



PROJECT TIME MANAGEMENT

PROJECT TIME MANAGEMENT

WHAT DOES THE TIME MANAGEMENT AREA ATTAIN?

- Manages the project schedule to ensure timely completion of the project
- Utilizes the Schedule Management Plan that is a subsidiary plan of, and integrated with, the Project Management Plan through the Develop Project Management Plan process



TIME PROCESSES

DEFINITIONS: TIME PROCESSES

6.1 Plan Schedule Management

- Establishing the policies, procedures and documentation for planning, developing, managing, executing and controlling the project schedule

6.2 Define Activities

- Identifying the specific actions to be performed to produce project deliverables (at the lowest level in the WBS, which is called the work package).

6.3 Sequence Activities

- Identifying & documenting relationships among the project activities.

6.4 Estimate Activity Resources

- Estimate the type & quantities of material, people, equipment, or supplies required to perform each activity.

TIME PROCESSES

6.5 Estimate Activity Durations

- Estimate the number of work periods needed to complete individual activities with estimated resources.

6.6 Develop Schedule

- Analyze activity sequences, durations, resource requirements, and schedule constraints to create the project schedule.

(The five processes above could be viewed as a single process in small projects)

6.7 Control Schedule

- Monitor the status of the project to update project progress and managing changes to the schedule baseline.

TIME PROCESSES

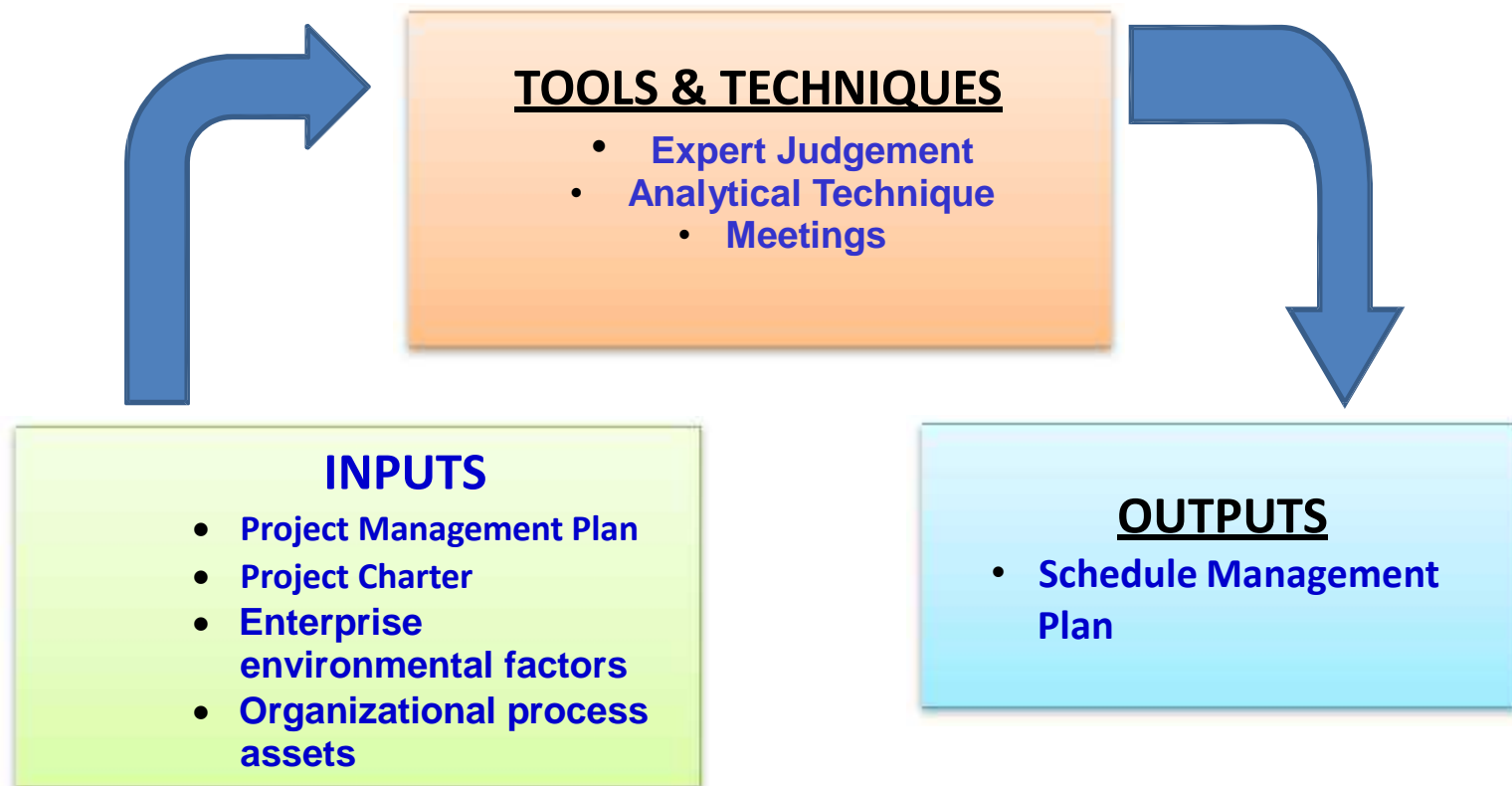
PLANNING	MONITORING & CONTROLLING
6.1 Plan Schedule Mgt	6.7 Control Schedule
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Plan Schedule Management

WHAT HAPPENS IN PLAN SCHEDULE MANAGEMENT?

Plan Schedule Management is the process of establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule. The key benefit of this process is that it provides guidance and direction on how the project schedule will be managed throughout the project.

PLAN SCHEDULE MANAGEMENT



PLAN SCHEDULE MANAGEMENT

1. **Project Management Plan** - The project management plan contains information used to develop the schedule management plan which includes, but is not limited to:
 - **Scope baseline.** The scope baseline includes the project scope statement and the work breakdown structure (WBS) details used for defining activities, duration estimation, and schedule management; and
 - **other information.** Other scheduling related cost, risk, and communications decisions from the project management plan are used to develop the schedule.
2. **Project charter** - The project charter defines the summary milestone schedule and project approval requirements that will influence the management of the project schedule.
3. **Enterprise Environmental Factors** - The enterprise environmental factors that influence the Plan Schedule Management
4. **OPA**

PLAN SCHEDULE MGT – T&T

TOOLS & TECHNIQUES

1. **Expert Judgment** - Guided by historical information, provides valuable insight about the environment and information from prior similar projects. Expert judgment can also suggest whether to combine methods and how to reconcile differences between them.
2. **Analytical techniques** - The Plan Schedule Management process may involve choosing strategic options to estimate and schedule the project such as: scheduling methodology, scheduling tools and techniques, estimating approaches, formats, and project management software. The schedule management plan may also detail ways to fast track or crash the project schedule such as undertaking work in parallel. These decisions, like other schedule decisions affecting the project, may affect project risks.
3. **Meetings** - Project teams may hold planning meetings to develop the schedule management plan.

PLAN SCHEDULE MANAGEMENT

OUTPUTS

Schedule Management Plan - A component of the project management plan that establishes the criteria and the activities for developing, monitoring, and controlling the schedule. The schedule management plan may be formal or informal, highly detailed or broadly framed, based upon the needs of the project, and includes appropriate control thresholds.

For example, the schedule management plan can establish the following:•

Project schedule model development. The scheduling methodology and the scheduling tool to be used in the development of the project schedule model are specified.•

Level of accuracy. The acceptable range used in determining realistic activity duration estimates is specified and may include an amount for contingencies.•

Units of measure. Each unit used in measurements (such as staff hours, staff days, or weeks for time measures, or meters, liters, tons, kilometers, or cubic yards for quantity measures) is defined for each of the resources.•

Organizational procedures links. The WBS (Section 5.4) provides the framework for the schedule management plan, allowing for consistency with the estimates and resulting schedules.•

PLAN SCHEDULE MANAGEMENT

OUTPUTS

Project schedule model maintenance. The process used to update the status and record progress of the project in the schedule model during the execution of the project is defined. •

Control thresholds. Variance thresholds for monitoring schedule performance may be specified to indicate an agreed-upon amount of variation to be allowed before some action needs to be taken. Thresholds are typically expressed as percentage deviations from the parameters established in the baseline plan.

Rules of performance measurement. Earned value management (EVM) rules or other physical measurement rules of performance measurement are set.

Reporting formats. The formats and frequency for the various schedule reports are defined. •

Process descriptions. Descriptions of each of the schedule management processes are documented.

TIME PROCESSES

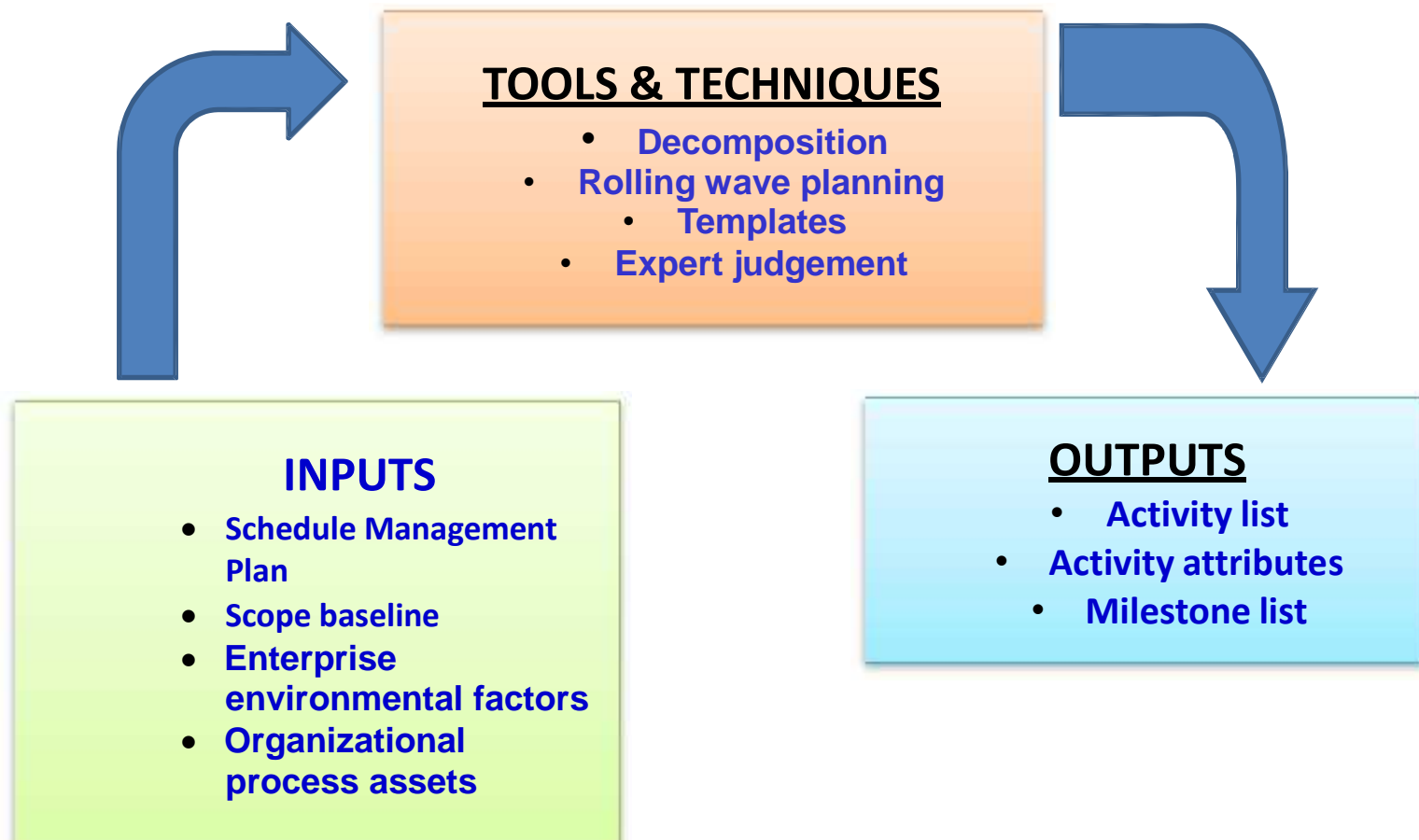
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DEFINE ACTIVITIES

WHAT HAPPENS IN DEFINE ACTIVITIES?

- Identifies the specific actions to be performed to produce the project deliverables. The Create WBS process identifies the deliverables at the lowest level in the Work Breakdown Structure (WBS), the work package.
- Decompose the work packages into smaller components called activities that represent the work necessary to complete the work package.
- Differentiate between a work package and an activity?
 - A work package is a deliverable as a result of work
 - An activity is an action that produces a deliverable alone or together with other activities
- Activities provide a basis for estimating, scheduling, executing, and monitoring & controlling the project work.
- Implicit in this process is defining and planning the schedule activities such that the project objectives will be met.

DEFINE ACTIVITIES



DEFINE ACTIVITIES - INPUTS

- **Schedule Management Plan**
- **Scope Baseline**
- **Enterprise Environmental Factors**
- **Organizational Process Assets**
 - Existing formal and informal activity planning-related policies, procedures, and guidelines, such as scheduling methodology, that are considered in developing the activity definitions, and
 - Lessons-learned knowledge base containing historical information regarding activities lists used by previous similar projects.

DEFINE ACTIVITIES – T&T

TOOLS & TECHNIQUES

Decomposition

- Subdivides work packages into smaller, more manageable components called activities. Activities represent the effort needed to complete a work package.

Rolling Wave Planning

- Rolling wave planning is a form of progressive elaboration planning, where
 - Work in near term is planned in detail
 - Work in future is planned at a higher level of WBS

Therefore, work can exist at various levels of detail depending on where it is in the project life cycle.

For example, during early strategic planning, when information is less defined, work packages may be decomposed to the milestone level. As more is known about the upcoming events in the near term it can be decomposed into activities.

DEFINE ACTIVITIES– T&T

Templates

- A standard activity list or a portion of an activity from a previous project is often used as a template for a new project.
- Templates are also used to identify typical schedule milestones.

Expert Judgment

- Experts - experienced and skilled in developing detailed project scope statements, the WBS, and project schedules can provide expertise in defining activities

DEFINE ACTIVITIES - OUTPUTS

OUTPUTS

Activity List

- The activity list is a comprehensive list of all schedule activities required on the project.
- The activity list includes the activity identifier and a scope of work description for each activity in sufficient detail to ensure that project team members understand what work is required to be completed.

Activity Attributes

- Multiple components associated with each activity that evolve over time.
During the initial stages of the project they include:
 - Activity ID, WBS ID, and Activity Name

and when completed may include

- Activity codes, activity description
- Predecessor activities, successor activities, logical relationships
- Leads & lags
- Resource requirements
- Imposed dates, constraints & assumptions
- Person or company responsible for executing the work
- Geographic area or place where the work has to be performed
- Activity type such as level of effort, discrete effort, and apportioned effort

DEFINE ACTIVITIES - OUTPUTS

OUTPUTS

Activity Attributes (Contd.)

- Activity attributes are used for schedule development and for selecting, ordering, and sorting the planned schedule activities in various ways within reports. The number of attributes varies by application area.

Milestone List

- A milestone is a significant point or event in the project. Its type that could be either:
 - Mandatory (required by contract or law)
 - Optional (based upon project requirements or historical information)

TIME PROCESSES

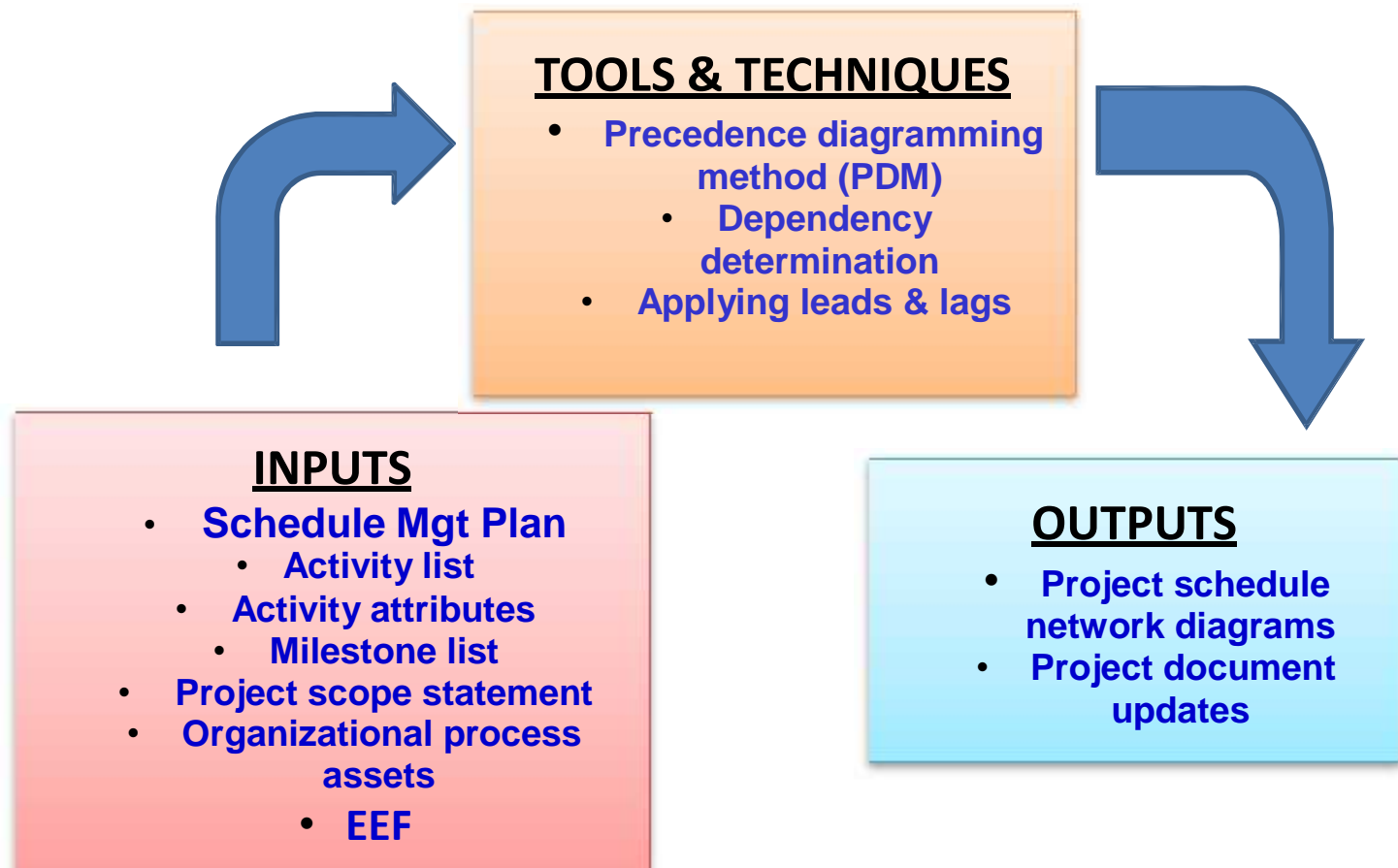
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SEQUENCE ACTIVITIES

WHAT HAPPENS IN SEQUENCE ACTIVITIES?

- Identifies & documents logical relationship among the project activities.
- Every activity and milestone except the first and last are connected to at least one predecessor and one successor.
- Defines precedence relationships and leads & lags to support development of a realistic & achievable project schedule.
- Sequencing can be performed by using project management software or by using manual or automated techniques.

SEQUENCE ACTIVITIES



SEQUENCE ACTIVITIES

INPUTS

- **Activity List**
- **Activity Attributes**
- **Milestone List**
- **Project Scope Statement**
- **Organizational Process Assets**

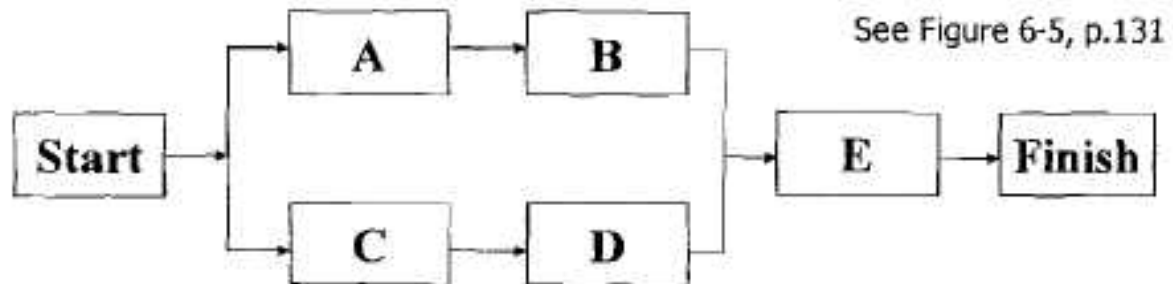
SEQUENCE ACTIVITIES

Tools & Techniques

1) Precedence Diagramming Method (PDM)

- Method of constructing a Project schedule network diagram that uses
 - Rectangles or boxes (called nodes) to represent activities
 - Arrows → show dependencies

This method is also called activity-on-node (AON)



SEQUENCE ACTIVITIES - T&T

Types of Predecessor

Finish-to-Start – Successor activity can not start until the predecessor activity is completed

Activity A Predecessor → Activity B Successor

e.g. Trouser cannot be stitched till the linen is cut.

Finish-to-Finish – Completion of successor activity depends upon completion of predecessor activity. Hence two tasks must finish at the same time
e.g. – ‘Wiring Inspection’ can’t finish until ‘House Wiring’ is completed.

Predecessor Activity A → Successor Activity B

SEQUENCE ACTIVITIES - T&T

Start-to-Start -Start of successor activity depends upon start of the predecessor activity
e.g. start canvassing only after candidature is announced by the Election Commission.

Predecessor Activity A → Successor Activity B

Start-to-Finish – Completion of successor activity depends upon start of the predecessor activity

e.g. – To pass PMP exams, you have to start reading PMBOK
Predecessor Activity A → Successor Activity B

SEQUENCE ACTIVITIES - T&T

Read just for knowledge

Arrow Diagramming Method (ADM)

ADM uses arrows to represent activities & connects to nodes to show their dependencies

- Also called activity-on-arrow (AOA)
- Used in **teaching** ‘Schedule Network Theory’
- Uses **only** finish-to-start dependencies and is not as prevalent as PDM
- Can require "dummy" relationships (dummy activities) (broken lines) that have zero value for duration
- Uses more than one time estimate.

SEQUENCE ACTIVITIES - T&T

2) Dependency Determination

Three types of dependencies are used

- ***Mandatory dependencies*** (sometimes called hard logic)
 - Inherent in the nature of the work e.g. before basement 1st floor
- ***Discretionary dependencies*** (preferred, preferential or soft logic)
 - Sometimes required in unusual aspect of the project
 - PM team decides based on knowledge, best practices & exp.
- ***External dependencies***

Relationship between *project & non-project activities*, i.e. dependent on delivery of computers before the software development can start

SEQUENCE ACTIVITIES - T&T

3) Applying Leads & Lags

- **A lead allows the following activity start before the previous one is finished.**
 - Start painting the bedroom before all the rooms are constructed.
 - Lead is overlap between activities
- **A lag allows a delay in the next activity.**
 - Staff joined but training to commence after 15 days (a lag of 15 days)
 - Lag is waiting time between activities.



SEQUENCE ACTIVITIES - T&T

2) Project Document Updates

Project documents that may be updated include, but not limited to:

- Activity lists
- Activity attributes
- Risk register

TIME PROCESSES

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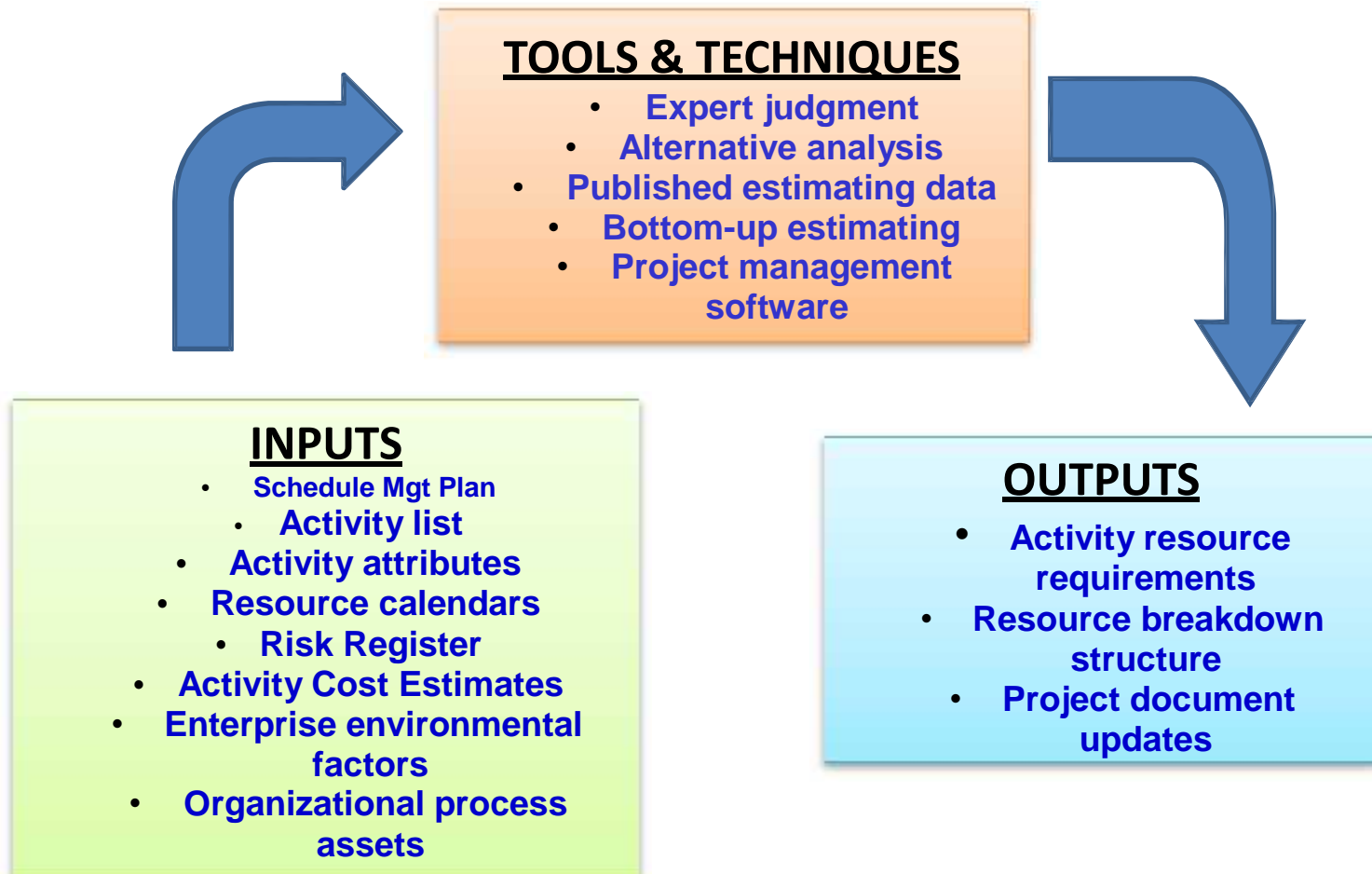


ESTIMATE ACTIVITY RESOURCES

WHAT IS IN “ESTIMATE ACTIVITY RESOURCES”?

- Estimate Activity Resources is the process of estimating the type and quantities of *material, people, equipment, or supplies* required to perform each activity.
- For example. a construction project team will need to be familiar with local building codes. Such knowledge is often readily available from local sellers. However, if the local labor pool lacks experience with unusual or specialized construction techniques, the additional cost for a consultant might be the most effective way to secure knowledge of the local building codes.

ESTIMATE ACTIVITY RESOURCES



ESTIMATE ACTIVITY RESOURCES - INPUTS

INPUTS

- **Activity List**
- **Activity Attributes**
- **Resource Calendars**

The composite resource calendar includes the availability, capabilities, and skills of human resources

- Which resources (people, equipment, material) are potentially available.
- Estimate resource types, i.e. senior vs. junior engineer at different phase of the project (e.g. during early phases of an Engineering Design Project-Junior engineer is fine but at later stages experienced engineers will be required).
- Consider geographical location & when they will be available.

- **Enterprise Environmental Factors**
- **Organizational Process Assets**

ESTIMATE ACTIVITY RESOURCES – T&T

Expert Judgment

Experts access the resource-related inputs in planning & estimating

Alternatives Analysis

Many schedule activities have alternative methods of accomplishment. They include:

- Using various levels of resource capability or skills
- Using different sizes or types of machines or tools, e.g. automated or manual
- Make-or-buy decisions regarding the resources (whether to outside contracting is cheaper than hiring)

ESTIMATE ACTIVITY RESOURCES – T&T

Published Estimating Data

Some companies publish production rate and unit cost of resources for different trades, material & equipment within countries, various info published by PMI for its members

Bottom-up Estimating

- For accuracy, the work within schedule activity is decomposed into more detail
- Each activity is then totaled into overall project
- Schedule activities may or may not have dependencies between them that can affect the application and use of resources.

Project Management Software

Sophisticated software help plan, organize and manage resource pools & develop resource estimates.

ESTIMATE ACTIVITY RESOURCES - OUTPUTS

Activity Resource Requirements

- Identification & description of types & quantities of resources required for each schedule activity
- Added up to determine estimated resources for each work package
- Schedule activity forms basis of estimate & determines type, availability and quantity of resources used
- Schedule Development process determines when resources are needed

ESTIMATE ACTIVITY RESOURCES - OUTPUTS

Resource Breakdown Structure (RBS)

Is hierarchical structure of identified resources by

- (i) Resource category, and
- (ii) Resource type

Project Document Updates

- Activity list,
- Activity attributes,
- Resource calendars.

TIME PROCESSES

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ESTIMATE ACTIVITY DURATIONS

WHAT IS THERE IN ESTIMATE ACTIVITY DURATION?

The process of approximating the number of work periods needed to complete individual activities with estimated resources. The process uses information on:

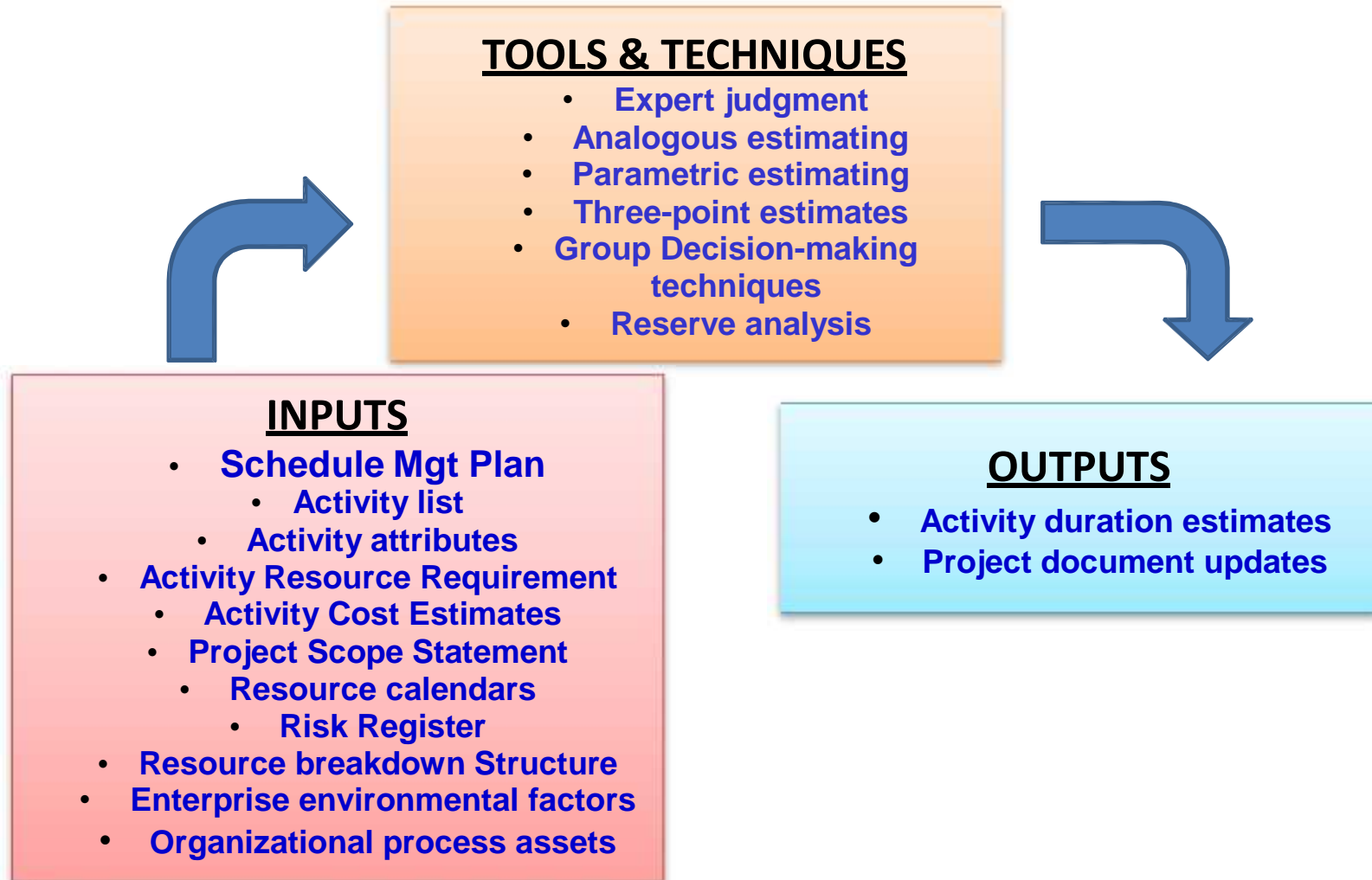
- Activity scope of work
- Required resource types, estimated resource quantities & resource calendars.

The duration estimate is:

- progressively elaborated
- the process considers the quality & availability of the input data
- All data and assumption that support duration estimating are documented for each estimate of activity duration.

Most project management software for scheduling will handle this situation by using a project calendar and alternative work-period resource calendars that are usually identified by resources that require specific work-periods. In addition to the sequencing logic, the activities will be performed according to the project calendar and appropriate resource calendars.

ESTIMATE ACTIVITY DURATIONS



ESTIMATE ACTIVITY DURATIONS - INPUTS

INPUTS

Activity List

Activity Attributes Activity

Resource Requirements

Resource Calendars

Project Scope Statement

Enterprise Environmental Factors

Organizational Process Assets

Expert Judgment

Analogous Estimating

- An estimate that's based on the duration of previous, similar schedule activity as the basis for estimating duration of a future schedule activity.
- It uses historical information & expert judgment.
- It is most reliable when the previous activities are similar in fact and not just in appearance, and the project team members preparing the estimates have the needed expertise (A form of a top-down estimate)

ESTIMATE ACTIVITY DURATION \$ – T&T

Parametric Estimating

Estimates activity durations quantitatively by multiplying the quantity of work to be performed by the productivity rate.

Basically uses some measurable parameter that changes the same way as cost does

Three – Point Estimates

The accuracy of the activity estimate can be improved by considering estimation uncertainty and risk. This concept originated with the Program Evaluation and Review Technique (PERT). PERT uses three estimates to define an approximate range for an activity's duration:

The three estimates are Optimistic, Pessimistic & Most Likely. PERT analysis calculates an Expected activity duration using a weighted average of these three estimates:

Weighted average = {Optimistic + (4* Most likely) + Pessimistic} / 6

ESTIMATE ACTIVITY DURATION \$ – T&T

Reserve Analysis (read 6.4.2.5, page 151)

- Project teams can choose to incorporate additional time referred to as contingency reserve or time reserves or buffers
- Can be applied to overall project schedule or at a point in the schedule as recognition of project risk
- They are planned provisions to mitigate the impact of variance in cost or schedule (takes care of risk in cost & time)

OUTPUTS

Activity Duration Estimates

- Quantitative assessments of the likely number of work periods required to complete a schedule activity
- Estimates should include some indication of the range of possible results, I.e. 2 weeks +/-2 days to indicate that schedule activity will take at least eight days and no more than 12 days (assume 5 day week)

Project Document Updates

TIME PROCESSES

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DEVELOP SCHEDULE

HOW DO YOU DEVELOP A SCHEDULE?

- Develop Schedule is the process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule.
- Determine planned start & finish dates for all project activities
- Schedule development is iterative (repeats in cycles) & continues throughout the project to modify duration & resource estimates as the:
 - Work progresses
 - Project Management Plan changes
 - the nature of risk events evolves
- The schedule baseline (developed at the beginning of the project) is used to track work progress and variance.

DEVELOP SCHEDULE

TOOLS & TECHNIQUES

- Schedule network analysis
 - Critical path method
 - Critical chain method
 - Resource levelling
- What-if scenario analysis
- Applying leads and lags
- Schedule compression
 - Scheduling tool

INPUTS

- Schedule Mgt Plan
 - Activity list
 - Activity attributes
- Project schedule network diagrams
- Activity resource requirements
 - Resource calendars
- Activity duration estimates
 - Project scope statement
 - Risk Register
 - Project Staff Assignments
- Resource Breakdown Structures
- Enterprise environmental factors
- Organizational process assets

OUTPUTS

- Project schedule
- Schedule baseline
 - Schedule data
 - Project Calendar
 - PM Plan Update
- Project document updates

DEVELOP SCHEDULE - INPUTS

INPUTS

Activity List

Activity Attributes

Project Schedule Network Diagrams

Activity Resource Requirements

Resource Calendars

Activity Duration Estimates

Project Scope Statement

Enterprise Environmental Factors

Organizational Process Assets

- e.g. Scheduling methodology, and project calendar

DEVELOP SCHEDULE – T&T

TOOLS & TECHNIQUES

1) Schedule Network Analysis

- Generates the project schedule with early and late start and finish dates using:
- Critical path method
- Critical chain method
- What-if analysis & resource leveling
- Schedule compression or analysis

2) Critical Path Method (CPM) – Read page 154-155

- Series (or path) of activities through the network diagram that determines the soonest time a project can finish
- Calculates the theoretical early start and finish dates, and late start and finish dates, for all activities without regard for any resource limitations, by performing a forward and backward pass analysis through the schedule network.
- longest path through the network diagram
- they have either zero or negative total float.
- Networks can have multiple near critical paths.
- the schedule activities on critical path are called critical activities

DEVELOP SCHEDULE – T&T

TOOLS & TECHNIQUES

3) Critical Chain Method (Read page 155)

- **Critical chain is a schedule network analysis technique that modifies the project schedule to account for limited resources.**
- **The critical chain method adds duration buffers that are non-work schedule activities to manage uncertainty. One buffer, placed at the end of the critical chain, is known as the project buffer and protects the target finish date from slippage along the critical chain.**

DEVELOP SCHEDULE – T&T

TOOLS & TECHNIQUES

4) Resource Leveling

- After using critical path to analyze your schedule, you may need to address:
 - Resource usage that needs to be kept at a constant level, e.g. a technician utilized for 120 hours for one week is better utilized at 40 hours a week for 3 weeks
 - Activities that need to be performed to meet specified delivery dates
 - to address the situation where shared or critical required resources are only available at certain times and in limited quantities
 - **Resource leveling often results in:**
 - A longer project duration
 - Allocating scarce resources to critical path activities
 - Using overtime or multiple shifts
 - Methods to increase resource productivity like different technology or machines
 - Can cause the original critical path to change
 - A cost increase, but staff cost may decrease if overtime is eliminated
 - Produces a resource-limited or resource-constrained schedule
 - Reverse resource allocation scheduling is done from project end.

DEVELOP SCHEDULE – T&T

TOOLS & TECHNIQUES

5) What-If Scenario Analysis

- Creates a schedule model, then computes different scenarios (simulations) if X happens; assess the feasibility of the project schedule under adverse conditions.
 - The most common technique is Monte Carlo Analysis (read Section 11.4.2.2)

6) Applying Leads and Lags

7) Schedule Compression

- Shortens project schedule without changing the project scope to meet schedule constraints, imposed dates, or other schedule objectives.
 - **Crashing** –addition of more resources on the critical path to complete the project earlier (generally increases cost).
- **Fast tracking** - activities or phases that normally would be done in sequence are performed in parallel; can require work to be performed without detailed info. & can increase risk.

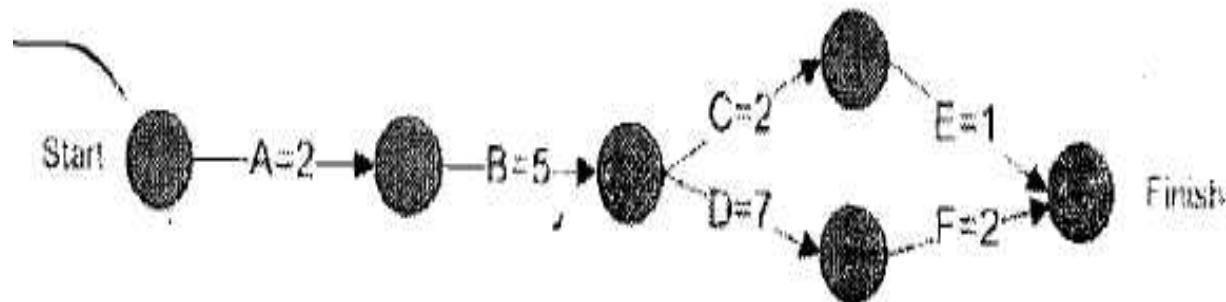
8) Scheduling Tool

- Automated scheduling tools expedite the scheduling process by generating start and finish dates based on the inputs of activities, network diagrams, resources and activity durations. A scheduling tool can be used in conjunction with other project mgmt. Software applications as well as manual methods.

DEVELOP SCHEDULE – T&T

Consider the following diagram of activities (time is given in days)

1. How many paths are on this network diagram?
2. How long is each path in days?
3. Which is the critical path?
4. What is the least amount of time needed to finish this project?



DEVELOP SCHEDULE – T&T

PERT (Problem)

What's the expected time to complete an activity given these times?

Optimistic = 15 min. Most Likely = 30 min. Pessimistic = 60 min.

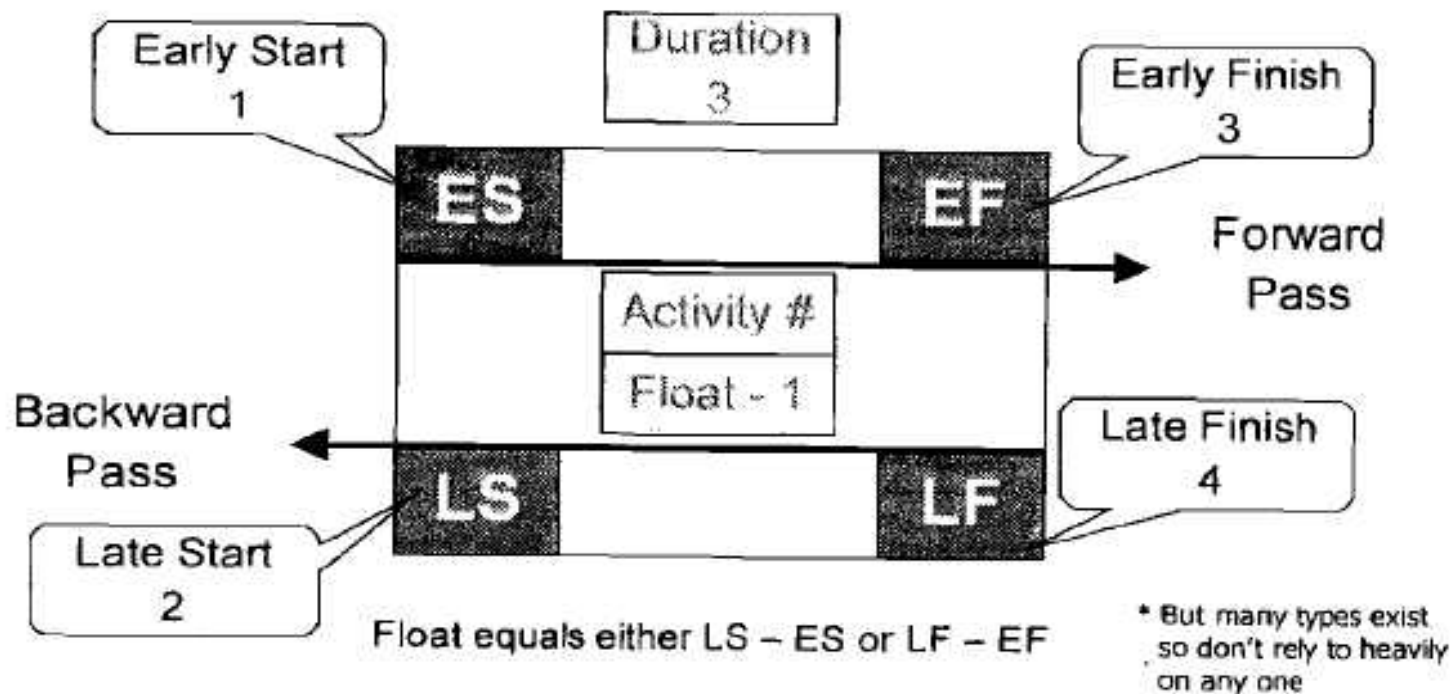
Weighted Average (Expected) Time using PERT calculations:

{Optimistic + (4 x Most Likely) + Pessimistic} divided by 6

Answer: (15 + 120 + 60) /6 = 32.5 min

DEVELOP SCHEDULE – T&T

Standard Node or Activity Presentation*



DEVELOP SCHEDULE – OUTPUTS

OUTPUTS

1) Project Schedule

- Includes at least a planned start date & planned finish date for each schedule activity.
- Project Schedule can be presented in summary form, called master or milestone schedule, or presented in detail.
- More often presented graphically using following formats:
 - *Project Schedule Network Diagrams* (These diagrams can be presented in the activity-on-node diagram format or in a time-scaled schedule network diagram format (see Figure 6-10, p.150), sometimes called a logic bar chart.

DEVELOP SCHEDULE – OUTPUTS

- **Milestone Charts**
 - Bar chart with only scheduled start or completion dates of major deliverables and key external interfaces (see Fig. 6-14, p.158 top milestone schedule)
 - In milestone chart activities have zero duration
- **Bar Charts**
 - Gantt Charts with bars representing activities show activity start and end dates & expected durations
 - For control & management communication, more comprehensive summary activity, (see Fig. 6-14, p.158 middle summary schedule) sometime referred to as a hammock activity, is used between milestones or across multiple interdependent work packages

DEVELOP SCHEDULE – OUTPUTS

Project schedule network diagrams (see Fig. 6-7 and Fig. 6-14)

2) Schedule Baseline

- Accepted & approved schedule

3) Schedule Data

4) Project Document Updates

- Activity resource requirements
- Activity attributes
- Calendar
- Risk register

TIME PROCESSES

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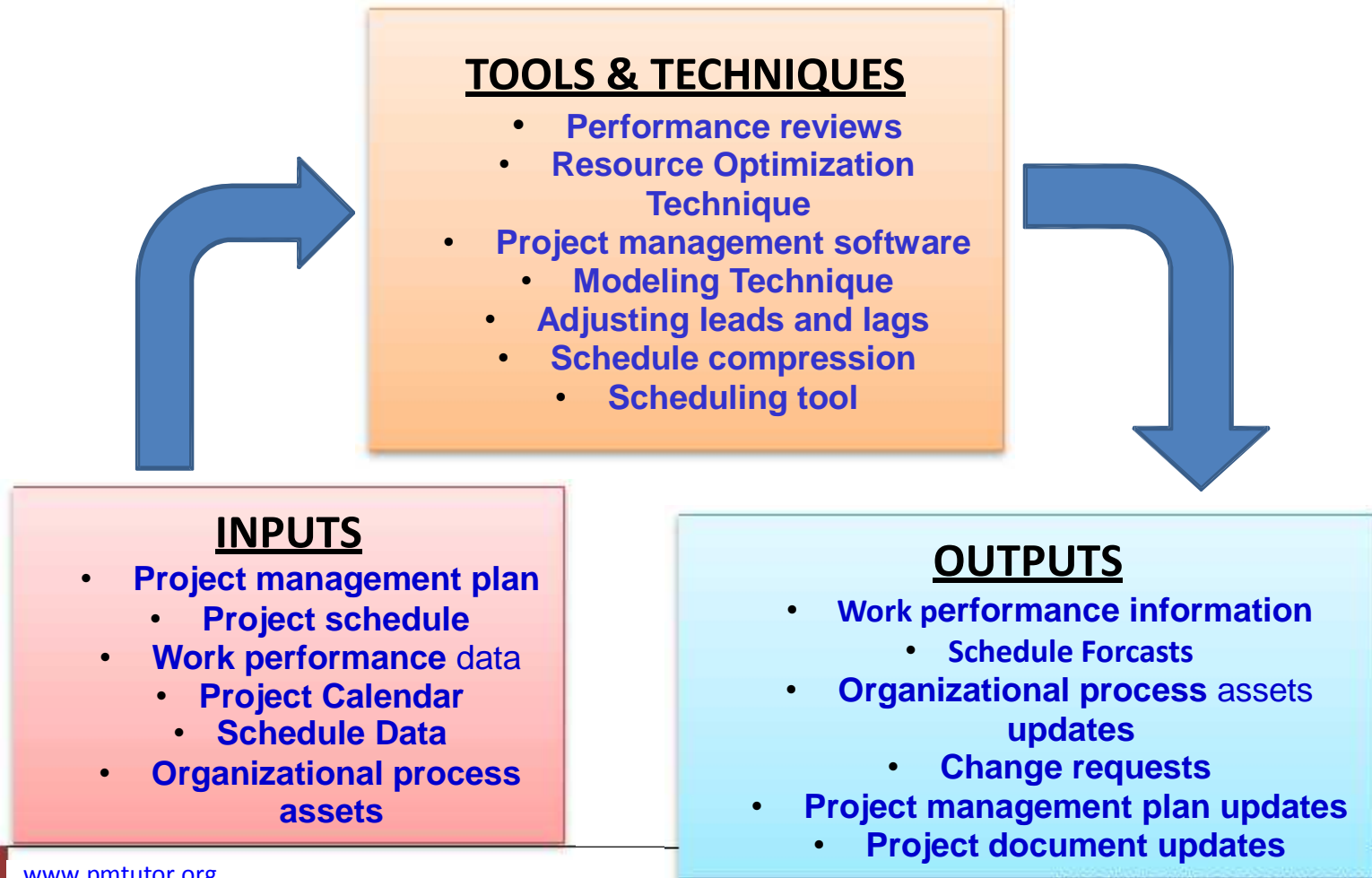
CONTROL SCHEDULE

WHAT HAPPENS IN CONTROL SCHEDULE?

- Schedule control is concerned with:
 - Determining the current status of the project schedule
 - Influencing the factors that create schedule changes
 - Determining that the project schedule has changed
 - Managing the actual changes as they occur

Schedule Control is a portion of Integrated Change Control process

CONTROL SCHEDULE



CONTROL SCHEDULE - INPUTS

INPUTS

Project Management Plan

- It describes how the schedule will be managed and controlled, for example:
 - Format of *your* schedule; rules for use of MS Project
 - How and how often is the schedule updated
 - Rules for authorizing schedule changes
 - Mechanisms for detecting schedule changes
 - How is time estimating done
- The schedule baseline is used to compare with actual results to determine if a change, corrective action, or preventive action is necessary.

Project Schedule

Work Performance Information

Organizational Process Assets

CONTROL SCHEDULE – T&T

Performance Reviews

Performance reviews measure, compare, and analyse schedule performance such as actual start and finish dates, percent complete, and remaining duration for work in progress.

If earned value mgmt.(EVM) is utilized the schedule variance (SV) and schedule performance index (SPI) are used to assess the magnitude of schedule variations (read page 162)

Variance Analysis

- Compare target vs. actual/forecast start and finished dates provides useful information for the detection of deviations and for the implementation of corrective actions in case of delays.



CONTROL SCHEDULE – T&T

Project Management Software

Resource Leveling

What-If Scenario Analysis

Adjusting Leads and Lags

Schedule Compression

Scheduling Tool



CONTROL SCHEDULE – OUTPUTS

OUTPUTS

- **Work Performance Measurements**
- **Organizational Process Assets Updates**
- **Change Requests**
- **Project Management Plan Updates**
- **Project Document Updates**