نحوه برآورد مدت زمان فعالیت‌ها در پروژه

(بر اساس اسنادی از AACE و AGC و PMI)

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What we will learn?

- Durations basics
- Time unit selection
- Estimating activity durations
- Example activity duration calculation
- Resource availability
- Factors affecting productivity
- Sources of quantity and productivity
- Activity duration assumptions

What we will learn?

- AACE Purpose and Overview
- AACE RP
  - Introduction
  - Phase I – Determine Unconstrained Activity Durations
  - Phase II – Adjust Activity Duration Based on Constraint Impact or Other Limiting Factors
  - Phase III – Revise Original Activity Durations to Meet Project Requirements
  - Calculating Remaining Durations
  - Duration Relationship with Actual Start and Finish Dates
  - Risk and Activity Duration Variability
  - Contract/Scheduling Specifications Requirements
  - Software Issues
  - Calculating Original Durations Using the Approved Estimate

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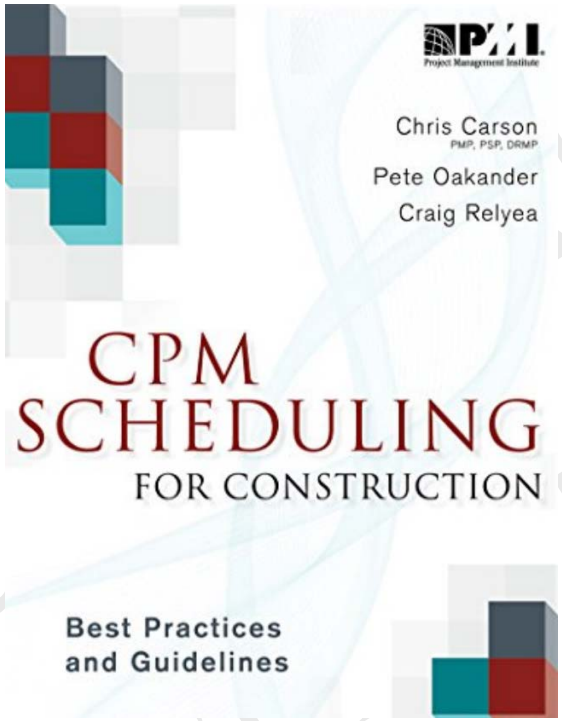
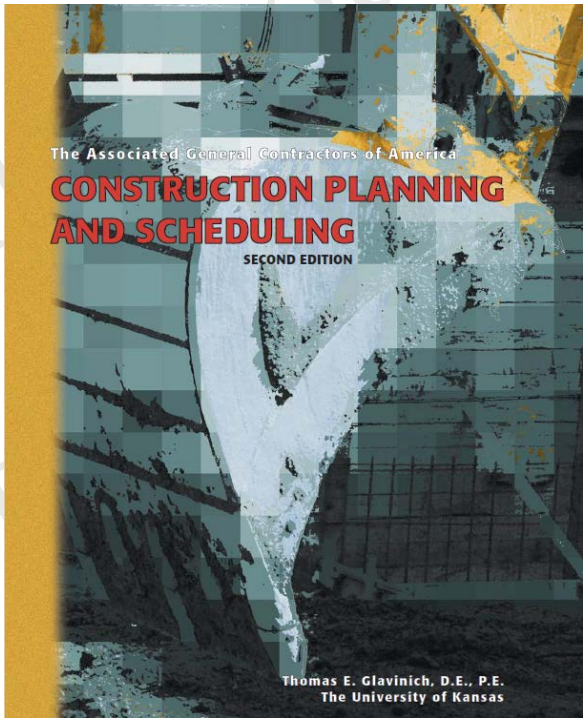
What we will learn?

- Improving Duration Accuracy
- Duration Verification
- Participation In Duration Review

Reference

Primary references





Other references

Durations Basics

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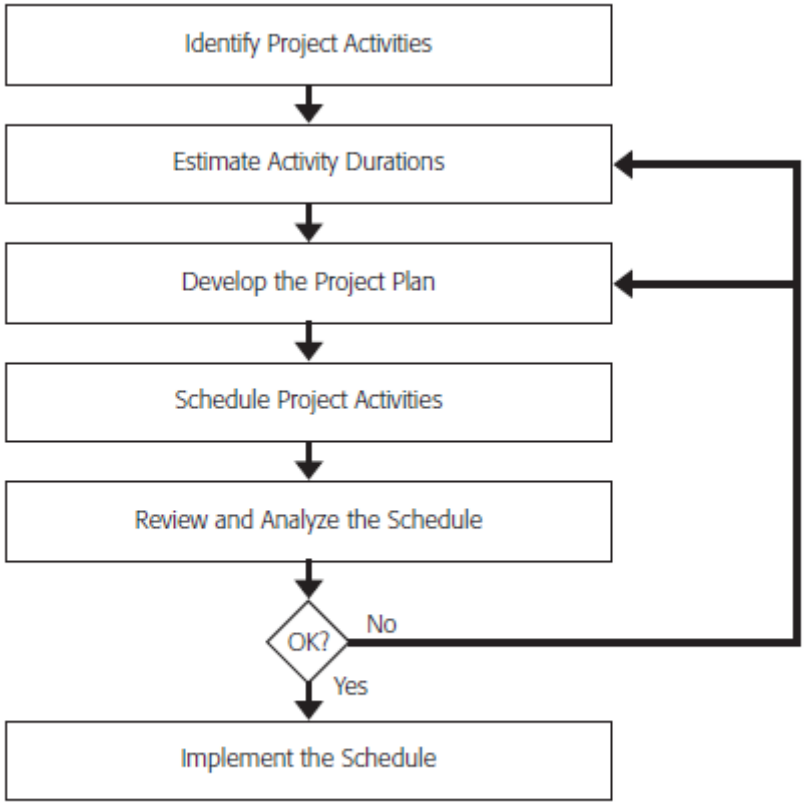
Definitions

- Activity durations, along with logic,

  are the **basic building blocks** of any schedule.

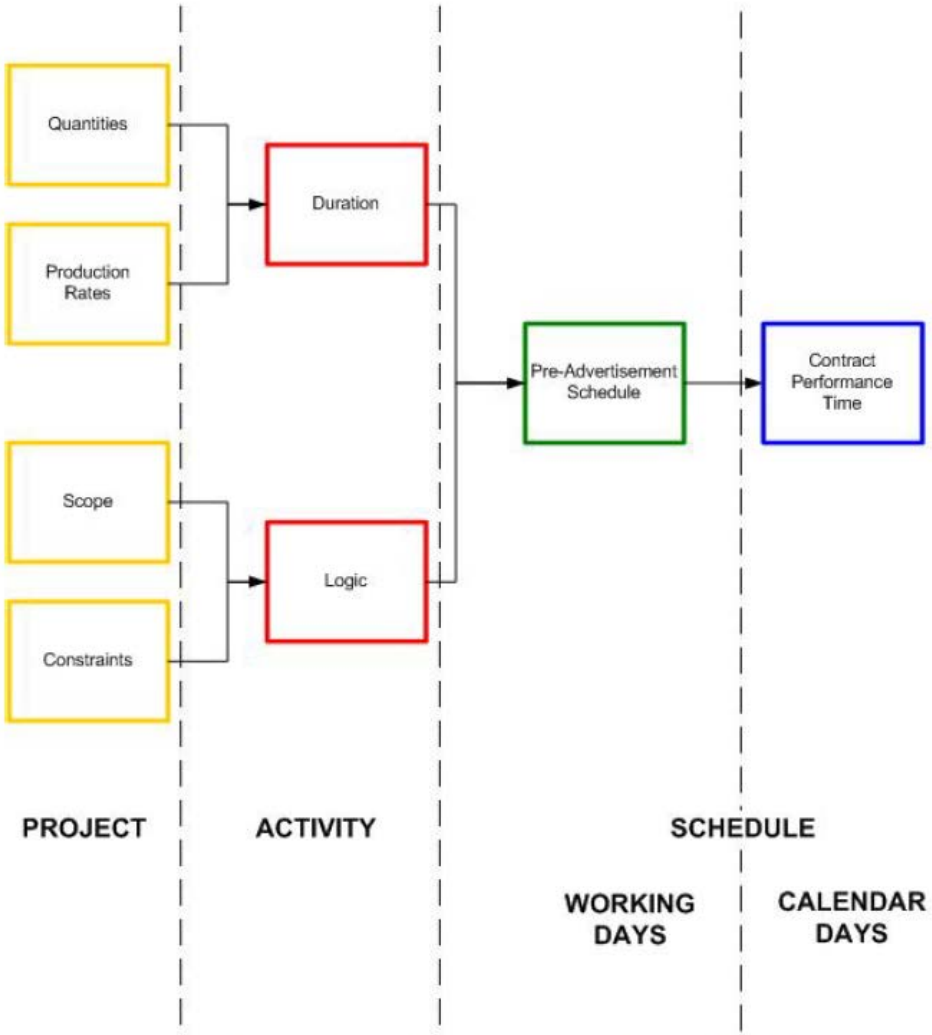
- The **scheduler** should be aware of
  1. the methods available to estimate activity durations, and
  2. how the method used will **influence the accuracy** of the schedule over the life of the project.

Definitions



The Planning and Scheduling Process

Definitions



. General Contract Time Determination Process flowchart

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Definitions

- Durations are **simply estimates** of the period of time to perform the work assigned to each schedule activity, **typically measured in days**.

- At **higher level summary schedules**, durations can be measured in weeks or even months.

- At the **other end of the spectrum**, a **very detailed schedule** to control a **relatively short project** or **specific phase** of a project could measure durations in hours.

- But use of **days to measure durations** is by far the **most common** planning unit.

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Original vs. remaining durations

- Most scheduling software will use, calculate, and display an activity's original duration and remaining duration.
  - The **original duration** is the number of days (or other unit of measure) **initially assigned** to a given activity.
  - Once an activity has **started**, and the **start date has been actualized** in the schedule,

    the **remaining duration** will be displayed as **the number of days (or other unit of measure)** remaining to finish that activity.

    ✓ The **remaining duration** will either be

    1. **manually entered** during the schedule update, or
    2. **calculated if** the percentage complete is **linked** to remaining duration and

       entered during the schedule **update** (software dependent).

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Risk management perspective

- From a **risk management perspective**,

  durations carry a certain **amount of uncertainty** in their values,

  so durations would **more appropriately** be modeled on probability distributions.

  - This is related to the range of production rates that could be assigned to

    tasks based on

    individual talents,

    project conditions,

    climate, and

    a number of other considerations.

Risk management perspective

- Traditionally,

  outside of CPM scheduling,

  there are **several methods** used to deal with this concern and **produce** probabilistic calculations of durations.

- In a CPM schedule, **durations** are typically deterministic, using a **single value**.

Deterministic schedule methods

- **One of the reasons** that deterministic schedule methods seem to **work reasonably** well is the self-correcting nature of the **project controls effort**.

- If there is a **good analytical process** in place during the routine schedule updates, any **stacking of pessimistic durations** will be identified in the update analysis, and **corrective actions** will be taken to bring the project **back onto schedule.**

Time Unit Selection

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Introduction

- **Activity durations** can be expressed in any **convenient time unit**, **depending on**
  1. **when** the schedule is prepared in the project life cycle and
  2. the **objective** of the scheduling effort.
- **Time units** used for construction planning and scheduling can include any of the following:
  - Years
  - Months
  - Weeks
  - Days
  - Hours

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Years

- For **very large construction projects** that have a long planning, design, and construction period,

  early project schedules may have activity durations expressed in years or fractions of a year.

- In the **early stages** of a large project, there may **not be enough information** to develop a **detailed schedule** with **smaller time units**.
  - *For example, the development of a large, multi-building commercial development or a planned residential community might have a schedule with durations expressed in years showing the phases of development.*
- **Large construction projects** such as power plants, dams, and highways could also have early schedules **expressed in years.**

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Months

- A schedule with activity durations expressed in **months** may also be **appropriate** in the **early stages** of a construction project.
- A construction schedule expressed in months could be **prepared** during the conceptual stages of a project to mark **milestones** that need to be met in order to complete the **project on time**.
  - *For example, during the early stages of a construction project the construction manager may develop master schedule in months to alert the project team as to*
    - ✓ *when design packages need to be completed,*
    - ✓ *procurement of long-lead items should be started, and*
    - ✓ *major construction activities will be finished.*

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Weeks

- A **construction schedule** expressed in **weeks** and developed in the **early stages of a project**

  can provide the **framework** for the developing a **more detailed schedule** as construction progresses.

- The **project team** can **gradually** divide the **summary activities** in the **construction schedule**

  into **greater detail** for the day-to-day planning and management of the project.

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Days

- **Days** are the **most common** and **convenient time unit** for planning and scheduling **most construction projects**.
- Estimating activity durations in days allows the **start and finish of activities** to be scheduled by **calendar date**,

  which takes into account rest days and holidays when **no work** is planned.
- Additionally, time in most construction contracts, subcontracts, and supply agreements is expressed in **days and dates.**
- When the schedule time unit is days, it is **easier to incorporate** the ter**ms of these agreements** into the project schedule.

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Hours

- **Hours** can also be used to plan and schedule complex, short-duration construction projects that must be completed by a specified time.
- Normally, schedules with activity durations expressed in hours involve the **shutdown** of a **process** or **system** to make modifications or perform **maintenance**

  when it is **imperative** that the **process or system be back** in operation at a specified time.

  - *For example, the replacement of a facility's electrical service might be scheduled in hours starting Friday evening to ensure that the facility is back in operation at the start of business on Monday morning.*

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Time unit selection

- In fact, **different time units** may be used for **different schedules** as the project develops and **becomes more defined**.
  - In the early stages of the project, activity durations may be expressed in **years or months.**
  - For detailed planning and scheduling of construction operations, activity durations expressed in **weeks** or **days** could be used.
  - Additionally, for critical short-term construction processes, activity durations may be expressed in **hours**.

Time unit selection

- In **addition to different schedules** used at different points in the project life cycle, **different time units** may be used for **schedules generated** from the master construction schedule for **specific users**.
  - *For example, summary schedules in years, months, or weeks might be developed from the master construction schedule in days for informing upper management, the owner, or the designer of the status of the project.*
- Similarly, **short-interval schedules** in days or hours can be developed from the **master construction schedule** for managing day-to-day construction operations at the site.

Time unit selection

- As **noted above**, the day is the **most common time unit** used in construction planning and scheduling.
  - For this reason, activity durations will be expressed in days throughout the remainder of this course.

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Time unit consistency

- **All activities** in a **construction schedule** must have their durations expressed in the **same time unit.**
- **Different time units cannot** be intermixed in the same construction schedule.
- If a **construction schedule** uses the **day as its time unit** and an **activity** has an estimated duration less than a full day, then that **activity's duration** must be rounded up to a **full day before** being included in the schedule.

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Time unit consistency

- Similarly, **activities** with durations expressed in weeks, months, or years must be **converted to days** **before** being **included in a construction schedule** **using days** as its base time unit.

Estimating Activity Durations

Estimating Method

- The PMBOK® Guide recognizes **three methods** for estimating deterministic schedule activity durations,

  useful for **progressively** elaborated schedules such as

  those **developed early** in the project and

  updated as **design** is **advanced**.

Estimating Method

- The methods are:
  - **Expert judgment.**
    - ✓ Relies on **knowledge** of **prior similar project durations** to inform estimates for the **current project**,

      more of a **"gut check"** on durations that may be **estimated** or **validated** by other methods that follow.

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Estimating Method

- The methods are:
  - **Analogous estimating.**
    - ✓ When **detailed information** about a project is **limited**,

      using **parameters** from previous similar projects can be used to estimate the current project durations;

      some schedulers will derive **"rules of thumb"** or other guidelines for **common activity durations** based on **past performance**,

      not as accurate as other methods and

      typically used in **earlier phases** of a project.

Estimating Method

- The methods are:
  - **Parametric estimating.**
    - ✓ A **more quantitative approach** that yields **more accurate durations**, by using known quantities and historical production rates to calculate durations;

      general contractors with history in self-performed work and records of trade subcontractor past performance often use **this method**, but it **still** requires assumptions or data on **available resources** to **apply the production rates** to the project quantities.

Estimating Method

- **Recommended Practice No. 32R-04**, "Determining Activity Duration" (AACE International, 2012) suggests that there are **three phases** to determining durations:
  1. determining unconstrained activity durations,
  2. adjusting activity duration based on constraint impact, and
  3. revising activity original durations to meet project requirements.

- These **phases are described in detail** in the Recommended Practice, and the concept is **very useful as an approach** to deterministic duration estimating.

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Estimating Method

- **This estimating** of durations for the official project schedule,

  the **baseline or as-planned**, becomes **more detailed**, requiring **reasonable calculations.**

- Once production rates and quantities are established to calculate the durations,

  it is **important to ensure** that the production rates are based on

  1. available resources and
  2. spaces.

- **Without** taking into account available resources to perform the activities, and **without** consideration of the available spaces in which to work,

  estimates of durations are **not appropriate** and may **not be reasonable**.

Estimating Method

- The **duration** of an activity is a **function** of
  1. the amount of work that **must be accomplished** and
  2. the rate at which **work can be accomplished**.

- Simply stated, the **duration** of an activity is the quantity of work **divided** by the production rate.

Estimating Method

- The **basic formula** for estimating activity durations is as follows:

Activity Duration = Work Quantity / Production Rate

Work Quantity Defined

- The **work quantity** is

  the **amount of work** that must be accomplished

  as **defined** by the **construction documents**.

- The **quantity of work** is expressed in some measurable quantity such as

  the **amount** of

  materials or the equipment that need to be **installed**.

- The **quantity of work** includes

  all work that is necessary to **complete the scope** of work

  defined by the **activity**.

Work Quantity Defined

- The **quantity of work**

  may **not be expressed** in the **exact quantity** of materials and equipment,

  such as the number of **concrete masonry units** that **must be installed**.

  - Instead, the **quantity of work** might be expressed in terms of some other measurable quantity such as

    number of **square feet of masonry wall** completed.

- This quantity will then **serve as a basis** for

  measuring progress and could include

  the **installation** of related materials such as

  reinforcing steel and filler in the case of masonry wall.

Production Rate Defined

- The **production rate** should be the **planned average** daily production rate based on
  1. the available resources and
  2. the environment within which the work will be performed.
- The **production rate** includes **not only** the productive time associated with a **particular activity**

  but also idle and non-productive time associated with
  1. the movement and setup of equipment,
  2. break times,
  3. expected equipment downtime for maintenance and repair, and
  4. other expected downtime.
- When estimating a production rate, resource availability and other factors affecting productivity need to be considered

Example Activity Duration Calculation

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Introduction

- The **accuracy** of activity duration estimates is **very important**.
- **Activity durations** in conjunction with **activity logic** form the **basis** for performing **network schedule calculations**.
- **Inaccurate** activity durations can **affect**
  1. the integrity of the network schedule and
  2. its usefulness as a management tool.
- **Care** must be taken by the **scheduler** when estimating activity durations to ensure that they reflect the planned means and methods of performing the activity and anticipated conditions at the **project site**.

Introduction

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Introduction

- As discussed, there are **two elements** that go into calculating activity durations, work quantity and production rate.

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Quantity of work

- The **quantity of work** is normally defined by the contract documents and is a **constant**.
  - The contractor has **little if any control** over this element.

- The **quantity of work** is usually taken **directly** from the plans and specifications when performing **quantity takeoffs** for the **bid estimate**.

Production rate

- The **production rate**, on the other hand, is **not a constant** and can be **affected** by a number of factors both **within** and **beyond** the contractor's control.
  - A number of these factors were discussed in this section.

- **These factors** should have been taken into account by the **estimator**

  when preparing the bid estimate in **determining**

  the type and

  amount of

  labor and equipment required to perform **each project activity**.

Preparing a detailed bid estimate

- In **preparing a detailed bid estimate** for a project, required labor, material and installed equipment, and production equipment for each activity are usually **estimated based** on planned means and methods for accomplishing the work.
- This information is **often not carried** over to the planning and scheduling of the project **once the contract** is awarded.
  - Instead, **activity durations** are estimated by project personnel based on **past experience** or other **available information**.
    - ✓ **Ignoring** the **detailed analysis** of the project performed by the estimator in **preparing the bid** overlooks a **valuable information source** that can be very useful in estimating activity durations

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Time and cost

- Time and cost are **related to one another** in the performance of any construction activity, and **both are a function** of the type and quantity of **resources** used.
  - **Resource usage** is the **basis for estimating both** activity time and cost.
- After contract award, the **bid estimate normally** becomes the **basis** for the project **budget**.

Why the bid estimate should be checked before using as a basis for project schedule?

Quantities of labor, materials, and installed equipment

- **Quantities** of labor, materials, and installed equipment and production equipment included by the **estimator** can be **converted into** daily production rates that **relate** schedule to budget.
  - *For example, a particular building requires the installation of 1500 grid ceiling-mounted, 2' x 4', 4-lamp, fluorescent fixtures evenly distributed between five floors for 300 fixtures per floor.*
  - *When **preparing the bid estimate** for this activity, it was **estimated** that an **electrician** could install 10 fixtures per day.*
  - *Following award of contract, **detailed** activity planning determined that a **crew of six electricians** would be **best** for installing the **fluorescent fixtures** on **each floor.***

Quantities of labor, materials, and installed equipment

- **Using** the bid estimate data and the planned crew size, the scheduler is able to **estimate** the production rate for the **planned crew** as follows:

$$\text{Production Rate} = \left(\frac{10\ \text{Fixtures}}{1\ \text{Electrician-Day}}\right)(6\ \text{Electricians})$$

$$= \frac{60\ \text{Fixtures}}{\text{Day}}$$

Quantities of labor, materials, and installed equipment

- The **estimated duration** for the **installation** of fixtures on each floor of the building can **now be calculated** as follows:

$$\text{Fixture Installation Duration} = \left(\frac{300\ \text{Fixtures}}{\text{Floor}}\right)\left(\frac{1\ \text{Workday}}{60\ \text{Fixtures}}\right)$$

$$= \frac{5\ \text{Workdays}}{\text{Floor}}$$

- Therefore, the **estimated activity duration** for the installation of fluorescent fixtures on each floor of the building would be **five workdays**.

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Finalizing estimate

- This **simple example** illustrates how duration estimates can be **derived** from bid estimate data.
- The **same care** and **attention** to detail that is put into estimating activity costs when bidding a project should be put **into estimating activity durations** when planning and scheduling the project after contract award.
- Forms similar to the one **shown Figure 3-1** can be developed by the contractor to **help** organize and document **activity duration estimates**.
- The **amount of detail and information** contained in the form will **vary** from **contractor to contractor** depending on need.
  - However, as a **minimum**, this form should **provide the contractor** enough information so that there is a **record** as to how activity durations were estimated and how these durations relate to the project budget.

Finalizing estimate

ACTIVITY		BUDGET REFERENCE	WORK QUANTITY		PLANNED PRODUCTIVITY (Workday/Unit)	ESTIMATED ACTIVITY DURATION (Workdays)
NUMBER	DESCRIPTION		AMOUNT	UNITS		

Figure 3-1
Activity Duration Worksheet

Finalizing estimate

- **Establishing** a relationship between an activity's duration and budget can be accomplished in a **number of ways**, for example, with a **simple line-item code** that **cross-references** the schedule activity to a budget line item.
- A **more effective** and **useful way** of relating the project schedule and budget is through the contractor's project cost accounting system.
- **Most contractors** have a project cost accounting system in place that is **tailored** to their **specific** work and informational needs.
- **Tying** the project schedule to the project cost accounting system will provide **additional information** that can be used **to better monitor and control** the activity during construction.

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Recommended practice

- The **Best Practices** section lists the **generally accepted methods** to use for estimating activity durations.

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Recommended practice

- **Additional considerations** regarding activity durations include:
  - **Maintaining** uniform activity durations during **early stages** of project schedule development can **simplify the process**
    as the **schedule is expanded** in level of detail.

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Recommended practice

- **Additional considerations** regarding activity durations include:
  - A **good guide** for the **maximum duration** of an activity is to **limit** it to half or the full reporting period **between schedule updates**.
    - ✓ Frequently, **updates** are required on a **monthly basis**, which would indicate a **maximum activity duration** of about 10 to 20 working days.

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Recommended practice

- **Additional considerations** regarding activity durations include:
  - **Feedback** from trade or project supervision that is closest to **those actually performing** the work is excellent input to schedule productivity,
    in this case to **estimate** activity durations,
    based on their **detailed** trade-specific knowledge and past experience.
  - Use of **experienced** general contractor and trade subcontractor superintendents and foremen can **improve the accuracy** of schedule duration estimates.

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Recommended practice

- **Additional considerations** regarding activity durations include:
  - **Once** the durations are **estimated** in compliance with **best practices**, the **individual** activity **durations** should be **reasonable** and **appropriate**.
    - ✓ However, this does **not guarantee** a reasonable and appropriate **schedule** because it **only addresses** the use of resources on **each activity**, **not necessarily all activities** planned to perform at the **same time**.

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Recommended practice

- **Additional considerations** regarding activity durations include:
  - It is **vital to examine** the issue of concurrent activities because the durations of each activity will require **concurrent resource use**.
  - This is also **true for spaces**; each trade individual needs a certain amount of **space for**
    1. materials storage,
    2. tool storage, and
    3. work.
  - The **available spaces** for **work** will **limit**
    1. the number of individuals, as well as
    2. the number of trades

    that can work at the **same time** in **each space**.

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Recommended practice

- **Additional considerations** regarding activity durations include:
  - As a result of this issue, trade and space stacking are **common causes** or symptoms of **inappropriate** or **unreasonable schedules**,

    so the **quality control verification** for the baseline or as-planned schedule should include a **review** of **available resources** of concurrent activities.

Recommended practice

- **Additional considerations** regarding activity durations include:
  - Review of the total number of crews and individual resources in the early and late date sorts of the schedule will help improve the **reasonableness** of the plan.

Resource Availability

Resource Availability

- The **key to estimating** activity durations is the availability of resources.

These resources include:

1. Labor
2. Equipment
3. Material
4. Subcontractors and
5. suppliers

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Resource Availability

- Most activity durations are **resource driven**, and activity duration estimates need to be based on **available resources**.
- If duration estimates are **not resource based** for the particular project, they **may not be valid**, resulting in distortion of the schedule.

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Resource Availability

- As a general rule, the **more resources available**, the **less time** it takes to perform an activity.
- The **time-resource trade-off** and its relationship to construction planning and scheduling course,

  which provides **addresses** schedule compression and decompression through **resource application**.

Factors Affecting Productivity

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Factors Affecting Productivity

- In addition to the availability of labor, equipment, materials, and subcontractors, there are a **number of other factors** that can have an impact on an activity's duration.
- These **factors** affect resource productivity and must be **considered when estimating** an activity's duration.
- The second step in estimating activity durations is to adjust productivity to account for special conditions associated with a **particular project**.

Factors Affecting Productivity

- **Factors** affecting **resource productivity** include:
  1. Nature of the work
  2. Resource productivity
  3. Management skill
  4. Material and equipment availability
  5. Seasonal conditions
  6. Work restrictions
  7. Quality of work
  8. Concurrent activities

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Nature of the Work

- The **nature of the work** will affect resource productivity and needs to be taken into account when estimating activity durations.
  - For example, **labor productivity** should **increase** as **experience** is gained for repetitive tasks.
    - ✓ Activities **composed** of repetitive tasks should benefit from
      1. the increased task productivity and
      2. have decreasing activity durations.

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Resource Productivity

- Labor and equipment productivity are **not constant** and can vary significantly from
  1. project to project and
  2. location to location.

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Resource Productivity

- **Labor productivity** is a function of a number of factors, including
  1. training,
  2. experience,
  3. motivation, and
  4. labor restrictions.

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Resource Productivity

- **Equipment productivity** is primarily a **function** of
  1. operator skill, but can also be affected by
  2. equipment maintenance policies,
  3. age, and
  4. site conditions.
- The **impact** of anticipated labor and equipment productivity needs to be **factored** into estimated activity durations.

Management Skill

- The **ability of the management team** to plan, organize, and execute the work is an important factor in estimating activity durations.
- Management skill is **key to the successful completion** of any construction project.
- The effective and innovative application of **available resources** can have a significant impact on **activity durations** and needs to be accounted for in the construction scheduling process.

Material and Equipment Availability

- **Material and equipment availability** can affect labor and equipment productivity and **ultimately** activity duration.
- **Sufficient** material and equipment must be **available to support** planned production rates.
- Insufficient quantities of material and equipment can lead to **lost productivity** and **idle resources**.
- Similarly, a large inventory of materials and equipment at the site can cause **congestion** and lower productivity.
- Material and equipment **deliveries** to the site need to be carefully planned and scheduled so as to **balance**
  1. production needs with
  2. available laydown and storage space

Material and Equipment Availability

- When estimating activity durations, the **ability of the supplier** to provide sufficient materials and equipment to the site to **support** the planned production rate needs to be considered.
- Estimating activity durations **based solely** on available labor and equipment may result in **optimistic durations** that **cannot realistically** be attained because of a lack of materials and equipment.
  - For example, it does **not good to estimate** the duration for **pile driving** using **two crews**

    if the pile supplier can provide **only enough piles** to support **one crew**.

Material and Equipment Availability

- In **addition to supplier production capacity**, other factors that could affect material and equipment availability should also be considered.
  1. Raw material availability,
  2. credit restrictions, and
  3. transportation bottlenecks

  may also affect material and equipment availability.

Seasonal Conditions

- **Construction productivity** is affected by weather conditions.
- Labor and equipment productivity usually **drops** in both hot and cold weather.
- In addition, **construction materials** become **more difficult to work** with in extreme weather conditions, requiring special protection from the elements and greater attention.
- This **decrease in productivity** results in construction activities taking **longer** than would ordinarily be expected in milder weather and needs to be accounted for in planning and scheduling activities.

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Seasonal Conditions

- **Construction** is a **highly seasonal** business, and the amount of seasonal fluctuation varies from location to location.
- The impact of seasonal fluctuation on activity planning and scheduling depends on the **type of construction activities** being undertaken.
- The **primary cause** of construction seasonality is weather, and there are **construction techniques** that can be used to **cope with adverse** weather conditions.

Seasonal Conditions

- **Rather** than **rejecting out-of-season** construction, the construction firm should
  1. analyze local weather conditions and
  2. consider the potential impact on the availability and cost of labor, equipment, and materials.
- **Carefully planned** and executed out-of-season construction may **cost less than anticipated** and provide the contractor with a **competitive advantage** in a particular locale.

Work Restrictions

- **Work restrictions** can be imposed by the
  1. construction contract,
  2. local customs,
  3. laws,
  4. labor agreements, and
  5. physical conditions.

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Work Restrictions

- **Some examples** of work restrictions that could affect activity durations are as follows:
  - Hours of the day when work can be performed;
  - Material delivery and movement restrictions;
  - Security requirements for labor;
  - Load limits on floors and elevators;
  - Zoning ordinances that restrict the erection and operation of temporary construction and plant facilities;
  - Provisions of labor agreements; Building codes and regulations; and
  - Safety requirements for protecting the general public, workers, and work in progress.

Quality of Work

- When estimating activity durations, the **specified quality** of work in place needs to be considered.
- In general, the more exacting the quality and the tighter the tolerances, the **longer it will take** to complete the work.
  - *For example, the placement and finishing of a super-flat concrete floor for an automated warehouse will take longer than a normal warehouse floor built to standard industry tolerances.*

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Concurrent Activities

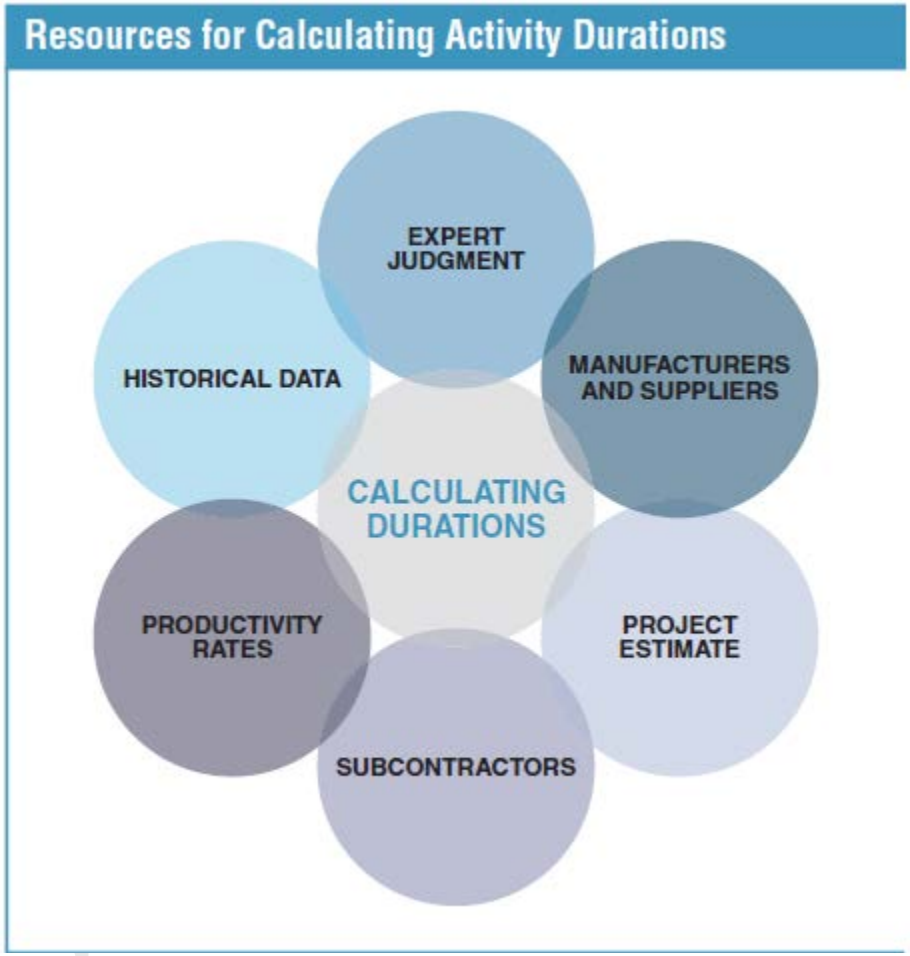
- The type and number of construction activities being **carried out simultaneously** at the **construction site** can affect productivity.

- **Interference** between activities being carried out in close proximity to one another slows production.

- **Interference** between concurrent activities needs to be considered when estimating activity durations.

Sources of Quantity and Productivity

Sources of Quantity and Productivity



Sources of Quantity and Productivity

- **Sources** of quantity and productivity data include:
  - Quantity takeoff;
  - Bid estimate;
  - Past experience;
  - Outside information;
  - Estimating guides;
  - Industry and trade organizations;
  - Manufacturers, fabricators, and
  - suppliers; and
  - Specialty contractors.

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Quantity Takeoff

- The **quantity takeoff** provides **information** on the quantity and type of materials and equipment that will be **incorporated** into the construction project, and usually serves as the **basis for the bid estimate**.
- Since the **length of time required** to perform a particular task is a function of the amount of work,

  the **quantity takeoff** is a **good source** for the raw data necessary for estimating activity durations.

Bid Estimate

- When estimating activity durations it is very important that the **duration estimates** are based on **available resources**.
- Normally, **detailed** construction **planning and scheduling** occurs after contract award.
- The **best source** of planned resources for a project is the bid estimate, on which the **bid project budget** will be based.
- The **bid estimate** includes **assumptions** regarding
  - crew sizes and makeup,
  - construction means and methods,
  - equipment types and spreads,
  - subcontractors and suppliers, and
  - planned duration for major equipment.

Bid Estimate

- **Estimate data** prepared during the **bid period** should provide planned man-hours and equipment hours that can be used to **estimate activity durations**.
  - *For example, the bid estimate may include a line item for the leasing of a tower crane on a high-rise building.*
    - ✓ This estimate would be based on the **length of time** the **tower crane** is planned to be **used at the site**.
    - ✓ **Failure** to consider this time could **result in substantial overruns** on this **line item** that could impact the cost of the **overall project**.

Bid Estimate

- Similarly, the **quantity** of equipment planned in the bid estimate needs to be considered **when estimating** activity durations.
- As noted above, the **duration** of a construction activity is **dependent** on the amount of resources dedicated to that activity.
- If the **bid estimate assumed** that there would only be one pile driver on site,
  - then the pile-driving activity duration should **not require** the **use of two pile drivers.**
- The **scheduling of additional resources** above and beyond that included in the bid estimate could result in unnecessary cost overruns

  if the **additional productivity gained** is not necessary to maintain the planned schedule.

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Past Experience

- **Past experience** is a **valuable source** of duration estimate data.
- **Unlike** research and development endeavors,

  which require **duration estimates** for activities that have never been **performed before**,

  construction activities normally have been **performed many times before** with the same crews, equipment, and materials.
- While **each** construction project is **unique**,

  seldom is the **contractor faced** with a construction activity that has **never been performed before.**

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Past Experience

- At times, the **contractor** is faced with a project that requires the **installation of new** materials and equipment,
  means and methods, or
  the use of different construction equipment.
  - However, the contractor can **still draw on past experience** to develop **reasonable durations** for the activity.
- While the **contractor's past experience** may **not be an exact match** to the current activity,
  the contractor may be **able to draw upon other similar experiences** to develop a reasonable duration estimate for the activity.

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Outside Information

- In **addition to experience**, the contractor can use information from outside sources when estimating activity durations.
- Information on **activity productivity** is compiled by many public and private groups associated with the **construction industry**.
- This information can be very **helpful in estimating** activity durations, but the contractor must be **very careful in how it is used**.
- Using **published information**

  without considering the conditions and assumptions on which the information was based can be **very risky** and result in a **distorted project** schedule

  if estimated activity durations are **too short or too long**.

Estimating Guides

- **Estimating guides** provide a variety of information that may include the **estimated labor and equipment units** required to complete an activity, and

  are **an outside source** that can be used to estimate activity durations.

- **Most published** estimating guides also provide the crew makeup and equipment used in developing the labor and equipment **units**,

  which are very helpful in **determining the applicability** of the information to the **specific** construction project being planned and scheduled.

Estimating Guides

- **Estimating guides** can also be very helpful to the contractor **when moving into a new market area**.
- **Different geographic locations** have varying skill levels and production rates.
- Normally, **estimating guides** provide adjustment factors for moving from one **geographic area to another**.
- **These productivity rates** can be used to **adjust estimated durations** for the new location.
- Again, it is important that the **contractor understand** the information provided in the estimating guide, and this information should be **just one input** to any productivity adjustment made; any **major adjustments** in productivity should be **verified** with other sources in addition to the estimating guide.

Industry and Trade Organizations

- Industry and trade organizations can also be a **valuable source** of productivity information

  that can be used when estimating activity durations.

  Industry and trade organizations can sometimes provide productivity information on different means and methods and for different geographic areas.

Manufacturers, Fabricators, and Suppliers

- Manufacturers, fabricators, and suppliers can **provide delivery information** that is **critical** to the effective planning and scheduling of construction projects.
- **Failure to consider** the time required to design, fabricate, and deliver necessary materials and equipment can result in problems during construction and delays in planned performance.
- The **duration of activities** associated with the **procurement of equipment** and **materials** must be considered when planning and scheduling construction projects.

Manufacturers, Fabricators, and Suppliers

- **Manufacturers, fabricators, and suppliers** can also provide information regarding the time required to install or erect

  supplied equipment and **materials** and

  necessary start-up and **testing operations** that need to be considered and incorporated into the construction planning and scheduling process.

Manufacturers, Fabricators, and Suppliers

- Information provided by **manufacturers, fabricators, and suppliers** can be very helpful in estimating activity durations during the construction planning and scheduling process.
- It is very important, however, that the contractor consider this **information** in conjunction with past experience with

  similar equipment and materials as well as

  input from specialty contractors who may be responsible for installing the materials and equipment.

Specialty Contractors

- **Specialty contractors** usually perform work and employ means and methods that are **unique** to their specialty, and should be **consulted regarding** the activity durations for which they are **responsible**.
- Additionally, in **preparing their bid estimate**, **specialty contractors** normally make **assumptions** regarding the timing and intensity of their work effort on a **particular project**.
- **Failure of the contractor** to **consult** with specialty contractors regarding the time required to perform their work could **result** in estimated activity durations that are too short or too long for the scope of work defined by a particular activity.

Activity Duration Assumptions

Activity Duration Assumptions

- **Once** the initial activity duration is **estimated**, the **initial duration estimate** can be **modified** to address the unique characteristics of a **particular project.**

- **Methods** for
  1. **identifying** activity and resource conflicts and
  2. **adjusting** schedule parameters to accommodate time constraints

  were addressed in Planning and Scheduling Course.

AACE
Purpose and Overview

Purpose of This RP

- This recommended practice (RP) for Determining Activity Durations is intended to provide a guideline and a resource, **not to establish a standard**.
- As a recommended practice of AACE International, it provides guidelines for the project scheduler to
  1. **determine** schedule activity durations and
  2. **understand** the limitations and assumptions involved in such determination as part of

     the total cost management (TCM) project planning, scheduling forecasting, and change management processes (7.2).

Purpose of This RP

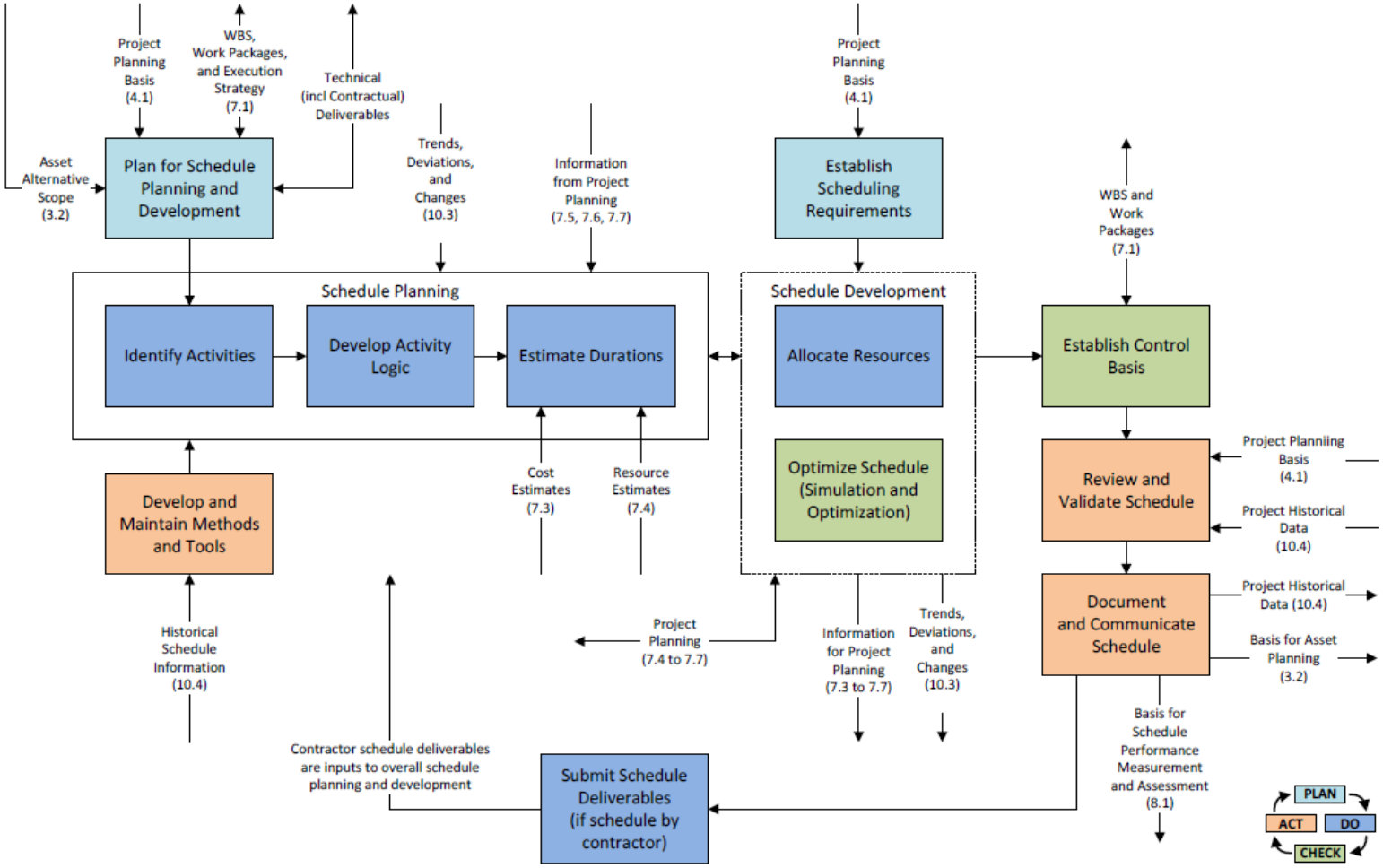

Figure 7.2-1 Process Map for Schedule Planning and Development

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Purpose of This RP

- This recommended practice provides information about
  1. **determining** the **original durations** for activities for developing the project schedule and
  2. **general considerations** related to the establishment of **remaining durations** while **updating** the project schedule.
- **Specific considerations** regarding the topic of establishing the activities **remaining durations** for schedule performance assessment are **not within the scope** of this RP.
  - Therefore, the **information presented** here generally applies to determining original activity durations; and

    general considerations for the establishment of **remaining durations** be provided **only as appropriate**.

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Purpose of This RP

- This **recommended practice** offers methods for determining original activity durations **through**
  1. the analysis of past project data with
  2. anticipated future performance data.

- It also incorporates an **iterative effect-analysis** of constraints on activity duration.

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