Chapter 6
Project Time Management
(PMBOK Guide)

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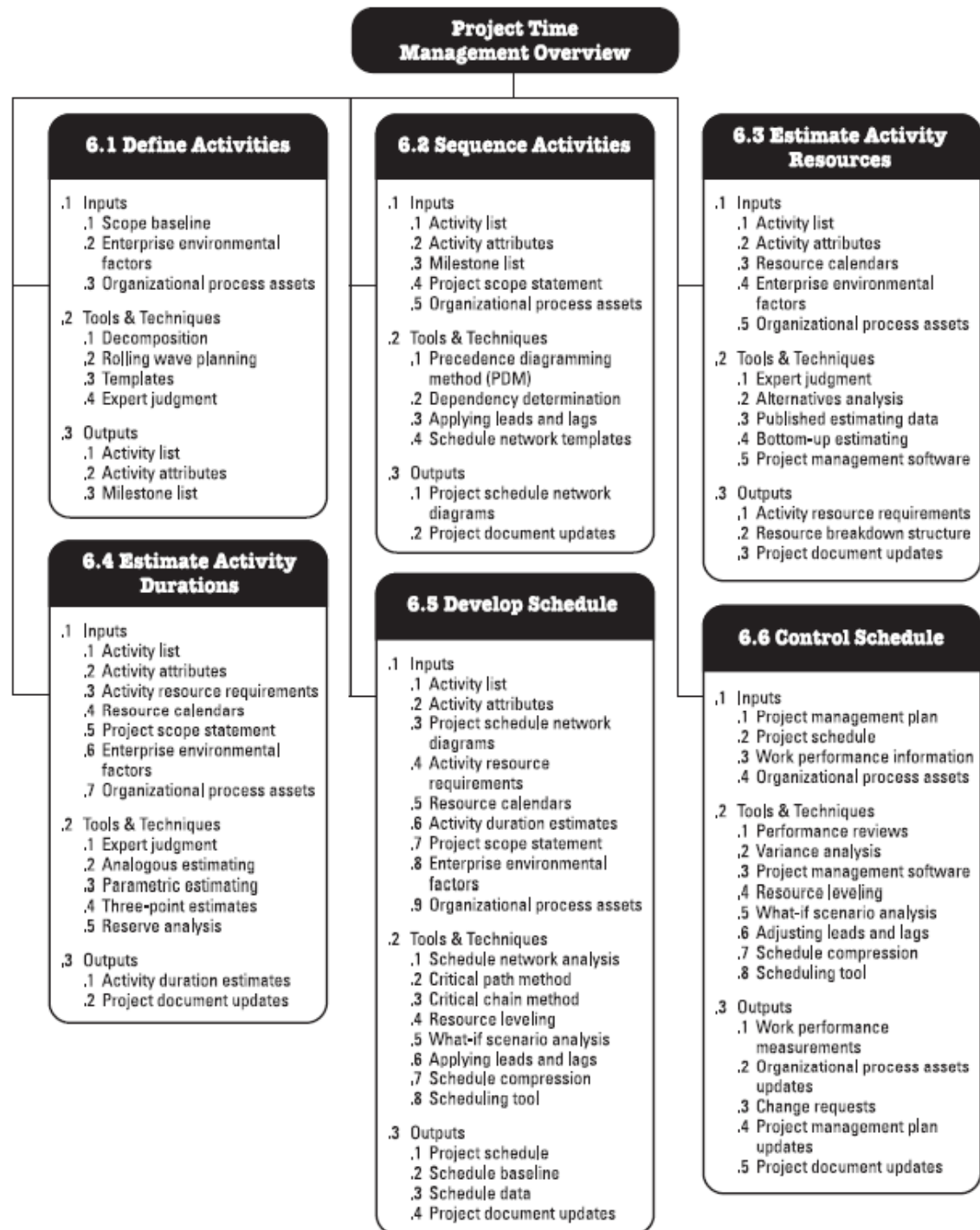**Tel: +98 21 8833 4341, Cell: +98 912 132 5823**

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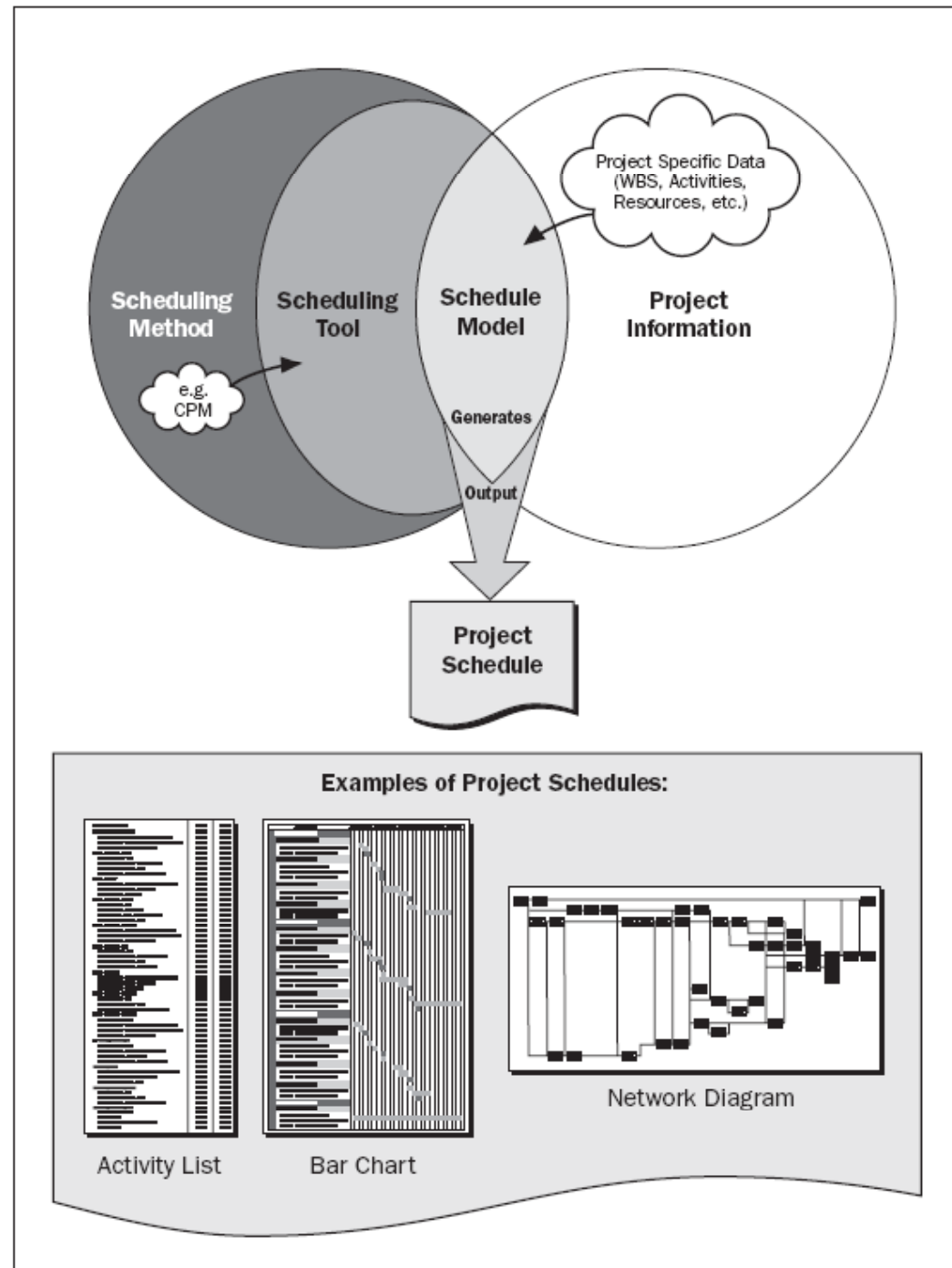**Homepage: http://www.marajabi.com**

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Introduction

- Includes processes required to manage timely completion of the project

- Define activities

- Sequence activities

- Estimate activity resources

- Estimate activity durations

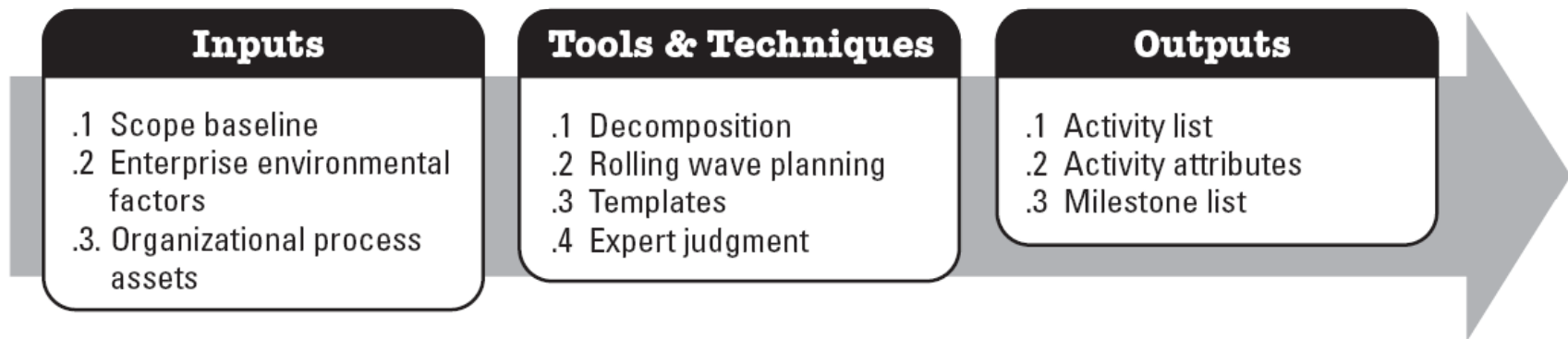- Develop schedule

- Control schedule

Project Time Management Overview

6.1 Define Activities

.1 Inputs
- .1 Scope baseline
- .2 Enterprise environmental factors
- .3 Organizational process assets

.2 Tools & Techniques
- .1 Decomposition
- .2 Rolling wave planning
- .3 Templates
- .4 Expert judgment

.3 Outputs
- .1 Activity list
- .2 Activity attributes
- .3 Milestone list

6.2 Sequence Activities

.1 Inputs
- .1 Activity list
- .2 Activity attributes
- .3 Milestone list
- .4 Project scope statement
- .5 Organizational process assets

.2 Tools & Techniques
- .1 Precedence diagramming method (PDM)
- .2 Dependency determination
- .3 Applying leads and lags
- .4 Schedule network templates

.3 Outputs
- .1 Project schedule network diagrams
- .2 Project document updates

6.3 Estimate Activity Resources

.1 Inputs
- .1 Activity list
- .2 Activity attributes
- .3 Resource calendars
- .4 Enterprise environmental factors
- .5 Organizational process assets

.2 Tools & Techniques
- .1 Expert judgment
- .2 Alternatives analysis
- .3 Published estimating data
- .4 Bottom-up estimating
- .5 Project management software

.3 Outputs
- .1 Activity resource requirements
- .2 Resource breakdown structure
- .3 Project document updates

6.4 Estimate Activity Durations

.1 Inputs
- .1 Activity list
- .2 Activity attributes
- .3 Activity resource requirements
- .4 Resource calendars
- .5 Project scope statement
- .6 Enterprise environmental factors
- .7 Organizational process assets

.2 Tools & Techniques
- .1 Expert judgment
- .2 Analogous estimating
- .3 Parametric estimating
- .4 Three-point estimates
- .5 Reserve analysis

.3 Outputs
- .1 Activity duration estimates
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6.5 Develop Schedule

.1 Inputs
- .1 Activity list
- .2 Activity attributes
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- .5 Resource calendars
- .6 Activity duration estimates
- .7 Project scope statement
- .8 Enterprise environmental factors
- .9 Organizational process assets

.2 Tools & Techniques
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- .2 Critical path method
- .3 Critical chain method
- .4 Resource leveling
- .5 What-if scenario analysis
- .6 Applying leads and lags
- .7 Schedule compression
- .8 Scheduling tool

.3 Outputs
- .1 Project schedule
- .2 Schedule baseline
- .3 Schedule data
- .4 Project document updates

6.6 Control Schedule

.1 Inputs
- .1 Project management plan
- .2 Project schedule
- .3 Work performance information
- .4 Organizational process assets

.2 Tools & Techniques
- .1 Performance reviews
- .2 Variance analysis
- .3 Project management software
- .4 Resource leveling
- .5 What-if scenario analysis
- .6 Adjusting leads and lags
- .7 Schedule compression
- .8 Scheduling tool

.3 Outputs
- .1 Work performance measurements
- .2 Organizational process assets updates
- .3 Change requests
- .4 Project management plan updates
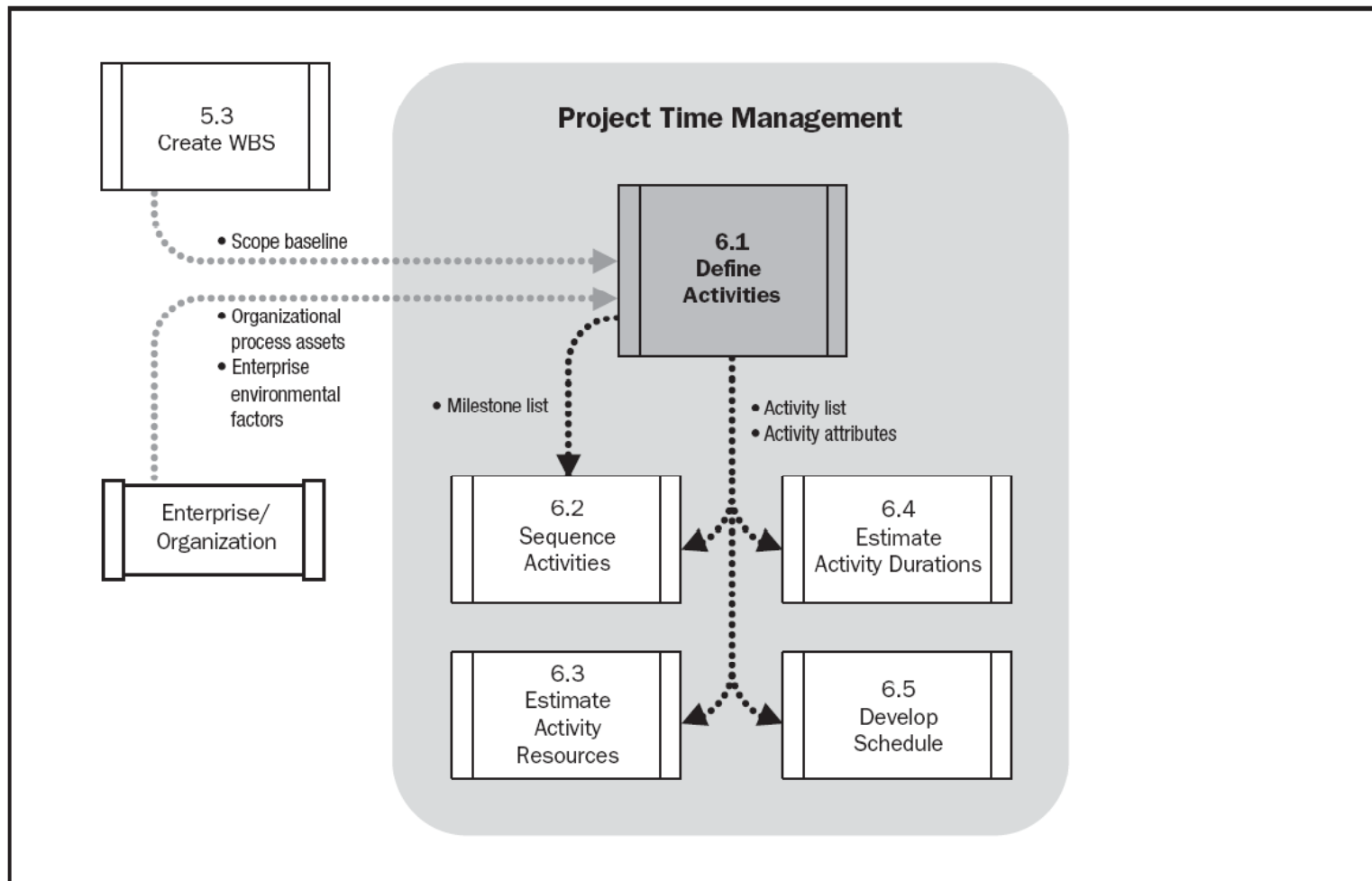- .5 Project document updates

Scheduling Overview

6.1 Define Activities

- Identifying the specific activities to produce the project deliverables

- WBS identifies the deliverables at the lowest level

Inputs, Tools & Techniques, Outputs

Inputs	Tools & Techniques	Outputs
.1 Scope baseline .2 Enterprise environmental factors .3. Organizational process assets	.1 Decomposition .2 Rolling wave planning .3 Templates .4 Expert judgment	.1 Activity list .2 Activity attributes .3 Milestone list

Data Flow Diagram

Inputs

- **Scope baseline**
  - Deliverables, constraints, assumptions
- **Enterprise environmental factors**
  - PMIS
- **Organizational process assets**
  - Existing formal and informal activity planning-related policies, procedures, and guidelines
  - Lessen learned

Tools and Techniques

- Decomposition
  - Subdividing the project work package
  - Developing WBS, WBS dictionary and decomposing it for development of the final activity list
  - Rolling Wave Planning
    - Work to be accomplished in the near future is planned in detail, future work is planned at a higher level
  - Templates
  - Expert judgment

Outputs

- Activity list
  - A comprehensive list including all schedule activities required for the project
  - Activity identifier
  - Scope of work description for each activity
- Activity attributes
  - Activity ID, WBS ID, activity name, when completed activity codes, activity description, predecessors, successors, logical relationships, leads, lags, resource requirement, imposed dates, constraints, and assumptions, person responsible, geographic area, Level of Effort (LOF)
- Milestone list

6.2 Sequence Activities

- The process of identifying and documenting relationships among the project activities

- Every activity (except the first and the last ones) is connected to one predecessor and one successor

- Leads and lags might be necessary

- PM software, manual, and/or automated

Inputs, Tools & Techniques, Outputs

Inputs
- .1 Activity list
- .2 Activity attributes
- .3 Milestone list
- .4 Project scope statement
- .5 Organizational process assets

Tools & Techniques
- .1 Precedence diagramming method (PDM)
- .2 Dependency determination
- .3 Applying leads and lags
- .4 Schedule network templates

Outputs
- .1 Project schedule network diagrams
- .2 Project document updates
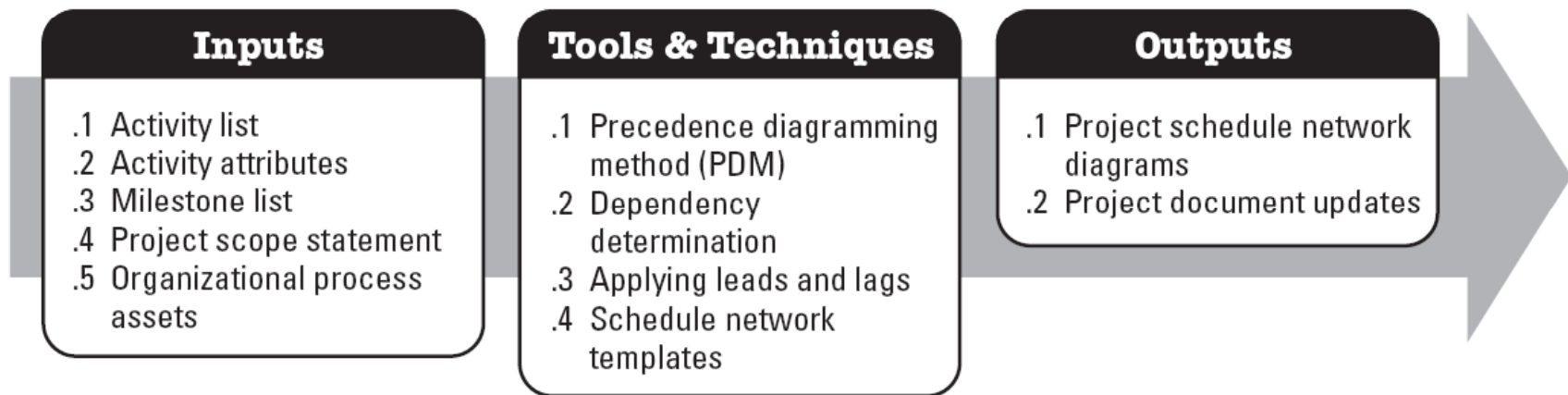
Inputs

- Activity list
- Activity attributes
- Milestone list
- Project scope statement
  - Checking scope description to ensure accuracy
- Organizational process assets
  - Project files from the corporate knowledge base used for scheduling methodology

Tools and Techniques

- Precedence Diagramming Method (PDM)
  - Also called Activity-On-Mode (AON)
  - Finish-to-start (FS), Finish-to-finish (FF), Start-to-start (SS), Start-to-finish (SF) [rarely used!]
- Dependency determination
  - Mandatory: by contract or inherent
  - Discretionary: preferred logic, preferential logic, or soft logic based on best practices
  - External: relationship between project and non-project activities (out of project team's control)
- Applying leads and lags
- Schedule network templates (specially good for repeated deliverables)

Precedence Diagramming Method
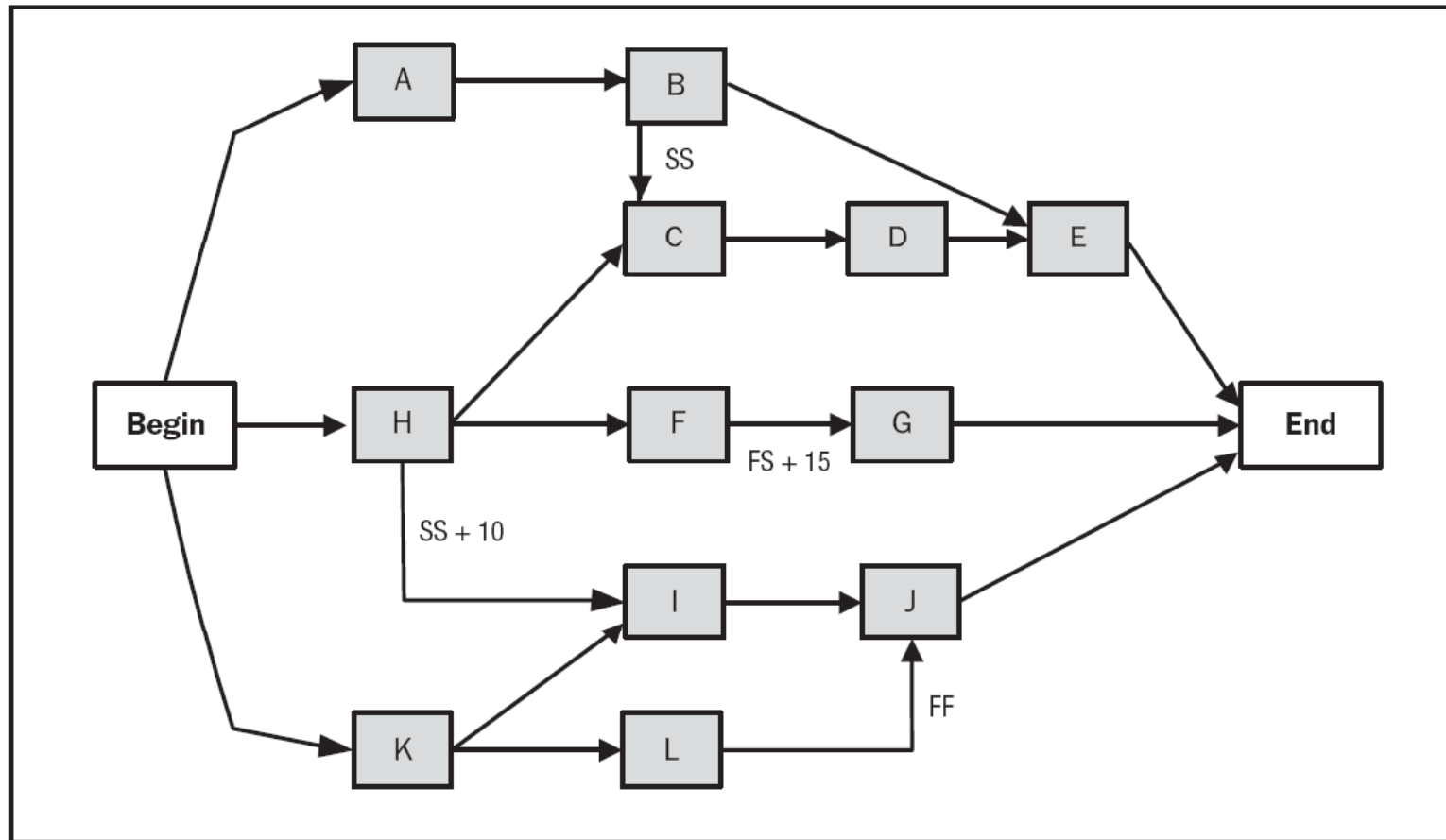
Outputs

- Project schedule network diagrams

- Project document updates
  - Activity lists

  - Activity attributes

  - Risk register

6.3 Estimate Activity Resources

- The process of estimating the type and quantities of material, people, equipment or supplies

Inputs, Tools & Techniques, Outputs

Inputs	Tools & Techniques	Outputs
.1 Activity list .2 Activity attributes .3 Resource calendars .4 Enterprise environmental factors .5 Organizational process assets	.1 Expert judgment .2 Alternatives analysis .3 Published estimating data .4 Bottom-up estimating .5 Project management software	.1 Activity resource requirements .2 Resource breakdown structure .3 Project document updates
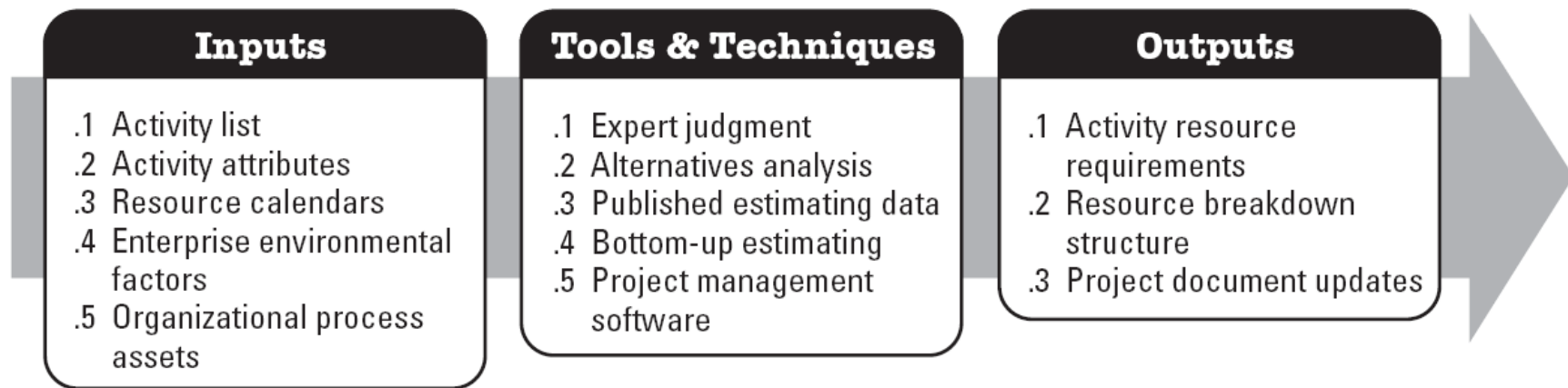
Data Flow Diagram
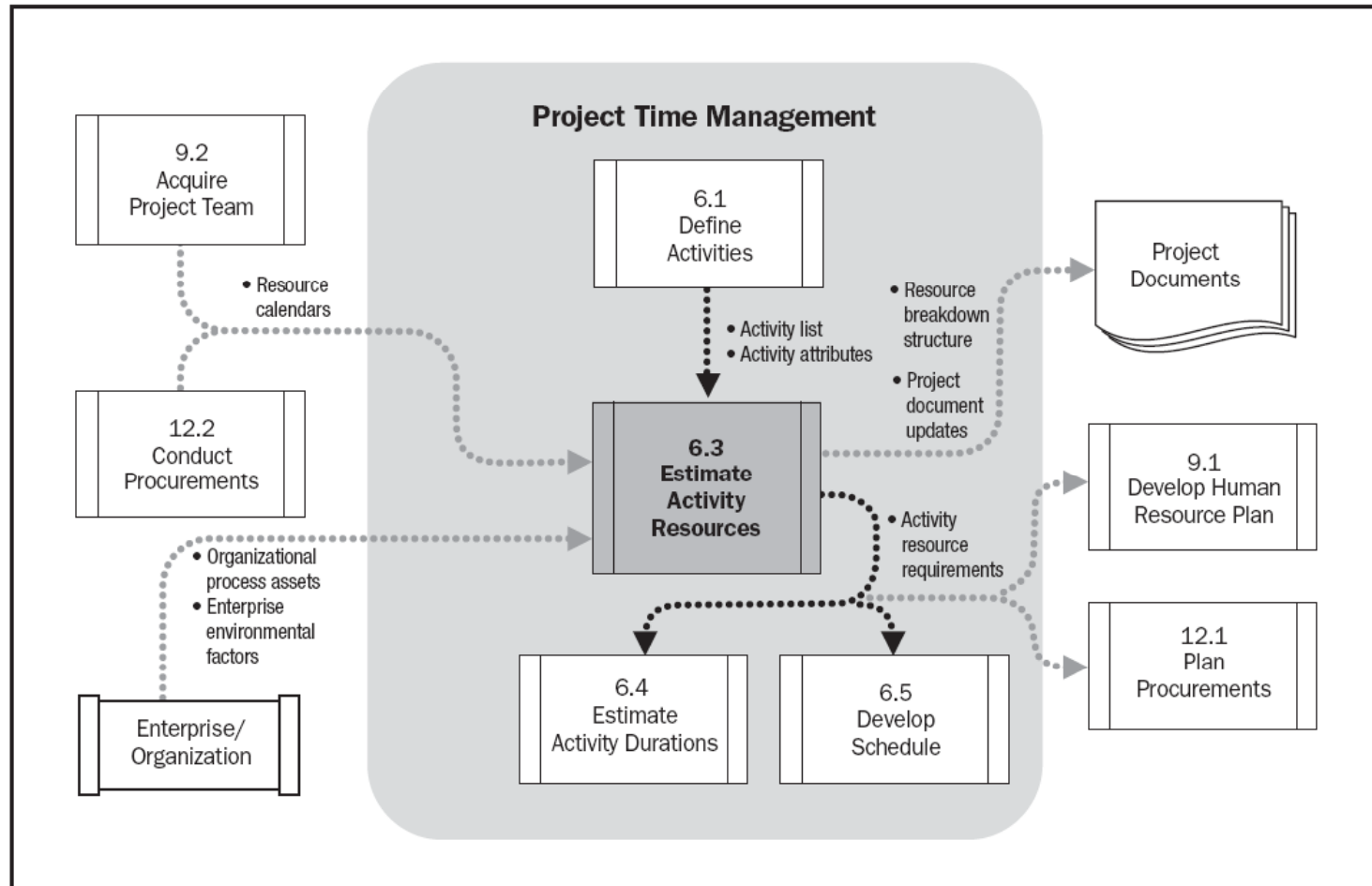
Inputs

- Activity list
- Activity attributes
- Resource calendars
  - When and how long a resources is available + its attributes (experience/skill, geographic location, i.e., availability, capability)
- Enterprise environmental factors (resource availability and skills)
- Organizational process assets (policies, procedures related to staffing, rental or purchase of equipment, historical information regarding types of resources

Tools and Techniques

- Expert judgment
- Alternative analysis (various level of resource capability, skills, size or type of machines, different tools, make or buy decisions
- Published estimating data
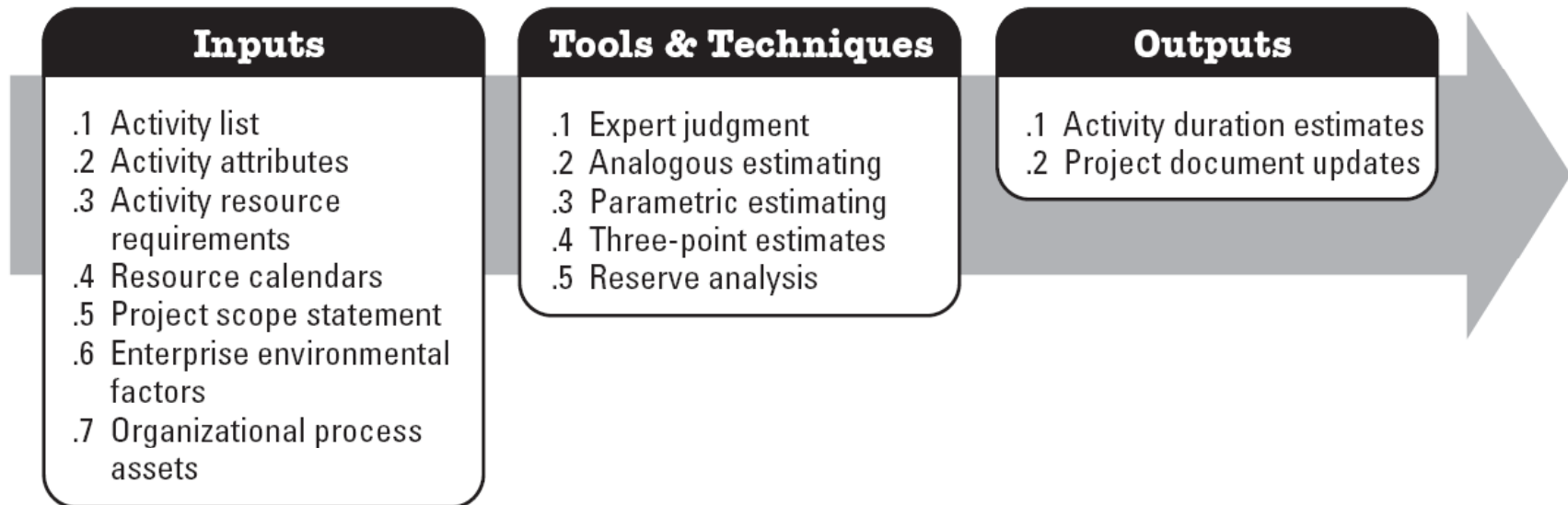- Bottom-up estimating
- Project management software

Outputs

- Activity resource requirements (types and quantities of resources)
- Resource breakdown structure (hierarchy of identified resources by resource category, and type (labour, material, equipment, and supplies))
- Project documents updates
  - Activity list
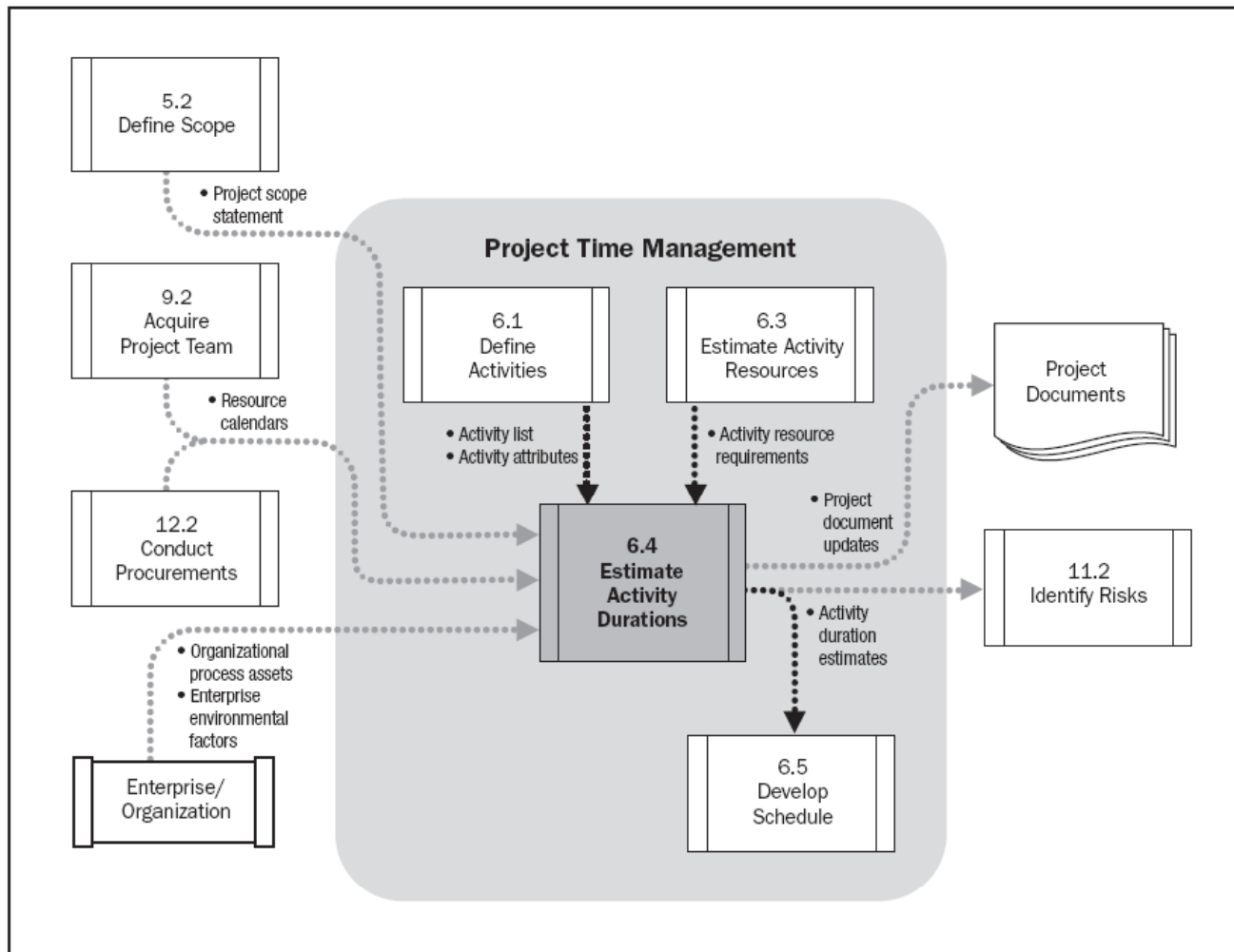 - Activity attribute
  - Resource calendar

6.4 Estimate Activity Duration

- Estimating the number of work periods needed to complete activities with estimated resources

- Progressively elaborated considering quality and availability of data

Inputs, Tools & Techniques, Outputs

Inputs

.1 Activity list
.2 Activity attributes
.3 Activity resource requirements
.4 Resource calendars
.5 Project scope statement
.6 Enterprise environmental factors
.7 Organizational process assets

Tools & Techniques

.1 Expert judgment
.2 Analogous estimating
.3 Parametric estimating
.4 Three-point estimates
.5 Reserve analysis

Outputs

.1 Activity duration estimates
.2 Project document updates

Data Flow Diagram

Inputs

- Activity list
- Activity attributes
- Activity resource requirements
- Resource calendars (type, quantity, availability, capability of human resources, equipment, material)
- Project scope management (constraints and assumptions such as existing conditions, availability of information , and length of reporting periods, for example: available skilled resources, contract terms and requirements)
- Enterprise environmental factors (duration estimating DB, productivity metrics, published commercial information)
- Organizational process assets (historical duration information, project calendars, scheduling methodology, and lesson learned)

Tools and Techniques

- Expert judgment
- Analogous estimating (duration, budget, size, weight and complexity from a previous similar project)
  - Less costly and time consuming but less accurate
- Parametric estimating (using statistical relationship between historical data and variables (e.g.: square footage)
- Three-point estimation (originated from Program Evaluation and Review Technique (PERT)
  - Most likely (Tm), optimistic (To), pessimistic (Tp), expected (Te): Te=(To+4Tm+Tp)/6
- Reserve Analysis: contingency reserves or time reserves or buffers) to account for schedule uncertainty shown by % of duration, fixed number of work periods. It should be clearly documented
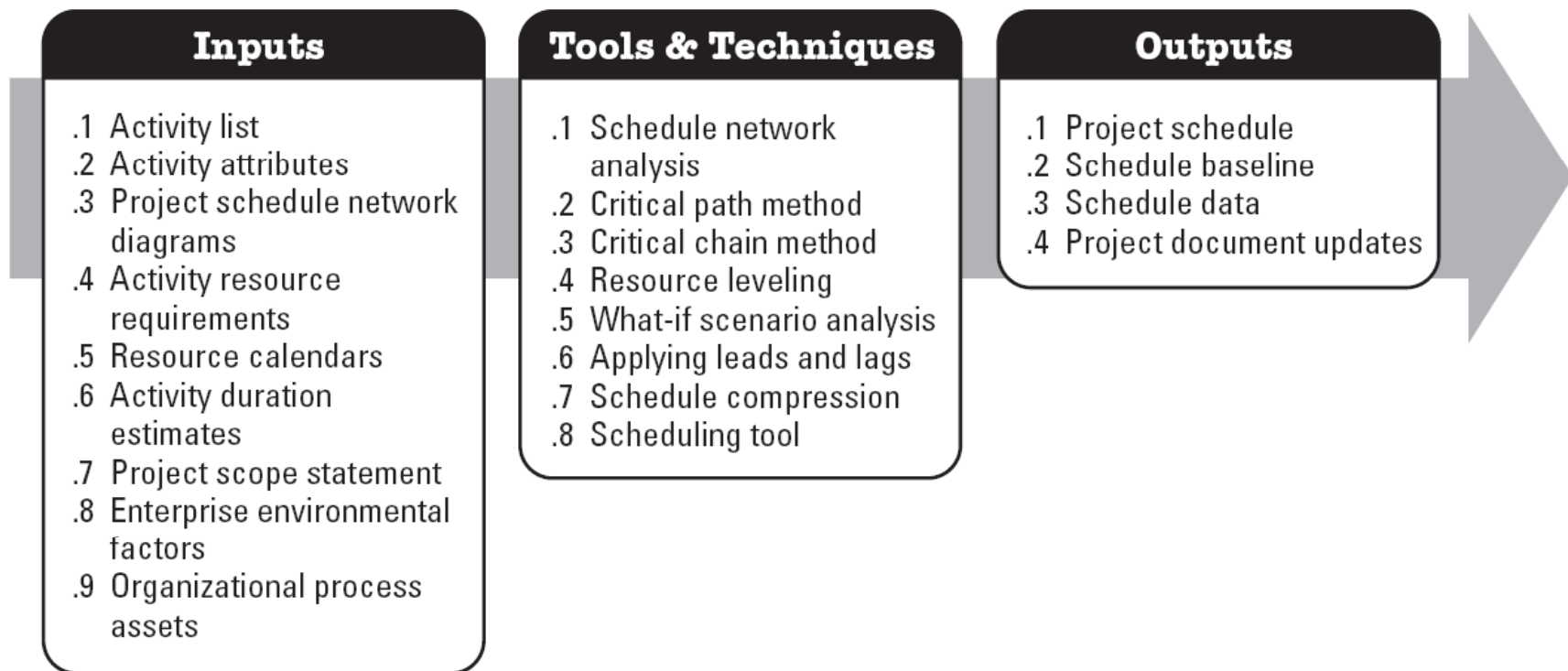
Outputs

- Activity duration estimates (do not include any lag)
  - E.g.: 2 weeks ± 2 days, 15% probability of exceeding 3 weeks
- Project document updates
  - Activity attributes
  - Assumption made in developing the activity duration estimate such as skill levels and availability
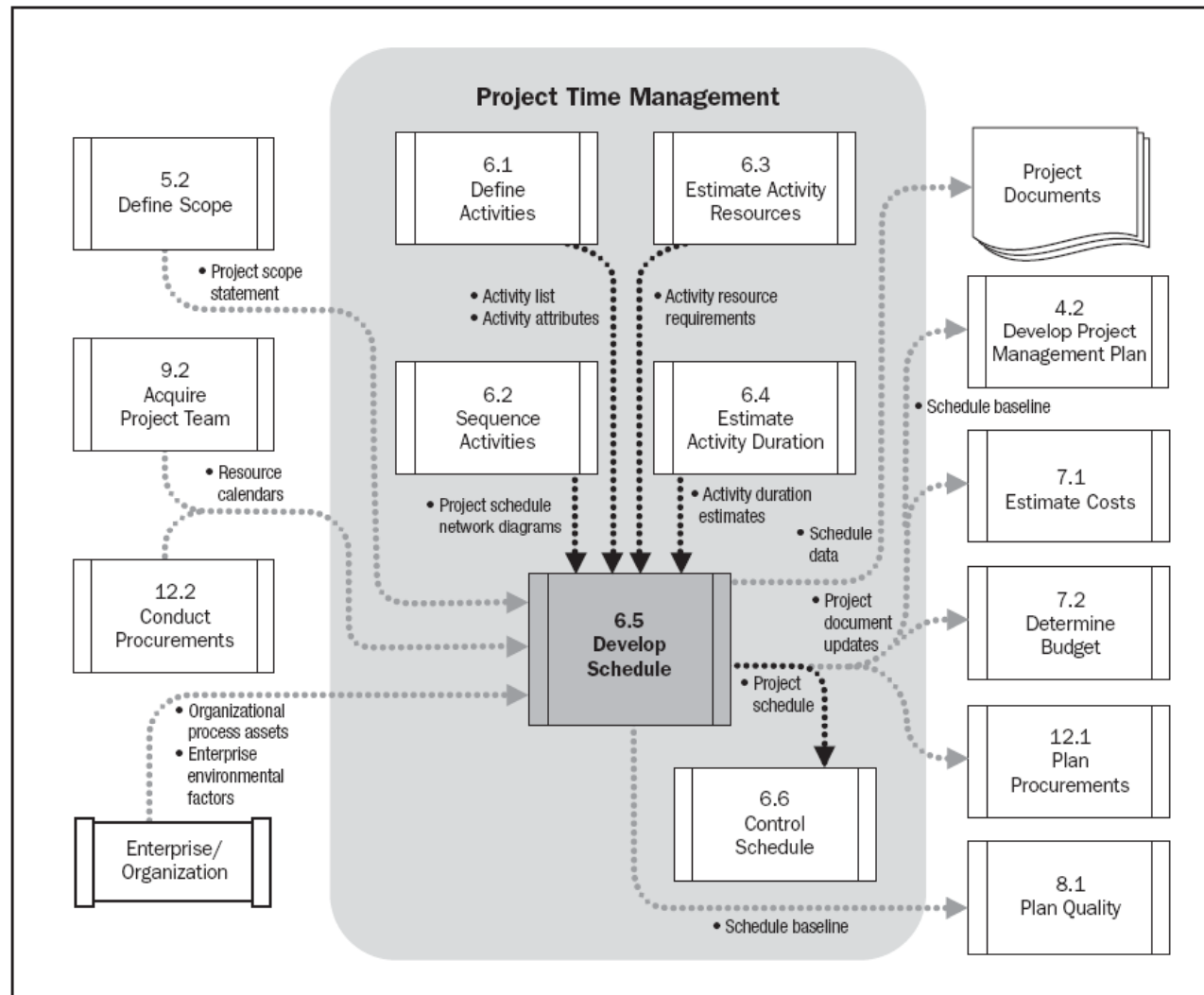
6.5 Develop Schedule

- The process of analyzing activity sequence, durations, resource requirements and schedule constraints to create the project schedule

- Often an iterative process

Inputs, Tools & Techniques, Outputs

Inputs

.1 Activity list
.2 Activity attributes
.3 Project schedule network diagrams
.4 Activity resource requirements
.5 Resource calendars
.6 Activity duration estimates
.7 Project scope statement
.8 Enterprise environmental factors
.9 Organizational process assets

Tools & Techniques

.1 Schedule network analysis
.2 Critical path method
.3 Critical chain method
.4 Resource leveling
.5 What-if scenario analysis
.6 Applying leads and lags
.7 Schedule compression
.8 Scheduling tool

Outputs

.1 Project schedule
.2 Schedule baseline
.3 Schedule data
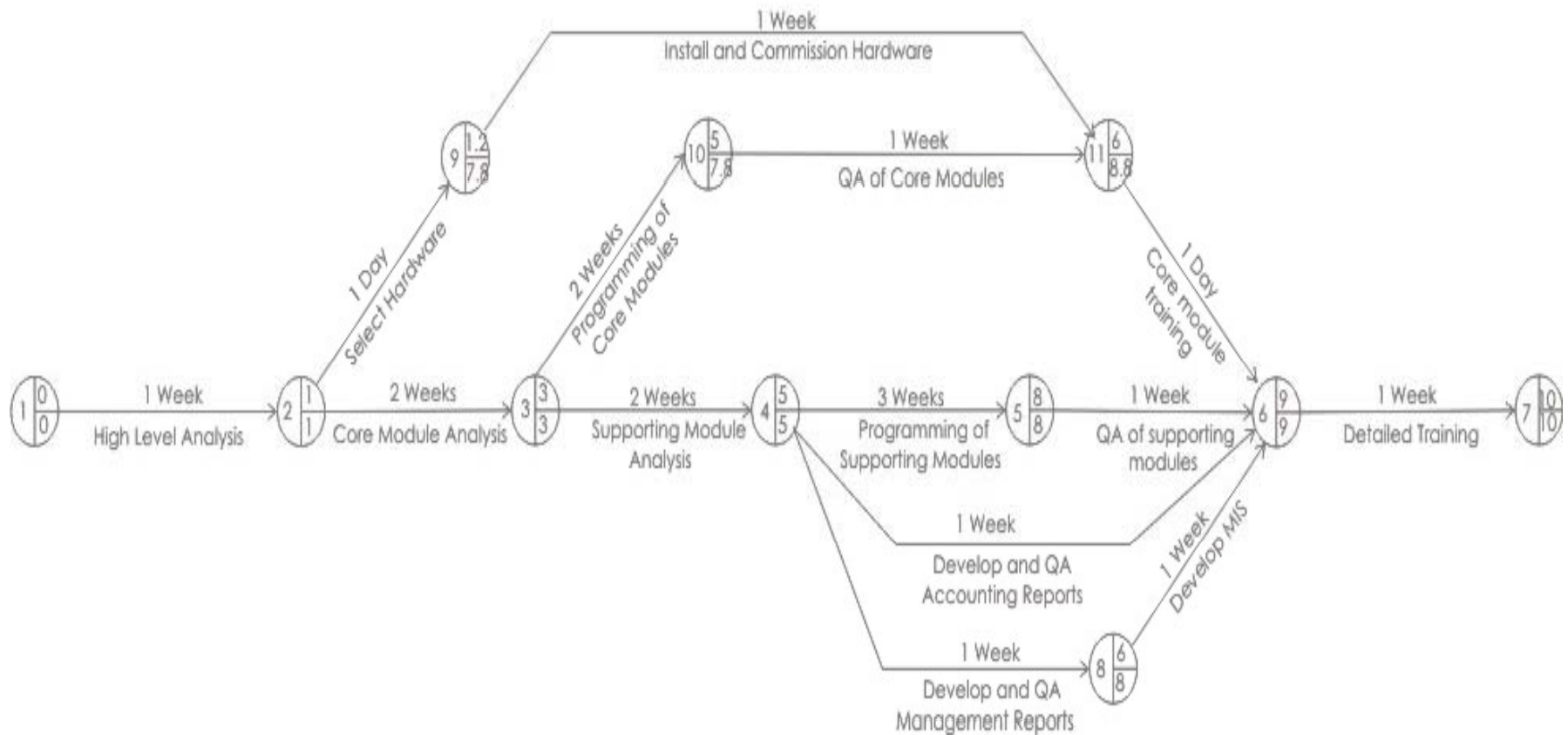.4 Project document updates

Data Flow Diagram

Inputs

- Activity list
- Activity attributes
- Project schedule network diagrams
- Activity resource requirements
- Resource calendars
- Activity duration estimates
- Project scope statement
- Enterprise environmental factors (scheduling tool)
- Organizational process asset (scheduling methodology and project calendar)

Tools and Techniques

- Schedule network analysis
- Critical Path Method (CPM)
- Critical Chain Method (resource-constrained CPM + buffers at the beginning and end of scheduled activities)
- Resource leveling (limited resources)
- What-if scenario analysis (Monte Carlo Analysis)
- Applying leads and lags
- Schedule compression
  - Crashing (approving overtime, adding resources for effort driven activities)
  - Fast tracking (overlapping the activities)
- Scheduling tool

CPM

Figure 5: Critical Path Analysis for Example Computer Project

Output

- Project schedule
  - Milestone charts
  - Bar charts
  - Project schedule network diagrams
- Schedule baseline
- Schedule data (milestones, activities, activity attributes, documented assumptions and constraints)
  - Resource histogram
  - Alternative schedules (best, worst case, resource-leveled, not resource-leveled, with or without imposed dates
  - Scheduling of contingency reserves
- Project document updates
  - Activity resource requirements
  - Activity attributes
  - Calendar
  - Risk register

Graphic Examples

Milestone Schedule

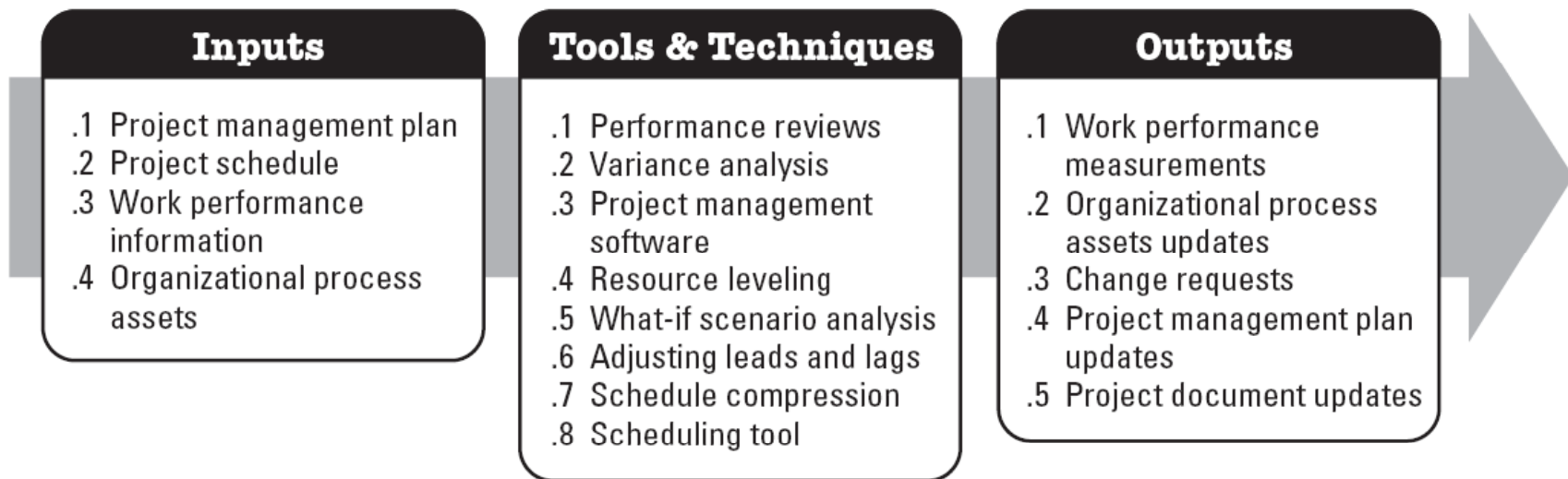| Activity Identifier	Activity Description	Calendar units	Project Schedule Time Frame				
			Period 1	Period 2	Period 3	Period 4	Period 5
1.1.MB	Provide New Product Z Deliverable - Begun	0	◇				
1.1.1.M1	Component 1 - Completed	0			◇		
1.1.2.M1	Component 2 - Completed	0			◇		
1.1.MF	Provide New Product Z Deliverable - Finished	0					◇

← Data Date

Summary Schedule

Activity Identifier	Activity Description	Calendar units	Project Schedule Time Frame				
			Period 1	Period 2	Period 3	Period 4	Period 5
1.1	Provide New Product Z Deliverable	120					
1.1.1	Work Package 1 - Develop Component 1	67					
1.1.2	Work Package 2 - Develop Component 2	53					
1.1.3	Work Package 3 - Integrate Components	53					

← Data Date

Detailed Schedule with Logical Relationships

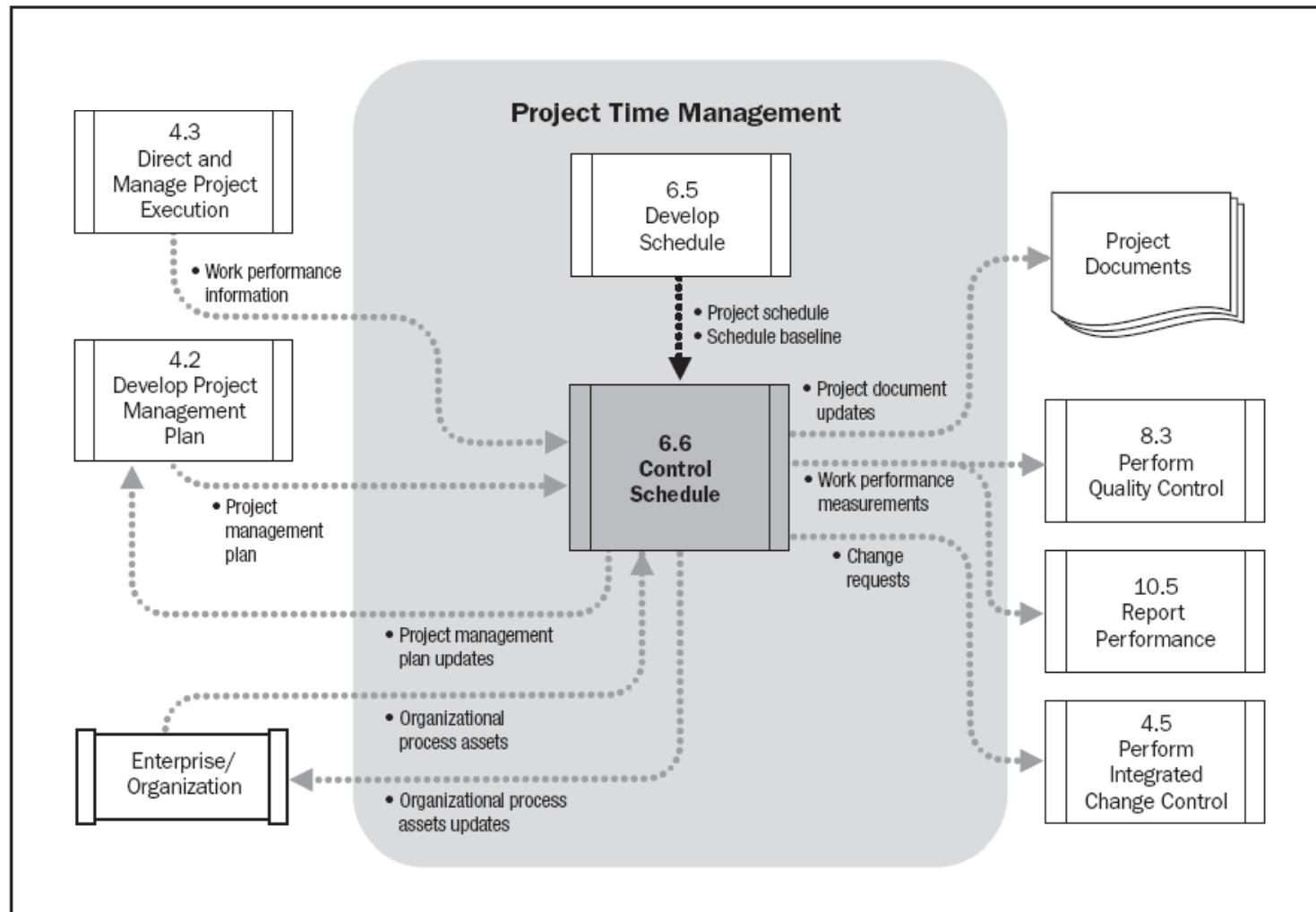| Activity Identifier	Activity Description	Calendar units	Project Schedule Time Frame				
			Period 1	Period 2	Period 3	Period 4	Period 5
1.1.MB	Provide New Product Z Deliverable - Begun	0					
1.1.1	Work Package 1 - Develop Component 1	67					
1.1.1.D	Design Component 1	20					
1.1.1.B	Build Component 1	33					
1.1.1.T	Test Component 1	14					
1.1.1.M1	Component 1 - Completed	0					
1.1.2	Work Package 2 - Develop Component 2	53					
1.1.2.D	Design Component 2	14					
1.1.2.B	Build Component 2	28					
1.1.2.T	Test Component 2	11					
1.1.2.M1	Component 2 - Completed	0					
1.1.3	Work Package 3 - Integrate Components	53					
1.1.3.G	Integrate Components 1 & 2	14					
1.1.3.T	Test Integrated Product Z	32					
1.1.3.P	Deliver Product Z	7					
1.1.MF	Provide New Product Z Deliverable - Finished	0					

← Data Date

6.6 Control Schedule

- The process of monitoring the status of the product to update project progress and manage changes to the schedule baseline

- 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

Inputs, Tools & Techniques, Outputs

Inputs
.1 Project management plan
.2 Project schedule
.3 Work performance information
.4 Organizational process assets

Tools & Techniques
.1 Performance reviews
.2 Variance analysis
.3 Project management software
.4 Resource leveling
.5 What-if scenario analysis
.6 Adjusting leads and lags
.7 Schedule compression
.8 Scheduling tool

Outputs
.1 Work performance measurements
.2 Organizational process assets updates
.3 Change requests
.4 Project management plan updates
.5 Project document updates

Data Flow Diagram

Inputs

- Project management plan
- Project schedule (the most recent version with notations to indicate updates, completed activities and started activities as of the indicated data date
- Work performance information (which activities have started/finished, their progress)
- Organizational process asset
  - Existing formal and informal schedule control-related policies, procedure and guidelines
  - Schedule control tools
  - Monitoring and reporting methods to be used

Tools and Techniques

- Performance reviews (measure, compare and analysis of performance (start, finish, percent complete and remained)). In Earned Value Management (EVM), Schedule Variance (SV), and Schedule Performance Index (SPI) are used to assess the schedule variance
- Variance analysis (determining the cause and degree of variance WRT schedule baseline)
- Project management software (tracking planned dates versus actual dates, forecast the change effects)
- Resource leveling
- What-if scenario analysis (to bring the schedule into alignment with the plan)
- Adjusting leads and lags
- Schedule compression
- Scheduling tool (to update schedule data, and project schedule

Outputs

- Work performance measurements (SV and SPI for WBS components, work packages are documented and communicated to stakeholders))
- Organizational process assets updates
  - Causes of variances
  - Corrective action chosen and the reasons
  - Other types of lessons learned
- Change request
- Project management plan updates
  - Schedule baseline
  - Schedule management plan
  - Cost baseline
- Project document updates
  - Schedule data
  - Project schedule