 - Establish Work Breakdown Structure, 1.3.6 - Establish Organization Breakdown Structure, 1.3.7 - Cost Breakdown Structure, 2.1.2 - Breakdown Structure Relationships
- Sequence and Relationships: 1.3.8 - Sequencing and Phase Relationships, 2.2.4 – Relationships
- Estimate: 1.3.10 – Cost Estimate Development, 2.1.5 – Cost Estimate Model
- Risk: 1.3.13 – Risk 7 Recovery Plan, 2.4.7 – Recovery Plan
- Activities: 2.2.2 - Define Activities
- Durations and Constraints: 2.2.3 – Durations, 2.2.5 – Constraints and Calendars
- Schedules: 2.1.1 – Define Schedule Scope, 2.1.3 – Schedule Specification, 2.2.1 – Types of Schedules, 2.3.1 – Baseline Schedule, 2.4.1 – Control Level Schedule
- Milestones: 2.2.7 – Milestones

Terms to Know
Phase.
Planning.

Key Points for Review

1. Understanding the scope of work is essential to model the appropriate phases and elements of work.

2. Phases are based on and derived from the scope of work, sequence of work, phase relationships and the WBS. Phases might be defined by a fragnet and can have distinct start and finish milestones.

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Summary

Identification of the phases within the scope of work for the project plan is an essential product of the planning process. As the scope of work evolves into greater detail the phasing likewise evolves.

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Sample Questions for Section 1.3.4

1. What is a phase?

2. Why is the identification of phases an essential product of the planning process?

3. Which is not a phase?

    A. Engineering
    B. Concrete
    C. Conceptual engineering
    D. Pre-construction

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Solutions to Sample Questions for Section 1.3.4

1. A phase is a significant period of time or grouping of related activities with the project. A phase I derived from the scope of work, sequence of work, phase relationships, and the WBS.

2. As the scope of work evolves into greater detail, phases are identified. A phase may encompass several stages of planning and work.

3. B. Concrete is an activity, not a project phase.

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1.3.5 Establish Work Breakdown Structure (WBS)

Introduction and Learning Objectives

Understand the purpose of devising a work breakdown structure (WBS) as part of the planning process.

The WBS is a hierarchy division of the work scope elements of a project to be performed. The function of the WBS is to divide the scope of work into manageable parts that correspond to key deliverables, phases, or milestones with the intent to avoid the omission of key elements and assist in the communication of cost, schedule, quality, and resource performance data to stakeholders.

The WBS is product-oriented or process-oriented. Defining the WBS, like all tasks in the planning process, may be dynamic, cyclical, and iterative.

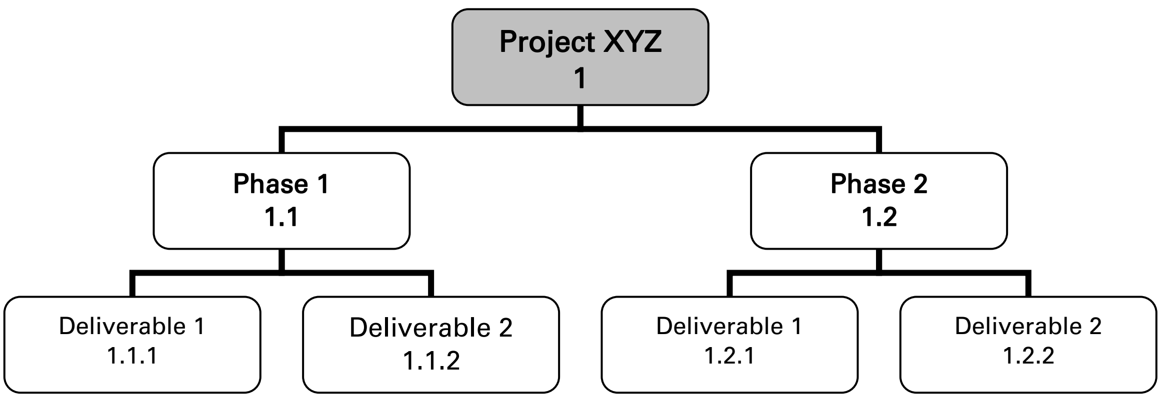

Figure 8—Sample WBS Structure

Related Sections

- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholders Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders
- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Phase: 1.3.4 - Phase Definition
- Breakdown Structures: 1.3.6 - Establish Organization Breakdown Structure, 1.3.7 - Cost Breakdown Structure, 2.1.2 - Breakdown Structure Relationships
- Estimate – Sections 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Risk: 1.3.13 – Risk and Recovery Plan
- Reports: 2.1.3 – Schedule Specification, 2.4.6 – Project Reports and Reviews
- Schedules: 2.1.1 – Define Schedule Scope, 2.1.3 – Schedule Specification, 2.2.1 – Types of

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Schedules, 2.3.1 – Baseline Schedule, 2.4.1 - Control Level Schedules

- Activities: 2.2.2 –Activities
- Change Management: 2.3.4 - Schedule Change Management, 2.3.5 – Acceleration, 2.4.7 – Recovery Schedule

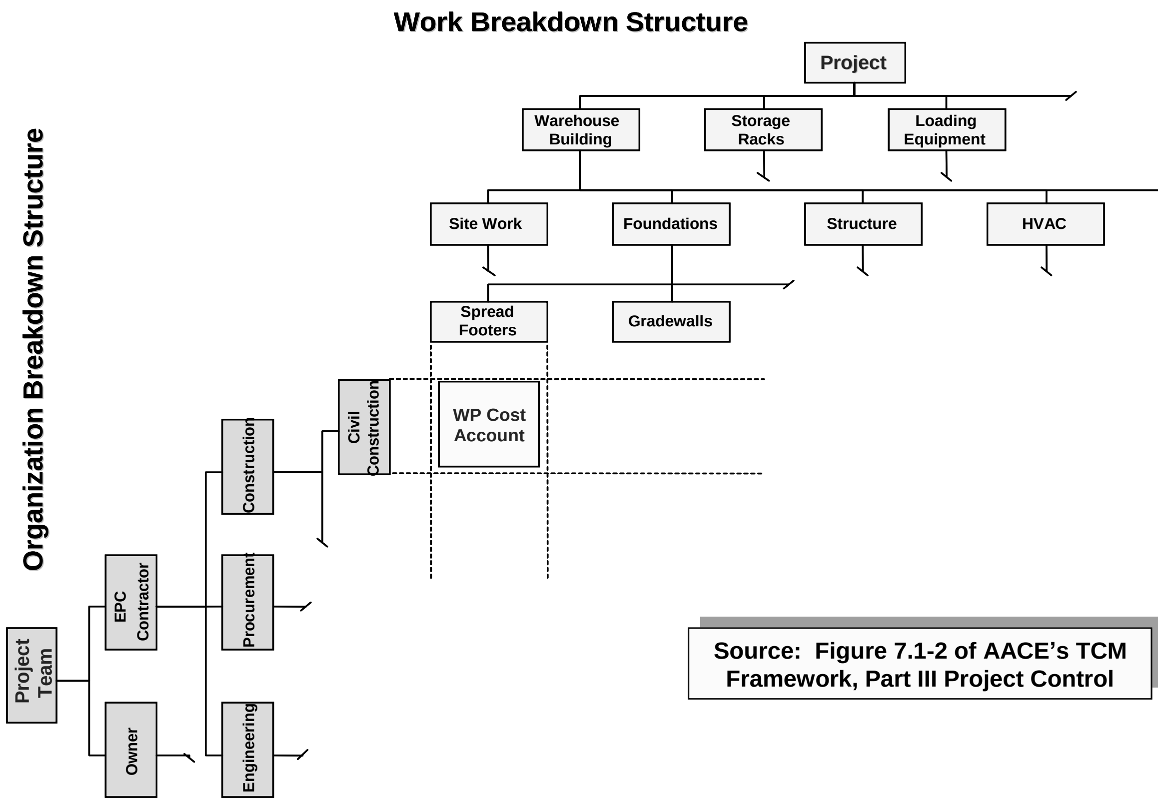

Figure 9—Sample WBS / OBS Structure

<u>Terms to Know</u>

Tasks.
Schedules.
Costs.

WBS development:

- Basic techniques.
  - ✓ Top-down.
  - ✓ Bottom-up.
  - ✓ Template-based.
- Roll-up and summarization.
- Code or chart of accounts.

Configuration management.
Change management.

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Key Points for Review

1. The hierarchical division of project scope defines and displays all work elements to be performed.

2. Provides a framework to define each specific element for which schedules will be developed.

3. Defines and facilitates the communication and integration of the project plan:
   a) Schedules.
   b) Resources.
   c) Costs.

4. Requires interaction among all members of the project team.

5. Should be project-specific, but may be based upon an organization's standard detailed template.

6. Must contain balance between complexity required for control and simplicity for accurate progress reporting. Rules of thumb for defining activity duration, which affects their complexity and number, is that (a) any activity should require at least a day, and (b) no activity duration should exceed a project routine reporting period, say, one month.

7. Must relate to code or chart of accounts. The difference between work package and a cost account:
   a) A work package is a WBS component, where resources can be budgeted.
   b) A cost account is the intersection of WBS and OBS components, where actual costs can be forecasted and collected.

8. Should be structured in accordance with how work will be performed, and who shall perform it.

9. After the WBS is fully and properly developed, all project work is defined somewhere in the WBS (no underlap), and no work is defined more than once in the WBS (no overlap).

10. Risks should be analyzed.

11. Each WBS should take into account:
    a) Technical performance parameters.
    b) Project organization.
    c) Contract funding.
    d) Configuration management.

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Summary

The WBS is a hierarchical division of the principal work elements for a project. An appropriate WBS links components of the cost estimate and activities of the schedule. The WBS assists the project team in transitioning the plan to the schedule. It provides the basis for all project reporting, including the collection and monitoring of data and forecasting of cost and schedule trends.

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Sample Questions for Section 1.3.5

1. Which of the following is untrue?

   A. OBS intersects with WBS to define a project cost account.
   B. Different managers might structure a WBS differently for the same project.
   C. A WBS can include design, procurement, and construction activites.
   D. None of the above.

2. True or False: WBS is a system by which work activities are organized and summarized into like activities?

3. True or False: WBS may be organized as a result of capital costing requirements?

4. How are the scope of work and the WBS related?

5. How are the WBS and the project schedule related?

6. Describe the difference between a work package and a cost account.

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Solutions to Sample Questions for Section 1.3.5

1. D. None of the above.

2. True – A WBS is a hierarchy division of work scope elements of a project to be performed.

3. True

4. The WBS breaks down the scope of work into manageable parts of work that correspond to deliverables, phases or milestones.

5. The WBS begins the process of breaking down the scope of work into project phases and work packages whose parts can be further segregated to create schedule activities.

6. A work package is a WBS component, while a cost account is the intersection of the WBS and OBS. The work package is a discretely identifiable element of work, whereas the cost account captures the time-phased resource cost required to execute a work package, as planned.

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1.3.6 Establish Organizational Breakdown Structure (OBS)

Introduction and Learning Objectives

Understand the purpose of devising and organization breakdown structure (OBS) during the planning process.

The OBS is a hierarchy division of the work scope elements of a project to be performed by a particular organization. The function of the OBS is to allocate the organization's resources against WBS elements, in order that the scope of work is efficiently and effectively performed and that a particular organization entity is responsible for its performance within budget and on time.

Related Sections

- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholders Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders
- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Breakdown Structure: 1.3.5 - Establish Work Breakdown Structure, 1.3.7 - Cost Breakdown Structure, 2.1.2 - Breakdown Structure Relationships
- Scope of Work – Sections 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Phase: 1.3.4 - Phase Definition
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Risk: 13.13 – Risk and Recovery Plan, 2.4.7 – Recovery Schedule
- Reports: 2.1.3 – Schedule Specification, 2.4.6 – Progress Reports and Reviews
- Change Management: 2.3.4 - Schedule Change Management
- Schedules: 2.2.1 – Schedule Types, 2.3.1 – Baseline Schedule, 2.4.1 -Control Level Schedule

Terms to Know

Tasks.
Schedules.
Costs.
OBS development:

- Basic techniques.
    - Top-down.
    - Bottom-up.
    - Template-based.
- Roll-up and summarization.
- Codes or chart of accounts.

Configuration management.
Change management.

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Key Points for Review

1. Hierarchical division of the organization structure that defines who performs work elements.

2. Defines and facilitates the communication and integration of the project plan:
   a. Schedules.
   b. Resources.
   c. Costs.

3. Requires interactively among all members of the project team.

4. Must be project-specific.

5. Must contain balance between complexity required for control and simplicity for accurate progress reporting.

6. Must relate to code or chart of accounts. The difference between work package and a cost account:
   a. A work package is a WBS component, where resources can be budgeted.
   b. A cost account is the intersection of WBS and OBS components, where actual costs can be forecasted and collected.

7. Risk should be analyzed.

8. Each OBS should take into account:
   a. Technical performance parameters.
   b. Project organization.
   c. Contract funding.
   d. Configuration management.

Summary
An OBS in the planning phase provides the organizational basis for collecting, monitoring and forecasting labor resource utilization data.

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Sample Questions for Section 1.3.6

1. When reporting progress and completion forecasts to the client's management, a schedule that is organized on the project's OBS provides ______.
   A. A list of all equipment resources utilized on the project.
   B. A baseline for change management reporting.
   C. A useful reporting tool that meets the client's project team special needs.
   D. Identifies resource utilization, and identifies gaps, utilization variances, and areas of management attention.

2. What is an OBS?

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Solutions to Sample Questions for Section 1.3.6

1. D. Identifies resource utilization and identifies gaps, utilization variances, and areas for management attention.

2. The OBS is a structure that breaks down the scope of work into organization functions. The OBS identifies who performs specific scope of work elements.

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1.3.7 Cost Breakdown Structure (CBS)

Introduction and Learning Objectives

Provide an understanding of how the Cost Breakdown Structure (CBS) for a project is developed during the planning process. The planner-scheduler must understand how the CBS is used for cost accounting and forecasting by management and the field during construction.

A CBS is either a hierarchical ranking that rolls or aggregates budgeted resources into elements of cost which are most typical: labor, materials, and other direct and indirect costs for a project; or a hierarchical ranking that defines the multiple project cost elements for cost accounting.

Related Sections:

- Scope of Work: 1.3.1 – Define Scope of Work, 2.1.1 – Define Schedule Scope
- Goals and Plan: 1.3.2 Define Project Goals, 1.3.3 – Define Project Plan
- Phases: - Sections: 1.3.4 – Phase Definition, 1.3.8 – Sequencing and Phase Relationships, 2.2.4 - Relationships
- Breakdown Structures: 1.3.5 – Establish Work Breakdown Structure, 1.3.6 - Establishing Organization Breakdown Structure, 2.1.2 – Breakdown Structure Relationships
- Estimates: 1.3.10 – Cost Estimate Development, 2.1.5 – Cost Estimate Model
- Risk: 1.3.13 – Risk and Recovery Plan
- Cost Loading: 2.2.6 – Cost and Resource Loading, 2.3.3 – Cost and Resource Management
- Progress – 2.3.2 – Tracking Schedule Progress, 2.4.6 – Progress Reports and Review, 2.4.8 – Management Summary
- Variances and Trends: 2.4.3 – Variances and Trends
- Forecasts: 2.4.4 – Schedule Forecasts

Terms to Know

Scope of work.
Goals.
Cost breakdown structure (CBS):

- Elements of cost.
- Labor.
- Materials.
- Direct costs.
- Indirect cost.
- Work breakdown structure (WBS).
- Organization breakdown structure (OBS).

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Key Points for Review

1. A cost breakdown structure is a key element of control for a project. The CBS allows all levels of management to track any project cost to meet their particular control and reporting needs. The CBS also allows management to evaluate the effectiveness of the estimate versus the work in place, remaining work, and overall costs.

2. A CBS is a hierarchical definition of the key elements of a project. At the highest level these are: labor, materials, and other direct and indirect costs. For a complex project there will be many sub-levels of these major elements.

3. A CBS is an effective tool both during the planning phase of a project as well as during the construction phase.

4. Depending upon the complexity of the project the schedule may or may not directly include elements of the, CBS, i.e., cost loading of the schedule. However, CBS is always an important element of the administrative effort required to ensure cost control.

Summary

Every project requires a CBS in order to define the full range of elements of cost associated with implementation. The development of the CBS allows tracking and forecasting of estimated costs versus actual costs.

As construction is undertaken, proper assignment of costs and roll-up summaries may be maintained for effective control of labor and materials both on-hand and installed. Accountability for direct and indirect costs associated with the project must be maintained.

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Sample Questions for Section 1.3.7

1. A CBS:
   A. Should generally not include indirect costs.
   B. Is not absolutely essential for effective management of a large project.
   C. Allows ready comparison of actual versus planned costs.
   D. All of the above.

2. What is a CBS?

3. How is the CBS related to the WBS and OBS?

4. Can the CBS be broken down between direct and indirect costs?

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Solutions to Sample Questions for Section 1.3.7

1. C. Allows ready comparison of actual versus planned costs.

2. A CBS is a structure that breaks down into cost types such as labor, material, equipment, subcontractor for cost forecasting purposes.

3. The CBS is the intersection of the WBS and OBS.

4. Yes

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1.3.8 Sequencing and Phase Relationships

Introduction and Learning Objectives

Understand how the various major elements of work scope will be completed in an interrelated, logical manner that identifies work phases and their relationship to each other. This sequencing is a planning process that iteratively drives the final plan and resultant schedule.

Work phases evolve from conceptual to specific during the life-cycle development of the program.

Work phases eventually become broad groupings within the schedule and ultimately “nest” specific work packages and activities. This provides a framework for monitoring, analyzing, controlling, and reporting.

Sequencing and phase relationships are an output as a result of project team defining the various phases of the project.

Related Sections:

- Variables: 1.2.4 – Project Variables
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Phase: 1.3.4 – Phase Definition
- Breakdown Structures: 1.3.5 - Establish Work Breakdown Structure, 1.3.6 - Establish Organization Breakdown Structure, 1.3.7 – Establish Cost Breakdown Structure, 2.1.2 - Breakdown Structure Relationships
- Forecasting: 1.3.12 - Periodic Forecasts, 2.3.6 - Cost and Resource Management, 2.3.2 - Tracking Schedule Progress, 2.4.2 - Variances and Trends, 2.4.3 – Schedule Analysis, 2.4.4 - Schedule Forecasts
- Schedules: 2.1.1 – Define Schedule Scope, 2.2.1 – Types of Schedules, 2.3.1 – Baseline Schedule, 2.4.1 – Control Level Schedules
- Activities and Durations: 2.2.2 – Activities, 2.2.3 - Durations
- Relationships: 2.2.4 - Relationships
- Constraints and Calendars: 2.2.5 – Constraints and Calendars
- Documentation: 2.2.8 – Schedule Quality Analysis and Compliance Reveiw2.2.9 - Schedule Basis Documentation
- Change Management: 2.3.4 – Schedule Change Management
- Reporting: 2.4.6 - Progress Reports and Review

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Terms to Know

Sequencing
Timeline
Logic
Elements of work
Phases
Relationships
Planning for reporting

- Progress
- Schedule
- Cost
- Earned value

Planning for forecasting:

- Periodic
  - ✓ Weekly
  - ✓ Monthly
  - ✓ Quarterly
- Special
  - ✓ Change in conditions
  - ✓ Added or deleted work
  - ✓ Progress variance(s)

Key Points for Review

1. Sequencing is a planning process that brings together the interrelated elements of a program using simple relationships.

2. Identification of phase relationships and their processes. Phase relationships are the basis for developing a framework for monitoring, analyzing, controlling, and reporting.

Summary

Sequencing and identification of phase relationships is the beginning process that results in the plan and schedule. Identification of the phases and their appropriate relationships within the project plan allows development of the means and methods to track progress.

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Sample Questions for Section 1.3.8

1. What is the difference between phases and sequencing?

2. What is a phase relationship?

3. What process does sequencing or phase relationships provide a framework for?

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Solutions to Sample Questions for Section 1.3.8

1. Phases are a significant period of time or grouping of activities within the project. The logical, chronological sequencing of the phases begins the process that builds phases into a schedule.

2. A phase relationship identifies how major work elements will be completed in a logical manner.

3. Progress monitoring, analyzing, controlling and reporting.

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1.3.9 Review by Stakeholders

Introduction and Learning Objectives
Stakeholder review is a key element in the planning process.

Key stakeholders' detailed reviews and decision-making are critical at this point. This may result in favorable or unfavorable actions that require replanning or stoppage.

Minor stakeholders' review and input is also critical at this point. Failure to embrace these stakeholders in the planning process may cause social or political issues to be over looked. This may result in additional planning and potentially significant cost and schedule impacts to project development and implementation.

Related Sections

- Stakeholders: 1.1.1 - Identification of Stakeholders, 1.2.3 - Stakeholder Considerations, 2.1.4 - Feedback from Stakeholders, 2.4.8 – Management Summary
- Variables: 1.2.4 – Project Variables
- Scope of Work: 1.2.1 – Define Scope of Work, 2.1.1 – Define Schedule Scope of Work
- Project Goals and Plans: 1.3.2 - Define Project Goals, 1.3.3 - Define Project Plan
- Phases: 1.3.4 – Phase Definition, 1.3.8 – Sequencing and Phase Relationships
- Breakdown Structures: 1.3.5 – Work Breakdown Structure, 1.3.6 – Organization Breakdown Structure, 1.3.7 – Cost Breakdown Structure, 2.1.2 – Breakdown Structure Relationships
- Estimate – Sections 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Risk: 1.3.13 – Risk and Recovery Plan
- Review / Feedback: 2.2.8 – Schedule Quality Analysis, 2.3.6 – Schedule Maintenance Feedback

Terms to Know
Decision-making.
Replanning.
Reprogramming.

Key Points for Review

1. Stakeholder input and review throughout the planning process are critical.

2. Stakeholder input and review must be cyclical, scheduled, and managed.

3. Stakeholders are usually divided into multiple groups depending on their direct or indirect involvement in the project.

Summary
Stakeholders affect the entire planning process. It is important to manage all stakeholder interests and concerns.

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Please see **Sample Questions for Section 1.3.9** on page 89

Please see **Solutions to Sample Questions for Section 1.3.9** on page 90

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Sample Questions for Section 1.3.9

1. Which is not a key component or characteristic of review by stakeholders?
   A. Cyclical
   B. Scheduled
   C. Managed
   D. Estimated

2. Stakeholder review is:
   A. Critical and divided into multi-groups.
   B. Not important
   C. One-dimensional
   D. Not considered

3. To what may stakeholders' decisions lead during the planning process?

4. Why is stakeholder review critical during the planning phase of a project?

5. Why should stakeholders be managed?

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Solutions to Sample Questions for Section 1.3.9

1. D. Estimated

2. A. Critical and divided into multi-groups.

3. Additional planning and potentially significant cost and impacts to the program or project.

4. Stakeholder decisions may require favorable or unfavorable actions that require re-planning or stoppage of the project and create significant cost impacts.

5. Stakeholders should be managed to ensure all interests and concerns are considered and if not managed could have negative cost and schedule impacts to a project.

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1.3.10 Cost Estimate Development

Introduction and Learning Objectives

Understand how:

- Constraints and resource considerations apply during the planning process. Impacts associated with resource constraints and considerations influence the timeline and budgeting process.
- Concepts of creating budget projections for the major elements to obtain an overall budget for the project.
- Contract documents may dictate how and when the cost estimate is developed.
- A WBS and OBS are integrated into the cost estimate, and how this integration may form the basis for the schedule model.

Alternatives for resource options are developed and evaluated based on timeline and the projected budget considerations as they evolve during the planning process. This includes value engineering and constructability determinations as well as change or revision to the project.

Ultimately the planning timeline, resource constraints, and budget projections form the basis for initial schedule and cash flow models.

The budget planning and development process incorporates stakeholder expectations for the project. Budget projections are continually refined based on identified constraints and considerations. Budget projections are often revised to be in agreement with project goals, objectives, and timeline.

Schedule risk should be evaluated when the scope of work, project plan, and phase definition develop into the initial cost estimate and schedule models.

Related Sections:

- Contract: 1.1.1 – Contract Requirements
- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.1 - Stakeholders Considerations, 2.1.4 - Feedback from Stakeholders
- Constructability: 1.1.3 - Constructability Methods, 2.4.5 - Constructability Review
- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Value Engineering: 1.2.2 - Value Engineering
- Variables: 1.2.4 – Project Variables
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Project Goals and Plans: 1.3.2 - Define Project Goals, 1.3.3 - Define Project Plan
- Baseline: 1.3.11- Baseline Plan, 2.3.1 - Baseline Schedule
- Forecasts: 1.3.12 - Periodic Forecasts, 2.3.2 - Tracking Schedule Progress, 2.4.4 - Schedule Forecasts
- Risk: 1.3.13 – Risk and Recovery Plans

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- Estimate: 2.1.5 - Cost Estimate Model
- Schedules: 2.1.1 Define Schedule Scope, 2.2.1 – Types of Schedule, 2.4.1 – Control Level Schedule
- Activities: 2.2.2 –Activities
- Durations: 2.2.3 – Durations, 2.2.5 – Constraints and Calendars
- Basis Documentation: 2.2.9 - Schedule Basis Documentation
- Variance and Trends: 2.4.2 - Variances and Trends, 2.4.3 – Schedule Analysis

Terms to Know

Timeline.
Budget.
Cash flow.
Estimate types and classes:

- Class 5 – Screening or Feasibility.
- Class 4 - Conceptual or Feasibility.
- Class 3 – Budget, Authorization, or Control.
- Class 2 – Control or Bid/tender.
- Class 1 – Check or Bid/tender.

Key Points for Review

1. Resources include all elements input in the life-cycle associated with the development, construction, and operation of a project.

2. Not all stakeholders contribute resources. Some may only have opinions and be activists, and their involvement requires that they invest few or no resources. Inputs and obligations of stakeholders with regard to resource availability are critical to the planning process.

3. During the planning process goals, objectives, and overall scope of work are known. That allows stakeholder budgetary projection to evolve into conceptual budget model development.

4. The planning timeline and associated budget are developed concurrently. At this point, major elements of work scope are known in sufficient detail to graphically depict them on a timeline to allow analysis of cash flow, overall resource utilization, and further optimization of the plan. If necessary, revisions are developed and evaluated to more suitably meet project goals.

Summary

The evaluation and determination of resource constraints and considerations play an important role in the planning process.

Budget development and evolution drives development of the program schedule. The budgetary process provides the underling basis of cost and schedule baselines used when monitoring, controlling, and reporting.

The estimate development for both direct and indirect costs should consider the schedule risks identified during the planning process.

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Sample Questions for Section 1.3.10

1. How do resource constraints and considerations affect cost estimate development?

2. Why are budgets often revised?

3. The budgetary process provides the basis for what?

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Solutions to Sample Questions for Section 1.3.10

1. Resources can influence the scheduling timeline and budgeting process. The end result is the basis for the initial schedule and cash flow models.

2. Stakeholder expectations can influence decisions during the budget development. The budget is often revised to be in agreement with project goals, objectives and timeline.

3. The budget is the basis for cost and schedule baselines used for monitoring, controlling and reporting.

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1.3.11 Baseline Plan

Introduction and Learning Objectives

Understand the baseline plan, as the definitive plan becomes the foundation for baseline schedule development. Understand concepts of creating a planning timeline, which lays out the major elements to obtain an appreciation of overall concept and duration for the project. The baseline plan should be agreed upon by the contracting parties in all major project aspects.

The baseline planning timeline evolves with the planning process. Ultimately the baseline plan forms the basis for the initial schedule and cash flow models and serves as the benchmark against which all measurements are evaluated and reported.

The baseline plan is a fixed document, unless significant modifications of the scope of work result. Significant changes to the scope of work can cause the previous baseline to be a poor representation of the work and to be of little value for work status reporting. When that occurs, a rebaselining effort is required. As before, this new baseline should be agreed upon by the contracting parties in all major aspects. Typically the budget, schedule, and percent complete status are all affected.

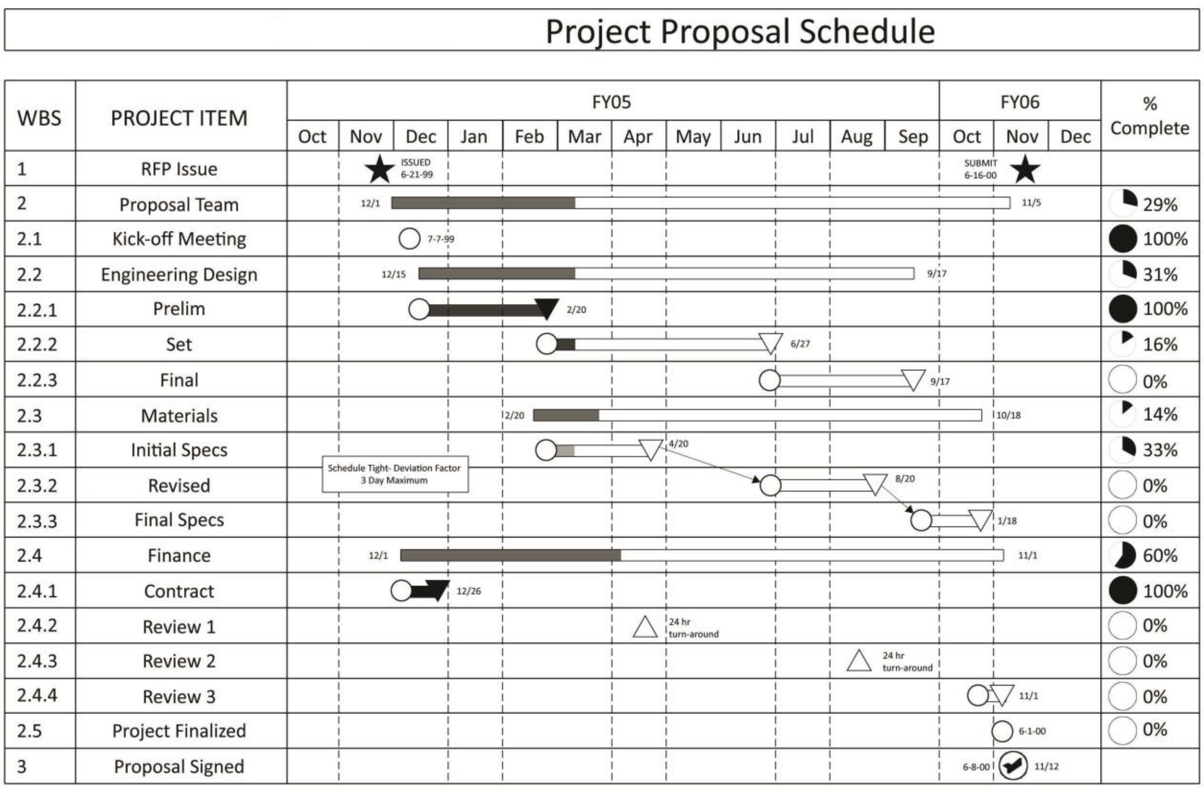

Figure 10—Baseline Plan

Each organization manages its project according to its own baseline plan and schedule. That is, an owner-client may not need to manage to as low or detailed a level as a contractor. Likewise, a subcontractor focuses on only its work scope and necessary coordination and interfacing with related trade work.

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Related Sections

- Contracts: 1.1.1 - Contract Requirements, 2.1.3 – Schedule Specification
- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholders Considerations, 1.3.9 – Review by Stakeholders, 2.1.4 - Feedback from Stakeholders
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Project Goals and Plans: 1.3.2 - Define Project Goals, 1.3.3 - Define Project Plan
- Phases: 1.3.4 – Phase Definition, 1.3.8 – Sequencing and Phase Relationship
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Forecasts: 1.3.12 - Periodic Forecasts, 2.4.4 - Schedule Forecasts
- Schedules: 2.2.1 – Schedule Types, 2.4.1 – Control Level Schedules
- Resources: 2.2.6 – Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Milestones: 2.2.7 - Milestones
- Quality: 2.2.8 – Schedule Quality Analysis and Compliance Review
- Baseline: 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Progress: 2.3.2 - Tracking Schedule Progress, 2.4.2 – Schedule Analysis
- Change Management: 2.3.4 - Schedule Change Management
- Variance and Trends: 2.4.2 - Variances and Trends
- Reporting: 2.4.6 - Progress Reports and Review, 2.4.8 - Management Summary

Terms to Know

Baseline:

- Schedule
- Budget and cost
- Quality requirements
- Forecasts
- Periodic reporting

Change and configuration management
Measurements
Earned value

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Key Points for Review

1. Project polices and procedures provide the method and means for developing, reviewing, and approving the baseline plan.

2. At this stage in the planning process the goals, objectives, and overall scope of work are known in sufficient detail. Sequencing and phasing of major tasks allow planning to evolve into conceptual schedule model development. Key milestones can be evaluated and established.

3. The planning timeline and associated budget are developed concurrently.

4. The baseline planning timeline and budget for completion are evaluated to determine the feasibility of meeting stakeholder requirements. If necessary, revisions are developed and evaluated to meet project goals.

5. A baseline plan should not be changed unless stakeholders agree, presumably in compliance with any established procedures for rebaselining.

Summary

Every project schedule model begins with a planning timeline and conceptual budget. These constraints allow stakeholders to quickly appreciate and evaluate the project planning status and likelihood of meeting established goals.

The baseline plan is the final output of the planning process for a project. The baseline provides the framework for all progress and measurement evaluation as the plan is implemented.

Since the plan is dynamic, cyclical and iterative, it will continue to evolve. When significant changes occur, whether a few large modifications or many smaller ones, a revised baseline of the project will be required. Once revised, the plan must be re-approved. This new baseline will then serve as the framework for future forecasting and measurement.

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Please see **Sample Questions for Section 1.3.11** on page 99

Please see **Solutions to Sample Questions for Section 1.3.11** on page 100

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Sample Questions for Section 1.3.11

1. The baseline plan is an end result of the planning process. What is not a basic step in the planning process that results in the baseline plan?
   A. Identification of the project goals and objectives.
   B. Scope of work definition.
   C. Phase identification and sequencing result in the baseline plan.
   D. Identification of the schedule specification.

2. Which is not a characteristic of the baseline plan?
   A. Serves as the basis for the initial schedule.
   B. Serves as the basis for the cash flow model.
   C. Provides the basis for progress measuring, evaluating and reporting.
   D. Is critical for schedule change management.

3. The baseline plan is a fixed document and should be changed only if the following occurs:
   A. Contract modifications result due to significant changes in the work.
   B. Change is allowed whenever one of the primary stakeholders thinks it appropriate.
   C. Never
   D. Once a year

4. A new baseline should:
   A. Never be approved
   B. Be agreed to by all primary stakeholders who have that right and responsibility.
   C. Only be approved by the contractor.
   D. Be approved by the public.

5. The baseline plan results from the planning process. What are the basic steps in the planning process that result in the baseline plan?

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Solutions to Sample Questions for Section 1.3.11

1. D. Identification of the schedule specification.

2. D. Is critical for schedule change management.

3. A. Contract modifications result, due to significant changes in the work.

4. B. Be agreed to by all primary stakeholders who have that right and responsibility.

5. Identification of the project goals and objectives; scope of work definition; and phase identification and sequencing result in the baseline plan.

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1.3.12 Periodic Forecasts

Introduction and Learning Objectives
Understand how the planning effort will assist in the development of means and methods to implement the project plan. Periodic forecasts are the means by which all concerned can be informed of whether or not the project should be delivered timely and within budget, per the current plan

A forecast is a prediction, an estimate of future conditions and events, based on factual information, observable trends, professional judgment, and documented assumptions available at the time of the evaluation.

A periodic forecast is produced on a regular schedule for a given future period. It usually is limited in scope.

Conditions may dictate that a special purpose forecast be produced. The special purpose forecast may be defined as a periodic forecast in the contract documents or created by one of the stakeholders to provide a proposed solution to a specific problem. A special purpose forecast might be used to aid managers to assess the risk associated with a contingent event.

Related Sections

- Contract: 1.1.1 - Contract Requirements, 2.1.3 – Schedule Specification
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Project Goals and Plans: 1.3.2 - Define Project Goals, 1.3.3 - Define Project Plan
- Estimate: 1.3.10 – Cost Estimate Development, 2.1.5 – Cost Estimate Model
- Baseline: 1.3.11 - Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Change Management: 1.3.13 – Risk and Recovery Plan, 2.3.4 - Schedule Change Management, 2.3.5 – Acceleration, 2.4.7 – Recovery Schedules
- Reports: 2.1.3 - Schedule Specification, 2.4.6 - Progress Reports and Reviews, 2.4.8 - Management Summary
- Forecasts: 2.3.2 - Tracking Schedule Progress, 2.4.2 – Variance and Trends, 2.4.3 – Schedule Analysis, 2.4.4 - Schedule Forecasts

Terms to Know
Contract general and special conditions.
Status reporting:

- Progress.
- Schedule.
- Cost.
- Earned value.
- Change and configuration management.

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Forecasts:

- Periodic.
  - ✓ Weekly.
  - ✓ Monthly.
  - ✓ Quarterly.
- Special.
  - ✓ Change in conditions.
  - ✓ Added or deleted work.
  - ✓ Progress variance(s).

Key Points for Review

1. Understanding the plan, scope of work, project goals, and contract requirements helps define forecasting requirements and their frequency.

2. Stakeholders should understand the various types of forecasts and how forecasts support controlling and measuring progress against the plan.

Summary

Forecasts fall into categories of periodic or special.

Identification of the work scope and goals within the project plan are essential tools to develop the means and methods to perform periodic forecasts. These forecasts are the basis to control and report against project deliverables and milestones.

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Sample Questions for Section 1.3.12

1. When performing a periodic forecast what should not be considered?
   A. The plan
   B. The project scope
   C. Contract requirements
   D. The WBS and OBS

2. Periodic forecasts are key to the following:
   A. Basis for control
   B. Reporting against project deliverables and milestones
   C. Based on trends and variances
   D. All of the above

3. What are three key components of periodic forecasts?
   A. Defining forecasting requirements, frequencies and timetables.
   B. Recovery schedules, scheduling change management and acceleration.
   C. Constructability methods, project variables and defining project goals.
   D. Sequencing and phase relationships, risk and recovery plans and schedule basis documentation.

4. Why is it important to have periodic forecasts?

5. Forecasts fall into two categories. Name both and discuss their differences.

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Solutions to Sample Questions for Section 1.3.12

1. D. The WBS and OBS

2. D. All of the above.

3. A. Defining forecasting requirements, frequencies and timetables.

4. Periodic forecasts provide information on the health of a project and assist in the prediction of future conditions and report against project deliverables and milestones

5. The two forecast types are (a) periodic and (b) special. Periodic are done on a specific time interval, while special are performed, as needed, to satisfy a particular purpose or to identify a specific problem.

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1.3.13 Risk and Recovery Plan

Introduction and Learning Objectives
Understand that both risk and changes require recovery plans.

Recovery plans propose potential solutions to impacts caused by risk or change. Change may have either a positive or negative impact on the current plan.

As the plan is developed, the project team should be aware of the risks and implement a risk management plan. The risk management plan may be used to mitigate risk and ensure recovery throughout the project life cycle.

As the plan evolves, the project team should continually perform a risk assessment on the plan to determine the feasibility of the plan. In some cases the risk may be great for the program to proceed, thus resulting in the cancellation of the program or major restructuring of the program.

Related Sections

- Resources: 1.2.1 – Identification of Resources, 2.2.6 – Cost and Resource Loading, 2.3.3 – Cost and Resource Management
- Project Variables: 1.2.4 – Project Variables
- Project Goals and Plan: 1.3.2 - Define Project Goals, 1.3.3 - Define Project Plan
- Estimate: 1.3.10 Cost Estimate Development, 2.1.5 Cost Estimate Model
- Baseline – Sections 1.3.11 - Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Schedules: 2.1.3 - Schedule Specification, 2.2.1 – Schedule Types, 2.4.1 - Control Level Schedules
- Constraints: 2.2.5 – Constraints and Calendars
- Progress: 2.3.2 Tracking Schedule Progress, 2.4.3 Schedule Analysis, 2.4.6 Progress Reports and Reviews
- Change Management: 2.3.4 - Schedule Change Management, 2.3.5 - Acceleration
- Variance and Trend: 2.4.2 - Variances and Trends
- Recovery Schedule: 2.4.7 - Recovery Schedules

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Terms to Know

Risk
Recovery
Risk management plan
Recovery plan
Contingency action plan
Schedule contingency plan
Budget contingency plan

Key Points for Review

1. Processes and procedures to develop a risk management plan to identify risks.

2. Identify, develop, and evaluate recovery alternatives.

3. Risk may be reduced as the plan is developed refined. Likewise, risk may increase as new variables are identified or the plan is revised or scope increased.

Summary

Developing procedures to identify impacts and recovery planning is necessary. During the planning phase it is appropriate to identify areas of potential risk and methods to apply to mitigate risks. Planning for change should be part of the planning process and the project team should develop recovery plans as part of the planning process.

Risk should be continually monitored as the project scope and plan evolve.

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Sample Questions for Section 1.3.13

1. Which of the following is not an effect of change on a contract?
   A. Increase in time for the work to be completed.
   B. Decrease in time for the work to be completed.
   C. Neutral as it affects time for the work to be completed.
   D. Articulate as it relates to time for the work to be completed.

2. Which of the following types of plans is not associated with risk and recovery?
   A. Baseline contingency plan.
   B. Budget contingency plan.
   C. Recovery plan.
   D. Schedule contingency plan.

3. Which one of the following is an important processing during planning for risk and recovery?
   A. Detailed cost evaluation.
   B. Planning for change.
   C. Using only the contract.
   D. Plan reevaluation for change.

4. Plan recovery is:
   A. Always part of the planning process.
   B. Sometimes part of the planning process.
   C. Usually required during planning.
   D. Always used during construction evaluation.

5. Why is it important to develop a risk and recovery plan?

6. What is the difference between a risk and a recovery plan?

7. Are risk and change the same?

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Solutions to Sample Questions for Section 1.3.13

1. D. Articulate as it relates to time for the work to be completed.

2. A. Baseline contingency plan.

3. B. Planning for change.

4. A. Always part of the planning process.

5. Change and risk are inevitable on projects. There must be a plan developed to identify and manage risk as well as a plan to mitigate negative impacts and exploit positive affects.

6. A risk plan defines how to identify and minimize the effect of risks, whereas a recovery plan is an array of means or methods to eliminate or reduce undesirable impacts of changes.

7. Maybe and maybe not. Risk might derive, in part, from the possibility of undesirable changes, but some changes might reduce risk and not increase it.

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Chapter 2.0 Scheduling

The objective of the scheduling chapter is to provide basic knowledge in an outline structure for a study of the means, methods, and tools necessary for project schedule development and periodic maintenance processes. These documents and data then form the basis for managing execution of the base scope of work, accommodating and accounting for change, and controlling outcomes. This chapter consists of two (2) main subchapters:

- Schedule Development.
  - ✓ Input and Data.
  - ✓ Creating Schedule.
- Schedule Maintenance and Controlling.
  - ✓ Maintain Schedule.
  - ✓ Output and Deliverables.

Each subchapter will develop concepts associated with each particular scheduling phase.

Key considerations are:

- **Schedule results from the plan.**
- **Scheduling is both cyclical and iterative.**
- **Scheduling is dynamic.**

Schedules are developed at various points in the planning process. Schedules are maintained to report progress, and forecast trends, work progress and completion. Schedules are used to control the successful execution of the project.

The schedule models the plan and the cost estimate using resources and execution strategy to meet the project objectives. The schedule must accommodate and account for change as it occurs.

The key characteristics of a successful schedule include elasticity, sensitivity, completeness, robustness, and clarity for all stakeholders. Elastic and sensitive schedules readily accommodate change to the schedule model over the life-cycle of the project. Complete schedules fully depict the plan and the cost estimate. Schedules that are robust meet the needs of key stakeholders for plan development, progress monitoring, key trends and milestone achievement forecasting, and reporting. Lastly, it must be clear and “readable” so that key stakeholders can have a common understanding of current status reported and trends forecasted.

All stakeholders inherently wish to properly, effectively use a schedule. The success of a well-developed and implemented schedule is dependent on a solid plan. The schedule should accurately reflect the physical project and the planning effort, and have the ability to properly forecast the outcome.

The modeling and scaling of the schedule must be appropriate to the phase of work. The schedule model is a database of extensive data elements. It is important to develop a well thought out and effective methodology of controls, tools, reports and reporting requirements to meet the needs of all stakeholders.

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The planning process provides the underlying, fundamental data for the baseline schedule. The baseline schedule, upon stakeholders' approval, becomes the standard for performance measurement.

The project baseline plan and the cost estimate are the fundamental documents used in the development of the plan and schedule for the next phase of the project.

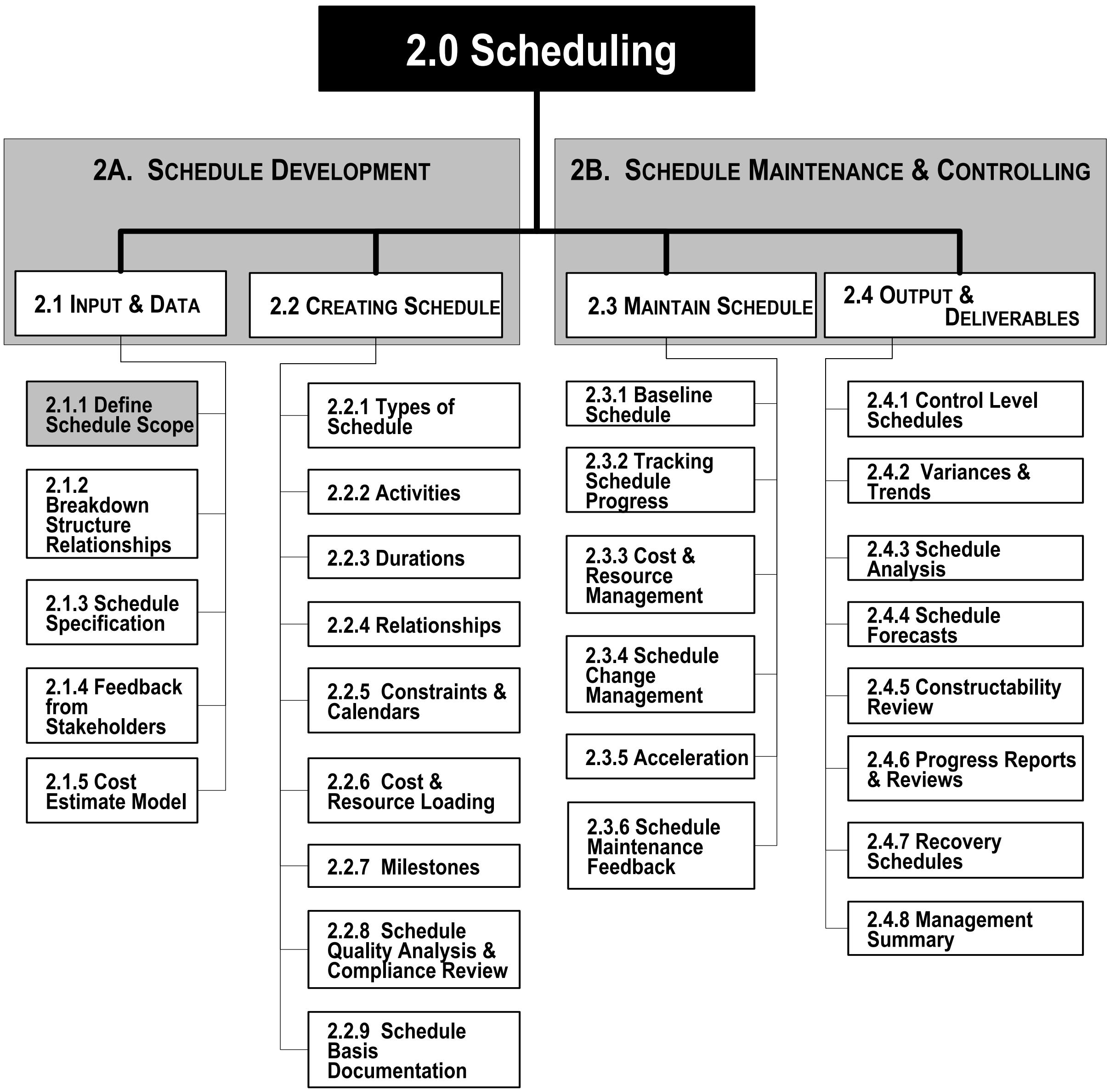

Figure 11—Scheduling

Section 2A. Schedule Development

Once the project is defined and the contract awarded a detailed schedule of the work is developed. This detailed schedule is often based upon milestone dates and phasing information developed in the conceptual planning phase. The intent of the detailed schedule development is to model the processes that the stakeholders will use in the creation of the project.

Schedule development consists of two (2) main sections:

- Input and Data.
  - ✓ Define Schedule Scope.
  - ✓ Breakdown Structure Relationships.
  - ✓ Schedule Specification.
  - ✓ Feedback from Stakeholders.
  - ✓ Cost Estimate Model.
- Creating Schedule.
  - ✓ Types of Schedule.
  - ✓ Activities.
  - ✓ Durations.
  - ✓ Relationships.
  - ✓ Constraints and Calendars.
  - ✓ Cost and Resource Loading.
  - ✓ Schedule Quality Analysis and Compliance Review.
  - ✓ Schedule Basis Documentation.

A schedule model is the planned effort necessary to complete the program/project successfully within the constraints and assumptions the parties have established. Based on this definition it is imperative that each of the stakeholders has a part in the design and review process for the schedule.

Types of schedules include:

- Baseline schedule.
- Control level schedules:
  - Level 1 – Milestone / Executive summary.
  - Level 2 – Contract master / Detailed integrated.
  - Level 3 – Area master / Contract.
  - Level 4 – Control – 2-3 Week Look-ahead schedules.
  - Level 5 – Daily / Hourly.
- Target schedules.
- Progress update schedules.
- Fragmentary and work schedules.

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- Major revisions to the schedule, if significant conditions have changed.
- Recovery / Acceleration schedules.

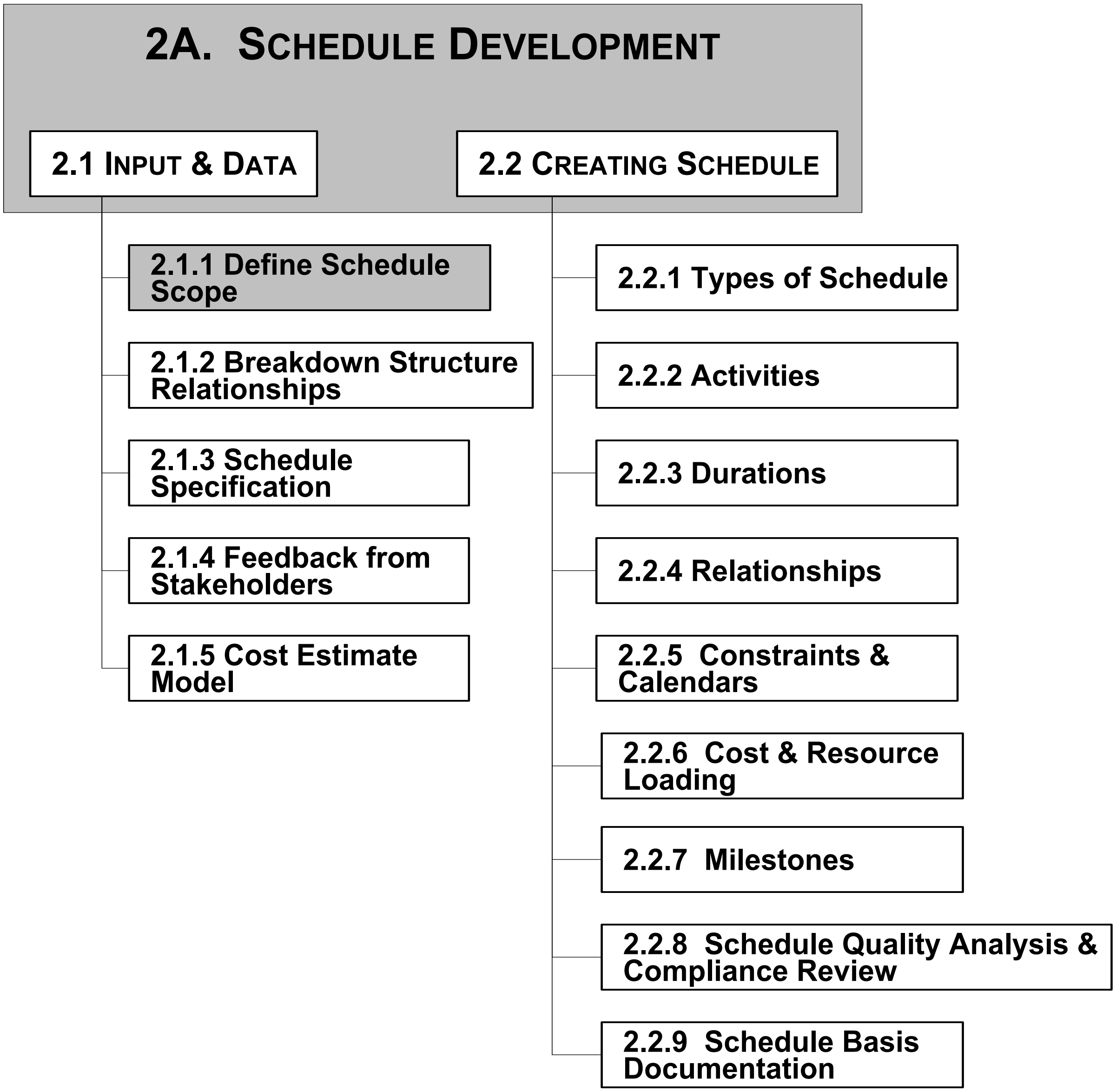

Figure 12—Schedule Development

NOTE: The Planning and Scheduling Professional (PSP) examination process makes every effort to be neutral with respect to the various proprietary software programs that are available. The questions and exercises are developed around scheduling principles that are common industry practice, not peculiarities of data entry and manipulation.

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Subchapter 2.1 Input and Data (from Planning)

The starting point for any schedule is the input of information developed during the planning process. Figure 13 outlines the major sources of information required to enable initial schedule development.

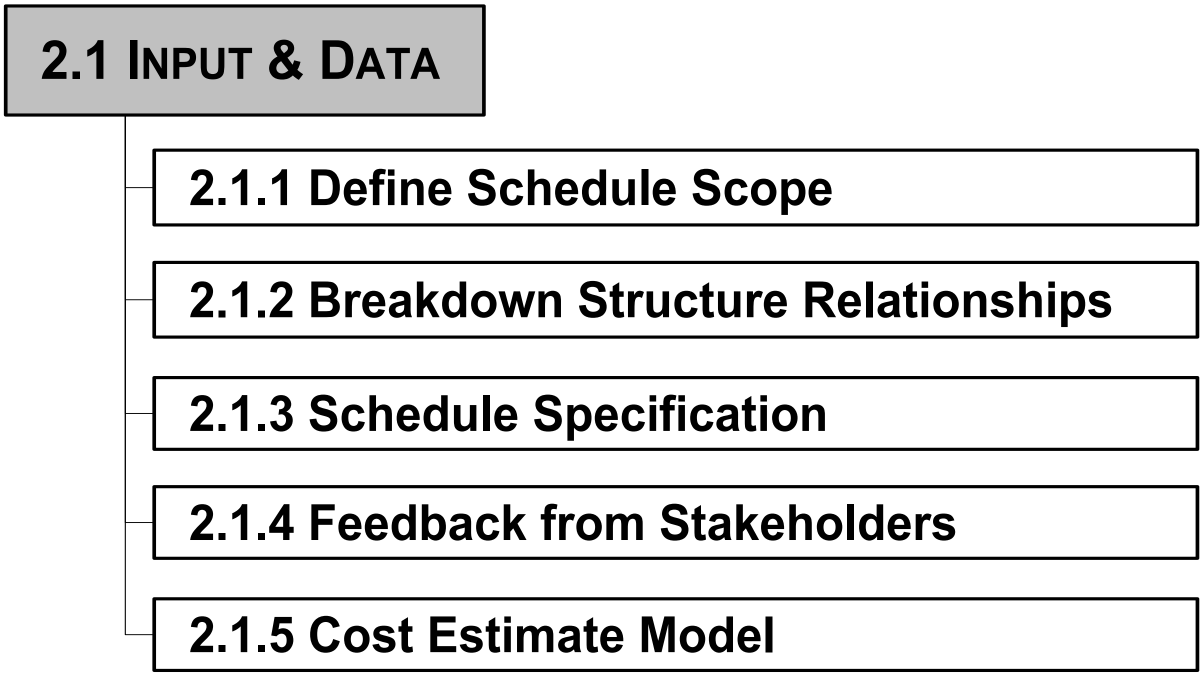

Figure 13—Schedule Input and Data

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Please see: **2.1.1 Define Schedule Scope**, on page 115

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2.1.1 Define Schedule Scope

Introduction and Learning Objectives

Understand how the scope for the schedule model is developed as well as the components of the schedule model. The scope and model should encompass:

- Development of the WBS and OBS elements into a scheduling format.
- Input from the planning process that develops and defines scope.
- Stakeholder goals and objectives and their relationship to the schedule model.
- Definition of minimum acceptable scheduling mechanics and reporting details.
- Basis for planning and model building, to include identification of
  - ✓ Deliverables
  - ✓ Milestone, timing, phasing and sequencing requirements (logic and constraints)
  - ✓ Resources, resource limitations and available work hours/week/shifts
  - ✓ Interface points and requirements

The schedule scope may define the types of control schedules that may be used during the project.

The contract requirements and the schedule specification may dictate the schedule scope and the types or levels of schedule to be developed and used.

Related Sections:

- Contract/Specification: 1.1.1 – Contract Requirements, 2.1.3 – Schedule Specification
- Stakeholders: 1.1.2 – Identification of Stakeholders, 1.2.3 – Stakeholder Considerations, 1.3.9 – Review by Stakeholders, 2.1.4 – Feedback from Stakeholders, 2.3.6 – Schedule Maintenance Feedback
- Constructability: 1.1.3 – Constructability Methods, 2.4.5 – Constructability Review
- Resources: 1.2.1 - Identification of Resource, 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Scope of Work: 1.3.1 - Define Scope of Work
- Goals and Plan: 1.3.2 – Define Project Goals, 1.3.3 – Define Project Plan
- Phases: 1.3.4 – Phase Definition, 1.3.8 – Sequencing and Phase Relationship
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Baseline: 1.3.11 - Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Risk /Recovery Assessment and Analysis: 1.3.13 - Risk and Recovery Plan, 2.4.7 – Recovery Plans
- Schedule: 2.2.1 – Schedule Types, 2.3.2 - Tracking Schedule Progress, 2.4.1 - Control Level Schedules
- Activities: 2.2.2 – Define Activities
- Durations: 2.2.3 – Durations, 2.2.5 – Constraints and Calendars

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- Milestones: 2.2.7 – Milestones
- Critical Path: 2.4.3 – Schedule Analysis

Terms to Know

Resources:

- Labor.
- Material.
- Equipment.
- Subcontract.

Work package.
Risk assessment and analysis.
Schedule types.
Deliverables.
Milestones.

Key Points for Review

1. Benefits and advantages of scheduling.
2. Scope definition and development.
3. Schedule development tools and techniques:
   a) Bar or Gantt charts.
   b) Critical Path Method (CPM) and network models:
      - ✓ Arrow Diagramming Method (ADM) / i – j Node, also known as Activity-on-Arrow (AOA).
      - ✓ Precedence Diagramming Method (PDM).
   c) Program Evaluation and Review Technique (PERT) and other risk models:
      - ✓ Parties.
      - ✓ Transactions and considerations.
      - ✓ Written versus oral.

Summary

Understanding the range of elements for the project is the first key requirement in the development of the schedule scope. The process requires explicit and detailed knowledge of the scope of work, scheduling tools' requirements and limitations, and the ability to communicate the plan into a workable schedule.

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Sample Questions for Section 2.1.1

1. If a plan estimates that 5,184 labor-hours will be expended on a series of related construction activities, and the projected number of construction worker equivalents expected to perform that activity is 12 personnel working a 12-hour day, what is the calculated overall duration for those activities? Assume the work is performed sequentially.
   A. 6 work weeks
   B. 35 calendar days
   C. 5 work weeks
   D. 36 work days

2. The primary source of information that defines the scope of work that the planner-scheduler relies upon to create a schedule model is what?
   A. Contract specifications.
   B. Contract provisions that define scope along with the contractor's execution plan and related assumptions.
   C. Contract special conditions and specifications.
   D. Pre-bid site visit and planning meetings.

3. What are three key elements in defining the schedule scope?

4. The basis for the schedule model should include identification of what components?

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Solutions to Sample Questions for Section 2.1.1

1. D. 36 workdays

2. B. Contract provisions that define scope along with the contractor's execution plan and related assumptions.

3. The scope of work; computer applications and limitations; and ability to communicate the plan into a workable schedule.

4. Deliverables, milestones, timing, phasing, sequencing requirements, resources and interface points.

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2.1.2 Breakdown Structures (WBS/OBS/CBS)

Introduction and Learning Objectives

Understand the work breakdown structure (WBS), organization breakdown structure (OBS), and cost breakdown structure (CBS), and their relation to scheduling:

- Understand WBS and the dependencies among work tasks to enhance team efficiencies.
- Understand OBS and the dependencies among parts of the organization to enhance team efficiencies.
- Understand CBS and its relationship to the WBS and OBS.
- Understand and document schedule change using WBS and OBS concepts.

Related Sections

- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Scope of Work: 1.3.2 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Phase: 1.3.4 – Phase Definition, 1.3.8 – Sequencing and Phase Relationships
- Breakdown Structures: 1.3.5 - Establish Work Breakdown Structure, 1.3.6 - Establish Organization Breakdown Structure, 1.3.7 - Establish Cost Breakdown Structure, 2.1.2 – Breakdown Structure Relationships
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Specification: 2.1.3 – Schedule Specification
- Schedules: 2.2.1 – Types of Schedule, 2.3.1 – Baseline Schedule, 2.4.1 – Control Level Schedule
- Activities: 2.2.2 –Activities
- Progress: 2.3.2 - Tracking Schedule Progress, 2.4.3 - Variances and Trends, 2.4.3 – Schedule Analysis, 2.4.4 - Schedule Forecasts, 2.4.6 - Progress Reports and Review

Terms to know

Breakdown structures:

- Work breakdown structure (WBS).
- Organization breakdown structure (OBS).
- Cost breakdown structure (CBS).

Work package.
Estimate.
Stakeholder.

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Key Points for Review

1. Work Breakdown Structure (WBS):
    a. Defining WBS by levels and elements.
    b. Coding techniques.
    c. Activity coding.
    d. How WBS is used in schedule modeling and control.
2. Organization Breakdown Structure (OBS):
    a. Defining OBS by levels and elements.
    b. Coding techniques.
    c. Activity coding.
    d. How OBS is used in schedule modeling and control.
3. Cost Breakdown Structure (CBS):
    a. Intersection of WBS and OBS.
    b. How CBS is used monitor, report, and control costs as the work progresses (actual and forecasted schedule).

Summary

A well-developed and managed WBS, OBS and CBS are critical aspects to managing the project schedule. The WBS and OBS assist the project team in defining the work packages and schedule levels. The CBS is used for tracking, reporting, and controlling costs.

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Sample Question for Section 2.1.2

1. Why is it important to understand how the WBS and OBS are related?

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Solution to Sample Question for Section 2.1.2

1. During schedule development the WBS and OBS define the overall work scope and the work packages.

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2.1.3 Schedule Specification

Introduction and Learning Objectives
Understand the components of a schedule specification and the effect of the schedule specification on scheduling and progress reporting, controlling, analyzing, and forecasting.

The purpose of a scheduling specification is to identify minimum requirements for:

- Key milestones and overall contract duration.
- Required phasing and sequencing.
- Contractor's plan, means and methods.
- Cost and resource loading and reporting.
- Subcontractor and supplier integration.
- Plan and schedule basis documentation.
- Owner and client requirements such as goals and objectives, ability to monitor the contractor, and control required when progress fails to meet contractual milestones and requirements.
- Schedule types and levels to be used and maintained.
- Reporting requirements: levels, frequencies, and formats.
- Scheduling software programs that are allowed, preferred, or required.

The schedule specification states the planning and scheduling requirements and purposes; level of detail required; reporting periods and capabilities; minimum and mandatory scheduling tools; initial schedule development; submission; phasing and milestones; changes; claims and disputes; scheduler experience and qualifications; and other requirements that the owner-client deems appropriate for the specific project.

The schedule specification defines who is responsible to prepare, maintain, and approve the schedule, as well as any required processes for these actions. The schedule specification may define sequencing; contract limitations; site restrictions; resource restrictions; weather constraints and assumptions; identification of and dealing with scope changes; submittal requirements; and any other requirements.

It is important that the scheduler understands the constraints and limitations of the applied scheduling software when developing the project schedule. Any tool on the market has some differences from the others.

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Related Sections

- Contracts: 1.1.1 - Contract Requirements
- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Relationships: 1.3.8 - Sequencing and Phase Relationships, 2.2.4 - Relationships
- Baseline: 1.3.11 – Baseline Plan, 2.2.9 – Schedule Basis Documentation, 2.3.1 – Baseline Schedule
- Risk Assessment and Analysis: 1.3.13 - Risk and Recovery Plan, 2.4.7 - Recovery Schedules
- Durations: 2.2.3 – Durations, 2.2.5 – Constraints and Calendars
- Constraints: 2.2.5 – Constraints and Calendars
- Milestones: 2.2.7 - Milestones
- Changes: 2.3.4 - Schedule Change Management, 2.3.5 - Acceleration
- Progress: 2.3.2 - Tracking Schedule Progress, 2.4.2 - Variances and Trends, 2.4.3 – Schedule Analysis, 2.4.4 - Schedule Forecasts, 2.4.6 - Progress Reports and Reviews
- Schedule: 2.2.1 – Schedule Type, 2.4.1 – Control Level Schedules, 2.4.7 – Recovery Schedules
- Change Management: 2.3.4 - Schedule Change Management, 2.3.5 – Acceleration
- Reports: 2.4.6 - Progress Reports and Reviews, 2.4.8 – Management Summary

Terms to Know

Scope change.
Schedule types:

- Baseline schedule
- Target schedule

Schedule development tools and techniques:

- Critical Path Method (CPM).
    - ✓ Arrow diagram method (ADM)
    - ✓ Precedence diagram method (PDM)
- Program Evaluation and Review Technique (PERT)
- Linear schedule
- Line of balance (LOB)
- Rolling wave

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Schedule control level.

    - Level 1 – Milestone / Executive summary
    - Level 2 – Contract master / Detailed integrated
    - Level 3 – Area master / Contract
    - Level 4 – Control – 2-3 Week look-ahead
    - Level 5 – Daily / Hourly
- Fragmentary and work schedule
- Recovery

Relationships:

- Finish-to-start (FS)
- Start-to-start (SS)
- Finish-to-finish (FF)
- Start-to-finish (SF)
- Leads and lags

Date constraints:

- Start
    - ✓ No earlier than
    - ✓ No later than
- Finish
    - ✓ No earlier than
    - ✓ No later than

Calendars:

- Types
- Lags

Activity types:

- Milestones
- Tasks
- Hammocks and summaries
- Level-of-effort (LOE)
- Flags
    - ✓ WBS
    - ✓ Independent
    - ✓ Start
    - ✓ Finish

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Reports:

- Tabular
- Graphic

Work package.
Critical path

Key Points for Review

The scheduling specification is the basis for reporting. The schedule specification may identify the scheduling software to be used, schedule format, cost and resource loading requirements, and reporting requirements. It is important that the scheduler understands the schedule software that is selected.

Summary

Understand schedule specification components, and how to develop a schedule within the constraints of the specification. This ensures that all contract-specific requirements are included in the development of the schedule and followed when reports are developed during the updating process.

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Sample Questions for Section 2.1.3

1. What is the general purpose of a scheduling specification?

2. The schedule specification may be the basis for what?

3. Who is responsible for schedule development and approval?

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Solutions to Sample Questions for Section 2.1.3

1. The schedule specification identifies the planning and scheduling requirements, level of required detail, reporting requirements, software requirements, milestones, change management and the responsible parties.

2. Project reporting.

3. Typically the scheduler is responsible to develop the schedule and the client is responsible for approval. A lot depends on what is written in the specifications and the contract documents.

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2.1.4 Feedback from Stakeholders

Introduction and Learning Objectives

Understanding the interests of the respective stakeholders in the schedule ensures that the schedule will be inclusive, encompassing, and responsive to the stakeholders and the contract.

The input of the stakeholders, internal and external, is required during the development and maintenance of the schedule. The project team must understand the perspective of each stakeholder, so that varying issues may be appropriately addressed and resolved.

Related Sections

- Contract: 1.1.1 - Contract Requirements
- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholders Considerations, 1.3.9 - Review by Stakeholders, 2.3.6 - Schedule Maintenance Feedback
- Goals and Plans: 1.3.2 - Project Goals, 1.3.3 – Define Project Plan
- Estimate: 1.3.10 – Cost Estimate Development, 2.1.5 – Cost Estimate Model
- Baseline: 1.3.11 – Baseline Plan, 2.2.9 – Schedule Basis Documentation, 2.3.1 – Baseline Schedule
- Specification: 2.1.3 – Schedule Specification
- Milestones: 2.2.7 – Milestones
- Review: 2.2.8 – Schedule Quality Analysis and Compliance Review
- Reporting: 2.3.2 - Tracking Schedule Progress, 2.4.6 - Progress Reports and Review, 2.4.8 - Management Summary
- Change Management: 2.3.4 – Schedule Change Management, 2.3.5 - Acceleration
- Schedule: 2.2.1 – Types of Schedules, 2.4.1 – Control Level Schedules, 2.4.7 – Recovery Schedules

Terms to Know

External stakeholders:

- Owner.
- Local political and community interests.
- Permitting and code enforcing entities.
- Owner's users and customers.

Internal stakeholders:

- Prime contractor and project management contractor.
- Principal subcontractors.
- Second tier of subcontractors.
- Suppliers.
- Installers.
- Startup, testing, and compliance support personnel.

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Key Points for Review

Identify stakeholder input and how it must be accounted for in schedule development and maintenance.

Understand when and how the various stakeholders influence the project over the timeline of development, construction, startup, testing, and transfer.

Summary

A key element of successful schedule development and maintenance is the scheduler's knowledge of the stakeholders' needs and desires.

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Sample Question for Section 2.1.4

1. Why is it important to get feedback from stakeholders during schedule development?

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Solution to Sample Question for Section 2.1.4

1. It is important to get stakeholder "buy-in" for the schedule. If they do not buy into the schedule, there may be no sense of ownership. Disagreements will increase, maybe resulting in delays or impacts.

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2.1.5 Cost Estimate Model

Introduction and Learning Objectives

The project team is responsible for providing the planner-scheduler with the cost estimate. The cost estimate is critical to understanding the project execution plan. This project execution plan identifies the means and methods and activities that schedule model must represent.

The cost estimate identifies and defines quantities and resources within the WBS/OBC/CBS that will be included in the schedule model. This allows for monitoring and controlling of the work in a consistent and reportable manner.

The cost and resource loaded schedule model forms a baseline for cash flow and resource management and change management purposes.

The cost estimate model assists in developing and identifying the risks to meet the schedule requirements.

Related Sections

- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Scope of Work: 1.3.1 – Define Scope of Work, 2.1.1 – Define Schedule Scope
- Breakdown Structures: 1.3.5 - Establish Work Breakdown Structure, 1.3.6 - Establish Organization Breakdown Structure, 1.3.7 – Establish Cost Breakdown Structure, 2.1.2 - Breakdown Structure Relationships
- Estimate: 1.3.10 - Cost Estimate Development
- Baseline Schedule: 1.3.11- Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Risk/Recovery: 1.3.13 – Risk and Recovery Plan, 2.4.7 – Recovery Schedule
- Progress: 2.1.3 – Schedule Specification, 2.3.2 - Tracking Schedule Progress, 2.4.2 – Variances and Trends, 2.4.3 - Schedule Analysis, 2.4.4 - Schedule Forecasts
- Schedule: 2.2.1 – Types of Schedule, 2.4.1 - Control Level Schedules
- Activities: 2.2.2 - Activities
- Constraints: 2.2.5 – Constraints and Calendars
- Changes: 2.3.4 - Schedule Change Management, 2.3.5 – Acceleration
- Reports: 2.4.6 - Progress Reports and Review, 2.4.8 - Management Summary

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Terms to Know

Cost estimate types:

- Class 5 – Screening or Feasibility.
- Class 4 - Conceptual or Feasibility.
- Class 3 – Budget, Authorization or Control.
- Class 2 – Control or Bid/Tender.
- Class 1 – Check or Bid/Tender.

Cost loaded schedule.
Change management.
Cash flow.
Resource loaded schedule.
Risk and risk analysis.

Key Points for Review

1. The cost estimate is a key building block for defining and developing the baseline schedule model.

2. Understand how to take the cost estimate using the WBS and develop the cost loaded baseline schedule.

3. The cost estimate in conjunction with the baseline schedule will determine the initial project cash flow and resource allocations.

Summary

The project team must fully understand how all aspects of the cost estimate are incorporated into the cost-loaded baseline schedule and form the basis for the initial project cash flow and resource allocations.

The cost estimate identifies the initial risk that is associated with the project timeframe and will be incorporated into the baseline schedule.

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Sample Questions for Section 2.1.5

1. For what is the cost estimate model used?

2. What does the project execution plan identify?

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Solutions to Sample Questions for Section 2.1.5

1. The cost estimate model is the basis for baseline scheduling, progress measurement, reporting, and change management.

2. The project execution plan identifies the means, methods, and activities that the schedule module should represent.

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Subchapter 2.2 Creating Schedule

The objective of this subchapter is to provide basic knowledge in an outline structure for a study of the means, methods, and tools necessary for project schedule development process.

The Creating Schedule chapter consists of the following sections:

- Types of Schedules.
- Activities.
- Durations.
- Relationships.
- Constraints and Calendars.
- Cost and Resource Loading.
- Milestones.
- Schedule Quality Analysis and Compliance Review.
- Schedule Basis Documentation.

Each section develops concepts associated with each particular scheduling phase. Figure 14 outlines the major topics in schedule development.

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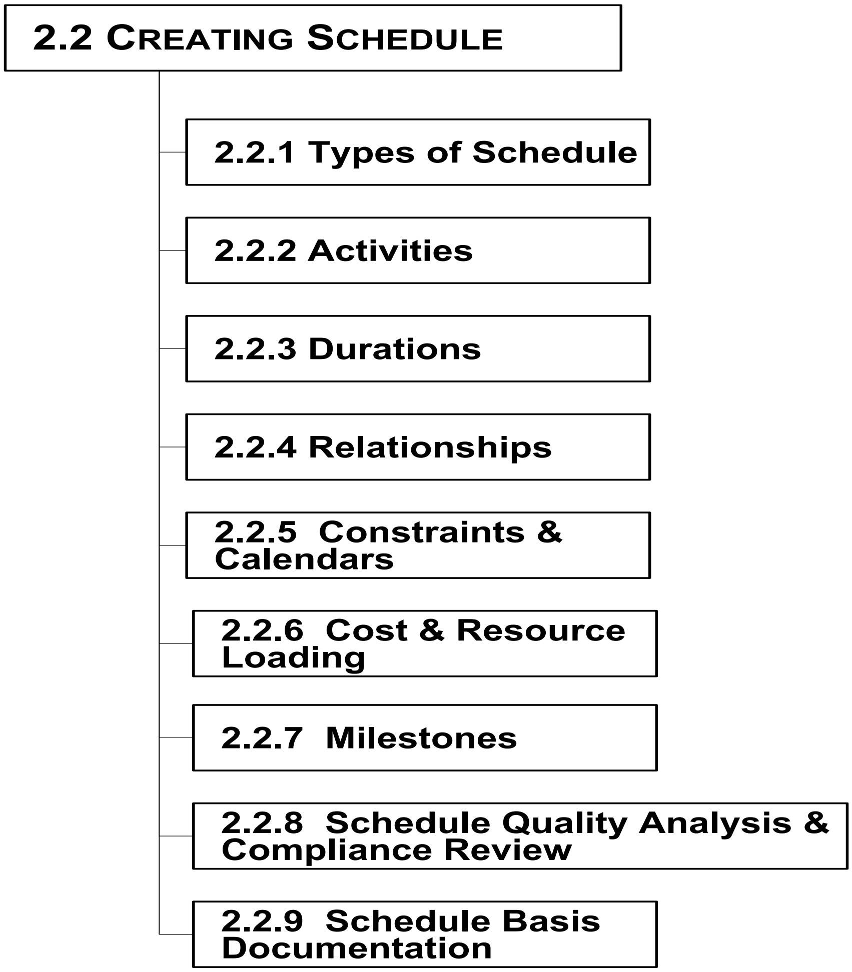

Figure 14—Creating Schedule

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2.2.1 Types of Schedules

Introduction and Learning Objectives

Understand the various schedules types and how each may be best suited for application on a particular project. The type of schedule used is directly related to the size, scope, and complexity of the project's planning, reporting, management and controlling needs.

Within the overall schedule, there may be a need to utilize other types of schedule, if required to address and convey critical aspects of the project.

At key times in the life of a project, the type of schedule may change from one format to another, such as from a graphical presentation to a simple list of requirements or visa versa. Types of schedules used during the life cycle of the project may include:

- Milestone.
- Phase.
- Area.
- Process system.
- List.
    - Work activity.
    - Punch list.
    - Commissioning.
- Control level.

During the life cycle of the project different control level schedules may be used to depict the schedule, contractual issues and concerns, or schedule progress for the various stakeholders.

Related Sections

- Contracts: 1.1.1 - Contract Requirements, 2.1.3 – Schedule Specification, 2.4.1 – Control Level Schedules
- Resources: 1.2.1 - Identification of Resources, 2.2.3 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Scope of Work: 1.3.2 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Relationships: 1.3.7 - Sequencing and Phase Relationships, 2.2.2 - Relationships
- Baseline: 1.3.11 – Baseline Plan, 2.2.9 – Schedule Basis Documentation, 2.3.1 – Baseline Schedule
- Risk Assessment and Analysis: 1.3.13 - Risk and Recovery Plans, 2.4.7 - Recovery Schedules
- Milestones: 2.2.5 - Milestones
- Progress: 2.3.2 - Tracking Schedule Progress, 2.4.2 - Variances and Trends, 2.4.3 - Schedule Analysis, 2.4.4 - Schedule Forecasts, 2.4.6 - Progress Reports and Review
- Change Management: 2.3.4 - Schedule Change Management, 2.3.5 – Acceleration
- Schedule: 2.4.1 – Control Level Schedules, 2.4.7 – Recovery Schedules
- Reports: 2.4.6 - Progress Reports and Reviews, 2.4.8 – Management Summary

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Terms to Know

Input/data for schedule development:

- Milestones
- Lists

Schedule development tools and techniques:

- Bar or Gantt charts
- Critical Path Method (CPM)
  - ✓ Arrow diagram method (ADM)
  - ✓ Precedence diagram method (PDM)
- Program Evaluation and Review Technique (PERT)
- Linear scheduling
- Line-of-balance (LOB)
- Rolling wave

Activity types:

- Milestones
- Tasks
- Hammocks and summaries
- Level-of-effort (LOE)
- Flags
  - ✓ WBS
  - ✓ Independent
  - ✓ Start
  - ✓ Finish
- Baseline
- Target
- Control level
- Fragmentary and work
- Recovery

Key Points for Review

The project may dictate the type of schedule that may be developed to track progress. When reporting the schedule, the resultant is in graphical format and often does not depict the logic that is built into the schedule.

Summary

Understand the components of various schedule types and how to choose a particular schedule type that best fits the need of the program or project.

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Sample Questions for Section 2.2.1

1. What are three requirements that determine what type of schedule should be utilized on a project?
   A. Cost estimate, number of stakeholders, reporting requirements.
   B. Project size, scope, complexity.
   C. Project size, project variables, phase definition.
   D. Risk and recovery plan, milestones, durations.

2. List four different types of schedules most commonly used?
   A. Bar and Gantt charts, Critical Path Method and network schedules, linear or line-of-balance, milestone.
   B. Critical Path Method and network schedules, hammocks, rolling wave, milestone.
   C. Gantt chart, linear or line of balance, level of effort, work lists.
   D. Flags, constraints, estimate, bar chart.

3. Explain why planner-scheduler would choose a linear schedule instead of a network schedule.

4. Explain why different schedules can and should sometimes be used within one project.

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Solutions to Sample Questions for Section 2.2.1

1. B. Project size, scope, complexity.

2. A. Bar and Gantt charts; Critical Path Method and network schedules; linear or line-of-balance; milestone.

3. A linear schedule is typically used on a project where there are multiple series of repetitive tasks, as with highway construction or construction of multiple, similar houses. A network schedule is used when non-repetitive activity arrays are determined. The network is derived from logical relationships among activities based on their time sequencing.

4. Different schedules should be used within one project based on the phase, system, timeframe, and complexity of the project. Different schedules are used based on the need of the project at the time or phase and the need to control that aspect of the project.

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2.2.2 Activities

Introduction and Learning Objectives

Understand the definition of an activity as the plan or phase is converted into a schedule model. The schedule models the scope of work to be performed and is made up of activities, which reflect items of direct work or indirect work support. Each activity is an individual element of work that becomes logically linked to other activities to form the schedule.

An activity has multiple components. Consider that an activity is the equivalent of a record in a database. Each record has multiple fields of data that define activity scope and characteristics for reporting and management of the work. The minimum components for an activity are:

- A unique alphanumeric identifier.
- A unique descriptive name, optimally phrased as verb-object.
- A duration

Individual activities have relationships and may have other attributes, such as:

- Cost and resource loading.
- Constraints.

The schedule activity is partly developed from the cost estimate model. The minimum and maximum allowable activity durations may be dictated by the scheduling specification.

Related Sections

- Contract: 1.1.1 – Contract Requirements,
- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope, 2.1.3 – Schedule Specification
- Phases and Relationships: 1.3.4 - Phase Definition, 1.3.8 - Sequencing and Phase Relationships, 2.2.4 - Relationships
- Breakdown Structures: 1.3.5 - Establish Work Breakdown Structure, 1.3.6 - Establish Organization Breakdown Structure, 1.3.7 – Establish Cost Breakdown Structure, 2.1.2 - Breakdown Structure Relationships
- Estimate: 1.3.10 – Cost Estimate Development, 2.1.5 – Cost Estimate Model
- Schedules: 2.2.1 – Types of Schedules, 2.3.1 – Baseline Schedule, 2.4.1 – Control Level Schedule, 2.4.7 – Recovery Schedule
- Durations: 2.2.3 – Durations, 2.2.5 – Constraints and Calendars
- Milestones: 2.2.7 - Milestones

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Terms to Know

Modeling

Activity:

- Alpha-numeric identifier systems
- Descriptive names
- Duration

Activity types:

- Elements of work
- Related support work examples
  - ✓ Ordering of long lead-time items which impact the work.
  - ✓ Submittal processes: schedules, submitting, approval, etc.
- Dividing of elements of work into increments or units of work, which are spaced over time.

Original duration.

Special types of activities (some may be software specific), including:

- Resource dependent
  - ✓ Independent
  - ✓ Meeting
- Milestones
- Summary
  - ✓ Hammocks and topics
  - ✓ WBS
  - ✓ Grouping bands
  - ✓ Level-of-effort (LOE)
- Flags

Key Points for Review

1. The scheduler should understand the components of each activity and of various elements that are required to better define and group activities. The scheduler needs to understand the use of special types of activities such as milestones or hammocks used to manage the scheduling process.

2. The schedule activity is partly defined by the cost estimate model.

Summary

The activity is the fundamental work element of the schedule. Logical linking of activities, together with contractual requirements and other constraints, form the schedule model.

Level of detail in an activity must be appropriate for monitoring, managing and reporting the project. That level of detail should be reviewed with concern to duration, complexity, execution methodology, cost and risk. The activity must be in conformance with WBS, OBS and CBS.

The type of control level schedule may dictate the type or description of the activity.

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Sample Questions for Section 2.2.2

1. Which is not a characteristic of an activity?
   A. Has a duration
   B. Should have at least one predecessor successor
   C. Is assigned to a calendar
   D. Is constrained in time

2. When activities are logically linked they become?
   A. Constraints
   B. The schedule
   C. Resources
   D. Milestones

3. What is an activity, and what are its primary characteristics?

4. What should the level of detail be for activities in the schedule?

5. What are the different activity types?

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Solutions to Sample Questions for Section 2.2.2

1. D. Is constrained in time.

2. B. The schedule.

3. An activity is an individual element of work that is logically linked to other activities to form the schedule. Its primary characteristics include an overall duration based upon the resources applied to it (manpower, materials and equipment), a start and completion date that is tied to a work calendar and has relationships to other activities (predecessor and successors).

4. The level of detail must be appropriate for managing the project with concern to duration, complexity, methodology, cost and risk.

5. Tasks, milestones, flags, and summary or hammocks.

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2.2.3 Durations

Introduction and Learning Objectives
Understand activity durations as an interactive component of the schedule.

In this section and subsequent sections on cost and resources, each activity is further defined, giving it strength and character by adding the dimensions of

- Activity duration.
- Activity's logical place in time.
- Cost.
- Resources.

Duration is the overall estimated time in which an activity is planned to be completed. This becomes the "Original Duration" for an activity and is an assigned element of the activity. Duration often includes multiple work elements within the activity scope. For example, the activity described as "Install concrete" may include the following processes: forming, rebar installation, concrete placement, formwork stripping, and concrete curing.

The schedule duration, in part, is derived from the Cost Estimate Model and may be limited by the contract requirements or scheduling specification.

The next section discusses relationships. The relationships define the activities in terms of pure sequencing logic.

Activity involves action; the activity should be uniquely identified with verb-object, e.g., "Erect steel," "Prepare documentation," etc.

Related Sections

- Contracts / Specifications: 1.1.1 - Contract Requirements, 2.1.3 - Schedule Specifications
- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope, 2.1.3 – Schedule Specification
- Project Goals and Plan : 1.3.2 - Define Project Goal, 1.3.3 - Define Project Plan
- Phase: 1.3.4 - Phase Definition, 1.3.8 – Sequencing/Phase Relationships
- Breakdown Structures: 1.3.5 - Establish Work Breakdown Structure, 1.3.6 - Establish Organization Breakdown Structure, 1.3.7 – Establish Cost Breakdown Structure and 2.1.2 - Breakdown Structure Relationships
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Forecasts and Analysis: 1.3.12 - Periodic Forecasts, 2.3.2 - Tracking Schedule Progress, 2.4.4 - Schedule Forecasts
- Activities: 2.2.2 - Activities
- Constraints and Calendars: 2.2.5 - Constraints and Calendars

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- Milestones: 2.2.7 - Milestones
- Variances and Trends: 2.4.2 - Variances and Trends, 2.4.3 - Schedule Analysis

Terms to Know
Duration
Time
Calendars
Critical path
Activity necking

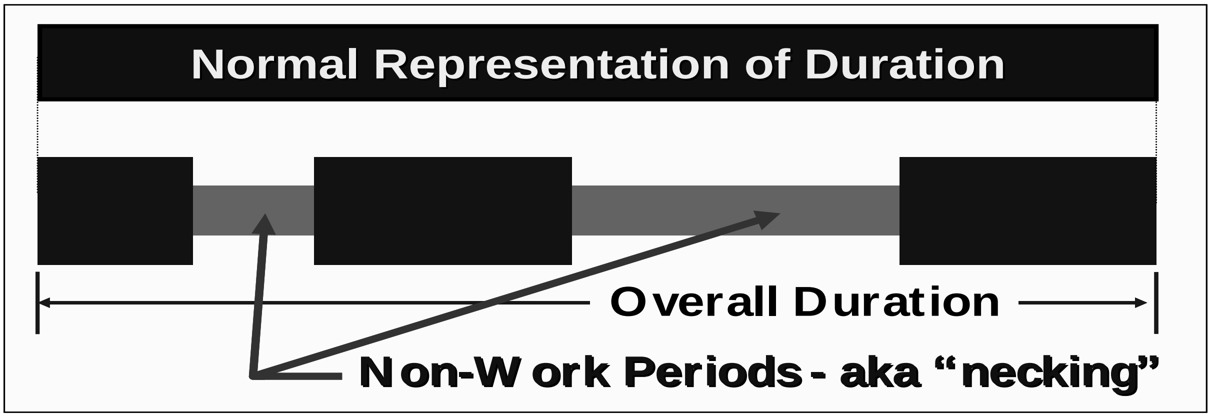

Figure 15—Understanding Activity Durations

As graphically demonstrated (Figure 15), an activity duration may not be continuous or contiguous from start to end. Understanding the implications of modeling activity durations within schedules is important. Further, as a schedule evolves, it may be prudent to change the activity duration model to account to change to that activity or related activities by consolidating or splitting activities.

Key Points for Review
Determining the duration of an activity is essential to schedule development. It is necessary to understand each element of the scope of the activity and its related time. Estimates of detailed work element time intervals--along with understanding the usage, availability, and constraints of resources--are analyzed to calculate an activity's planned duration.

A tried and true means of mathematically determining the duration:
Duration (time) = Work Quantity (units) ÷ Applied Resources (units/time)

Duration increases with the amount of work of the activity, and it decreases with additional resources applied to the work. However, this is only the initial calculation. As the plan and schedule development evolves, activity durations are adjusted for better-refined scope, resource utilization, location considerations, and demonstrated crew productivity.

Summary
Interconnectivity of the activity duration and constraints calendar forms the basis for determining the timeframe required to complete an activity. The logical linking of multiple activities becomes the foundation for the project schedule. The cost estimate model is one of the key elements in determining an activity's duration.

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Sample Questions for Section 2.2.3

1. Pick the least accurate statement concerning schedule activity durations:
   A. They are often determined by examining the quantity of work and the resources that will be applied to perform that work.
   B. Work is always performed continuously from start to finish.
   C. There is a "rubber band" for overall duration, depending upon the quantity of work actually performed and the number of hours of work expended.
   D. Planned and assumed productivity factors, location factors, and other considerations are applied against the optimum duration, to determine a planned duration.

2. Durations are not derived from the following:
   A. Cost estimate
   B. Resource loading
   C. Activity ID
   D. Cost

3. Durations may include the following:
   A. Multiple elements of the scope of work.
   B. Relationships
   C. Risk plan
   D. Scheduling specification

4. In combining multiple logically tied activities with the duration provides the basis for the following:
   A. Cost estimate model
   B. Defines the schedule scope
   C. A fragnet schedule duration
   D. The baseline schedule

5. Why is it important to understand the interconnectivity between an activity's duration, constraints, and calendar?

6. What is a key element in determining the duration of an activity?

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Solutions to Sample Questions for Section 2.2.3

1. B. Work is always performed continuously from start to finish.

2. C. Activity ID

3. A. Multiple elements of the scope of work.

4. D. The baseline schedule.

5. The relationship between an activity's duration, calendar assignment, and constraints form the basis for determining the overall timeframe required to complete an activity. One must understand the how constraints and the activity's calendar directly affect the activity's duration, based on the calendar and constraints imposed on either the start or finish of the activity.

6. A key element in determining the duration of an activity is understanding the scope of the activity.

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2.2.4 Relationships

Introduction and Learning Objectives

The scheduling process requires that activities be logically linked to form a network schedule model. The network model is a representation of the project teams' plan to accomplish the work in a mutually exclusive and interconnected manner so that the program/project is brought to a successful completion.

Every activity must have a predecessor and a successor activity with the exception of the first and last activities. The first activity will only have one or more successor activities. The last activity will have one or more predecessor activities. Relationships provide a logical link or connection between two or more activities in a schedule. When a chain of activities of the longest duration are linked together, they define the critical path in a project schedule.

The project team should understand how various types of relationships affect the schedule model and the data that it reports. Nesting and grouping of activities is a functional part of scheduling and models how work is actually performed.

Candidates for AACE International's Planning and Scheduling Professional (PSP) certification must have a complete knowledge of the full range of mechanics used to construct logic diagrams. Candidates must be able to demonstrate this capability by completing forward and backward passes during the exam process when only part of the information required to solve the network diagram is provided.

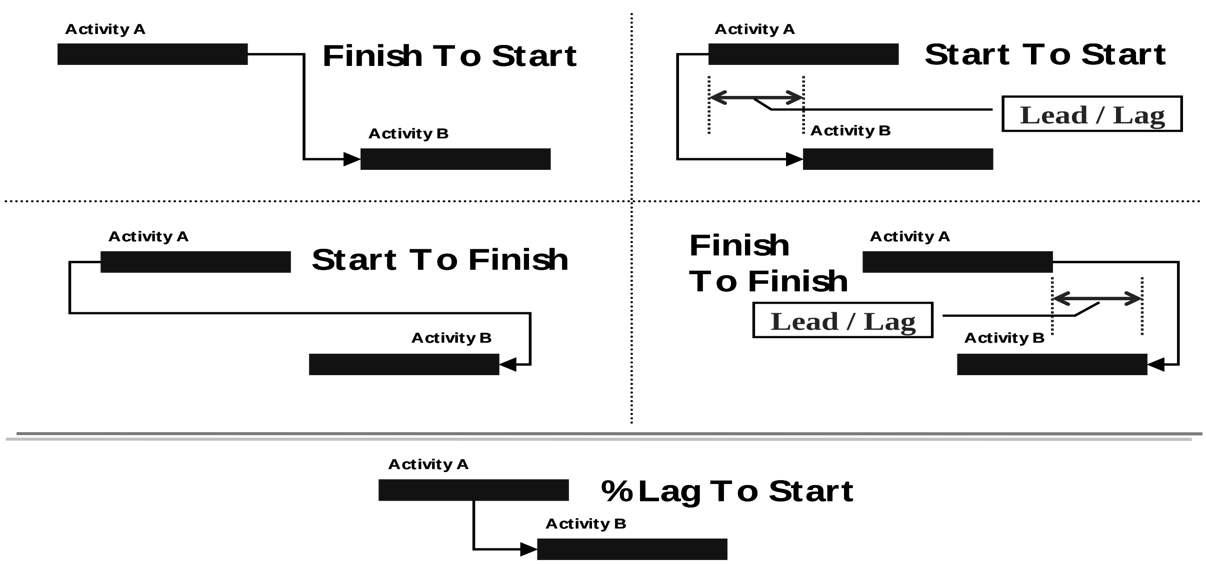

Figure 16—Logical Relationships

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Related Sections

- Activities: 1.3.4 - Phase Definition, 2.2.2 - Activities
- Breakdown Structures: 1.3.5 - Establish Work Breakdown Structure, 1.3.6 - Establish Organization Breakdown Structure, 1.3.7 – Establish Cost Breakdown Structure and 2.1.2 - Breakdown Structure Relationships
- Sequencing: 1.3.8 - Sequencing and Phase Relationships
- Baseline: 1.3.11 - Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Forecasts: 1.3.12 - Periodic Forecasts, 2.4.4 - Schedule Forecasts
- Change: 1.3.13 - Risk and Recovery Plan, 2.3.4 - Schedule Change Management, 2.3.5 - Acceleration, 2.4.7 - Recovery Schedules
- Schedule: 2.1.3 – Schedule Specification, 2.2.1 – Schedule Types, 2.4.1 - Control Level Schedules, 2.2.8 – Schedule Quality Analysis and Compliance Review
- Durations: 2.2.3 - Durations
- Constraints and Calendars: 2.2.5 - Constraints and Calendars
- Milestones – Section 2.2.7 Milestones
- Trends/Analysis: 2.4.2 – Variances and Trends, 2.4.3 - Schedule Analysis

Terms to Know

Logic ties and relationship types:

- Finish-to-start (FS).
- Start-to -start (SS).
- Finish-to-finish (FF).
- Start-to-finish (SF).

Relationship functional ties.

- Leads and Lags (+ / -)

Schedule network.

Constraints:

- Date.
- Resource.
- Contractual.
- Preferential.
- External.

Calendars.

Critical path.

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Key Points for Review

1. Understand how to transform an execution plan into a network schedule model. The schedule model must account for stakeholders and contractual needs and requirements.

2. Understand how the use of various logic relationships, calendars, milestones, and hammocks, are used to create a schedule model. The schedule model, in addition to meeting the stakeholder needs, must be able to accommodate change and change management.

3. Understand how the different logic relationships or sequencing between activities and their lags have an effect on the schedule, critical path and the work to be performed.

Summary

Relationships between a series of activities form the schedule. (Technically, the schedule is created when prospective dates are assigned to early or late start and finish events of the network.) The simple logic network is the fundamental tool for building a schedule that reflects the plan for completing the project.

As schedule activities are linked by relationships the critical path is formed. Revising the logic and relationships between the various schedule activities may have an affect on the schedule and the critical path.

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Please see **Sample Questions for Section 2.2.4** on page 155

Please see **Solutions to Sample Questions for Section 2.2.4** on page 156

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Sample Questions for Section 2.2.4

1. In addition to relationships and lags, which of the following should not be considered when building a schedule?

A. Constraints

B. Calendars

C. Stakeholders

D. Durations

2. Name and describe the different types of schedule relationships that are used in scheduling software tools based on the Precedence Diagram Method (PDM).

3. Describe the function of relationship lags.

4. What is a schedule relationship?

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Solutions to Sample Questions for Section 2.2.4

1. C. Stakeholders

2. Finish-to-Start; Activity A finishes before Activity B starts.
   Finish-to-Finish; Activity A finishes when Activity B finishes. The activities finish simultaneously after running concurrently, but they may start at different times.
   Start-to-Start; Activity A starts when Activity B starts. The activities begin simultaneously and run concurrently, both they may finish at different times.
   Start-to-Finish; Activity A starts before Activity B finishes.

3. Relationship lags delay start-finish relationships. One should be careful in determining the lag duration, since preparation time and the actual delay between activities should be considered.

4. A schedule relationship is a logic link between activities that becomes the fundamental tool in building a schedule network.

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2.2.5 Constraints and Calendars

<u>Introduction and Learning Objectives</u>
Understand constraints--types, uses, implications for schedule analysis--and calendars as interactive components of the schedule model.

Constraints may take on many forms. Constraints are any factors that affect the start, finish (including intermittent progress) or duration of an activity. Factors may include but are not limited to calendars, date restraints, and external such as resources, weather or physical in nature.

Constraints may have an impact on the calculation of the critical path and the scheduler should understand how various scheduling software packages calculate dates, float and the critical based on the constraints identified and input into the schedule.

Calendars are sequences of actual time developed for functional purposes. Calendars may vary depending on the purpose for which the calendar is assigned. There may be multiple calendars contained within a project schedule model. Examples include:

- Global (7-day).
- Workday.
- Resource.
- Weather, environmental, and seasonal.
- Contractor or owner-constrained.

Calendars may have an impact on the calculation of the critical path and the scheduler should be aware and understand how various scheduling software packages calculate dates, float and the critical path based on the identified calendars and their input into the schedule.

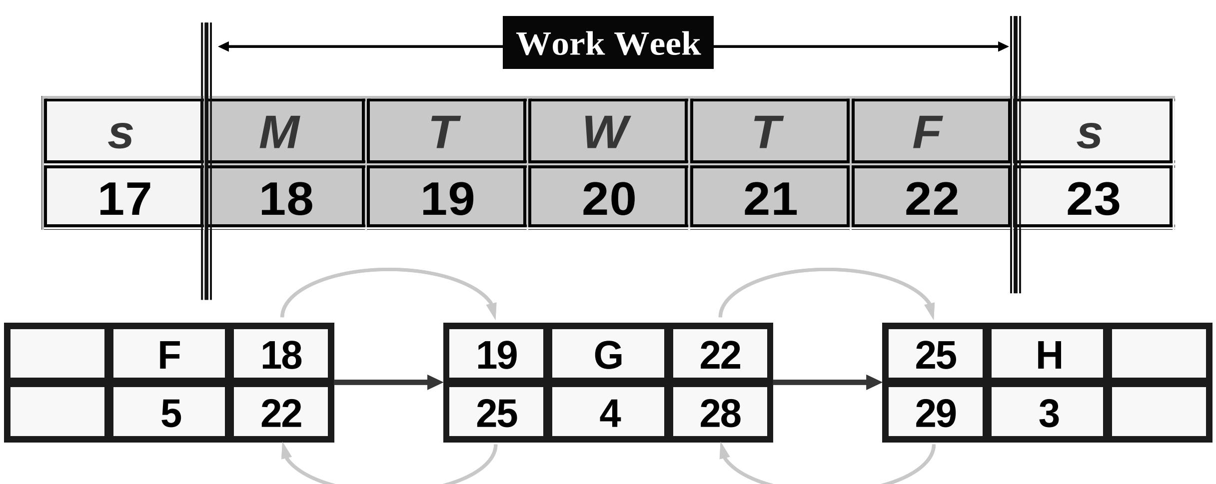

Figure 17—Work Day Calendar Conventions

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Related Sections

- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope, 2.1.3 - Schedule Specification
- Variables: 1.2.4 – Project Variables
- Relationships: 1.3.8 - Sequencing / Phase Relationships, 2.2.4 – Relationships
- Changes: 1.3.13 – Risk and Recovery Plan, 2.3.4 – Schedule Change Management, 2.3.5 – Acceleration, 2.4.7 – Recovery Schedule
- Schedule: 2.2.1 – Schedule Types, 2.2.9 – Schedule Basis Documentation, 2.3.1. Baseline Schedule, 2.4.1 – Control Level Schedules, 2.4.7 – Recovery Schedule
- Activities: 2.2.2 – Activities
- Durations: 2.2.3 Durations
- Milestones: 2.2.7 – Milestones
- Acceleration / Change Management: 2.3.4 – Schedule Change Management, 2.3.5 – Acceleration, 2.4.7 – Recovery Schedule
- Analysis: 2.4.2 – Variances and Trends, 2.4.3 – Schedule Analysis, 2.4.4 – Schedule Forecasts

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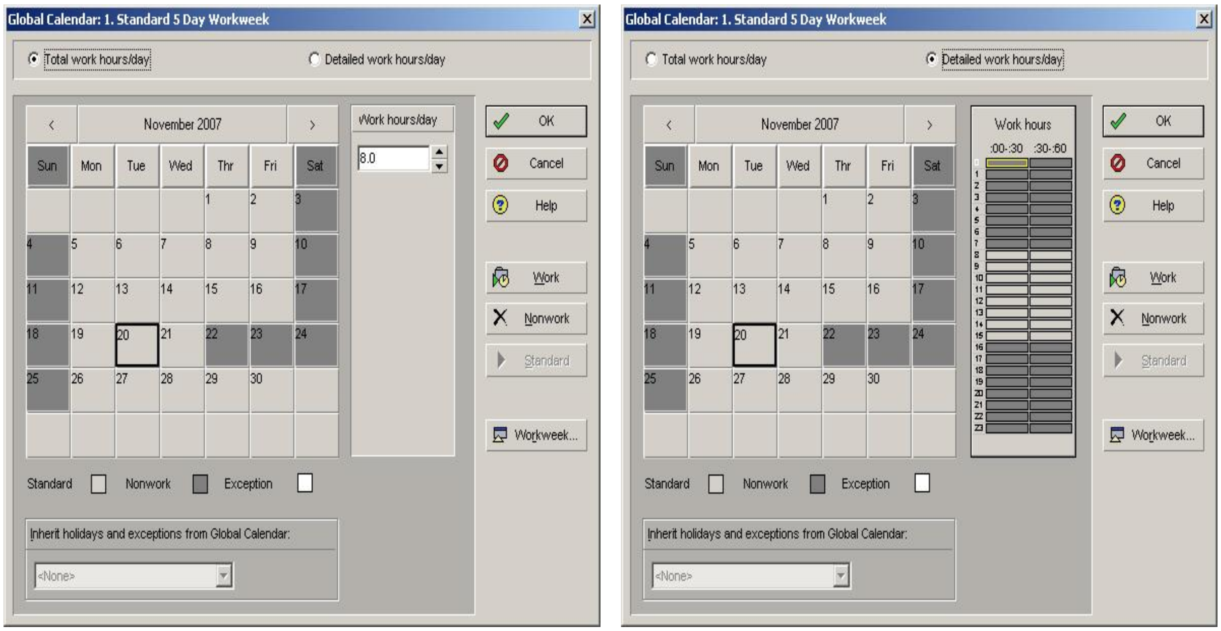

Figure 18—Calendar Examples in Primavera Software

<u>Terms to Know</u>

Constraints:

- Calendars
- Weather
- Resources:
    - Labor
    - Material
    - Equipment
- Date:
    - Start
    - Finish

Calendar:

- Types
- Purposes and uses

Critical path

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Key Points for Review

1. Constraints include limitations and prescriptions for when events must or must not yet occur that affect the logic of a schedule model. Constraints may include resource limits or usage profiles. Constraints must be carefully considered and used only when appropriate. The scheduler should remember that application of any constraint will either (a) extend the duration of the project or (b) have no effect on the project duration. Correspondingly, removal of any constraint will (a) shorten the duration of the project or (b) have no effect on the project duration. Importantly, unnecessary or inappropriate constraints included in the network, or failure to include essential constraints, may create or define an artificial critical path and eliminate the true critical path.

2. Project calendars are formulated to reflect specific events, long-running conditions, or circumstances associated with a project. A project calendar is assigned individually or globally to each activity, so that the duration of the activity may be allocated based on the characteristics of the calendar.

3. Activity, calendar and resource constraints will create discontinuous float paths. The path with the least Total Float value is called the critical or longest path. When analyzing near-critical paths it is important to review how the constraints interact with schedule calculations to give false impressions of criticality.

Summary

Combining activity durations, constraints and calendars, forms the underlying basis of a project schedule model. The resultant linking of the activities provides the identification of the multiple work paths through the schedule, as well as the critical and near-critical paths.

Understand the affects that constraints and calendars have on the baseline schedule, identification of the critical path and schedule analysis and forecasting.

Sample Questions for Section 2.2.5

1. Constraints are factors that affect an activity's start, finish and/or duration. Which of the following is not an example of a constraint?
   A. Calendar
   B. Date restraint
   C. Stakeholder
   D. Weather

2. Which is not a characteristic of typical project calendars?
   A. Multiple
   B. Weather, environmental, seasonal
   C. Workday
   D. Based on the type of schedule used.

3. Project calendars are formulated:
   A. For estimates
   B. To reflect specific, long-running conditions or circumstances.
   C. For relationships
   D. For resource loading

4. Calendars along with durations provide the basis for an activity's estimated:
   A. Resources
   B. Cost
   C. Timeframe
   D. Relationships

5. Why are multiple calendars used on a project?

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Solutions to Sample Questions for Section 2.2.5

1. C. Stakeholder

2. D. Based on the type of schedule used.

3. B. To reflect specific, long-running conditions or circumstances.

4. C. Timeframe

5. Multiple calendars are used to depict various workday scenarios or conditions that can occur on a project. For example a project may have the following calendars: 5-day work week, 7-day work week, and exterior calendar to reflect weather days, seasonal, and weekend only work.

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2.2.6 Cost / Resource Loading

Introduction and Learning Objectives

Understand the principles, procedures, and processes for introducing cost and resource loading into schedule models. Cost and resource loading incorporates the activity cost estimate and the project execution plan into the schedule model.

The WBS and OBS are fundamental elements used to assist in resource and cost loading.

Cost and resource loading become the basis for resource leveling and scheduling the initial cash flow.

Understand the implications of resource leveling on the schedule, especially how the various scheduling software programs load and level resources.

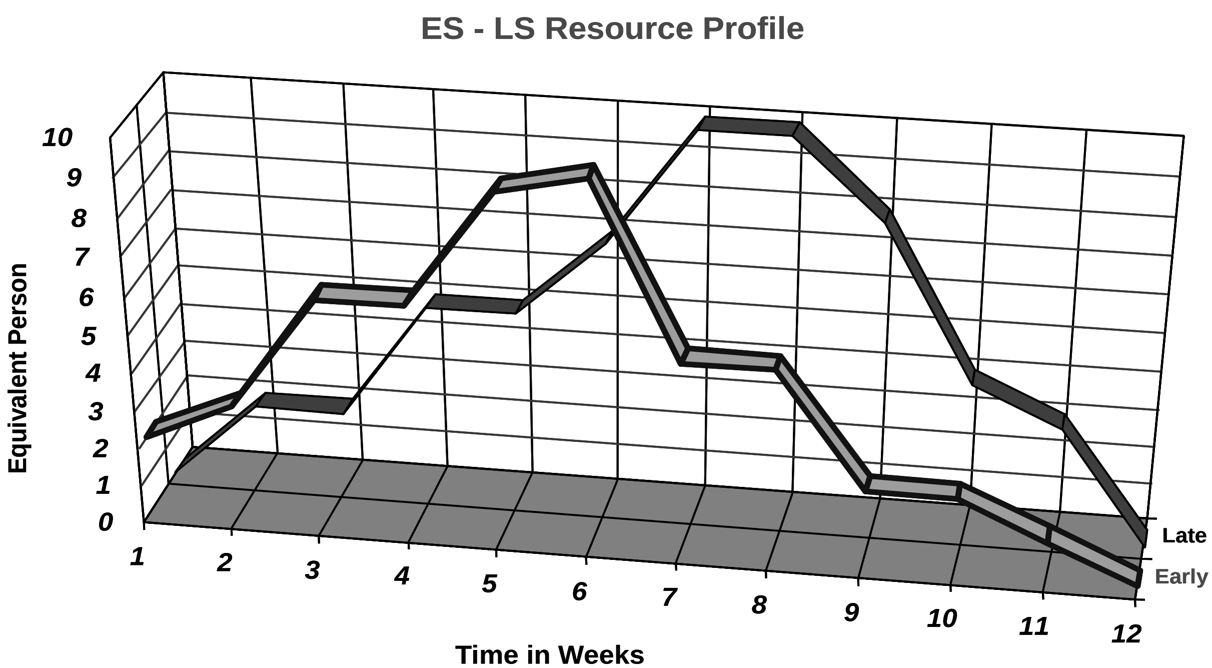

Figure 19—Example of Resource Profile

Related Sections

- Resources: 1.2.1 - Identification of Resources, 2.3.3 – Cost and Resource Management
- Variables – Section 1.2.4 – Project Variables
- Breakdown Structures: 1.3.5 - Establish Work Breakdown Structure, 1.3.6 - Establish Organization Breakdown Structure, 1.3.7 – Cost Breakdown Structure, 2.1.2 - Breakdown Structure Relationships
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Forecasts: 1.3.12 – Periodic Forecasts, 2.4.4 – Schedule Forecasts
- Reports: 2.1.3 – Schedule Specification, 2.4.6 - Progress Reports and Review, 2.4.9 – Management Summary

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- Schedules: 2.2.1 – Schedule Types, 2.2.6 – Schedule Basis Documentation, 2.3.1 – Baseline Schedule, 2.3.2 – Tracking Schedule Forecasts, 2.4.1 – Control Level Schedules
- Activity: 2.2.2 - Activities
- Variances and Trends: 2.4.2 Variances and Trends, 2.4.3 – Schedule Analysis

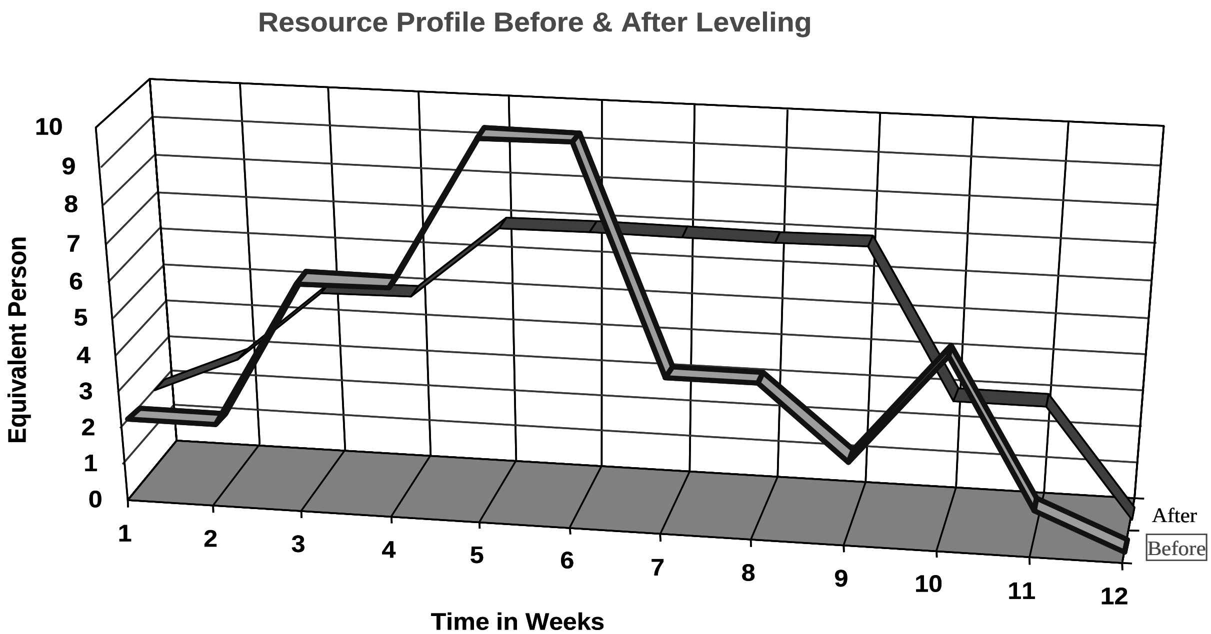

Figure 20—Example of Resource Leveling

Terms to Know

Resource loading:

- Resource allocation
- Resource availability
- Resource management
- Front-end
- Back-end

Resource curves and lags
Resource leveling
Cash flow
Code or chart of accounts
Historical data

Key Points for Review

1. Cost and resource loading processes are key elements of complex schedules. Know how resource assignments are developed and loaded into the schedule. Understand how schedule status reporting reflects the cost and resource elements of activities.

2. Understand the basic concept of manually resource leveling a schedule model, considering all the resource constraints. Those constraints may be imposed by stakeholders or the contract and be internal or external to the project.

3. Understand how to update a schedule to reflect the utilization of cost and resource elements of an activity, related activities, and the general and overall progress of the project.

4. Understand how to apply resources and the impact that cost and resource leveling may have on the project schedule.

Summary

Cost and resource allocations are major elements of a schedule. Effective allocation of costs and resources imposes a fundamental, underlying requirement for successful project completion.

One must understand how the various scheduling software programs load, allocate, and level cost and resources, as well as the potential impact the software leveling and calculation routines may have on the project schedule.

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Please see **Sample Questions for Section 2.2.6** on page 167

Please see **Solutions to Sample Questions for Section 2.2.6** on page 168

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Sample Questions for Section 2.2.6

1. What may be a limit for a number of resources assigned to an activity?
   A. Resources assigned to other activities on the project.
   B. Availability of resources as a result of external constraints.
   C. Stakeholder driven.
   D. All of the above.

2. Which of the following would limited resources not affect on a project?
   A. Extend the project schedule.
   B. No impact.
   C. Modify the critical path.
   D. Increase the cost of the project.

3. What are the two key fundamental elements of cost and resource loading?

4. Cost and resource loading incorporate what two major elements into the schedule model?

5. What are two outputs of cost and resource loading?

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Solutions to Sample Questions for Section 2.2.6

1. D. All of the above.

2. B. No impact.

3. The WBS and OBS.

4. Cost estimate and project execution plan.

5. Resource leveling and initial cash flow.

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2.2.7 Milestones

<u>Introduction and Learning Objectives</u>

Understand milestones and their effect on the project schedule, when information is converted from the planning phase to the scheduling phase. Milestones are key events that the project team must determine and incorporate into the schedule as it is developed.

Milestones for a project may be an imposed or contractual requirement (often with related bonus and penalty provisions) or an internal metric for progress of the project in part or whole. However in all cases, schedule milestones should be agreed upon by all stakeholders prior to approval of the project baseline schedule.

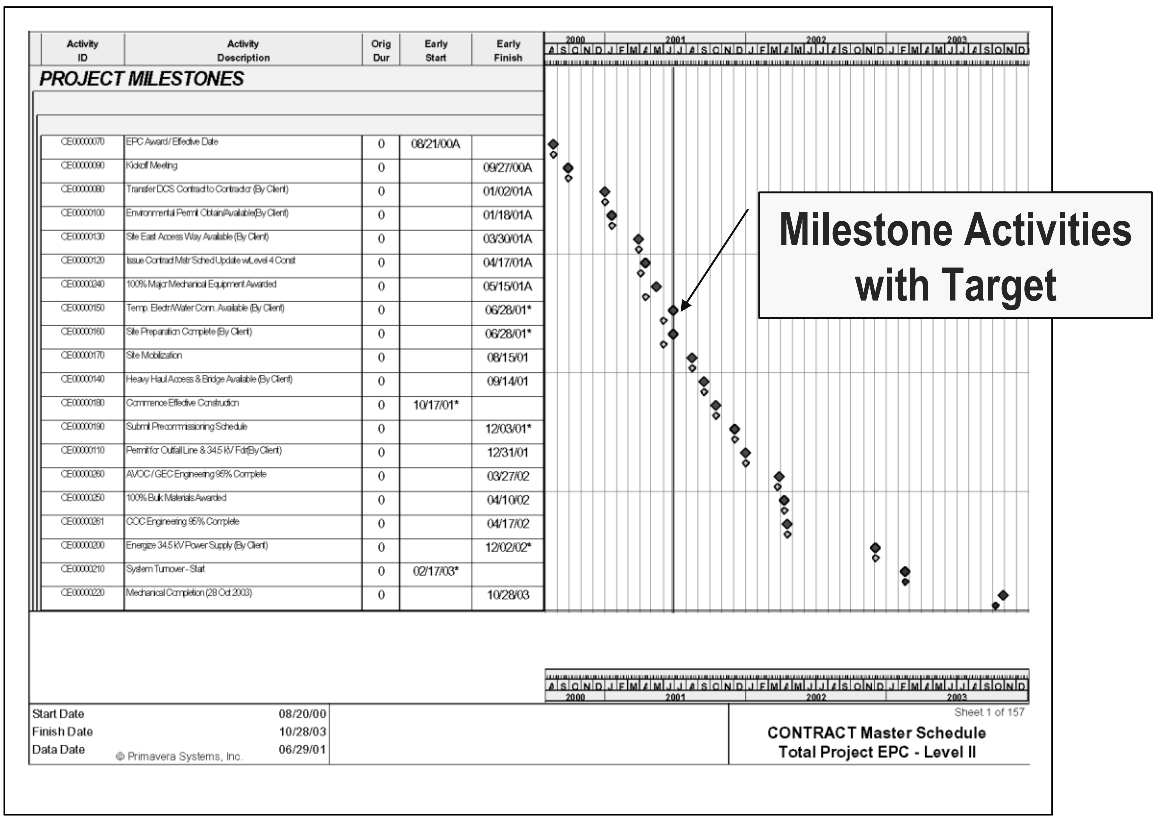

Figure 21—Milestone Schedule Example

Related Sections

- Contracts: 1.1.1 - Contract Requirements
- Goals and Plan: 1.3.2 – Define Project Goals, 1.3.3 – Define Project Plan
- Relationships: 1.3.4 - Phase Definition, 1.3.8 - Sequencing and Phase Relationships, 2.2.4 - Relationships
- Baseline: 1.3.11 – Baseline Plan, 2.2.9 – Schedule Basis Documentation, 2.3.1 - Baseline Schedule,
- Reports: 2.1.3 – Schedule Specification, 2.3.2 - Tracking Schedule Progress, 2.4.1 - Control Level Schedules, 2.4.6 - Progress Reports and Review, 2.4.8 - Management Summary
- Schedule: 2.2.1 – Schedule Types, 2.2.8 – Schedule Quality Analysis and Compliance Review, 2.4.1 – Control Level Schedules, 2.4.7 – Recovery Schedule
- Activities: 2.2.2 –Activities
- Constraints and Calendars: 2.2.5 – Constraints and Calendars

Terms to Know

Milestones:

- Start.
- Finish.

Float:

- Total.
- Free.

Constraints:

- Start.
- Finish.
- Expected finish.

Key Points for Review

Milestones are intermediate or final events, control points that indicate certain goals or objectives have been achieved. The project team determines them and the planner-scheduler incorporates them. In some cases, milestones may be tied to contractual requirements.

Summary

Understand the impact milestones have on a project schedule, including the development of the schedule.

Milestones may be contractual or may be functional, administrative elements of the schedule, but in all cases they should be mutually agreed by the contractual parties and, perhaps, other stakeholders.

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Sample Questions for Section 2.2.7

1. When should milestones be developed?
   A. Prior to identifying the project scope.
   B. When defining the schedule scope.
   C. Prior to baselining the schedule.
   D. When performing schedule updates.

2. Name six examples of milestones.

3. What is a milestone?

4. True or False: Milestones can be tied to payments?

5. True or False: Milestones should be agreed by principal stakeholders?

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Solutions to Sample Questions 2.2.7

1. C. Prior to baselining the schedule.

2. Start milestone.
   Finish milestone.
   Start no sooner than (constraint).
   Start no later than (constraint).
   Finish no sooner than (constraint).
   Finish no later than (constraint).

3. A milestone is a key event (without duration) that serves to indicate that an interim project requirement has been achieved. A milestone may be a contractual or functional requirement in the schedule.

4. True.

5. True.

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2.2.8 Schedule Quality Analysis and Compliance Review

Introduction and Learning Objectives

Understand how attributes associated with schedule quality analysis and compliance review ensure the viability of the scheduling process and the developed schedule model.

Schedule quality analysis is an integral part of developing and reviewing a baseline schedule. It proves the scope of work representation within the schedule model. Schedule quality analysis is also an on-going process during the life of the schedule.

Schedule quality analysis must be customer- and product-focused and functionally based. The process is accomplished by the interaction of all the stakeholders to resolve issues and choices that may be in conflict.

Schedule quality analysis is multi-leveled, interactive, and repetitive. The key interactive relationships are among time, cost and quality.

Questions for schedule quality analysis include these:

1. Is the critical path reasonable?
2. Are there multiple critical paths; or could there be, if a few non-critical tasks are delayed?
3. What activities are near-critical?
4. Does the work flow as planned?
5. Are there space or safety conflicts between concurrent activities?
6. Is there an excessive amount of work being done at any one time?
7. Are there resources enough to support all concurrent activities?
8. Can subs and suppliers meet the schedule?
9. Are any activities scheduled out of season?

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Related Sections

- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 – Stakeholder Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders, 2.3.6 - Schedule Maintenance Feedback
- Scope of Work: 1.3.1 – Define Scope of Work, 1.3.2 – Define Project Goals, 1.3.3 – Define Project Plan, 1.3.4 – Phase Definition, 2.1.1- Define Schedule Scope
- Breakdown Structures: 1.3.5 - Establish Work Breakdown Structure, 1.3.6 - Establish Organization Breakdown Structure, 1.3.7 – Establish Cost Breakdown Structure and 2.1.2 - Breakdown Structure Relationships
- Relationships: 1.3.8 - Sequencing and Phase Relationships, 2.2.4 – Relationships
- Schedules: 1.3.11 – Baseline Plan, 2.1.3 - Schedule Specification, 2.2.1, Schedule Types, 2.2.9 – Schedule Basis Documentation, 2.3.1 – Baseline Schedule, 2.4.1 – Control Level Schedules
- Activities: 2.2.2 – Activities
- Constraints: 2.2.5 – Constraints and Calendars, 2.2.7 - Milestones
- Critical Path: 2.4.2 – Variances and Trends, 2.4.3 - Schedule Analysis

Terms to Know

Schedule quality analysis.
Schedule compliance review.
Schedule basis.
Baseline schedule.

Key Points for Review

Know how schedule quality analysis and compliance review are used to provide continuous improvement to the schedule.

Summary

The schedule quality analysis and compliance review process is dynamic and interactive throughout the project. Effective use of the techniques is most important in the development phase of the schedule and remains relevant to all reviews and changes to the work.

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Sample Questions for Section 2.2.8

1. Schedule quality analysis is performed?
   A. At the beginning of the project.
   B. At changes of phases.
   C. Throughout the duration of the project.
   D. At the beginning and end of a project.

2. The three interactive relationships in a schedule quality analysis are?
   A. Safety, quality, time.
   B. Cost, safety, time.
   C. Time, quality, cost.
   D. Safety, cost, time.

3. The end result of a schedule quality analysis is?
   A. Continual improvement in the schedule.
   B. Schedule acceleration.
   C. Tracking schedule progress.
   D. Identification of constraints.

4. Schedule quality analysis should be performed by?
   A. The scheduler only.
   B. The scheduler and project manager.
   C. All stakeholders.
   D. Only the client.

5. What does a schedule quality analysis and compliance review accomplish?

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Solutions to Sample Questions for Section 2.2.8

1. C. Throughout the duration of the project.

2. C. Time, quality, cost.

3. A. Continual improvement in the schedule.

4. C. All stakeholders.

5. It provides a means to resolve issues between stakeholders and proves the representation of the scope of work.

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2.2.9 Schedule Basis Documentation

Introduction and Learning Objectives

Understand the documentation required for the project baseline schedule. The baseline schedule documentation is recorded from the assumptions, constraints, and parameters--as well as from the contract and supplementary documentation--that goes into the development of the baseline schedule.

The baseline schedule documentation includes a short narrative that describes baseline schedule development, the critical path, and key characteristics of the schedule model. Each stakeholder's input and assumptions are clearly identified.

The baseline schedule provides the documentation and foundation for schedule change or delay and impact identification and management. As such, it is important to create necessary documentation so that at a later date the schedule basis can be clearly understood by all. Any changes in the schedule that result in significant variance from the baseline schedule can be traced to this document and the proper schedule adjustment developed and incorporated.

When it is necessary to develop a revised baseline schedule, the revised schedule must include the supporting documentation to support the changes made to the schedule. The schedule basis is contemporaneously updated throughout the life of the project.

Related Sections

- Contract: 1.1.1 - Contract Requirements
- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 – Stakeholder Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders, 2.2.8 – Schedule Quality Analysis and Compliance Review, 2.3.6 – Schedule Maintenance Feedback
- Variables: 1.2.4 - Project Variables
- Scope of Work: 1.3.2 Define Scope of Work, 1.3.3 – Define Project Plan, 2.1.1 Define Schedule Scope, 2.1.3 - Schedule Specification
- Activity: 1.3.4 - Phase Definition, 2.2.2 – Activities
- Breakdown Structures: 1.3.5 - Establish Work Breakdown Structure, 1.3.6 - Establish Organization Breakdown Structure, 1.3.7 – Establish Cost Breakdown Structure, 2.1.2 - Breakdown Structure Relationships
- Relationships: 1.3.8 - Sequencing and Phase Relationships, 2.2.2 – Relationships
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Baseline: 1.3.11 - Baseline Plan, 2.3.1 - Baseline Schedule
- Milestones: 2.2.7 - Milestones
- Schedule Progress: 2.3.2 - Tracking Schedule Progress, 2.4.1 - Control Level Schedule, 2.4.2 - Variance and Trends, 2.4.3 – Schedule Analysis, 2.4.4 - Schedule Forecasts
- Change Management: 2.3.4 - Schedule Change Management, 2.3.5 - Acceleration, 2.4.7 - Recovery Schedule

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Terms to Know
Baseline schedule.
Constraints.
Critical path.
Variance.
Trend.
Schedule delay, impact, and disruption.
Forecasts.

Key Points for Review

1. Understand how the project scope definition, contract specifications, and the project cost estimate are critical aspects in the development of the baseline schedule.

2. It is important that schedule assumptions, constraints, and parameters are documented to provide a basis for schedule progress updating and change management.

3. The baseline schedule documentation is a written narrative with detailed supporting materials to provide underlying information about the assumptions, constraints, and parameters that went into the development of the baseline schedule.

Summary

The baseline schedule is a significant document that is the foundation for identifying and analyzing schedule change. Documentation of the underlying principles that support the assumptions, constraints, and parameters used to build the schedule are put into a narrative, with supporting materials to form the complete baseline package.

If changes occur to the schedule and significantly impact the critical path or completion date, the schedule and supporting documentation may be referenced and the necessary action taken to support status updating, changes, and rebaselining, as appropriate.

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Sample Questions for Section 2.2.9

1. Which is not an example of critical aspect of schedule documentation?
   A. Project scope definition.
   B. Contract specifications.
   C. Type of schedule used.
   D. Project cost estimate.

2. The schedule basis documentation narrative includes the following:
   A. Baseline schedule development and schedule change management procedures.
   B. Baseline schedule development and critical/near critical path activities.
   C. Critical and near-critical path activities and cost estimate model.
   D. Schedule change management procedures and cost and resource management guidelines.

3. If the baseline schedule is revised and rebaselined, what should one do to the schedule basis documentation?
   A. Leave it as is.
   B. Revise the document as necessary when the rebaseline has been approved.
   C. Revise the document at the completion of the project.
   D. Revise the document monthly.

4. Why is it important to develop schedule basis documentation?

5. If significant changes impact the critical path or completion date, what is used for analysis?

- ➢ Be prepared to develop a detailed outline for a typical schedule baseline for a mid-sized project.

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Solutions to Sample Questions for Section 2.2.9

1. C. Type of schedule used.

2. B. Baseline schedule development and critical and near-critical path activities.

3. B. Revise the document as necessary when the new baseline has been approved.

4. This documentation provides the assumptions, constraints and parameters that the development of the baseline schedule is derived. It also provides the foundation for schedule change or delay and impact identification.

5. The baseline schedule is the significant document used for identifying and analyzing schedule change.

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Section 2B Schedule Maintenance / Controlling

The objective of this chapter is to provide basic knowledge in an outline structure for studying the means, methods, and tools necessary for project schedule management and control.

This subchapter consists of two sections:

- Maintain Schedule.
- Output and Deliverables.

Each subchapter develops concepts associated with the particular scheduling phase.

- **Schedule results from the plan.**
- **Scheduling is both cyclical and iterative.**
- **Scheduling is dynamic.**

Schedules are maintained to report progress and to forecast trends, progress, and completion. Schedules are used to control successful execution.

A schedule models the plan using resources and execution strategy to meet project objectives. The schedule must accommodate and account for change as it occurs.

Periodic updates are undertaken to measure actual progress achieved. Information obtained in the updating process, along with trend analysis and forecast of future progress, is reported to stakeholders. Included within these progress updates is schedule maintenance to account for nominal changes to the execution plan.

When conditions and assumptions upon which the schedule was based significantly change, the schedule must be re-examined and updated, as necessary, to develop a new baseline for measuring further progress. Depending upon the nature of change necessitating a new baseline, the schedule model may undergo a complete rebaselining or just a significant revision.

As a project is executed, periodic progress reporting, change management, and schedule updating and forecasting--with reporting to stakeholders--becomes the ongoing work of the scheduler. The schedule is usually updated on a periodic, contractually stipulated timeframe and provides a basis for tracking progress, for use as a management tool, for recording and supporting actual performance, and for providing documentation for changes, delays and impacts.

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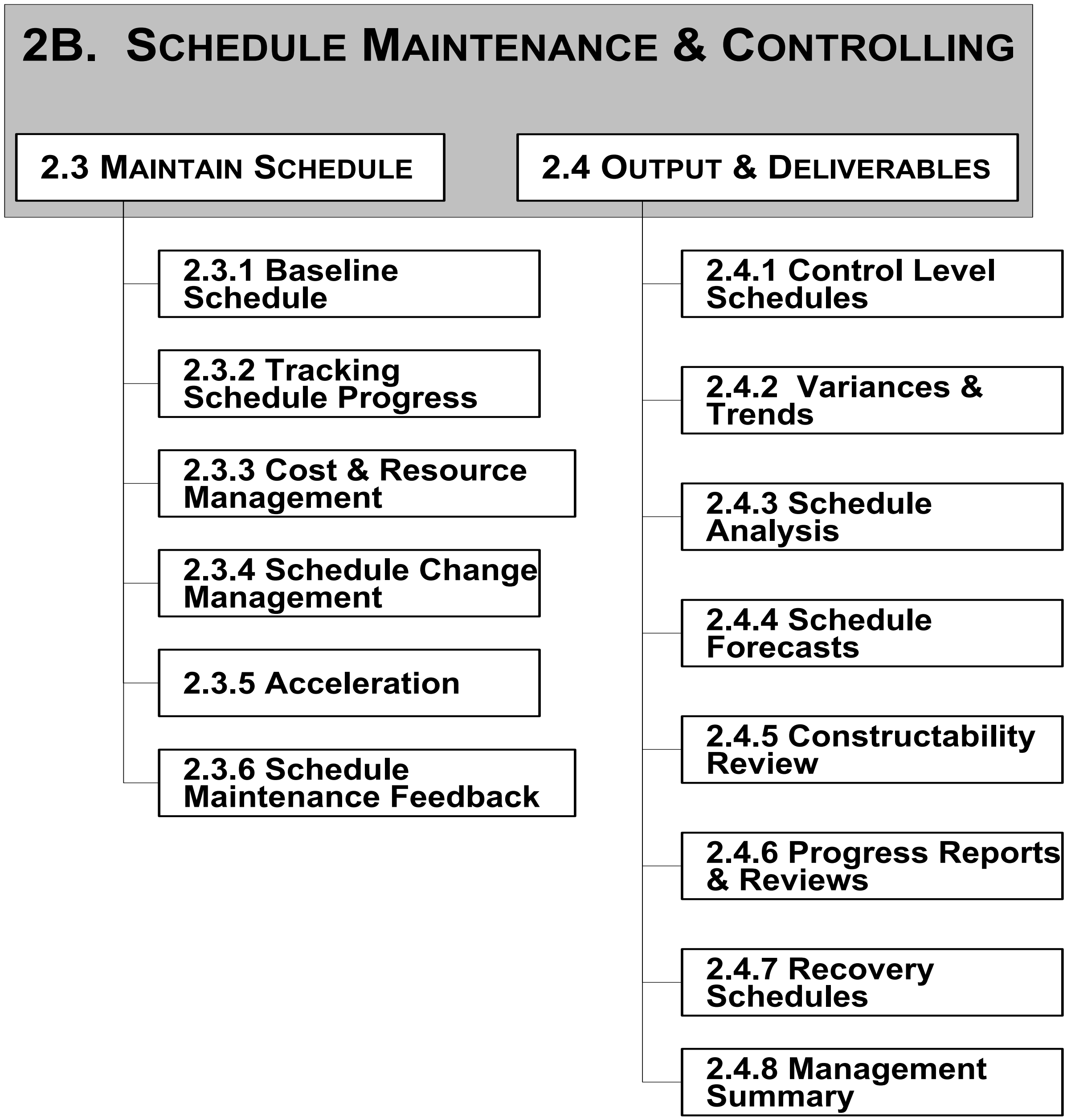

Figure 22—Schedule Maintenance and Controlling

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Subchapter 2.3 Maintain Schedule

As a project is executed, periodic progress reporting, change management, schedule updating and forecasting are required. This process is generally referred to as schedule maintenance.

Maintain Schedule consists of the following elements:

- Baseline Schedule.
- Tracking Schedule Progress.
- Cost and Resource Management.
- Schedule Change Management.
- Acceleration.
- Schedule Maintenance Feedback.

A schedule with key milestones established is used as a performance measurement benchmark or baseline. As the project moves forward the schedule is updated on a periodic timeframe that provides the basis for tracking progress and observing trends. Schedule maintenance includes all the functions associated with documenting progress, accounting for change and reforecast.

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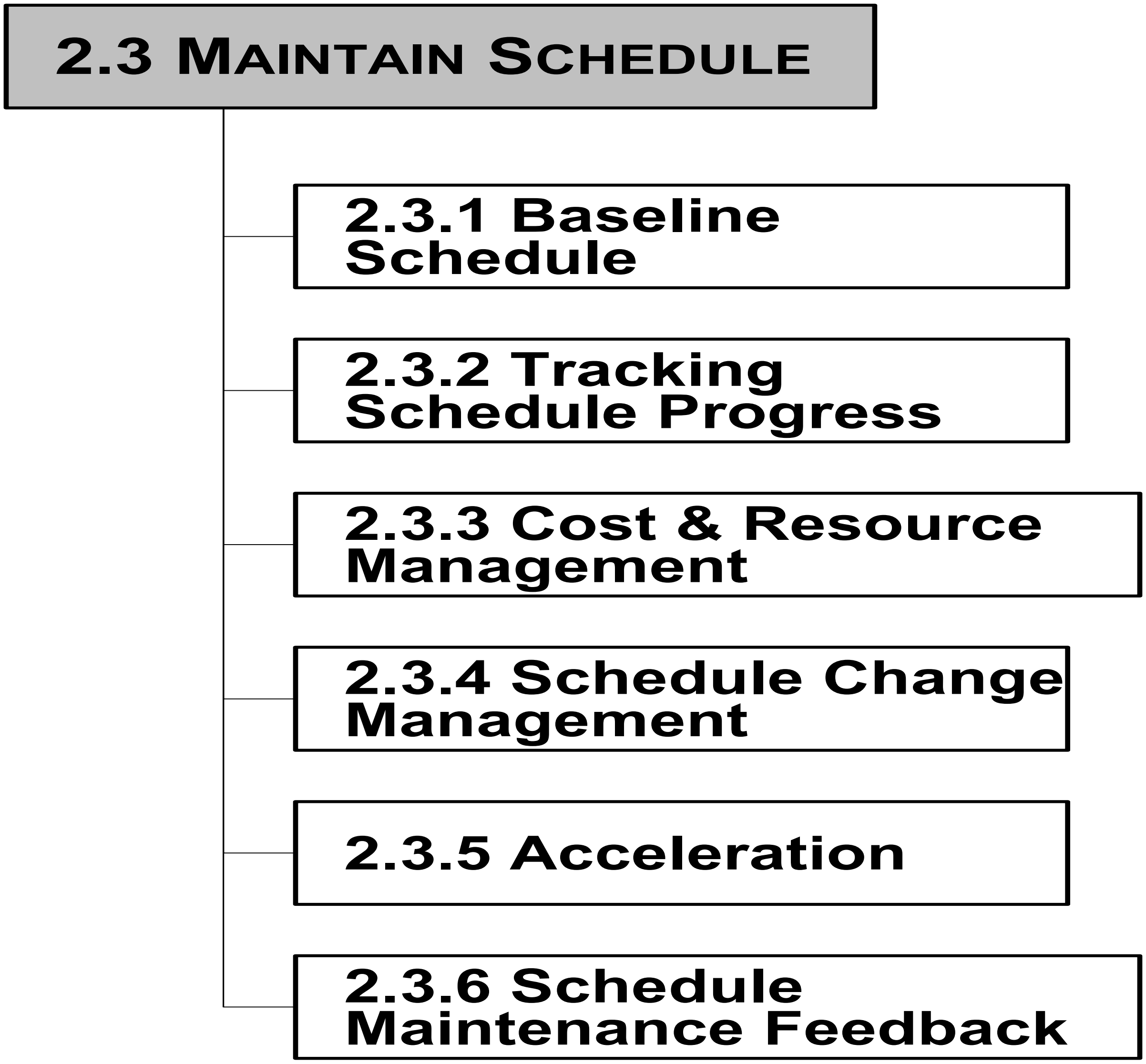

Figure 23—Maintain Schedule

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2.3.1 Baseline Schedule

Introduction and Learning Objectives

Understand what a baseline schedule is and what its functions are. The baseline schedule derives from a schedule model to meet the project execution plan and achieve management approval for use as a baseline.

The baseline schedule is used to measure progress and identify trends and changes. Analysis of the updated schedule against the baseline will show the impact of any milestone or completion date variance.

Contract modifications of budget or schedule of any significance create a need for a new baseline schedule, and progress is then measured against the new and approved baseline. Ideally, conditions that trigger a schedule rebaselining are contractually delineated.

The baseline schedule identifies the initial critical path and provides the basis for measuring progress.

The baseline schedule will be the foundation for cash flow planning, resource managing, trending for cost and schedule forecasting, and reporting.

Related Sections

- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders, 2.3.6 - Schedule Maintenance Feedback
- Scope of Work –Sections: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope, 2.1.3 – Schedule Specification
- Plan and Goals: 1.3.2 – Define Project Goals, 1.3.3 – Define Project Plan
- Phase: 1.3.4 – Phase Definition, 1.3.8 – Sequencing and Phase Relationship
- Estimate: 1.3.10 – Cost Estimate Development, 2.1.5 – Cost Estimate Model
- Baseline: 1.3.11 - Baseline Plan, 2.2.9 - Schedule Basis Documentation
- Delay and Impacts: 1.3.13 – Risk and Recovery Plan, 2.3.4 - Schedule Change Management, 2.3.5 - Acceleration, 2.4.7 - Recovery Schedule
- Specification: 2.1.3 – Schedule Specification
- Activity: 2.2.2 - Activities
- Relationship: 2.2.4 - Relationships
- Milestones: 2.2.7 - Milestones
- Quality: 2.2.8 – Schedule Quality Analysis and Compliance Review
- Progress: 2.3.2 - Tracking Schedule Progress, 2.4.1 – Control Level Schedule, 2.4.2 - Variances and Trends, 2.4.3 - Schedule Analysis, 2.4.4 - Schedule Forecasts , 2.4.5 - Constructability Review, 2.4.6 - Progress Reports and Review, 2.4.8 - Management Summary

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Terms to Know

Baseline schedule
Trend
Progress
Delay
Impacts
Critical path

Key Points for Review

The baseline schedule is the basis for trending and reporting progress. The baseline should not be updated or revised as part of the normal progress update process. Rather, if significant changes, particularly contract modifications, occur during the project then a new baseline should be developed and approve.

Summary

The baseline schedule is the foundation for progress measuring, trending, and reporting. The baseline schedule should be agreed upon by stakeholders prior to commencing significant work and is not progressed. The baseline schedule remains unchanged until a new baseline is approved, typically upon approval of contract modifications of budget or schedule.

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Sample Questions for Section 2.3.1

1. The baseline schedule does all of the following, except?
   A. Measure progress
   B. Identify trends
   C. Identify milestones
   D. Identify changes

2. Important concepts for use of baseline schedules include?
   A. Updating
   B. Realigning
   C. Dumping
   D. Impacts

3. The baseline schedule is a fully developed schedule for construction with all of the following attributes, except?
   A. Activities with durations.
   B. Activities with all appropriate attributes.
   C. Activities that are linked.
   D. Activities that solve logic issues.

4. True or False: The baseline schedule is the foundation for progress reporting?

5. The baseline schedule is the foundation and basis for what?

6. If there are significant variances to the baseline schedule, what should occur?

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Solutions to Sample Questions for Section 2.3.1

1. C. Identify milestones.

2. D. Impacts

3. D. Activities that solve logic issues.

4. True

5. Trending, progress measuring and reporting, and change management.

6. A new baseline schedule should be created and used for progress measurement and change management.

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2.3.2 Tracking Schedule Progress

Introduction and Learning Objectives
Understand how progress is observed, tracked, and used for forecasting in schedule updates.

The means, methods, and techniques used to report progress are essential elements to the updating process. The process of identifying update input, logic changes, reporting periods and actual dates for beginning and completing activities is critical to accurate schedule progressing. Accurate progressing of a schedule forms a basis for competent and accurate forecasting.

When updating a schedule, consideration of contract requirements for resource, cost and payment loading into the schedule model may be necessary. Further, the contract may impose phasing and milestone tracking and reporting requirements which require evaluation during the update process. The scheduler must include such requirements into schedule analysis, forecasting and reporting.

Ensure change management and historical documentation is accurate to support as-built schedule data. As-built data would include logic changes, actual start and completion information, interruptions and finishes of work activities, along with resource utilization data.

The scheduler should be aware of how the different scheduling software functions when progress is updated and the software programs perform their unique schedule calculations.

Related Sections

- Contracts: 1.1.1 - Contract Requirements
- Cost and Resource Loading: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 Cost and Resource Management
- Phases: 1.3.4 - Phase Definition
- Relationships: 1.3.8 – Sequencing and Phase Relationships, 2.2.4 – Relationships
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Baseline: 1.3.11 - Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Forecasts: 1.3.12 - Periodic Forecasts, 2.4.4 - Schedule Forecasts
- Recovery: 1.3.13 – Risk and Recovery Plan, 2.3.4 – Schedule Change Management, 2.3.5 – Acceleration, 2.4.7 – Recovery Plans
- Specifications: 2.1.3 - Schedule Specification
- Milestones: 2.2.7 - Milestones
- Progress: 2.4.1 - Control Level Schedules, 2.4.2 - Variance and Trends, 2.4.3 – Schedule Analysis, 2.4.5 - Constructability Review, 2.4.6 - Progress Reports and Reviews, 2.4.8 - Management Summary

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Terms to Know

Progress measurement:

- Level-of-effort (LOE).
- Physical progress (units complete).
- Incremental milestones.
- Activity start and finish dates.
- Substantial start and substantial finish.
- Supervision judgment.

Data date

Reporting periods

Payment applications

Actual dates

Progress calculations (progress calculations within different scheduling software may vary):

- Progress override.
- Retained logic.
- Percent completion (actual and calculated).
- Remaining duration (actual and calculated).

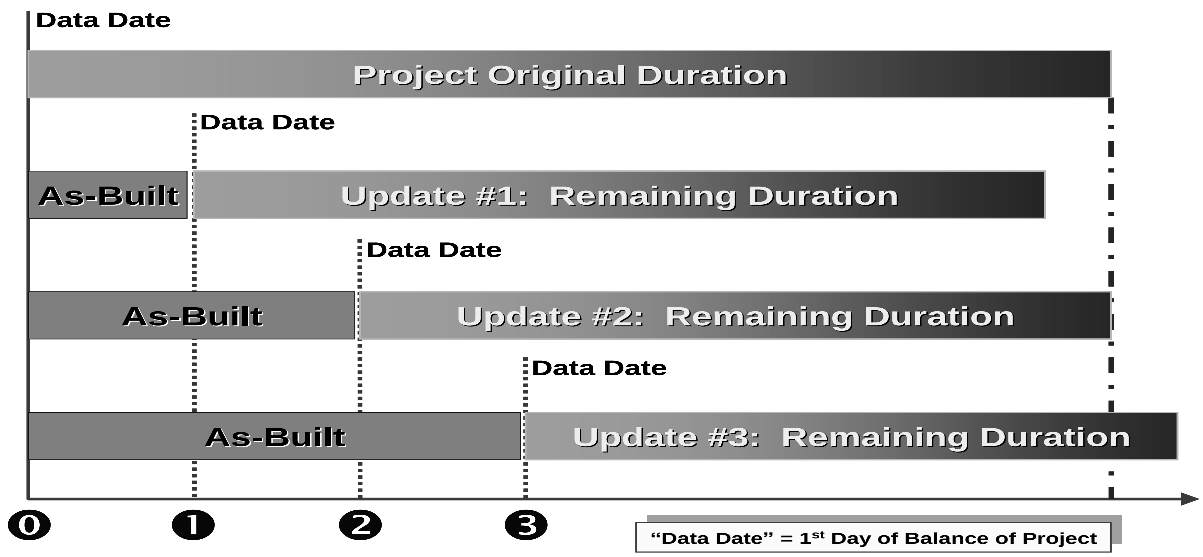

Figure 24—Data Date Concepts

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Key Points for Review

1. Review and understand key contract or specification requirements imposed for tracking progress, schedule updating, forecasting and reporting.

2. Know and understand implications of using progress override or retained logic in schedule update calculations. In addition, understand needs, requirements and impacts when revising logic during a schedule update and document any logic changes in the reporting process. Understand different schedule software perform different calculations when performing similar functions.

3. Progress measurement should be based on an approved organization's policy and procedure, and should be customized for each project. Contract requirements may impose higher or different levels of compliance.

4. Any changes to logic relationships that are implemented in a schedule update process must be reported to all appropriate stakeholders.

5. Know and understand the means and methods to determine progress and percentage complete as well as how these attributes are calculated by scheduling software used. Recognize importance of tracking actual dates for starting or completing an activity is important and must match field conditions.

6. All changes should be documented and communicated to appropriate stakeholders. Policies and procedures established during the planning process in conjunction with contract requirements will direct how and when changes are incorporated into both the schedule and supporting progress reports.

7. Project schedules are often linked to invoice applications and pay requests. Therefore, accuracy in reporting and scheduling of the update is important. Often during the updating process trend analysis and forecasting is done using a variety of tools and techniques outside of the scheduling software alone. Polices and procedures should be established to acquire, certify and receive accurate data. (While not directly a part of the PSP certification process, progress updating is an integral part of Earned Value processes and is the subject of a separate AACE International certification – EVP – Earned Value Professional.)

Summary

Knowing how to track progress is critical to producing an updated schedule that is accurate, meaningful, and useful to all involved. The process requires explicit and detailed knowledge of both the baseline and current scope of work; the tools used to measure progress, analyze trends, and forecast remaining work; and the policies and procedures used to ensure that the end product produces credible and accurate results.

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Please see **Sample Questions for Section 2.3.2** on page 193

Please see **Solutions to Sample Questions for Section 2.3.2** on page 194

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Sample Questions for Section 2.3.2

1. Important considerations when tracking schedule progress include all but which of the following?
   A. Deductive documentation.
   B. Future change management.
   C. Historical documentation.
   D. Summary reporting.

2. All but one of the following requirements is likely to be spelled out in the contract requirements for CPM periodic updates?
   A. Time period for updates.
   B. Number of copies to be submitted.
   C. Supporting data.
   D. List of completed change orders.

3. From the following list of requirements that an owner might specify for a baseline submittal, which one is most likely not a requirement?
   A. Time for submittal after Notice-to-Proceed.
   B. Time for submittal after construction is initiated.
   C. Time as a requirement for completion of the work.
   D. Time length for increments of long duration activities.

4. Name six methods to measure progress.

5. What forms the basis for trending, forecasting and change management?

6. What should one consider when updating the schedule?

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Solutions to Sample Questions for Section 2.3.2

1. A. Deductive Documentation

2. C. Supporting Data

3. D. Time length for increments of long duration activities.

4. Level-of-effort (LOE), physical progress, incremental milestones, activity start/finish, substantial start/finish, supervisor judgment.

5. Accurate progressing of the schedule.

6. One should consider the contract requirements for cost and payment loading into the schedule model.

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2.3.3 Cost and Resource Management

Introduction and Learning Objectives

Understand cost and resource management requirements during the updating and maintenance of the schedule. Cost and resource management includes the collection of actual data, monitoring and analysis through cost, resource leveling, and earned value techniques.

Schedule Earned Value techniques and analysis use the same principles as Earned Value techniques and analysis. The data gathered in tracking and updating the schedule is used to determine percent complete, schedule performance, and variances. Information is then analyzed, reported, and disseminated. Trends and variances are used for forecasts, critical path analysis, and proactive schedule corrective action implementation or scope change identification.

Understand the how the different scheduling software programs perform cost and resource calculations and leveling.

Related Sections

- Stakeholders: 1.1.2 Identification of Stakeholders, 1.2.3 - Stakeholder Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders
- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Forecasting: 1.3.12 - Periodic Forecasts, 2.4.3 - Variances / Trends, 2.4.3 - Schedule Analysis, 2.4.4 - Schedule Forecasts
- Change Management: 1.3.13 - Risk and Recovery Plan, 2.3.4 - Schedule Change Management, 2.3.5 - Progress: 2.3.2 - Tracking Schedule Progress, 2.4.6 - Progress Reports and Reviews
- Specifications: 2.1.3 – Schedule Specification
- Acceleration: 2.3.4 – Schedule Change Management, 2.3.5 – Acceleration, 2.4.7 - Recovery Schedules

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Terms to Know

Earned value (EV) terminology related to schedule progress:

- Budgeted cost of work scheduled / planned work (BCWS).
- Budgeted cost of work performed / earned progress or %-complete. (BCWP).
- Schedule performance index (SPI).
- Schedule variance (SV).
- Resource loading.
- Resource leveling.
- Cash flow.

Key Points for Review

1. Cost and resource management is a process of collecting accurate data; monitoring field activities and progress; analyzing conditions found against the schedule; and communicating necessary information to stakeholders. Depending on the results of the analysis, changes in the means, methods depicted in the schedule model may be recommended with proposed alternatives.

2. The various scheduling software may calculate cost and resource management and leveling differently and it is important to understand how the calculation may affect the updated schedule.

Summary

Cost and resource management is the comparison and analysis of planned, earned, and actual cost and resource performance. Variances are reported and input into the change management process.

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Sample Questions for Section 2.3.3

1. Which of the following principles is not used in cost and resource management?
   A. Effective and efficient data gathering.
   B. Accurate data creation and manipulation.
   C. Schedule performance evaluation.
   D. Variance evaluation.
2. Which of the following acronyms does not apply to cost and resource management?
   A. SPI
   B. VE
   C. SV
   D. BCWP
3. Cost and resource management is a process to optimize all but?
   A. The accurate collection of data.
   B. Careful monitoring of field activities.
   C. Ensuring that reporting is correct.
   D. Back-checking home office costs.
4. Recommendations, resulting from effective cost and resource management, include which of the following?
   A. Changes in means and methods.
   B. Scope of work effort used.
   C. Changing in the pay estimates.
   D. Schedule manipulation.
5. Cost and resource management is a process that accomplishes all of the following goals except?
   A. Collecting accurate data.
   B. Monitoring field activities and progress.
   C. Analysis of conditions found versus the schedule.
   D. Determining new activity duration.
6. Described planned work.
7. Described earned value.
8. What is the SPI?
9. What is a schedule variance?
10. What is resource leveling?

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Solutions to Sample Questions for Section 2.3.3

1. B. Effective and efficient data gathering.

2. B. VE

3. D. Back-checking home office costs.

4. A. Changes in means and methods.

5. D. Determining new activity duration.

6. The scheduled value of work for a given time.

7. The value of work that was completed in a specific time period.

8. SPI is the ratio of worked performed divided by work scheduled.

9. Schedule variance is the difference between work schedule and work performed.

10. Leveling is the smoothing of resources is to better allocate use of resources and avoid peaks or valleys and will utilize the available float of the activity.

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2.3.4 Schedule Change Management

Introduction and Learning Objectives

Understand schedule change management and the implications change has on a project schedule. It is important that the project team analyze and understand the underlying causes that result in a changed condition. Recommendations for change management and the tracking change over the course of a project are critical techniques.

Suspension, delay, and disruption encountered during the project are all elements of change and must be integrated into the schedule model. Such issues may result from scope change, a change in circumstances, or outside influences on work progress. Analyses of these events drive the development of alternatives.

Owners and outside stakeholders may cause either positive or negative change. Either have impact on the current or baseline schedule. This may result in the need for a new baseline schedule.

As appropriate the "plan for change management" may need to be adapted to circumstances that develop during the implementation of the project.

Related Sections

- Contract: 1.1.1 - Contract Requirements
- Constructability: 1.1.3 - Constructability Methods, 2.4.5 - Constructability Review
- Variables: 1.2.4 - Project Variables
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Phases: 1.3.4 - Phase Definition
- Relationships: 1.3.8 - Sequencing and Phase Relationships, 2.2.4 - Relationships
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Baseline: 1.3.11 - Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Forecasts: 1.3.12 - Periodic Forecasts, 2.4.4 - Schedule Forecasts
- Recovery: 1.3.13 - Risk and Recovery Plan, 2.4.7 - Recovery Schedule
- Specification: 2.1.3 - Schedule Specification
- Acceleration: 2.3.5 - Acceleration
- Variance and Trends: 2.4.2 - Variance and Trends
- Critical Path: 2.4.3 - Schedule Analysis

Terms to Know

Change management
Scope variance:

- Positive change.
- Negative change.

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Time extension
Impacts
Delay
Suspension and resumption
Acceleration and mitigation
Disruption
Activity splitting
Time impact analysis (TIA)

Key Points for Review

1. The process of change management requires an extensive knowledge of and attention to the scope of work and contractual requirements of a project. It is important to understand what impacts change has on a project and how to identify, implement and track changes to a project schedule. It is important to identify a change early, separately track that change and, as appropriate, incorporate that change into the scope of the project to minimize its effect on the overall schedule.

2. When much change occurs on a project, reporting against the original or baseline may become difficult and impractical, thus requiring a new baseline. It is important that policies and procedures are in place to accurately evaluate and implement progress. The schedule must be able to not only analyze and document the changed work, but also do the same for the impact of change on unchanged work.

3. Depending upon contract, project, or organizational needs and requirements, authorization to implement change can be very formalized. Often a project will publish a contract-specific change management process, including a flowchart of actions to take once change is first identified. Actions include notifications, characterization of change, analyzing the cost and schedule impacts of change. These include identification of who is responsible for any cost implications, seeking approval to implement steps necessary to accommodate change, monitoring and controlling the changed work, and reporting. As in the planning process, change management is often an iterative or cyclical process.

Summary

Change occurs on almost every project. Planning for, monitoring, and accounting for change through appropriate change management procedures is critical to project success.

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Sample Questions for Section 2.3.4

1. When should a change be incorporated into the schedule?
   A. During the planning phase.
   B. After it is approved.
   C. As soon as it is identified.
   D. Never

2. Which of the following is an important characteristic of schedule change management?
   A. Doing nothing
   B. Time impact analysis
   C. Baseline delineation
   D. Two-week look-ahead schedule

3. What elements of change should be integrated into the schedule model?

4. What are key elements of the change process that need to be fully understood by the project team?

5. Why is it important to identify and incorporate changes early?

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Solutions to Sample Questions for Section 2.3.4

1. B. After it is approved.

2. B. Time impact analysis.

3. Schedule suspension, delay and disruption.

4. Extensive knowledge of and attention to the scope of work and contractual requirements.

5. To minimize the affect of change on the project schedule and cost.

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2.3.5 Acceleration

Introduction and Learning Objectives

Understand the effects that schedule acceleration has on a project. It is important to know the various methods of acceleration, the changes in logic typically used to model acceleration, and the impact of changes in construction methods. Duration changes that impact a schedule and the implications that adding resources have on a project is also important in considering acceleration.

Often when the critical path of a schedule network is condensed, activities may be 'crashed'. Crashing a schedule is the result of drastic action to reduce the duration of one or more critical activities. This action should only be taken in exceptional circumstances, due to the resulting dramatic increase in resource consumption and cost.

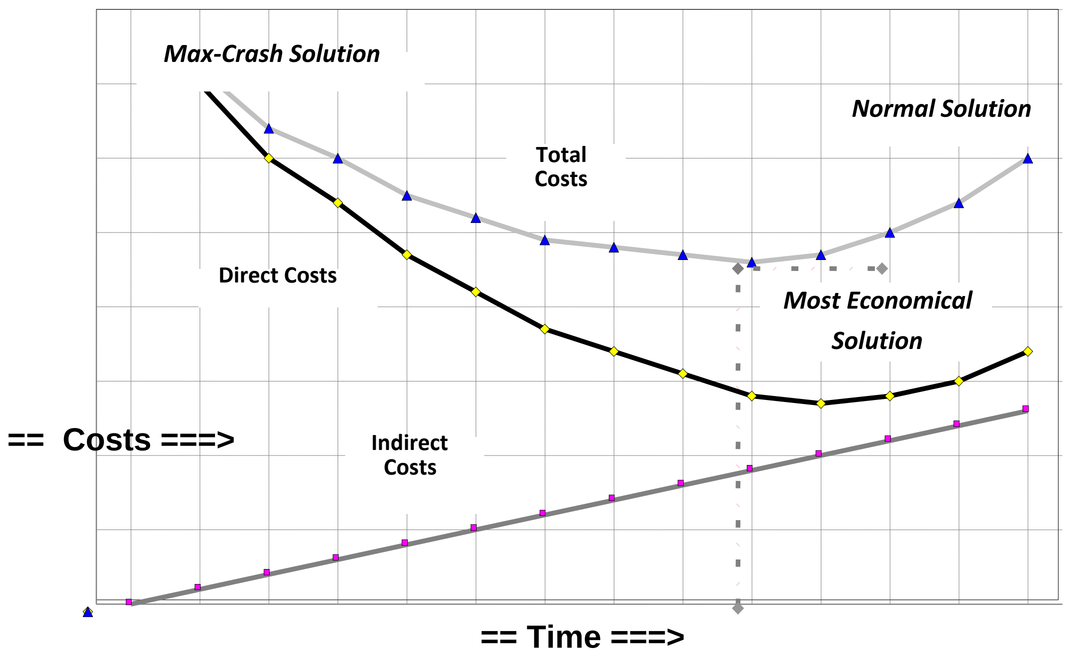

Figure 25—Crashing Analysis

Related Sections

- Contract: 1.1.1 - Contract Requirements
- Constructability: 1.1.3 - Constructability Methods, 2.4.5 - Constructability Review
- Resources: 1.2.1 - Identification of Resources, 2.2.3 - Cost and Resource Loading, 2.3.3 Cost and Resource Management
- Variables: 1.2.4 - Project Variables
- Scope of Work: 1.3.2 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Phases: 1.3.4 - Phase Definition
- Relationships: 1.3.8 - Sequencing and Phase Relationships, 2.2.2 - Relationships
- Estimate: 1.3.10 - Develop Cost Estimate, 2.1.5 - Cost Estimate Model
- Baseline: 1.3.11 - Baseline Plan, 2.2.6 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Recovery: 1.3.13 - Risk and Recovery Plan, 2.4.7 - Recovery Schedule

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- Schedules: 2.1.1 – Define Schedule Scope, 2.1.3 - Schedule Specification, 2.2.1 – Types of Schedules, 2.4.1 – Control Level Schedule
- Activities: 2.2.2 – Activities
- Constraints: 2.2.5 – Constraints and Calendars, 2.2.7 - Milestones
- Change Management: 2.3.4 - Schedule Change Management, 2.4.7 – Recovery Schedule
- Critical Path: 2.3.2 – Tracking Schedule Progress, 2.4.2 – Variances and Trends, 2.4.3 - Schedule Analysis, 2.4.4 – Schedule Forecasts

Terms to Know

Schedule crashing.

Schedule acceleration:

- Directed acceleration.
- Constructive acceleration.

Schedule compression.

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Key Points for Review

1. Schedule acceleration is a result of delay, increasing work production per unit time, either to maintain the original completion date or to expedite completion.

2. When modeling schedule acceleration, there are many methods to document and implement schedule acceleration in a project. The scheduler must understand how to analyze a schedule and determine the implications to cost and productivity that could occur if acceleration is contemplated so that an achievable, credible model is created and can be used to monitor and control the revised execution plan.

3. It is important to analyze what effect adding resources may have on the outcome as well as the cost impact of acceleration. Contract provisions may dictate when and how schedule acceleration may be required, implemented, and documented.

4. When accelerating a schedule, there are often logic and duration changes that will impact the schedule. Acceleration may change the critical path of the schedule network. The scheduler must consider the effect of multiple shifts, overlapping activities, overtime, changing work methods, and increasing or changing resources on the project. Also the scheduler must understand cost implications of schedule acceleration. Lastly, the scheduler needs to understand, document, and analyze the impact of disruption that acceleration may have on the work, on both a macro and a micro level.

5. Acceleration of a schedule is not done lightly and without much forethought and planning. Depending upon the circumstances necessitating acceleration (e.g., the need to overcome a delay or the desire to achieve early completion), and who is ultimately responsible for that cost, approval to proceed will depend upon following change management procedures established for the project. In the case of disputed responsibility, the contractor may be forced to proceed while incurring the cost, marshalling the resources, and later claiming against the owner to recover its costs of acceleration.

Summary

There may be many reasons to accelerate, whether because of a delay, an increase in scope, maintaining the original completion date, or expediting completion. In acceleration, there are many impacts that require an in-depth knowledge of the scope of work. The scheduler must understand the means and methods of implementing an acceleration plan fully to analyze the options for acceleration. As the implementation of an acceleration plan is often a contractual issue, the need to document and communicate the means, methods, assumptions of the revised execution plan is critical.

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Please see **Sample Questions for Section 2.3.5** on page 207

Please see **Solutions to Sample Questions for Section 2.3.5** on page 208

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Sample Questions for Section 2.3.5

1. Which of the following is not a form of acceleration?
   A. Crashing
   B. Compression
   C. Constructive baselining
   D. Directive acceleration

2. What is the difference between directive and constructive acceleration?

3. Schedule acceleration is a result of ________.

4. When accelerating a schedule, what should be considered?

5. Why is it important to document and communicate actions, when implementing schedule acceleration?

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Solutions to Sample Questions for Section 2.3.5

1. C. Constructive baselining

2. Directive is when it is directed versus a stakeholder's inaction or action in advance of direction.

3. Delay, increase in work scope, maintaining the current completion date, or expediting the completion date is an example of acceleration.

4. Effect of multiple shifts, overlapping of activities, overtime, modifying work methods, increasing or changing of resources, and cost among other elements.

5. Schedule acceleration is often a contractual issue, therefore it is important to communicate the means, methods, and assumptions used in revising the execution plan.

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2.3.6 Schedule Maintenance Feedback

Introduction and Learning Objectives

Understand the need to seek and incorporate feedback from stakeholders during the maintenance of a schedule to depict actual conditions, impacts, and delays. This allows all stakeholders the opportunity to "buy in" to the modeled execution plan.

The roles, goals, and objectives of each stakeholder should be considered as feedback is gathered. Each stakeholder has an interest in the project and each item of feedback needs to be analyzed and incorporated, as appropriate. This feedback may expose failures in alignment of the execution plan with stakeholder goals. Such failures to satisfy expectations must be resolved before the misalignments become contractual disputes.

Related Sections

- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholder Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders
- Goals and Plan: 1.3.2 – Define Project Goals, 1.3.3 – Define Project Plan
- Documentation: 2.2.8 - Schedule Quality Analysis and Compliance Review, 2.2.9 - Schedule Basis Documentation
- Progress: 2.3.2 - Tracking Schedule Progress, 2.4.1 - Control Level Schedules, 2.4.2 – Variances and Trends, 2.4.3 - Schedule Analysis, 2.4.4 - Schedule Forecasts, 2.4.6 - Progress Reports and Reviews
- Management – Section 2.4.8 - Management Summary

Terms to Know

Stakeholders:

- Client.
- Project.
- Management.
- Site staff.
- Non-project related stakeholders such as NGOs, non-governmental organizations.

Key Points for Review

1. Understanding the role of each stakeholder is important to the feedback process.

2. The planner-scheduler analyzes and responds to feedback, to incorporate it into scheduling and managing the work, as appropriate.

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Summary

Stakeholder feedback is important in maintaining and updating a schedule. During the execution of a project, since the schedule is dynamic, continual re-assessment of the work is important to the overall success of the project. It is essential that feedback is received, analyzed and incorporated from all stakeholders.

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Sample Questions for Section 2.3.6

1. Which is not a resultant of schedule maintenance feedback?
   A. Recovery schedules
   B. Schedule acceleration
   C. Constructability review
   D. Control level schedules

2. Stakeholder schedule maintenance feedback includes?
   A. Documentation
   B. Management
   C. Project team
   D. All of the above

3. Feedback to the scheduler is not received as?
   A. Written responses to previous update reports.
   B. Stakeholder meetings
   C. Comments from the project team.
   D. Contract request for change.

4. Why is stakeholder feedback important in maintaining and updating the schedule?

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Solutions to Sample Questions for Section 2.3.6

1. D. Control level schedules

2. D. All of the above

3. D. Contract request for change

4. Continual reassessment is important to the overall success. Feedback may also identify failures in alignment with the execution plan.

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Subchapter 2.4 Schedule Output and Deliverables

As an end product of maintaining the schedule, periodic reporting of progress, trends and forecasts to various stakeholders is required by the contract or as requested by stakeholders. Other deliverables include control schedules, cost performance analysis, constructability reviews, recovery schedules and management summaries.

The Schedule Output and Deliverables subchapter consists of:

- Control Level Schedules.
- Variances and Trends.
- Schedule Analysis.
- Schedule Forecasts.
- Constructability Review.
- Progress Reports and Reviews.
- Recovery Schedules.
- Management Summary.

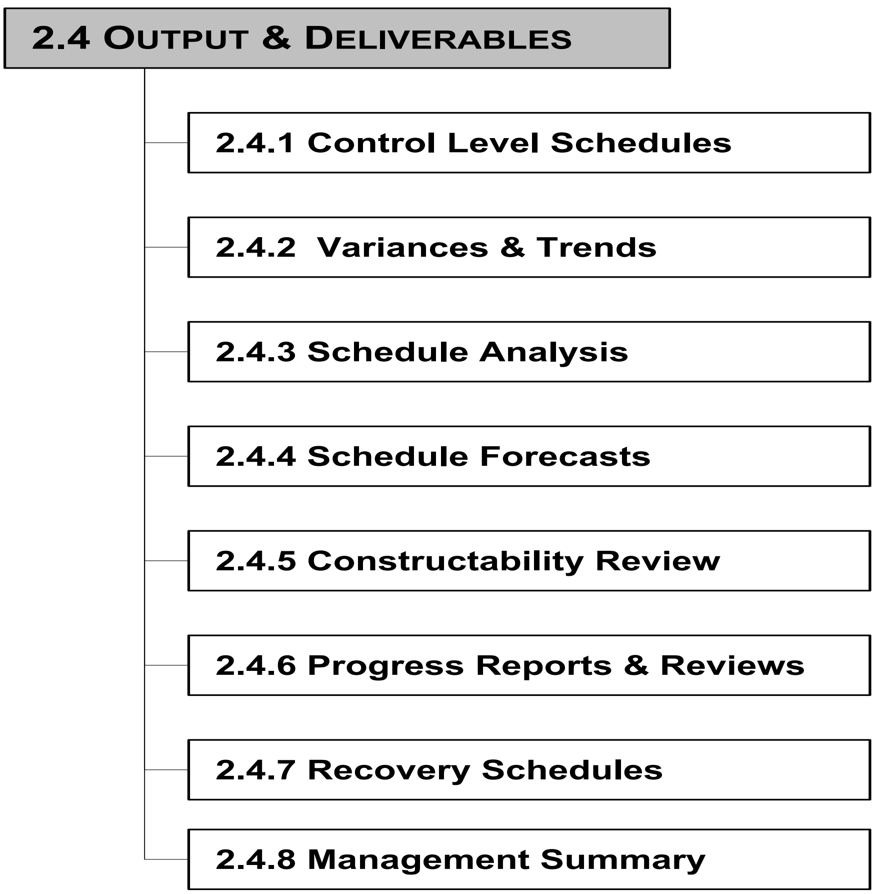

Figure 26—Schedule Output and Deliverables

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Please see **2.4.1 Control Level Schedules**, on page 215

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2.4.1 Control Level Schedules

Introduction and Learning Objectives

Understand how control level schedules are used to monitor and report progress. The project schedule may be broken down into different reporting scenarios (levels of detail or filtering of information) based on the needs of stakeholders.

It is important to understand the various levels of detail that schedule information may be summarized and arranged for managing the schedule and reporting to a variety of stakeholders.

Different levels of the schedule may be used at different phases or periods in the project depending on the scope and the requirements to report the schedule to the stakeholders.

Schedule levels are both a reporting mechanism and a schedule development and progress updating system. Schedule levels allow one to report plan and progress to different audiences according to their need for detail and use for the information. The industry has yet to formally define a common practice for schedule levels.

Related Sections

- Contract: 1.1.1 – Contract Requirements
- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholder Considerations, 1.3.9 - Review by Stakeholders 2.1.4 – Feedback from Stakeholders, 2.3.6 - Schedule Maintenance Feedback
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Baseline Schedule - Sections: 1.3.11 - Baseline Plan, 2.2.6 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Progress: 1.3.12 - Periodic Forecasts, 2.3.2 - Tracking Schedule Progress, 2.4.2 - Variances and Trends, 2.4.3 - Schedule Analysis, 2.4.4 - Schedule Forecasts, 2.4.6 - Progress Reports and Review
- Change Management: 1.3.13 - Risk and Recovery Plan, 2.3.4 - Schedule Change Management, 2.4.5 - Acceleration, 2.4.7- Recovery Schedules
- Specifications: 2.1.3 - Schedule Specification
- Schedules: 2.2.1 – Types of Schedules, 2.4.7 – Recovery Schedules
- Quality: 2.2.4 – Schedule Quality Analysis and Compliance Review
- Management Summary: 2.4.8 - Management Summary

Terms to Know

The schedule levels most often used in EPC (engineering-procurement-construction) projects:

- Level 1 – Milestone / Executive summary.
- Level 2 – Contract master / Detailed integrated.
- Level 3 – Area master / Contract.
- Level 4 – Control – 2-3 Week look-ahead schedules.
- Level 5 – Daily / Hourly.

Schedule control measures:

- Identification and notice of change.
- Documentation and classification of change.
- Analysis of change on schedule.
- Management of change to mitigate impacts.
- Resolve change orders, disputes and claims in a timely manner.

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Figure 27—Schedule Levels of Detail / Filtering

Key Points for Review

Schedule reports are developed to meet monitoring and reporting requirements. Various mutually-agreed or contract-specified schedule reports are required to meet individual stakeholders' needs.

Summary

The key to producing control schedules is to know stakeholders' unique needs. Not all stakeholders will be able to use one schedule format. During the schedule update process, it may be necessary to reconsider the needs and objectives of the stakeholders. If properly considered, necessary schedule formats, frequencies, and recipients will be specified within the contract.

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Sample Questions for Section 2.4.1

1. Which one is not a schedule control measure?
   A. Identification or notice of change.
   B. Analysis of change on schedule.
   C. Management of change to mitigate impacts.
   D. Management summary report.

2. Why are different levels of schedules developed?

3. What is the hierarchy of schedule types?

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Solutions to Sample Questions for Section 2.4.1

1. D. Management summary report.

2. Different schedule levels are developed to communicate the schedule to various stakeholders to reflect their specific interests. The control level schedules incrementally "drop down" from the master schedule.

3. Schedule types are:
   - Level 1 – Milestone/Executive summary
   - Level 2 – Contract master/Detailed integrated
   - Level 3 – Area master/Control
   - Level 4 – Control /2-3 Week look-ahead
   - Level 5 – Daily/Hourly

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2.4.2 Variances and Trends

Introduction and Learning Objectives

Understand how schedule progressing may identify variances and trends, and how the variances and trends will assist in schedule analysis, forecasts, and recovery plans.

As the schedule is updated and compared against a baseline schedule, schedule and cost variances and trends are identified and analyzed. If the variance or trends fall within certain thresholds, they should be noted and observed for further variances. If the variances or trends fall outside accepted norms, corrective action or recovery plans and alternatives should be developed, communicated, concurred, and implemented.

Thresholds are levels or limitations that have been determined as guidelines for the project team to identify potential concerns or issues that require action to keep the project on schedule.

Variances and trends provide the basis for revisions to the project control plan, corrective actions, alternatives and recommendations, or potential changes in scope.

Related Sections

- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholder Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders, 2.3.6 - Schedule Maintenance Feedback
- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 Cost and Resource Management
- Scope of Work – Section 1.3.1 - Define Scope of Work, 1.3.2 – Define Project Goals, 1.3.3 – Define Project Plan, 1.3.4 – Phase Definition, 1.3.8 – Sequencing and Phase Relationships, 2.1.1 - Define Schedule Scope of Work, 2.1.3 – Schedule Specification, 2.2.2 - Activities, 2.2.4 - Relationships
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Baseline Schedule: 1.3.11 - Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Forecast: 1.3.12 - Periodic Forecasts, 2.4.4 - Schedule Forecasts
- Recovery Plan and Schedule: 1.3.13 Risk and Recovery Plan, 2.3.4 - Schedule Change Management, 2.3.5 – Acceleration, 2.4.1 – Control Level Schedules, 2.4.7 - Recovery Schedules
- Milestones: 2.2.7 - Milestones
- Progress: 2.3.2 - Tracking Schedule Progress, 2.4.6 - Progress Reports and Review
- Critical Path: 2.4.2 - Schedule Analysis

Terms to Know

Variance

Variance and index calculations:

- Schedule variance (SV).
- Schedule performance index (SPI).

Trend

Thresholds

Scope change

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Key Points for Review

1. Schedule variance is the comparison of the current schedule progress against a baseline. Based on the comparison the scheduler can determine if the project is ahead or behind schedule, or if changes have occurred since the last update. During analysis the scheduler also notes if the variances are on the critical path, near-critical paths, or are non-critical activities--thus giving consideration to the criticality of the variance.

2. Trends are possible predictors that might result from schedule analysis and assist in forecasting. Early and late in a project the trend information should be analyzed carefully to verify its accuracy, as the information may be faulty due to a variety of reasons such as incomplete data collection, reporting errors, learning curves, front-end loading, or back-end loading of the schedule. Trend forecasting is usually more effective or applicable for specific scope elements and work packages versus the overall schedule. The use of schedule variances can be used in the "trended" forecasting of schedule elements.

Summary

Variances and trends are progress indicator tools that assist the project team in determining the status and health of a project. The team can use variance and trend information in planning recovery schedules and identifying changes. The team must use this information and take the necessary corrective action early, when that action can be effective and cost efficient.

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Sample Questions for Section 2.4.2

1. Which of the following is not a progress indicator?
   A. Variances
   B. Objectives
   C. Trends
   D. Total float

2. Why are variances and trend reporting important?

3. What can variance and trends influence?

4. Explain how earned value concepts affect variances and trends.

5. The current progress report indicates that electrical conduit installation is 5 work days behind the baseline schedule, 65% complete, and driving the critical path. The previous monthly update showed this activity to be on schedule and was 15% complete. The baseline indicates the task should be complete in two weeks (remaining planned duration when at 55% complete) and the current update requires three weeks to complete the task using a 5 day workweek.

   A. What is the current trend?
   B. Describe the current variance.
   C. If you add an additional crew with the same capability as the current work effort, will the task be completed on time or early?

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Solutions to Sample Questions for Section 2.4.4

1. B. Objectives

2. Variances and trends are progress indicators that assist in determining the status and health of a project. The earlier variances and adverse trends are recognized, the easier it is to take corrective action.

3. Variance and trends can influence the end result of the project. Variances and trends provide the basis for revisions to the baseline plan, corrective action, alternatives and recommendations or potential change orders.

4. Earned value concepts assist in the analysis of variances and trends that lead to schedule forecasts.

5. A. The schedule critical path activity is slipping and impacting completion for the entire project.

   B. The current variance is negative and may continue to grow, based on the difference between the previous and current reports unless corrective action is taken.

   C. 5-day workweek = 20 days in a month

   Current 5-day delay = 25% productivity loss (5 days behind in 20 workdays last period).

   Existing crew created the 5-day delay during the month, therefore = 75% variance.

   Adding the new crew should finish the activity on time, assuming the same conditions. The activity will not finish earlier than originally planned by adding a second crew.

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2.4.3 Schedule Analysis

Introduction and Learning Objectives

Understand common schedule analysis tools and techniques and the results that they typically generate. Schedule analysis determines the critical or longest path(s) of the project activity network, to identify critical activities and near-critical activities, the timely completion of which is a primary focus for managers seeking to keep the schedule on track.

For network activity schedule models, schedule analysis will identify float values for non-critical activities, determine implications of “what-if” scenarios, and monitor and control the schedule. Schedule analysis assists in resource and cost loading and leveling review. For bar chart and line of balance schedules which do not have network logic integrated into the model, the same objectives are achieved using techniques unique to those scheduling techniques.

The scheduler’s review and analysis needs to be careful and thorough, since the schedule may be difficult to assess or status. The software tool used to model the schedule might not report “at the click of a mouse” all of the analysis the scheduler and managers wish to see. If the analysis is incomplete or overly optimistic bias creeps into the schedule, the results may lead to a false sense of security and miss the opportunity for taking timely corrective actions.

To properly understand critical path analysis it is important to understand the mechanics of the software that is used to model and analyze the schedule. Algorithms applied by the software might not perfectly replicate calculations the scheduler has used in the past. Further, the tools and techniques used to measure progress, incorporate that progress, and forecast the remaining work, if not used properly and documented fully, can provide faulty results and forecasts.

A properly developed and understood critical path analysis is a valuable tool for the project team. The process assists the team in developing recovery or work-around alternatives to minimize the adverse impact of changes and delays.

Related Sections

- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholder Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders, 2.3.6 - Schedule Maintenance Feedback
- Resource Loading: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 Cost and Resource Management
- Phase: 1.3.4 - Phase Definition
- Relationships: 1.3.8 - Sequencing and Phase Relationships, 2.2.4 - Relationships
- Baseline - Sections: 1.3.11 - Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Forecasts: 1.3.12 - Periodic Forecasts, 2.4.4 - Schedule Forecasts
- Recovery Schedule: 1.3.13 - Risk and Recovery Plan, 2.4.7 - Recovery Schedules
- Specification: 2.1.3 - Schedule Specification
- Activity: 2.2.2 - Activities
- Milestones: 2.2.7 - Milestones
- Monitoring and Progress: 2.3.2 - Tracking Schedule Progress, 2.4.2 – Schedule Analysis, 2.4.6 - Progress Reports and Reviews
- Changes: 2.3.4 - Schedule Change Management
- Trends: 2.4.2 - Variances and Trends

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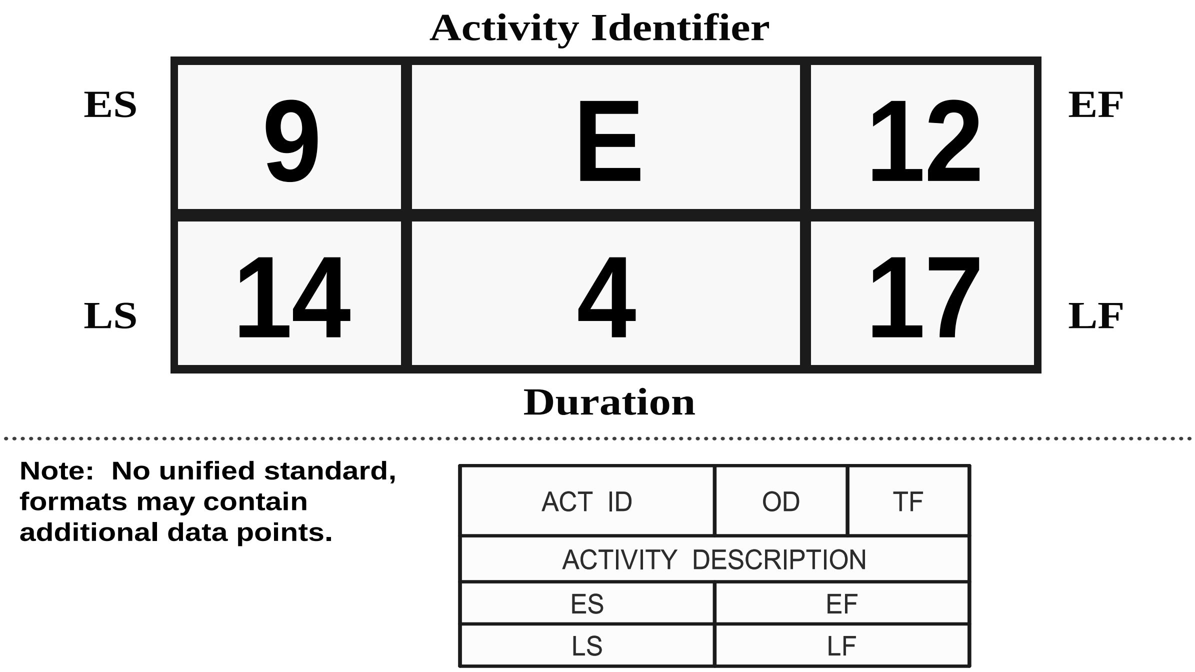

Figure 28—PDM Activity Notations

<u>**Terms to Know**</u>

Schedule analysis
Critical path
Longest path
Critical activities
Near-critical activities
Total float
Free float
Monitoring
Forward pass
Backward pass
Driving and controlling activities or chains of activities.
Logic calculation methods:

- Retained
- Progress override

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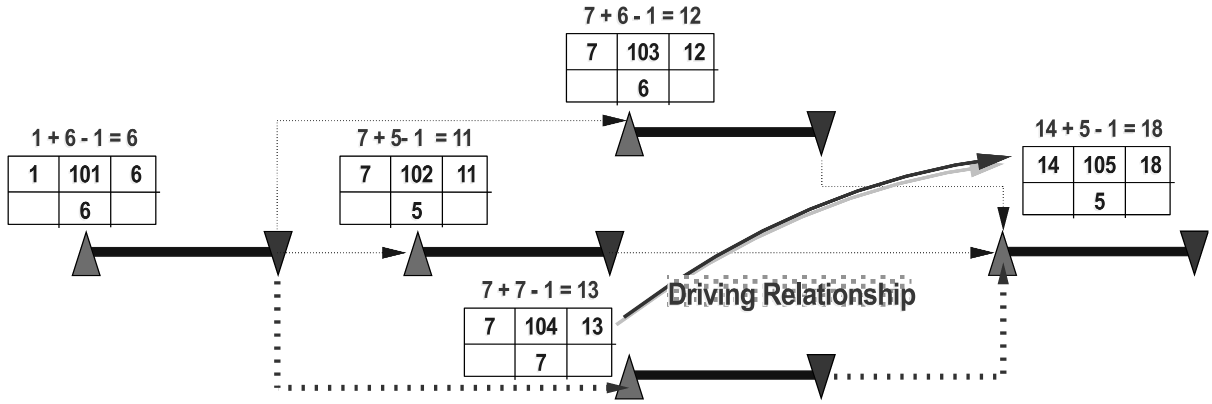
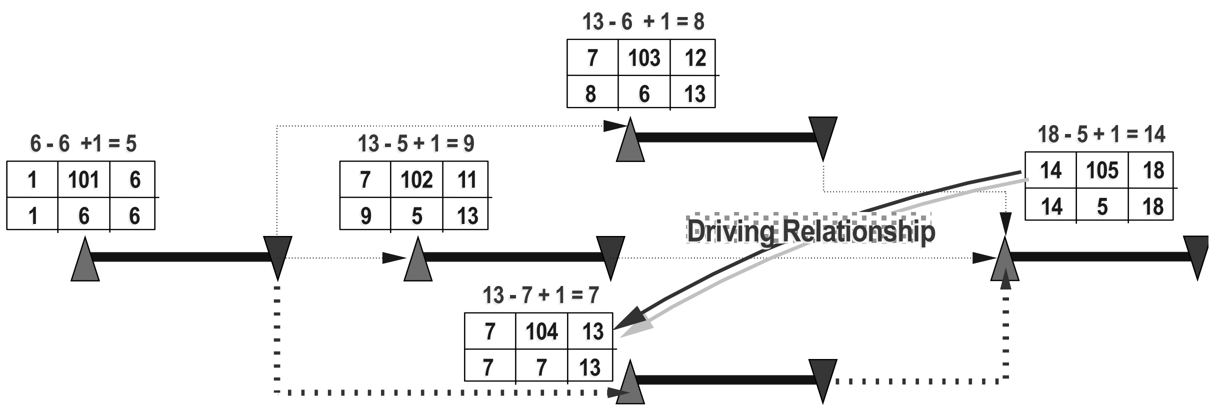


A forward pass calculates the Early Start (ES) and Early Finish (EF) of each activity.
Time begins at "Time 1" and defines ES of first activity.
Activities start the day after the finish of their predecessors.
EF time of Activity = ES + Activity Duration – 1.

Figure 29—Forward Pass Example



Backward pass calculates the Late Finish (LF) and Late Start (LS) of each activity.
Start with terminal activity of network.
Activities finish the day before the start of their predecessors.
LF time of Activity = LS - Activity Duration + 1.

Figure 30—Backward Pass Example

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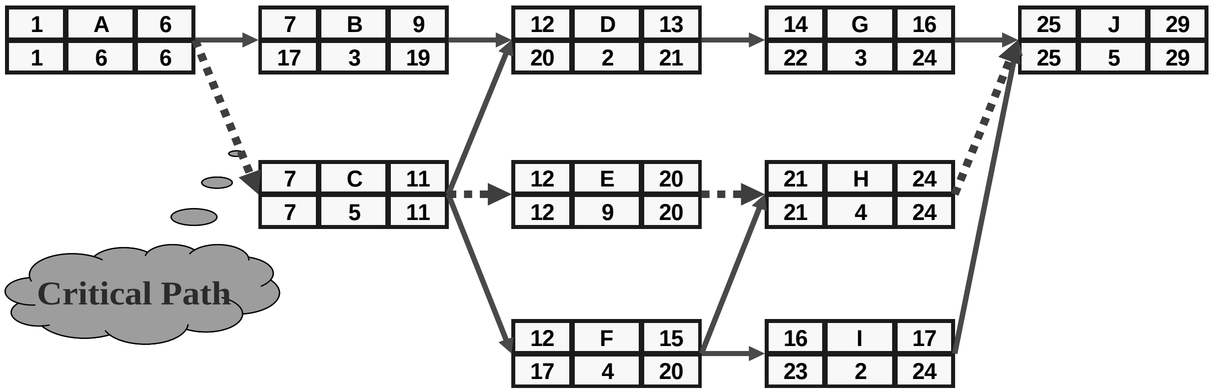
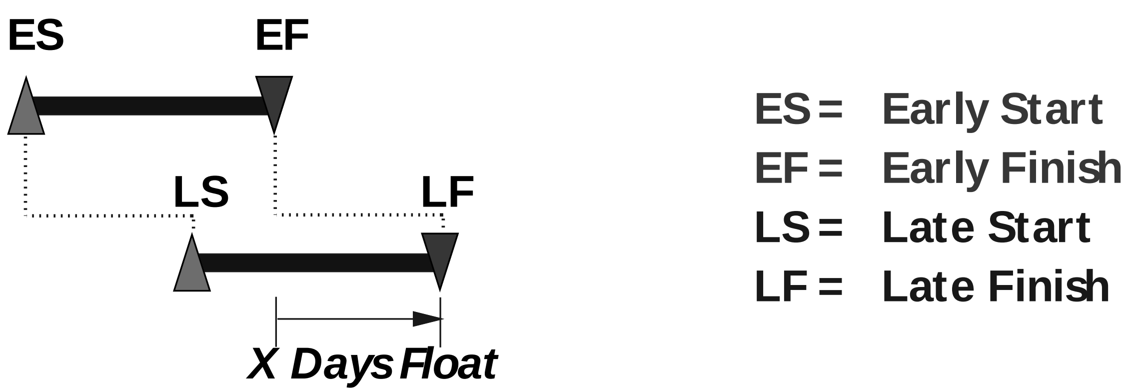


Figure 31—Critical Path through Network

<u>Key Points for Review</u>

Both schedule and critical path analyses are valuable processes to use during the project life cycle when properly performed. Schedule analysis should be a proactive process when maintaining the schedule. The project team must understand the procedures of schedule analysis and critical or longest path analysis, including the significance of critical activities versus near-critical activities. Schedule and critical path analyses form much of the basis for schedule trending, forecasting, and developing recovery and work-around plans.



- Total Float (TF): Amount of time an activity may be delayed before affecting project's finish date.
  - TF = LF – EF, or LS – ES.
- Free Float (FF): Amount of time an activity may be delayed without delaying early start of successor activities.
  - FF = $ES_{Successor} - EF_{Predecessor}$
  - FF ≤ TF.

Figure 32—Float Defined

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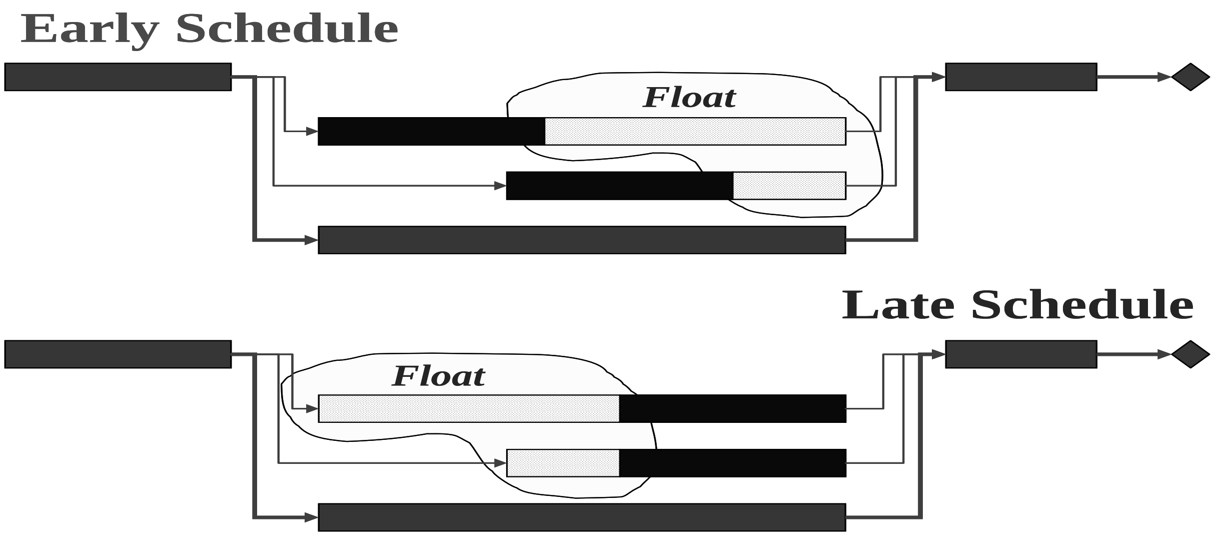

Figure 33—Float: Early and Late Schedules

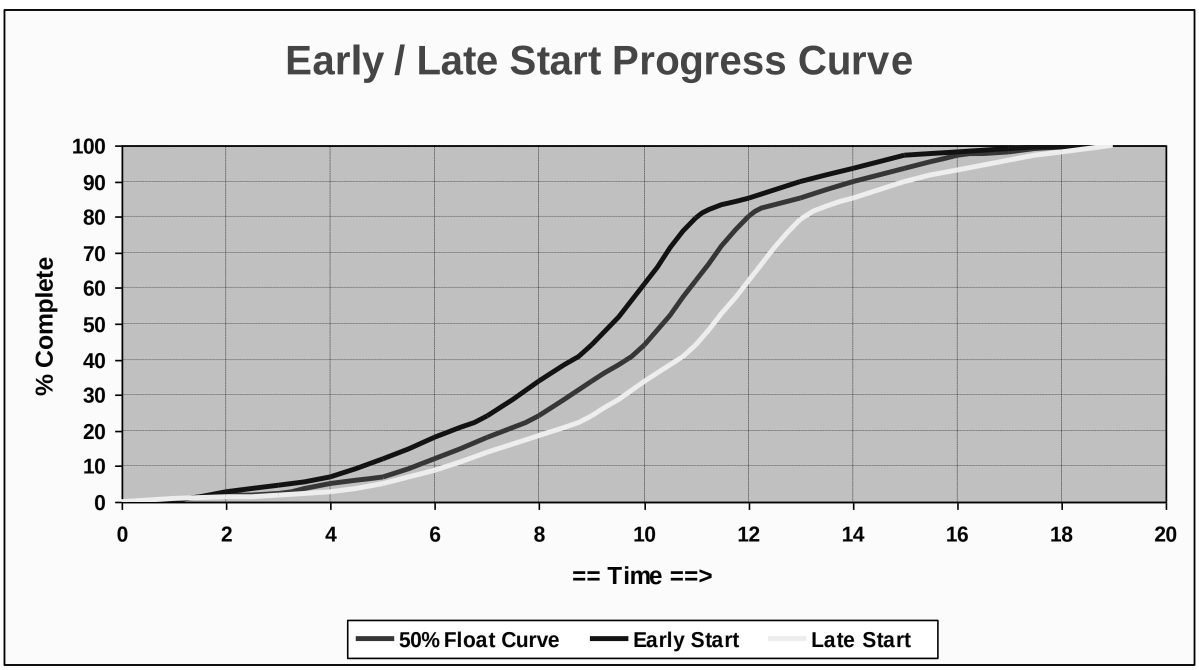

Figure 34—Float: S-Curve Depiction

Summary

Schedule analysis assists in determining the status and outcome of the project work portrayed in the schedule. Resultant forecasts are often the first indicators to stakeholders that critical milestones with be achieved or not.

The scheduler must know how to perform both schedule and critical (longest) path analyses, and the impact if results of the analyses are improperly communicated to the project team. Successful schedule and critical path analyses require an accurate collection of as-built project data, analysis of trends, and the ability to accurately forecast and model remaining work. Essential to this effort is the need for the scheduler to understand and act upon the contractual and organizational requirements for analysis and reporting--as well as how the tools, techniques, and software work together to produce data points and information for review and analysis.

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Sample Questions for Section 2.4.3

1. Which of the following is not an element of critical path analysis?
   A. Evaluating activity relationships.
   B. Ensuring that change orders have been properly integrated into the schedule.
   C. Deleting milestones.
   D. Evaluating performance against the baseline.

2. What is the primary focus of the critical path analysis?

3. Why is it important for the scheduler to understand the mechanics of scheduling software when performing analysis?

4. What is a key process in schedule analysis?

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Solutions to Sample Questions for Section 2.4.3

1. C. Deleting milestones.

2. The primary focus of the critical path analysis is to evaluate the longest path of the project and identify critical or near-critical activities.

3. It is important to understand how the software tool calculates start and finish dates, float, constraints, and durations. All of these impact calculations that determine the critical path.

4. Gathering accurate information about schedule progress and analyzing trends to properly forecast the remaining work in the schedule model.

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2.4.4 Schedule Forecasts

Introduction and Learning Objectives

Understand how schedule forecasts are developed and used to predict the outcomes. Tools and techniques such as Earned Value (EV) analysis must be implemented at the outset to allow for consistent and credible analysis and forecasting.

EV concepts should be understood as performance indicators, which are the basis for schedule forecasting.

Forecasts are vital planning information for project control, in order to develop corrective action alternatives and recommendations. Once the forecast is accepted by stakeholders, it becomes the basis for developing an updated baseline for monitoring and controlling projects.

Schedule forecasts may provide the basis for understanding and analyzing historical schedule data.

Forecasts must be developed in alignment with contract requirements, while meeting the reporting needs of all stakeholders. The facts and assumptions upon which forecasts are based should be fully documented.

Related Sections

- Contract and Specification: 1.1.1 - Contract Requirements, 2.1.3 - Schedule Specifications
- Stakeholders: - 1.1.2 Identification of Stakeholders, 1.2.3 - Stakeholder Considerations, 1.3.9 – Review by Stakeholders, 2.1.4 - Feedback from Stakeholders, 2.3.6 - Schedule Maintenance Feedback
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Baseline: 1.3.11 - Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Recovery Plan and Schedule: 1.3.13 - Risk and Recovery Plan, 2.4.7 - Recovery Schedules
- Milestones: 2.2.7 - Milestones
- Progress: 2.3.2 - Tracking Schedule Progress, 2.4.6 - Progress Reports and Review
- Change Management: 2.3.4 - Schedule Change Management
- Control Schedules: 2.4.1 - Control Level Schedules
- Critical Path: 2.4.3 – Schedule Analysis
- Trend Analysis and Variances: 2.4.2 - Variances and Trends

Terms to Know

Forecasts
Earned value concepts:

- Planned value (PV); Budgeted cost of work scheduled (BCWS).
- Earned value (EV). Budgeted cost of work performed (BCWP).
- Actual cost (AC). Actual cost of work performed (ACWP).
- Budget-at-completion (BAC).
- Estimate-to-complete (ETC).
- Estimate-at-completion (EAC); some organizations use indicated total cost (ITC).
- Percent complete.
- Schedule variance (SV).
- Cost variance (CV).

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Historical information
Staffing and manning levels and utilization
Critical path
Schedule analysis
Critical path analysis
Schedule crashing

Key Points for Review

1. Forecasts are based on trends developed during the life of a project. This may be at individual activity or milestone level, levels of effort, areas or other metrics that identify critical and near critical path progress. Forecasts assist team members in making decisions and revising the work and schedule model necessary to achieve timely completion of milestones and contractual requirements.

2. Earned value concepts and data are used as the basis for analyzing and forecasting the progress of a project.

3. Forecasts are used to identify alternative work plans and corrective actions that may be required to maintain schedule milestones. Forecasts may be communicated as part of the normal periodic progress update reporting process, or may require special reporting as it relates to a need to create a new baseline or target schedule. Because they often come under special scrutiny after the fact, forecasts should be fully documented, just as the planner-scheduler documents the original schedule basis.

Summary

Forecasts based upon observed trends, reported progress, and expected productivity are incorporated into estimates of remaining work durations. The project should be constantly monitored, since the plan and schedule are dynamic tools to be used by the project team and stakeholders. Through trending and forecasting, the parties have tools that assist in decision-making, schedule refinement, and adjustments that are required to keep work on track, minimize adverse impacts, and accurately forecast completion of key milestones and phases.

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Sample Questions for Section 2.4.4

1. The following earned value concepts are included in schedule forecast development?
   A. Actual costs
   B. Estimate-to-complete (ETC)
   C. Schedule variance (SV)
   D. All of the above

2. Important factors in developing schedule forecasts do not include?
   A. Historical information, along with staffing and manning levels.
   B. Future productivity factors.
   C. Negative float.
   D. Baseline schedule.

3. Why is it important to perform “what-if” scenarios for significant pending change orders?
   A. Impact to schedule and cost.
   B. Equipment and material delivery lead time implications.
   C. Evaluation of available resources.
   D. All of the above.

4. Which of the following is not an element of schedule forecasts?
   A. Prediction of future work.
   B. Planned sequence of activities.
   C. Baseline schedules.
   D. Labor and material utilization.

5. From what do schedule forecasts result?

6. With what must forecasts align?

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Solutions to Sample Questions for Section 2.4.4

1. D. All of the above.

2. A. Historical information, along with staffing and manning levels.

3. D. All of the above.

4. C. Baseline schedules.

5. Schedule forecasts are a result of actual performance and the analysis of variances and trends.

6. Contract requirements while meeting the reporting needs of stakeholders.

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2.4.5 Constructability Review

Introduction and Learning Objectives
Understand constructability analysis and review as it relates to scheduling. Constructability is associated with building techniques and means and methods of construction that may expedite the schedule or save costs.

As the schedule is updated and analyzed, different methods of construction may be considered and implemented to keep the project on target.

Constructability may be influenced by specifications, location, climatic conditions, site conditions, maintainability, progress, and interim and final completion dates.

Related Section
- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholder Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders, 2.3.6 - Schedule Maintenance Feedback
- Constructability: 1.1.3 - Constructability Methods
- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 - Cost and Resource Management
- Variables: 1.2.4 - Project Variables
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Baseline: 1.3.11 - Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Forecasts: 1.3.12 - Periodic Forecasts, 2.4.4 - Schedule Forecasts
- Specifications: 2.1.3 - Schedule Specifications
- Progress: 2.3.2 - Tracking Schedule Progress, 2.4.6 - Progress Reports and Reviews
- Variance: 2.4.2 - Variances and Trends, 2.4.3 – Schedule Analysis

Terms to Know
Constructability
Means and methods
Functional versus literal specifications
Maintainability

Key Points for Review
Means and methods of construction need to be constantly evaluated in terms of schedule progress, trends, and forecasts. Means and methods initially considered feasible during the planning or baseline schedule development might later be considered inappropriate.

Summary
The working schedule is dynamic. The current progress and the projected completion are calculated and verified to be acceptable or not. If the forecast is unacceptable, managers determine alternative construction methods that will speed work completion. The most appropriate methods are implemented.

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Please see **Sample Questions for Section 2.4.5** on page 237

Please see **Solutions to Sample Questions for Section 2.4.5** on page 238

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Sample Questions for Section 2.4.5

1. All of the following conditions predicate a constructability review, except which one?
   A. Schedule progress
   B. Trends
   C. Stakeholders
   D. Forecasts

2. What factors could affect the constructability of a project?

3. Why should constructability be continually reevaluated?

4. Why would encountering a differing site condition result in constructability review?

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Solutions to Sample Questions for Section 2.4.5

1. C. Stakeholders

2. Specifications, location, climatic conditions, site conditions, maintainability, progress and interim and final completion dates.

3. Means and methods initially considered feasible may now be considered inappropriate.

4. Latent or patent conditions are different from existing contract requirements and, therefore, result in the need to reevaluate current construction means and methods and calculate possible impacts on the schedule.

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2.4.6 Progress Reports and Reviews

Introduction and Learning Objectives

Understand the need and type of progress reports and schedule reviews that are necessary during life of a project.

Progress reports must be accurate, credible, and reliable. The reports should be tailored to the needs of any appropriate stakeholder. Progress reports enable the stakeholders to analyze trends and make decisions that best serve organizational and project needs.

Progress reports become an important part of historical project records and may be used to estimate and schedule future work.

Related Sections

- Contracts: 1.1.1 - Contract Requirements
- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholder Consideration, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders, 2.3.6 - Schedule Maintenance Feedback
- Resources: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 Cost and Resource Management
- Breakdown Structures: 1.3.5 - Establish Work Breakdown Structure, 1.3.6 - Establish Organization Breakdown Structure, 1.3.7 – Establish Cost Breakdown Structure, 2.1.2 - Breakdown Structure Relationships
- Baseline: 1.3.11 - Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Forecasts: 1.3.12 - Periodic Forecasts, 2.4.4 - Schedule Forecasts
- Specification: 2.1.3 - Schedule Specification
- Schedules: 2.2.1 – Types of Schedules, 2.4.1 - Control Level Schedules
- Progress: 2.3.2 - Tracking Schedule Progress
- Trend Analysis: 2.4.2 - Variances and Trends, 2.4.3 – Schedule Analysis
- Management: 2.4.6 – Progress Reports and Reviews, 2.4.8 Management Summary

Terms to Know

Types of Reports:

- Tabular and written
    - ✓ Narrative status
    - ✓ Variance
        - ➢ Percent duration
        - ➢ Float
        - ➢ Milestone analysis
    - ✓ Trend
        - ➢ Percent (%)-complete
        - ➢ Period
    - ✓ Forecast
    - ✓ Float
    - ✓ Target or baseline comparison
    - ✓ Earned value

- Graphic

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- ✓ Bar charts
- ✓ Time-scaled network diagram
- ✓ Time-scaled bar chart
- ✓ PERT diagram
- ✓ Progress curves
  - ➢ Early and late curves (aka “S-curves” and “banana curves”)
  - ➢ Resource utilization (period and cumulative)
- ✓ Earned value
- ✓ Target or baseline comparison

Historical data

Key Points for Review

1. Progress reports and reviews should be tailored to the appropriate stakeholder. The information on each report should include only what is necessary to accurately convey the message needed by that particular stakeholder or audience: give them what they need, but no unnecessary information “noise.”

2. There are two types of reports: one array is contractually required, while others are necessary for a stakeholder’s internal analysis and reporting needs. These reports may be derived directly from the scheduling software or formatted and prepared with other tools.

Summary

When communicating schedule progress, reports should be concise, accurate, and targeted to the appropriate stakeholder. There are many different types and variations of reports used in a particular industry or organization or under a given contract. Contract documents may specify types and frequencies of reports that are generated as the minimum requirements for communicating with stakeholders.

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Sample Questions for Section 2.4.6

1. For what can a progress report be used?
   A. Become the basis for historical data.
   B. Used to estimate and schedule future work.
   C. Convey information concerning the project progress.
   D. All of the above.

2. True or False: The progress report includes the following?
   A. Status of impacts and delays.
   B. Descriptive analysis of progress since last reporting period.
   C. Brief statements on short term and long term future work.
   D. Various types of progress, trend, and variance graphs and charts.

3. Which is not a characteristic of progress reports?
   A. Reliable
   B. Fixed
   C. Credible
   D. Accurate

4. Should one report be used for all stakeholders? Explain.

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Solutions to Sample Questions for Section 2.4.6

1. D. All of the above.

2. True

3. B. Fixed

4. No, reports should be adapted to meet the needs and purposes of the intended stakeholder.

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2.4.7 Recovery Schedules

Introduction and Learning Objectives
Understand why and how recovery schedules are developed and implemented.

Recovery schedules are used when a project is in jeopardy of missing its cost or schedule targets. When developing and implementing a recovery schedule, there are potential cost implications that must be reported to stakeholders.

Often, as a result of trending, analyzing, and forecasting, it is determined that the original target dates or cost budgets are no longer achievable under the current execution plan. As a result, recovery schedules and "work-arounds" are developed and implemented to minimize the impacts of changes and delays. Recovery schedules attempt to bring the schedule and cost back into alignment with contract requirements and stakeholder needs.

The project team should understand the different methods used to develop and implement recovery schedules and their supporting cost implications.

Contracts may specify under what progress reporting circumstances a recovery schedule should be developed. The contractor may request to implement a recovery schedule when considering plan alternatives.

Related Sections

- Contract and Specification: 1.1.1 - Contract Requirements, 2.1.3 - Schedule Specification
- Stakeholders - Sections: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholder Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholder, 2.3.6 - Schedule Maintenance Feedback
- Scope of Work: 1.3.1 - Define Scope of Work, 2.1.1 - Define Schedule Scope
- Estimate: 1.3.10 - Cost Estimate Development, 2.1.5 - Cost Estimate Model
- Baseline: 1.3.11 – Baseline Plan, 2.2.9 - Schedule Basis Documentation, 2.3.1 - Baseline Schedule
- Trend Analysis and Variances: 2.4.2 - Variances and Trends, 2.4.3 – Schedule Analysis
- Forecasts: 1.3.12 - Periodic Forecasts, 2.4.4 - Schedule Forecasts
- Risk: 1.3.13 - Risk and Recovery Plan
- Schedules: 2.1.1 – Types of Schedules, 2.4.1 - Control Level Schedule
- Progress: 2.3.2 - Tracking Schedule Progress, 2.4.6 - Progress Reports and Reviews
- Milestones: 2.2.7 - Milestones
- Change Management: 2.3.4 - Schedule Change Management
- Acceleration: 2.3.5 - Acceleration

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Terms to Know

Corrective action plan
Change management
Recovery schedules:

- Schedule acceleration
- Schedule compression
- Overtime
- Multiple shifts
- Additional resources
- Schedule crashing

Productivity
Scope change
Substantial completion
Milestone and project completion
Schedule acceleration
Schedule crashing

Key Points for Review

1. Project schedules are dynamic, so schedule and cost variances are common. When achieving critical milestones might be in jeopardy, recovery action and "work-around" plans may need to be developed. These plans are commonly called recovery plan alternatives and may suggest acceleration, schedule compression, overtime, multiple shifts, or the addition of resources necessary to again bring the project into time or cost alignment.

2. Through schedule maintenance, updates, and performance measurements, trends and key indicators will alert the project scheduling team that critical milestones deadlines may be missed. As a result, a recovery schedule should be developed as a corrective action to get the project back on target.

3. In developing recovery schedules, both cost and time must be considered.

Summary

Project schedules are dynamic, so updated forecasts sometimes show that critical deadlines will probably be missed. When this occurs, a recovery plan and schedule should be developed and implemented. The recovery plan and schedule must be closely monitored to ensure that targets are met.

Recovery schedules are based on updated trends, analysis, and forecasts. When trends and forecasts indicate that the current targets may not be achievable, alternatives must be developed.

Once a recovery schedule is implemented, it is confirmed with continuous trending and forecasting, and progress is monitored and reported to appropriate stakeholders.

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Sample Questions for Section 2.4.7

1. What are some common types of recovery schedule techniques?
   A. Acceleration, schedule compression, overtime, multiple shifts, or additional resources.
   B. Extending the schedule duration.
   C. Reducing manpower or subcontracts.
   D. Deceleration of critical activities in order to have non-critical path activities reaches a par with critical path activities.

2. How is recovery schedules triggered?
   A. By contractual requirement
   B. By the prime contractor
   C. By the owner
   D. By the project plans

3. Recovery schedules are a result of what?

4. For what are recovery schedules used?

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Solutions to Sample Questions for Section 2.4.7

1. A. Acceleration, schedule compression, overtime, multiple shifts, or additional resources.

2. A. By contractual requirement.

3. Variances and trends, delays, or revisions to the scope of work.

4. Bringing the schedule and cost back into alignment with contract requirements and stakeholder needs.

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2.4.8 Management Summary

Introduction and Learning Objectives

Understand the need for summarizing and reporting schedule monitoring and control information for management. The goal of such reporting is to give brief, concise, and accurate overviews of status to management. Since management does not have the time to look through the detail, consistently presented summary information using key metrics is provided, so there are no surprises during the course of a project.

Summary information is valuable for management, since it assists them in making decisions about resources and risks, and it aids in the broader aspects of decision-making.

Related Sections

- Stakeholders: 1.1.2 - Identification of Stakeholders, 1.2.3 - Stakeholder Considerations, 1.3.9 - Review by Stakeholders, 2.1.4 - Feedback from Stakeholders, 2.3.6 - Schedule Maintenance Feedback
- Resources - Sections: 1.2.1 - Identification of Resources, 2.2.6 - Cost and Resource Loading, 2.3.3 Cost and Resource Management
- Forecasts: 1.3.12 - Periodic Forecasts, 2.4.4 - Schedule Forecasts
- Quality: 2.2.8 – Schedule Quality Analysis and Compliance Review
- Schedules: 2.1.1 – Define Schedule Scope, 2.1.3 – Schedule Specification, 2.2.1 – Types of Schedules, 2.2.8 – Schedule Quality Analysis and Compliance Review, 2.2.9 – Schedule Basis Documentation, 2.3.1 – Baseline Schedule, 2.4.1 - Control Level Schedules
- Milestones: 2.2.7 - Milestones
- Progress: 2.3.2 - Tracking Schedule Progress, 2.4.6 - Progress Reports and Reviews
- Trends - Section: 2.4.2 - Variances and Trends, 2.4.3 – Schedule Analysis

Terms to Know

Quality data points

Key Points for Review

Understanding the levels and types of reports required by management is important. Summary information using key metrics is provided to management using consistent reporting formats. This allows making key decisions to keep the project on target, and it serves well for development and control of broader policy.

Summary

Management requires concise, consistently presented, and accurate information. Different levels of management need different breadth, depth, and summarization of information. One of the key requirements when reporting to management is to make sure there are no surprises, when it comes to the progress of the work.

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Please see **Sample Questions for Section 2.4.8** on page 249

Please see **Solutions to Sample Questions for Section 2.4.8** on page 250

Sample Questions for Section 2.4.8

1. What is a management summary?
   A. A detailed report
   B. A set of construction documents
   C. A concise summary of key points and issues
   D. A report that excludes problem areas

2. The summary report is directed toward?
   A. Superintendents
   B. Project controls staff
   C. Management and owners
   D. Subcontractors

3. The management summary assists in?
   A. Making decisions about risk
   B. Giving detailed advice to the owner
   C. Procurement of third party equipment and materials
   D. Developing operating procedures

4. What type of information does management require?
   A. Concise and accurate with no surprises
   B. General information about the project
   C. Graphs and presentations on similar projects
   D. Detailed schedule analysis

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Solutions to Sample Questions for Section 2.4.8

1. C. A concise summary of key points and issues.

2. C. Management and owners.

3. A. Making decisions about risk.

4. A. Concise and accurate with no surprises.

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Appendices

Appendix A—*Complex Problems*

Appendix B—*Recommended References and Resources*

Appendix C—*PSP Glossary of Terms*

Appendix D—*AACE International Canons of Ethics*

Appendix E—*PSP Exam Written Memorandum*

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Please see **Appendix A** on the next page

Appendix A:

Complex Problems

Example Scenario

Draw a CPM network diagram using the data in Table 1. Use PDM format to show Activity ID, Description, Original Duration (OD), Total Float (TF), Free Float (FF), Early Start (ES), Early Finish (EF), Late Start (LS), and Late Finish (LF). Assume a 5-day, 8-hour work week with no holidays and notice to proceed on 5 March 2007.

<u>NOTE</u>: Review *Skills & Knowledge of Cost Engineering, 6th Edition*, Chapter 13 Scheduling before answering the Sample Questions below. Refer to **Forward and Backward Pass for Overlapping Relationships** in Chapter 13.

<u>Sample Questions for Appendix A:</u>

1. What is overall duration of project in workdays (WDs) and calendar days (CDs)?
2. Identify all non-critical path activities.
3. Identify TF and FF for each activity.
4. If completion of Activity 1030 is delayed by 20 CDs, determine the ES of Activity 1070 and FF of Activity 1020.
5. Given 25 WD delay to Activity 1040, what can be done to maintain as-planned final completion date? Identify potential actions and associated issues and risks.

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Table 1

	Description	Duration	Relationship
1010	NTP Notice to Proceed	Milestone	No other activity can start until NTP issued
1020	Mobilize to site	20 WD	Succeeds finish of Activity 1010
1030	Bid and select subcontractor	30 WD	Succeeds finish of Activity 1010
1040	Deliver owner equipment	40 WD	Succeeds finish of Activity 1010 by 10 days
1050	Construct foundations	25 WD	Succeeds finish of Activity 1020 Succeeds finish of Activity 1030
1060	Install equipment	20 WD	Succeeds finish of Activity 1030 by 10 days Succeeds finish of Activity 1040 Tie Finish to Finish of 1050 (predecessor)
1070	Connect and install controls	15 WD	Succeeds start of Activity 1060 by 10 days
1080	Start and test equipment	10 WD	Succeeds finish of Activities 1060 and 1070
1090	Mechanical completion	Milestone	Succeeds finish of Activity 1080
1100	Commission equipment	15 WD	Succeeds finish of Activity 1090
1110	Final completion	Milestone	Succeeds finish of Activity 1100
WD = Workday 5-Day Workweek NTP Issued Monday, 3/05/07			

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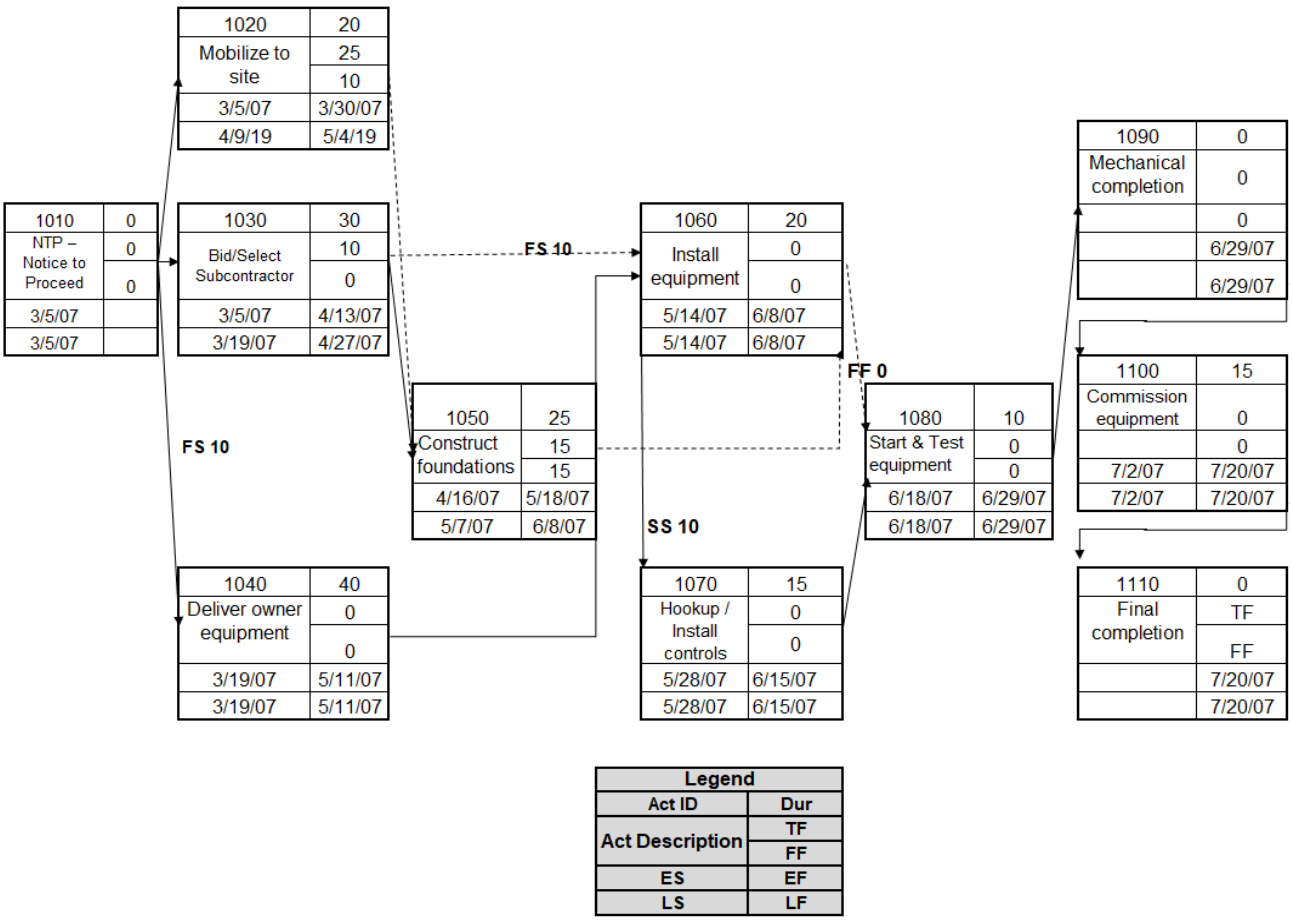
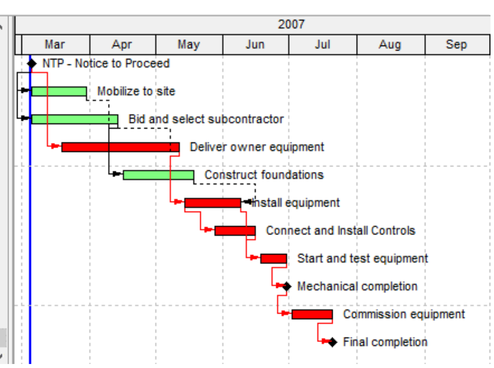
Example Scenario: PDM Diagram – TF and FF

PDM Diagram – TF and FF:



Example Scenario: Bar Chart in P6 of Solution:

Activity ID	Activity Name	Original Duration	Early Start	Early Finish	Late Start	Late Finish	Total Float	Free Float	Predecessors	Successors
1010	NTP - Notice to Proceed	0	05-Mar-07		05-Mar-07		0	0		1020, 1030, 104
1020	Mobilize to site	20	05-Mar-07	30-Mar-07	09-Apr-07	04-May-07	25	10	1010	1050
1030	Bid and select subcontractor	30	05-Mar-07	13-Apr-07	19-Mar-07	27-Apr-07	10	0	1010	1060, 1050
1040	Deliver owner equipment	40	19-Mar-07	11-May-07	19-Mar-07	11-May-07	0	0	1010	1060
1050	Construct foundations	25	16-Apr-07	18-May-07	07-May-07	08-Jun-07	15	15	1020, 1030	1060
1060	Install equipment	20	14-May-07	08-Jun-07	14-May-07	08-Jun-07	0	0	1030, 1040, 1050	1070, 1080
1070	Connect and Install Controls	15	28-May-07	15-Jun-07	28-May-07	15-Jun-07	0	0	1060	1080
1080	Start and test equipment	10	18-Jun-07	29-Jun-07	18-Jun-07	29-Jun-07	0	0	1060, 1070	1090
1090	Mechanical completion	0		29-Jun-07		29-Jun-07	0	0	1080	1100
1100	Commission equipment	15	02-Jul-07	20-Jul-07	02-Jul-07	20-Jul-07	0	0	1090	1110
1110	Final completion	0		20-Jul-07		20-Jul-07	0	0	1100	



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Solutions to Sample Questions for Appendix A:

1. Overall duration: Monday, 3/05 Friday, 7/20/07
    a. Calendar days = 138 CDs [7/20 3/05 +1].
    b. Workdays = 100 WDs [138 19 weekends *2].

2. Non-critical path activities: 1020, 1030 and 1050.

3. TF and FF for each activity: See PDM diagram.

4. Delayed Activity 1040: See delay chart.
    a. ES Activity 1070 5/28/07
    b. FF Activity 1020 = 24 WDs
5. Options and risks: must be reasonably achievable.
    a. Reduce durations of activities on critical path.
        i. Add resources
        ii. Re-sequence work
    b. Reduce start lag durations to follow-on activities
    c. Added resources may introduce disruptions
        i. Learning curve, inefficiencies, impact, etc.

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More Appendix A Questions and Answers

Notes:

a. Instead of providing a logically tied together network diagram, a listing of activities, attributes, and logic ties is provided. Examinee would then use whatever means deemed most appropriate to solve the problem.

Questions:

Using Table 2, which describes a CPM schedule, answer the following questions

Table 2

Activity #	Description	Original Duration (OD)	Crew Size (Equivalents)	Run Rate ($/day)	Fixed Cost ($)	Predecessors	Successors
1100	Notice To Proceed (NTP)	0	0	$0	$0	- - -	1200
1200	Mobilization & Site Work	10	50	$4,500	$10,000	1100	1300
1300	Foundations	14	80	$6,500	$45,000	1200	1500
1400	Rough-In MEP	30	45	$4,000	$65,000	1200	1700
1500	Structure	28	90	$7,500	$95,000	1300	1700
1600	Interior Work	35	30	$2,500	$75,000	1200	1700, 1800
1700	Finish Work	7	50	$6,000	$75,000	1400, 1500, 1600	1900
1800	Install Fixtures & Equipment	7	10	$1,500	$25,000	1600	1900
1900	Substantial Completion	0	0	$0	$0	1700, 1800	- - -

Determine the following:

(a) Which activities have total float (TF) and what are their values?

(b) What is the total value of the work as planned and when does it achieve substantial completion?

(c) Using late start dates, what is the peak staffing and when does it occur?

(d) Assume that the project progresses as planned until the 15th workday [15Mar08]. From 15Mar to 19Mar, Activity 1600 makes no progress (pure delay). What affect does this have on:

- i. Substantial Completion
- ii. Staffing and Cost to Complete

(e) The client seeks to complete the project ten (10) days early. It is agreed to do this that activity 1500, structure, would be shortened by ten (10) work days. To achieve this accelerated completion:

- i. What else must be done to achieve the early completion date (by 10 days)?
- ii. What is the new completion date?
- iii. Assume that the acceleration costs for the compressed activity(ies) are 2.5 times the "normal" run rate. In addition, there will be a one-time cost of $12,500 to implement the acceleration. What is the new total cost estimated to complete the accelerated work?

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Answers:

(a) 1400 (TF=12), 1600 (TF =7), and 1800 (TF=7)

(b) $996,000 on 28Apr08

(c) 165 equivalents, March 25, 2008

(d)
i. None Activity 1600 has a TF value of 7 work days (WD). With delay of only 5 WDs, no impacts to SC

ii. Theoretically, there should be no change to cost to complete, it will only shift downstream within the overall project spend curve. However, resource use issue is an open question. Can staffing be efficiently shifted to support other work (on or off the critical path)? This must be analyzed and answered. The contractor may encounter disruption costs if excess staffing cannot be used elsewhere.

(e)
i. Reduce the duration of Activity 1600, Interior Work, by 3 work days (it originally has 7 days total float) such now that it becomes concurrently critical with Activity 1500, Structure.

ii. 18Apr08

iii.

		Accel.	Normal	Delta
Activity 1500: (28-10 days) x $7,500/day x 2.5	=	$337,500	$210,000	$127,500
Activity 1600: (35-3 days) x $2,500/day x 2.5	=	$200,000	$87,500	$112,500
			Total Increased Run Rate Cost:	$240,000
			Add Fixed Acceleration Cost:	$12,500
			“Normal” Duration Project Total Cost:	$996,000
			TOTAL ACCELERATED PROJECT COST:	**$1,248,500**

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Appendix B

Recommended References and Resources

Recommended PSP Resources

PSP Certification Review Course

AACE International's Planning and Scheduling Professional (PSP) Certification Review Course enables participants to sharpen their knowledge and skills prior to sitting for the examination. The course is not required in order to become certified, and attending the course does not guarantee that one will pass the certification exam. By no means does the review course "teach the test," but it allows attendees to become familiar with how questions are posed about the most critical topics in order that they might better prepare and maximize their performance. Participants must come to the review course well-prepared, preferably after gaining a strong working knowledge of the topics of this ***Study Guide*** and related references, preferably by working sample questions prior to attending the course.

The following are the most commonly used references that apply to the PSP certification exam. When preparing for the PSP certification exam, one should check AACE International's web site for the latest information about the exam. It is also wise to ensure that one's references are the latest editions, so please check the AACE International website for the latest editions of AACE International publications. As AACE International Recommended Practices are continuously being developed and updated, please visit https://web.aacei.org/resources/publications/recommended-practices for the latest information.

Primary References

1. **AACE International Recommended Practice (RP) 10S-90**, *Cost Engineering Terminology*, (Rev. April 25, 2013)
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3. **AACE International Recommended Practice (RP) 14R-90**, *Responsibility and Required Skills for a Planning and Scheduling Professional*. (2006).
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5. **AACE International Recommended Practice (RP) 21R-98**, Project Code of Accounts As Applied in Engineering, Procurement, and Construction for the Process Industries. (Rev. Jan. 27, 2003).

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15. Kerzner, H. **Project Management: A Systems Approach to Planning, Scheduling and Controlling**, 9th Edition, 2005.

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2. Griffis, F. and Farr, J. **Construction Planning for Engineers**, 1999.

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Appendix C

PSP Glossary of Terms

Foreword

This special list of common planning and scheduling terms and acronyms derives from **AACE International's Recommended Practice (RP) 10S-90**, *Cost Engineering Terminology.*

The most current version of AACE Recommended Practice 10S-90, with its full definitions of all cost engineering terminology is posted online at:

http://library.aacei.org/terminology

This glossary:

- Lists common terms and acronyms used in PSP Certification process;
- Identifies terms and phrases, which should be familiar to planning and scheduling professionals; and
- Includes terms and phrases from a variety of industries and entities.

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Budgeted Cost of Work Performed (BCWP) - Syn.: Earned Value

Budget Estimate (This term is superseded by Recommended Practice No. 17R-97 “Cost Estimate Classification System”.)

Budgeted Cost of Work Scheduled (BCWS) - In current Earned Value Management System usage, it is referred to as “planned value” or PV Syn.: Planned Value (PV)

Budgeting

Bulk Material

Burden of Proof

Burn Rate

Business Planning

Business Case

Calculate Schedule

Calendar

Calendar Range

Calendar Unit

Calendar Start Date

Capital Project

Cards-on-the-wall Planning

Cash Flow

Cash Flow (NET)

Cash Flow Management

Causation

Certainty

Chain

Change

Change, Cardinal

Change, Constructive

Change, Unilateral

Change Control - Three Definitions

Change Documentation/Log

Change in Scope

Change in Sequence

Change Management

Change Order Two Definitions

Changed Conditions

Chart of Accounts - Syn.: Code of Accounts (COA)

Child

Child Activity

Claim

Client Two Definitions

Closeout

Code

Code of Accounts (COA) - Syn.: Chart of Accounts

Coding

Commissioning

Company

Completed Activity

Completion (Contract)

Completion Date (Planned)

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Compound Risk

Concept Definition Document - Syn.: System Concept Document

Concept Phase

Conceptual Estimate (This term is superseded by Recommended Practice No. 17R-97 “Cost Estimate Classification System”.)

Conceptual Schedule

Concurrency

Concurrent Activities

Concurrent Delay Five Types

Condition (Uncertain)

Conditional Risk

Confidence Level

Configuration Two Definitions

Configuration Control

Configuration Management

Conflict

Conflict in Plans and Specifications

Conflict Management

Constraint Syn.: Restraint

Constraint Date See: Plug Date

Constructability Three Definitions

Construction Cost

Construction Management Two Definitions

Construction Progress

Construction Progress Report

Constructive Acceleration Five Types

Constructive Change

Constructive Delay

Consumable Resource

Consumables

Contingency

Contract Two Types

1. Cost- Plus Contracts
   Cost- Plus Percentage Burden and Fee
   Cost- Plus Fixed Fee
   Cost- Plus Fixed Sum
   Cost- Plus Percentage Fee
2. Fixed Price Contracts
   Lump- Sum
   Unit- Price
   Guaranteed Maximum (Target) Price)
   Bonus Penalty

Contract Change Four Types

Contract Completion Date

Contract Dates

Contract Documents

Contract Master Schedule

Contract Plan

Contract Price

Contract “Read as a Whole"

Contract Time

Contract Work Breakdown Structure (CWBS)

Contractor Two Definitions

Control Three Definitions

Control Account (CA) - Syn.: Cost Account

Control and Coordination

Control Baseline

Control Gate

Controlling Path

Controlling Relationship

Correction Period

Cost

Cost Account - Syn.: Control Account (CA)

Cost/Schedule Control System Criteria (C/SCSC)

Cost Baseline

Cost Breakdown Structure (CBS) - Two Definitions

Cost Category

Cost Codes

Cost Control

Cost Control System

Cost Curve

Cost Distribution

Cost Estimate - See: Cost Estimate Classification System.

Cost Estimate Category - Syn.: Cost Estimate Classification System.

Cost Estimate Class - Syn.: Cost Estimate Classification System

Cost Estimate Classification System - Five Classes - Syn.: Cost Estimate Type, Cost Estimate Class, Cost Estimate Category. See: AACE International Recommended Practices No. 17R-97 "Cost Estimate Classification System" and No. 18R-97 "Cost Estimate Classification System As Applied in Engineering, Procurement, and Construction for the Process Industries".

Cost Estimate Type - Syn.: Cost Estimate Classification System

Cost Estimating

Cost Loading

Cost Performance Index / Indicator (CPI)

Cost to Complete

Cost Value See: Functional Worth

Cost Variance

Costing - Three Definitions

Costing, Activity Based (ABC)

CPM - See: Critical Path Method (CPM)

Crash Costs

Crash Duration

Crashing

Crew Hour

Crew Rate

Critical Activity

Critical Chain

Critical Path

Critical Path Analysis

Critical Path Method (CPM) - Two Definitions

Critical Relationship

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Critical Sequence

Critical Sequence Analysis

Critical Task

Criticality

Criticality Index

Crude Materials - Syn.: Raw Materials

Current Date Line

Current Dollars

Current Finish Date

Current Schedule

Current Start Date

Current Status

Customer

Customer Furnished Equipment (CFE)

Cutoff Date

Cycle Time

Damages, Actual

Damages, Liquidated

Damages, Ripple

Dangle

Data Date Two Definitions

Date Constraint

Date for the Commencement of the Contract Time

Date of Acceptance

Day Work Account

Deceleration

Decision Event

Decision Model

Decision Policy

Decision Tree

Decisions Under Certainty

Decisions Under Risk

Decisions Under Uncertainty

Defect

Defective

Defective Specifications

Defect, Latent

Defect, Patent

Definition (Project)

Definition Phase - Syn.: Planning Phase; Development Phase; Front End

Definitive Estimate Two Definitions - (This term is superseded by Recommended Practice No. 17R-97 “Cost Estimate Classification System”.)

Delay

Delay, Compensable Three Definitions

Delay, Concurrent

Delay, Excusable

Delay, Inexcusable

Delay, Non-Prejudicial

Delay, Pacing - Three Definitions

Delay, Parent

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Earned Hours (EH)

Earned Value (EV)

Earned Value Concept

Earned Value Reports

Earnings Value

Effective Date of the Agreement

Efficiency - Syn.: Productivity

Efficiency Factor

Effort

Effort Remaining

Effort-Driven Activity

Eighty-Hour Rule

Eighty-Twenty Rule (Pareto's Law)

Elementary Commodity Groups (Elementary Groups)

End Activity

End Event (of a project)

End Item

Ending Node of Network (ADM)

End Network Event

Engineer (In Contracts)

Engineering Change Notice (ECN)

Engineering Change Proposal (ECP)

Engineering Change Request (ECR)

Engineered Items

Enterprise - Two Definitions

Enterprise Project Management

Enterprise Resource Planning (ERP)

Equitable Adjustment

Equivalent Sets of Commodities

Errors and Omissions

Estimate - Two Definitions - See: Forecast

Estimate Backup

Estimate, Cost

Estimate at Completion (EAC)

Estimate to Complete - Two Definitions

Estimated Completion Date

Event - Two Definitions

Event Name

Event Number

Event Oriented

Event Slack

Event Times

Exception Report

Exceptions

Exclusive or Relationship

Excusable Compensable Delays

Excusable Non-Compensable Delays

Exit Criteria

Expansion

Expected Begin Date - Syn.: Target Start Date

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Expense

Expert Judgment

External Constraint

Expected Duration

Facility

Fee

Field Indirects

Field Labor Overhead

Field Order

Field Supervision Costs

Field Supervision

Finish Date

Finish Float

Finish-to-Finish Lag

Finish-to-Finish (FF)

Finish-to-Start Lag

Finish-to-Start (FS)

Finished Goods

First Event Number

Fixed Cost

Fixed Date

Fixed Start

Fixed-Duration Scheduling

Fixed-Price Contract

Float - Two Definitions - Syn.: Slack

Float Trend Charts

Flow Diagram

Follow-on Work

Forecast - Two Definitions

Forecasting - Two Definitions

Forward Pass - Two Definitions

Fragnet - Two Definitions

Free Float (FF)

Free Haul

Free Slack

Fringe Benefits

Front End - Syn.: Definition Phase.

Front End Loading (FEL)

Front End Schedule

Function

Functional Replacement Cost

Functional Use Area

Functional System

Gantt Chart Syn: Bar Chart

General and Administrative Costs (G&A)

General Requirements

General Terms and Conditions Two Definitions

Given Year

Global Calendar

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Graphical Evaluation and Review Technique (GERT)

Gross Area

Gross Concurrency

Guideline

Hammock Activity

Hanger

Hard Logic - Two Definitions

Haul Distance

Hedge

Heuristic

Hierarchical Coding Structure

Hierarchical Planning

Hierarchy (hierarchical)

Highest and Best Use

Historic Records

Historical Database

Holding Time

Holiday

Hypercritical

Hypercritical Activities

I-Node

I-J Notation

Identifier

Idle Time

Immediate Activity

Impact Cost

Imperfection

Imposed Date - Two Definitions

Imposed Finish Date

Imposed Start Date

Impossibility

Impracticability

In-Progress Activity

In-Progress Inventory

Inclusive or Relationship

Independent Event

Independent Float

Indicated Total Cost

Indirect Costs - Three Definitions

Indirect Pacing

Individual Work Plan

Inefficiency

Inexcusable Delays

Inflation

Initiation

Input Milestones

Input-Output Analysis

Intangibles - Two Definitions

Integrated Change Control

Integrated Cost/Schedule Reporting

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Interdependent Event

Interface

Interface Activity

Interface Management

Interface Node

Interference

Interim Dates

Interim Deliverables

Intermediate Events

Intermediate Materials

Intermediate Node

Interruption

Inventory

Irrefutable Logic

Ishikawa Diagram

Issues Management

Item

J-Node

Job

Job Overhead

Judgmental Sampling

Just-In-Time

Key Activity

Key Event Schedule

Key Events

Key Performance

Key Performance Indicators (KPI)

Key Success Indicators (KSI) - Syn.: Key Performance Indicators (KPI)

Labor

Labor Burden

Labor Cost - Three Types

Labor Factor

Labor Hour - Syn.: Workhour

Labor Productivity

Labor Productivity Factor

Labor Rate

Ladder

Ladder Activity

Laddering

Lag

Lag Duration

Lag Relationship - Four Types

Lag Time

Late Dates

Late Event Date

Late Finish (LF)

Late Start (LS)

Latent Condition

Latest Event Time (LET)

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Late Start

Latest Revised Estimate

Laws and Regulations

Lead

Lead Duration/Lead Time

Learning Curve

Lessons Learned

Level Finish/Schedule (FS)

Level Float

Levelized Fixed-Charge Rate

Level of Detail

Level of Effort (LOE)

Level Start/Schedule (SS)

Leveling

Levels of Schedules - Three Levels

Life - Two Definitions

Life Cycle - Three Types

Line of Balance (LOB)

Line of Credit

Linear Programming

Linear Responsibility Chart

Linear Scheduling Method (LSM)

Link

Linked Bar Chart

Linked Projects

Linking Procedure

Liquidated Damages

Load Factor - Two Definitions

Load Leveling - Syn.: Work Power Leveling

Local Cost

Location Factor

Logic

Logic Constraint

Logic Diagram - Syn.: Logic Network Diagram.

Logic Network

Logic Network Diagram - Syn.: Logic Diagram.

Logic Restraint - Two Definitions

Logic Sequencing

Long Lead Items

Long Lead Procurement

Longest Path (LP)

Look-Ahead Schedule

Loop / Logic Loop

Loss of Productivity/Efficiency - See: inefficiency

Lost Productivity

Lot Batch

Lot Size

Lowest Management Level (LML)

Lowest Static Baseline (LSB)

Lump Sum

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Major Components

Major Milestones

Management by Exception

Management by Methods (MBM)

Management by Objectives (MBO)

Management by Politics (MBP)

Management by Rules (MBR)

Management by Values (MBV)

Management by Walking Around (MBWA)

Management Control Point

Management Control Systems

Management Reserve - Syn.: Reserve; Reserve Allowance

Management Science

Mandatory Dependency

Manpower Loading Chart

Manpower Planning

Manufacturing Cost

Manufacturing Resource Planning (MRP II)

Marginal Analysis

Mark-up

Master Production Schedule (MPS)

Master Schedule

Master Schedule Item

Master Scheduler

Material Cost

Material Difference

Material Requirements Planning (MRP)

Means and Methods - Syn.: Method of Performance

Mechanical Completion

Mechanical Completion

Merge Node

Merit Shop - Syn.: Open Shop

Method of Measurement

Method of Performance - Syn.: Means and Methods

Micro-Scheduling

Milestone

Milestone Dictionary

Milestone Flag

Milestone Level

Milestone, Payment

Milestone Plan

Milestone Report

Milestone Schedule

Misrepresentation

Mitigation - Two Definitions

Mitigation of Damages

Modeling

Modification, Bilateral

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Modification, Unilateral

Monitoring

Monte Carlo Method

Monthly Guide Schedule - Syn.: Short-Term Activities

Month-to-Month Price Index

Most Likely Time

Moving Average

MRP - Syn.: Material Requirements Planning (MRP)

MRP II - Syn.: Manufacturing Resource Planning (MRP II)

Multi-Project Scheduling

Multiple Finish Network

Multiple Start Network

Multiple Straight Line Depreciation Method

Must Finish See: Imposed Finish Date

Must Finish By Date

Must Start

Near-Term Activities

Negative Float - Two Definitions

Negligence

Net Area

Network

Network Analysis

Network Diagram - Syn.: Logic Diagram

Network Float

Network Interface

Network Logic

Network Path

Network Planning

Network Scheduling

Node

Non-Critical Activities or Work Items

Non-Excusable Delays - Two Definitions

Non-Exempt Employees

Non-Splittable Activity

Non-Work Unit

Normalization

Normal Weather

Not Earlier Than

Not Later Than

Notice of Award

Notice to Proceed (NTP)

Objective

Objective Event

Obsolescence - Three Definitions

Offsites

Omission

On-Stream Factor

Open Shop - Syn.: Merit Shop.

Operation

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Operation Phase

Opportunity

Optimistic Duration

Optimistic Time Estimate

Order of Magnitude Estimate (This term is superseded by Recommended Practice No. 17R-97 “Cost Estimate Classification System”.)

Organizational Breakdown Structure (OBS)

Organizational Codes

Original Duration

Out-Of-Sequence Progress

Overhaul

Overhead

Overload

Overplan (Underplan)

Overrun (Underrun)

Owner

Owner Furnished Fixtures and Equipment (OFFE)

Parallel Activities

Parametric Estimate

Parent

Parent Activity

Pareto Diagram

Partial Utilization

Path

Path Float

PDM - Syn.: Precedence Diagramming Method

PDM Arrow

PDM Finish to Finish Relationship

PDM Finish to Start Relationships

PDM Start to Finish Relationship

PDM Start to Start Relationship

Percent Complete

Percent on Diminishing Value - Syn.: Declining Balance Depreciation

Performance Measurement Baseline

Performance Measurement System - Two Definitions

PERT (Project Evaluation and Review Technique)

PERT Analysis - Three Scenarios

PERT Chart

Pessimistic Time Estimate

Phase

Phased Construction

Physical Percentage Complete

Physical Progress

Physical Restraint

Plan - Five Definitions

Plan-Do-Check-Act (PDCA) Cycle - Two Definitions - Syn.: Deming Cycle.

Planned Cost

Planned Value (PV)

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Planner

Planning - Two Definitions

Planning Bill (of Material)

Planning Horizon

Planning Package

Planning Phase - Syn.: Definition Phase

Planning Session

Plug Date - Syn.: Constraint Date

Policy

Portfolio Management

Positive Float

Precedence Diagramming Method (PDM) - Two Definitions

Preceding Event - Syn.: Beginning Event

Preconstruction CPM

Predecessor

Predecessor Activity

Predecessor Activity - Two Definitions

Predecessor Event

Preferential Logic - Two Definitions

Preliminary CPM Plan

Preliminary Engineering

Prescriptive

Prevention

Pricing

Primary Classification

Prime Contractor

Proactive

Probabilistic Dependencies

Probabilistic Network

Probability of Underrun (Or Overrun)

Procedure

Process

Process Control

Process Design

Procurement

Product

Product Breakdown Structure (PBS)

Production Plan

Production Planning

Production Rate

Production Schedule Two Definitions

Productivity

Productivity Factor

Profit - Three Types

Profit Margin

Profitability

Profitability Analysis

Profitability Index (PI)

Program - Three Definitions

Program Management

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Program Manager

Progress - Two Definitions

Progress Date

Progress Line

Progress Measurement

Progress Milestones

Progress Override

Progress Report

Progress Trend - Syn.: Trend

Project

Project Boundary

Project Calendar

Project Code

Project Control - Four General Steps

Project Definition

Project Duration Two Definitions

Project Finish Date (Schedule)

Project Float

Project Life

Project Management - Two Definitions

Project Management Software

Project Manager

Project Network Analysis - Syn.: Network Analysis

Project Office

Project Phases

Project Plan

Project Scope - Syn.: Scope

Project Start Date

Project Summary Work Breakdown Structure (PSWBS)

Project Time

Projected Finish Date

Projected Start Date

Projection

Proposal Schedule

Proposed Base Contract Price

Proposed Combined Contract Price

Proposed Change Order - Three Types

Punchlist

Pure Price Change

Qualification Submittals

Qualifications and Assumptions

Quality

Quality Acceptance Criteria

Quality Activities

Quality Appraisal

Quality Assurance

Quality Audit

Quality Conformance

Quality Control

Quality Corrective Action

Quality Management

Quality Management Costs

Quality Nonconformance

Quality Performance Tracking System

Quantification

Quantity Ratio

Quantity Survey

Quantity Survey

Quantity Surveying

Quantity Surveyor

Range Estimating

Raw Materials - Syn.: Crude Materials

Re-baselining

Recovery Schedule

Recurring Task

Recycle

Relationship

Relationship Float

Relative Total Float

Remaining Available Resources

Remaining Duration

Remaining Float (RF)

Remeasurement

Rental (Leased) Equipment Cost

Replacement

Replanning - Two Types

Reprogramming

Repudiation

Required Completion Date

Requirements - Two Definitions

Reschedule - Two Definitions

Reserve - Syn.: Management Reserve

Reserve Allowance - Syn.: Management Reserve

Resident Engineer

Resource

Resource Aggregation

Resource Allocation Plan (RAP)

Resource Availability Date

Resource Availability Pool

Resource Calendar - Two Definitions

Resource Code

Resource Constraint

Resource Description

Resource Driven Task Duration

Resource Group

Resource Histogram - Syn.: Resource Plot

Resource Level

Resource Leveling

Resource Limited Scheduling

Resource Loading / Resource Allocation

Resource Optimization

Resource Planning

Resource Plot - Syn.: Resource Histogram

Resource Requirements Planning

Resource Smoothing

Resource Thresholds

Responsible Organization

Responsibility

Responsibility Code

Rest Day

Restraint - Syn.: Constraint

Retainage - Syn.: Retention

Retained Logic

Reverse Scheduling

Revision

Rework - Two Definitions

Ripple Effect

Risk Three Definitions

Risk Analysis

Risk Analysis Method - Three Techniques

Risk Assessment

Risk Control

Risk Management

Risk Management Plan - Four Steps

Risk Mitigation - Two Definitions

Risk Sources Divided into five Groups

Risk Types - Five Types

Rolling Wave Planning

Rules of Credit

S-Curve

Safety Time

Sales

Schedule - Two Definitions

Schedule Compression

Schedule Contingency - Two definitions

Schedule Decompression

Schedule Graphics

Schedule Model

Schedule of Values

Schedule Percent Complete

Schedule Performance Index (SPI)

Schedule Refinement

Schedule Report

Schedule Revision

Schedule Risk

Schedule Slip

Schedule Update

Schedule Variance - Two Definitions

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Schedule Work Unit

Scheduled Completion Date

Scheduled Event Time

Scheduling - Two Definitions

Scheduling Rules

Scheduling Techniques

Scope - Syn.: Project Scope

Scope Change - Syn.: Change in Scope

Scope Creep

Scope Definition - Three Components

Seasonal Commodities

Seasonal Variation

Secondary Float (SF)

Secular Trend

Sensitivity

Sensitivity Analysis

Sequence

Serviceability

Servicing

Service Worth Value

Shall

Shifting Base

Shop Drawings

Shop Order Number - Syn.: Account Number

Shop Planning

Short-Interval Scheduling

Short-Term Activities

Shutdown Point

Significant Variances

Site Preparation

Slack - Syn.: Float

Slack Paths

Slack Time

Slip Chart

Slippage

Smoothing

Soft Logic

Specification, Design

Specification, Performance

Specification(s) - Two Definitions

Specification Tree

Splicing Technique

Split Task

Splittable Activity

Splitting

Stand Alone

Standard

Standard Error of Estimate

Standard Network Diagram

Standard Operating Procedure

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Systems Studies

Take-off

Tangibles

Target Date

Target Finish Date

Target Plan

Target Reporting

Target Start Date

Task

Task Two Definitions

Task Monitor

Task Types

Template

Temporary Construction Cost

Termination

Terms of Payment

Theory of Constraints (toc)

Third Party Claim

Threat

Tied Activity

Time Extension

Time Horizon - Syn.: Study Period.

Time is of the Essence

Time Line

Time Now

Time Now Line

Time Phasing

Time Unit

Time Value of Money - Three Definitions

Time-Constrained Scheduling

Time-Limited Resource Scheduling

Time-Limited Scheduling

Time-Scaled CPM

Time-Scaled Logic/Network Drawing (or Diagram)

Total Cost Bidding

Total Cost Management (TCM)

Total Float (TF) - Three definitions

Total Quality Management (TQM)

Tracking

Trend

Trend Analyses

Trend Chart

Trend Line

Trend Monitoring

Trend Reports

Trending

Turnover – Syn: Delivery

Turnover Ratio

Unbalancing

Uncertainty –Two Definitions

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Underground Facilities

Union

Unit Cost

Unit Hours

Unit Rate

Unjust Enrichment Doctrine

Unlimited Schedule

Unusually Severe Weather

Updating

Update

Update Date

Value, Activity

Value Added by Distribution

Value Added by Marketing

Value of Work Performed To Date

Value Engineering

Value Engineering Cost Avoidance

Value Engineering Cost Reduction

Value Engineering Job Plan

Variable Costs

Variance

Variance Analysis - Includes six (6) Variances

Variance at Completion (VAC)

Variation in Estimated Quantity

Velocity Diagram

Vertical Event Numbering

Wage Rate

WBS Dictionary

Weights

Work

Work Breakdown Structure (WBS) - Two definitions and variations

Work Breakdown Structure Element

Work Breakdown Structure Levels

Work Category

Work Directive Change

Work Flow

Work Item - Two Definitions

Work Package - Two Definitions

Work Pattern

Work Power Leveling - Syn.: Load Leveling

Work Sampling

Work Site

Work Unit

Work-in-Progress - Two definitions - Syn.: In-Progress Inventory

Workaround

Workday

Worker

Workhour - Syn.: Labor Hour

Workhour Analysis

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Working Calendar

Workweek

Written Amendment

Zero Float

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Abbreviations and Acronyms

Words in parentheses support definition

AD Activity Description
ACWP Actual Cost of Work Performed
ADM - Arrow Diagramming Method
ADR - Alternative Dispute Resolution
AE - Apportioned Effort
AF - Actual Finish date
ALAP - As Late As Possible
AOA - Activity on Arrow (method)
AON - Activity on Node (method)
AS - Actual Start (date)
ASAP - As Soon As Possible
BAC - Budget at Completion
BCWP - Budgeted Cost of Work Performed
BCWS - Budgeted Cost of Work Scheduled
CA - Control Account
CAC - Cost at Completion
CM - Construction Management
CPI - Cost Performance Index
CPM - Critical Path Method
C/SC2 - Cost/Schedule Control System Criteria
CV - Cost Variance
CWBS - Contract Work Breakdown Structure
DCN - Design Change Notice
DCR - Design Change Request
DD - Data Date
DDT&E - Design, Development, Test and Evaluation
DU / DUR Duration
EAC - Estimate At Completion
ECN - Engineering Change Notice
ECR - Engineering Change Request
EF - Early Finish (date)
EH - Earned Hours
ES - Early Start (date)
ETC - Estimate To Complete
EV - Earned Value
EVMS - Earned Value Management System
FF - Finish-to-Finish (logic tie)
FF - Free Float
FS - Finish-to-Start (logic tie)
GAAP - Generally Accepted Accounting Principles
ITC - Indicated Total Cost
KPI - Key Performance Indicators
KSI - Key Success Indicators
LF - Late Finish (date)
LOB - Line of Balance (method)
LOE - Level Of Effort
LML - Lowest Management Level
LP - Longest Path
LS - Late Start (date)
LSB - Lowest Static Baseline
LSM - Linear Scheduling Method
MBM - Management By Methods
MBO - Management By Objectives
MBP - Management By Politics
MBR - Management By Rules
MBV - Management By Values
MBWA - Management By Walking Around
MRP - Material Requirements Planning
MRP - Manufacturing Resource Planning
MPS - Master Production Schedule
NTP - Notice To Proceed
OBS - Organizational Breakdown Structure
OFFE - Owner Furnished Fixtures and Equipment
OD - Original Duration
PC / PCT - Percent Complete
PDM - Precedence Diagramming Method
PDS - Product Breakdown Structure
PERT - Project Evaluation and Review Technique
PF - Planned Finish (date)
PM - Project Management
PM - Project Manager
PMIS - Project Management Information System
PMO - Program / Project Management Office
PMS - Performance Measurement System
PS - Planned Start (date)
RAP - Resource Allocation Plan
RBS - Resource Breakdown Structure
RD - Remaining Duration
SF - Scheduled Finish (date)
SF - Start-to-Finish (logic tie)
SOW - Statement Of Work
SPI - Schedule Performance Index / Indicator
SS - Scheduled Start (date)
SS - Start-to-Start logic (tie)
SV - Schedule Variance
TC - Target Completion (date)
TCM - Total Cost Management (process) (AACE International)
TF - Target Finish (date)
TF - Total Float
TS - Target Start (date)
WBS - Work Breakdown Structure
WD Workday
WH Workhour
WW Workweek

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Appendix D

AACE International's Canons of Ethics

AACE International members and those certified by AACE International agree to be bound by the terms of the AACE International Canons of Ethics, a criterion that says all individuals will practice their profession in a manner that meets fundamental ethical standards. The Canons of Ethics can be found at the AACE International website at web.aacei.org.

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Please see **Appendix E** on the next page

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Appendix E

PSP Exam Written Memorandum

The communication competency portion of the PSP exam requires the candidate to demonstrate writing skills and general knowledge around the planning and scheduling competency. The candidate is required to write a memorandum demonstrating their ability to communicate effectively their knowledge on a planning and scheduling subject.

The exam consists of a sample question in addition to any on-screen instructions given during the exam.

Question:

The question will identify your position, description of the project and general scope of the question. You should review the documentation required in the listing and prepare the memo as required.

MEMO

To: John Doe, Project Manager

From: John Smith, Risk Manager

Date: August 31, 2017

Subject: Appropriate Subject Based on the Question

- Introduce the problem;
- Discuss potential solutions;
- Perform an analysis;
- Make a recommendation based upon the analysis; and,
- Close the memo.

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