Politechnika Wrocławska

Organization of construction works

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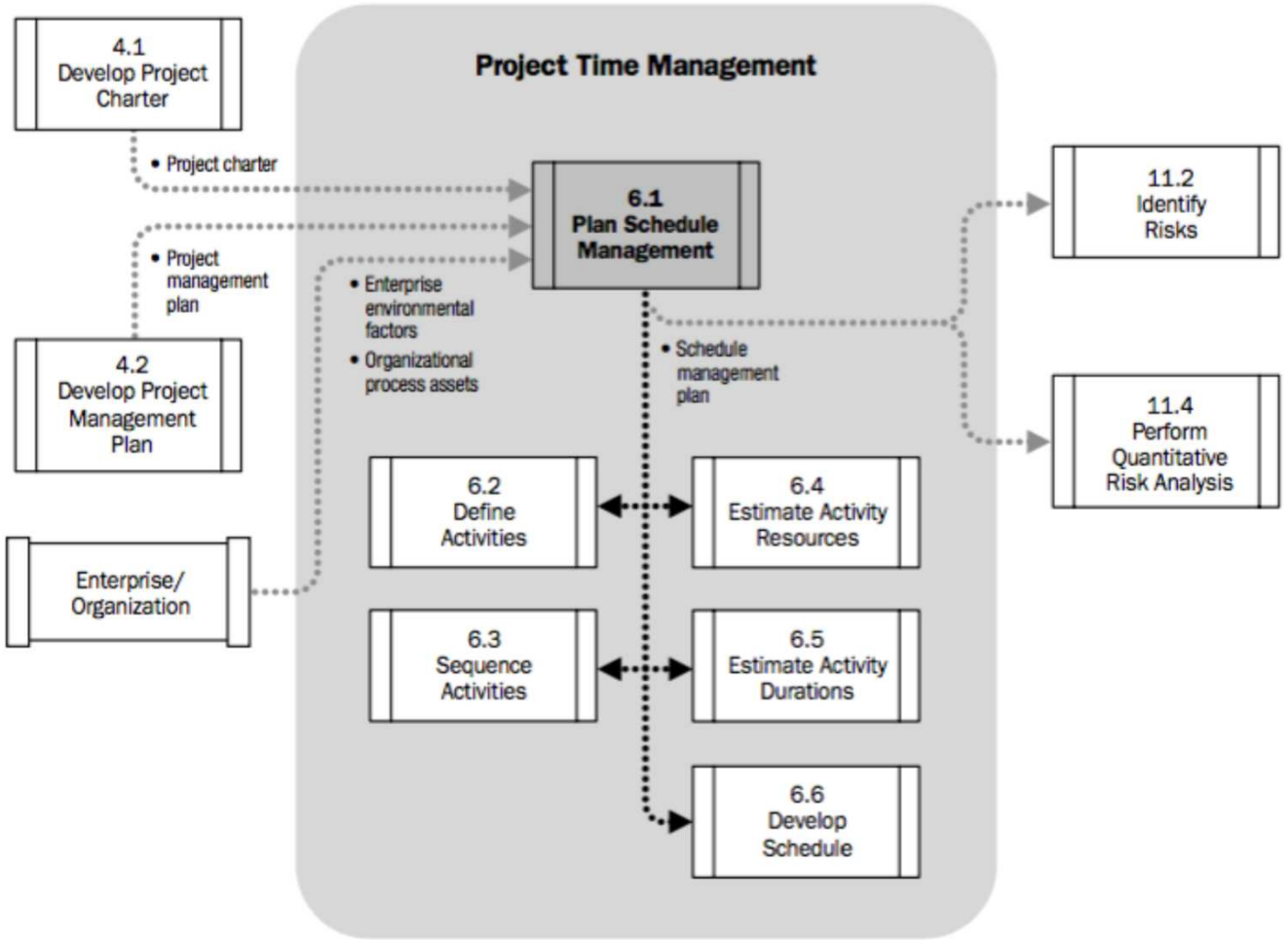
Self-evident truth

- **Project time management** involves the processes required to finish a project on time

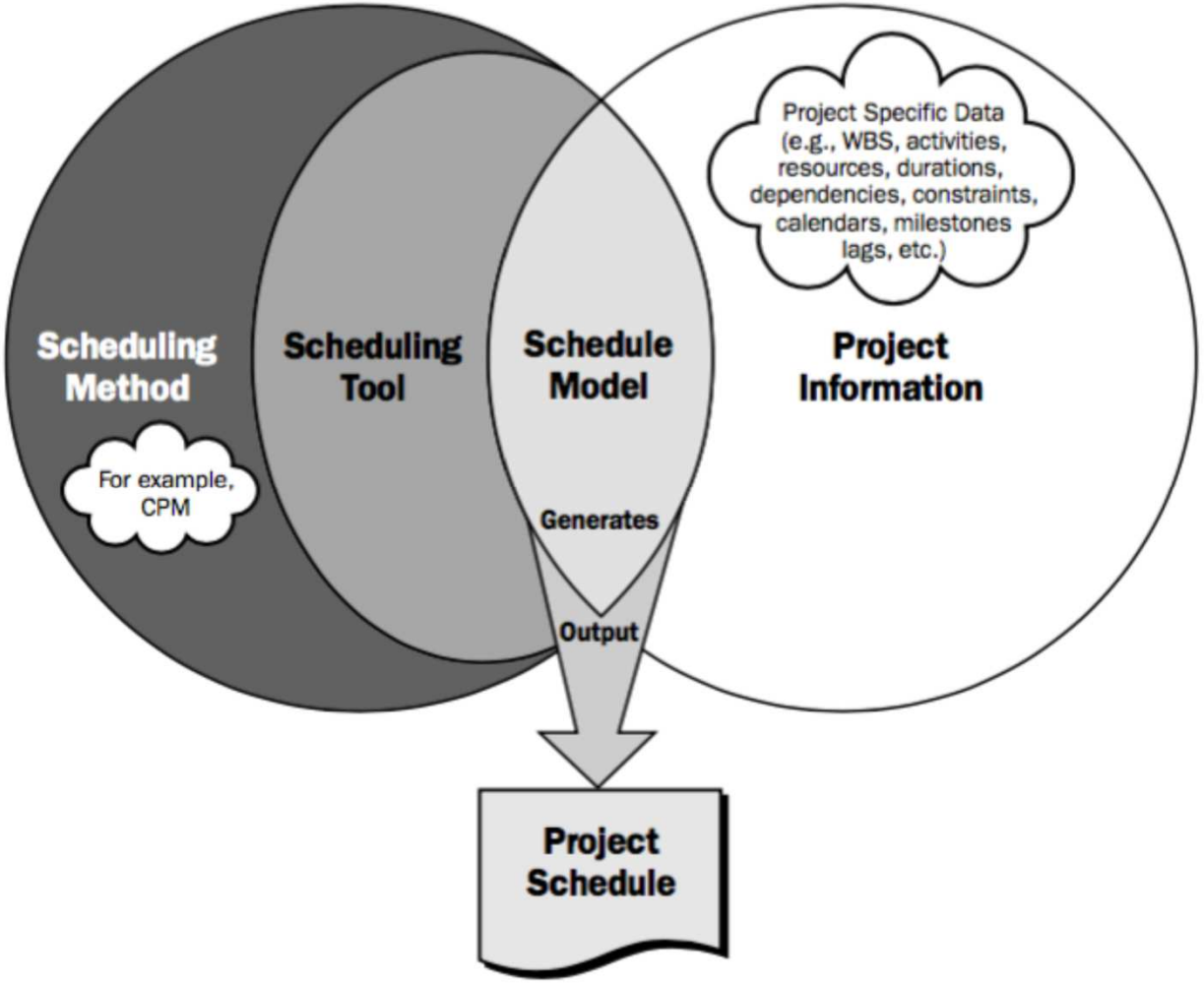
Project time management process overview

1. **Plan schedule management** - establishing policies, procedures and documentation for project schedule
2. **Define activities** - identification of specific activities to be performed to produce the project deliverables
3. **Sequence activities** - identification and documentation of relationships between the project activities
4. **Estimate activity resources** - estimation of type and quantities of material, people, equipment and supplies
5. **Estimate activity durations** - estimation of number of work periods needed to complete each activity with estimated resources
6. **Develop schedule** - analysis of activity sequences, durations, resource req. and schedule constraints to finally create the project schedule
7. **Control schedule**

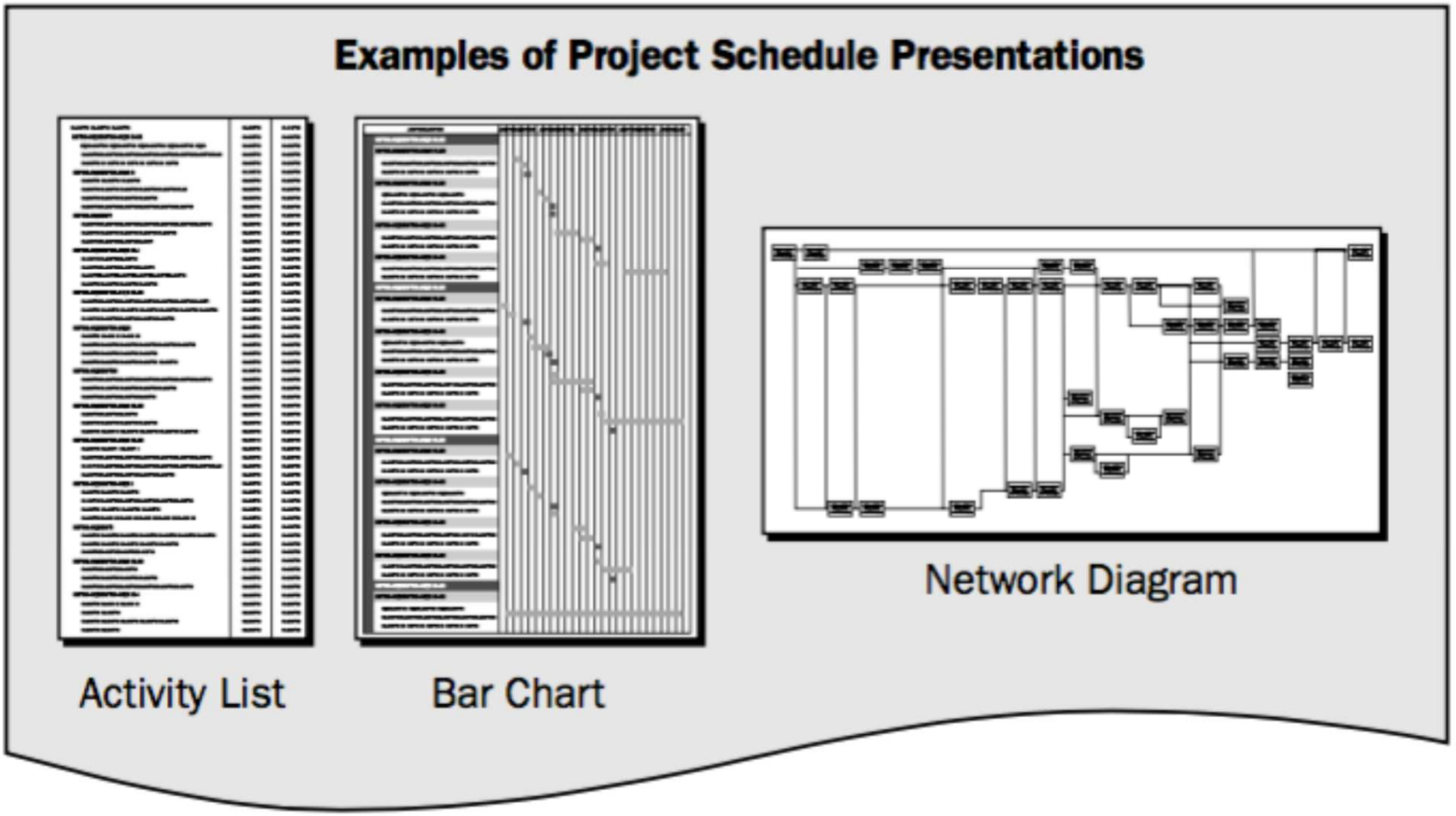
Project time management process overview



Project scheduling - process overview



Graphical/text representation of project schedule

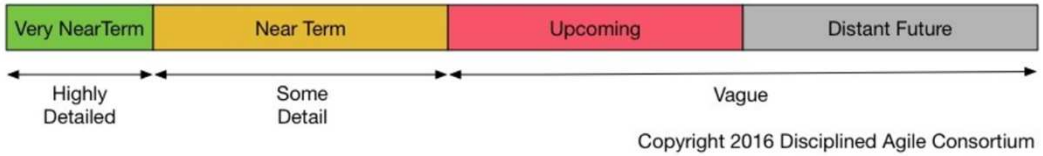


Planning schedule management

- Scheduling methodology and tools to be used
- Acceptable level of accuracy
- Units of measure
- Schedule maintenance - updating schedule
- Control thresholds
- Rules of performance estimation (definition of task % complete)
- Reporting formats

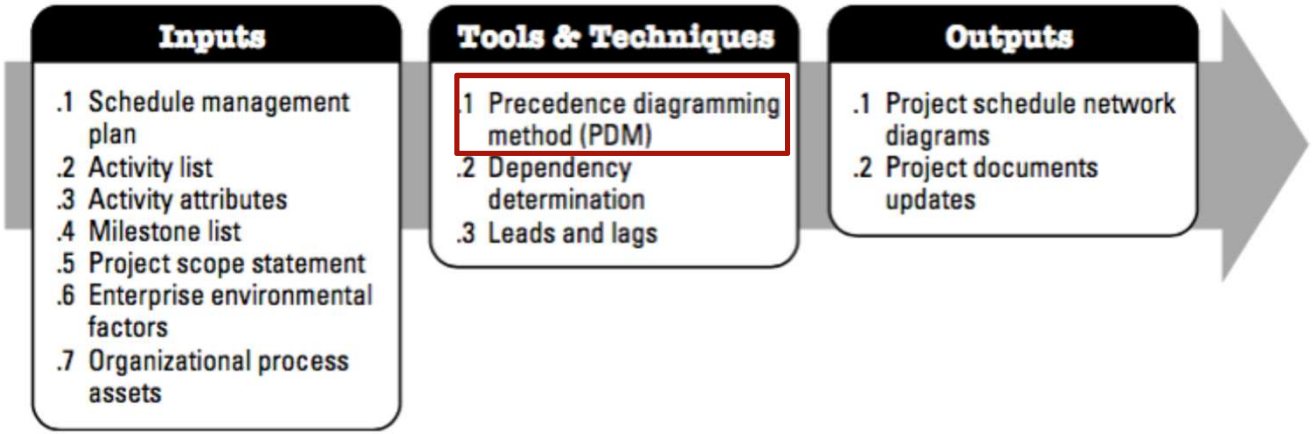
Defining activities

more details to come!



Work package decomposition usually supported by Work Breakdown Structure (WBS) method

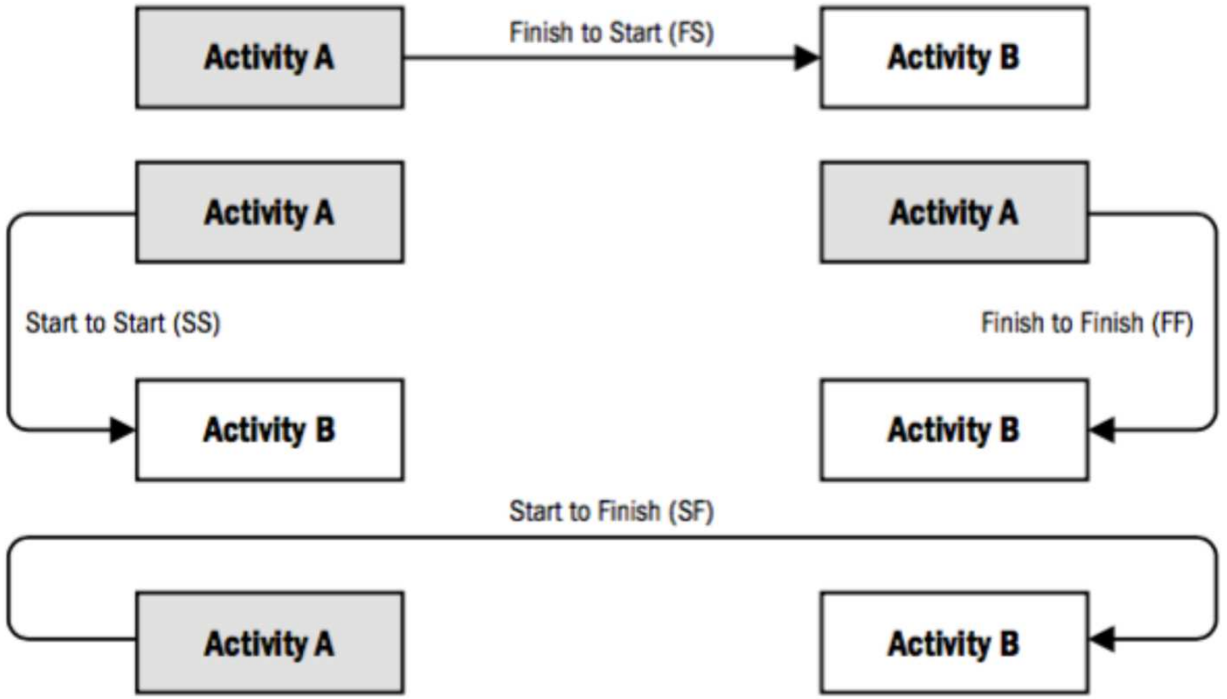
Sequence activities



Precedence Diagramming Method (PDM)

- **Precedence Diagramming Method** (PDM) is used for constructing a schedule model
- In schedule model all activities are represented by nodes and are **graphically linked** by one or more **logical relationships** (SF, FF, SS - explained on next slide) to show the **sequence** in which the activities are to be performed
- **Activity-on-node (AON)** is one method of representing a precedence diagram (used in most project management software packages)

Precedence Diagramming Method (PDM)

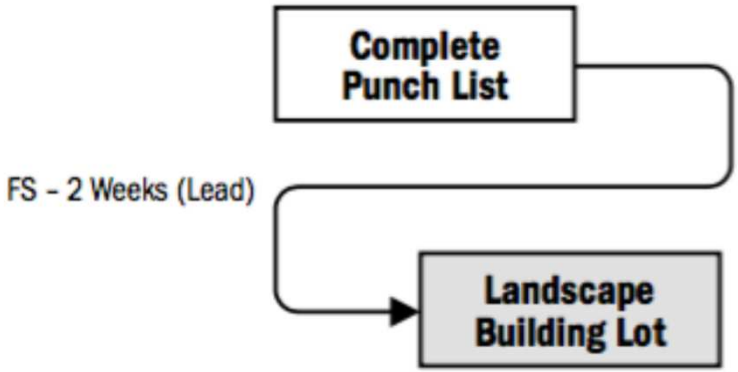


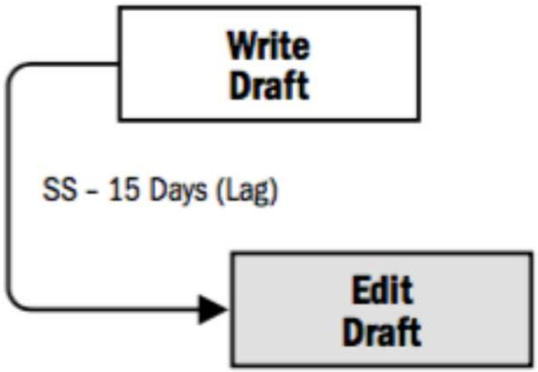
Dependency types:

- **mandatory** - predecessor activity must be completed before successor (physical necessity)
- **external**
- **discretionary (preferential)** - based on best practices, business knowledge etc.

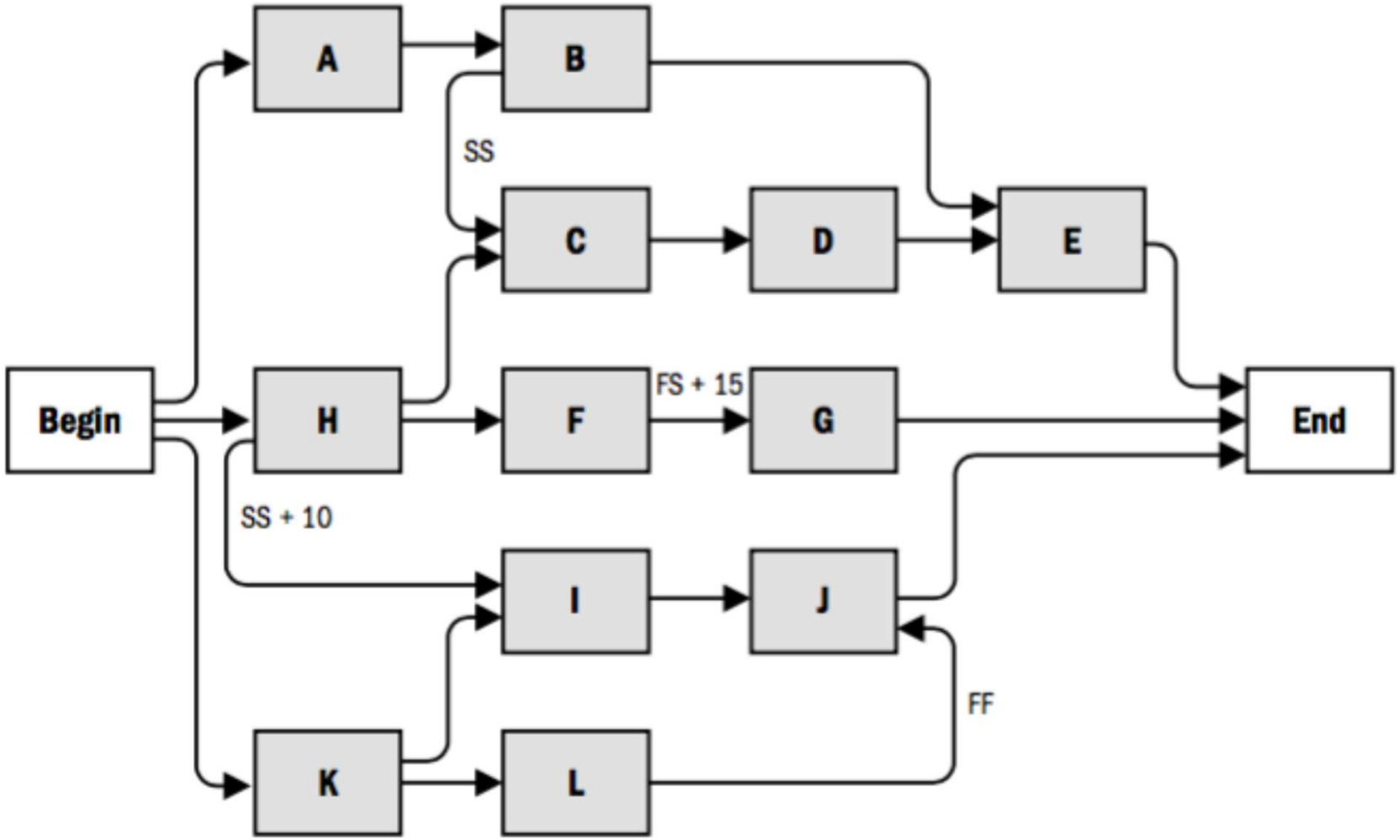
Leads and lags

- **Lead** is the amount of time the successor activity can be **advanced** with respect to a predecessor activity
- **Lag** is the amount of **delay** time between activities





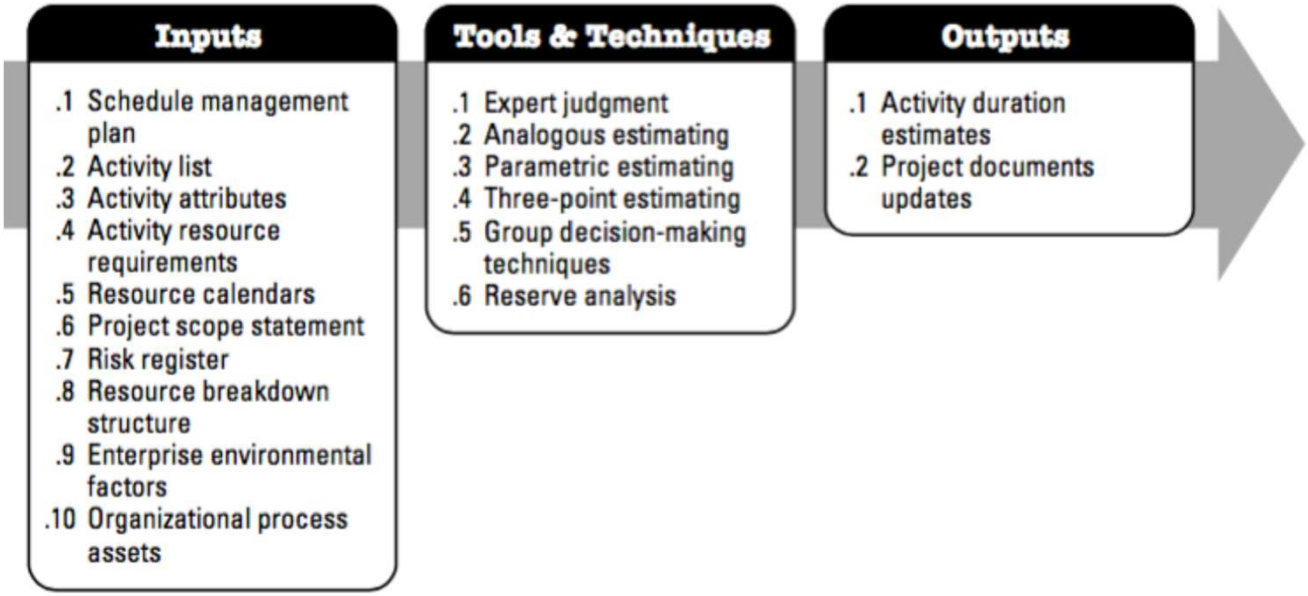
Project Schedule Network Diagram



Estimate Activity Resources

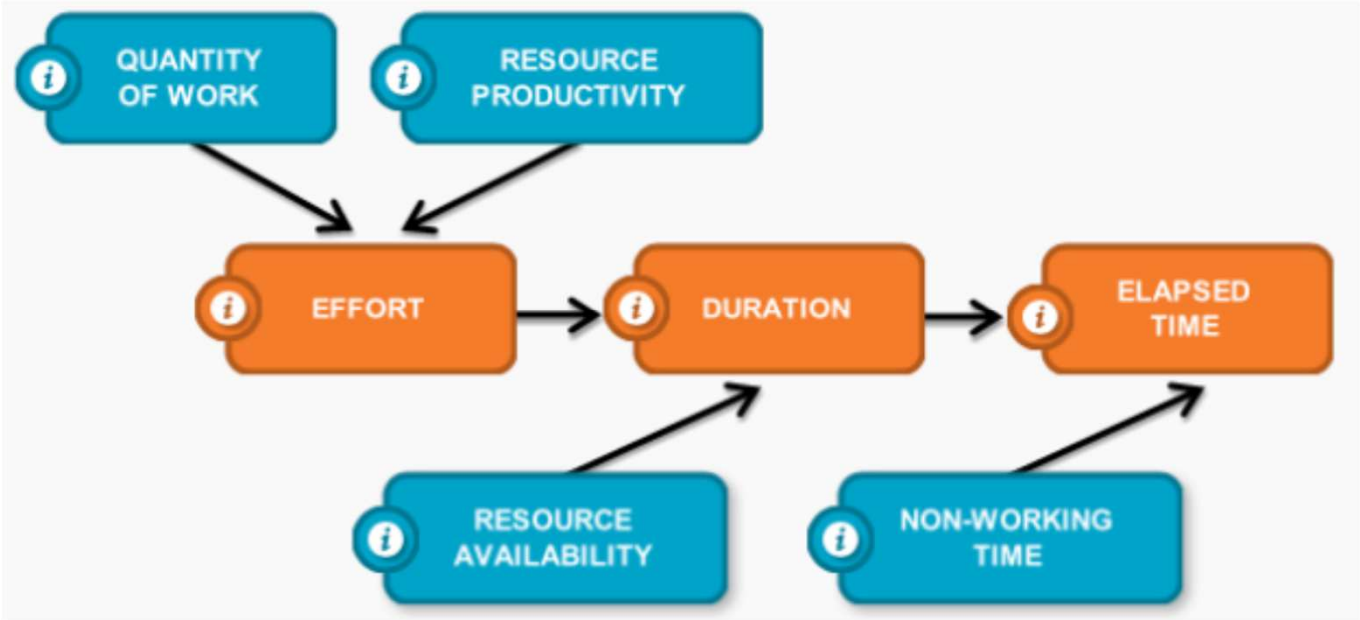
Inputs	Tools & Techniques	Outputs
.1 Schedule management plan .2 Activity list .3 Activity attributes .4 Resource calendars .5 Risk register .6 Activity cost estimates .7 Enterprise environmental factors .8 Organizational process assets	.1 Expert judgment .2 Alternative analysis .3 Published estimating data .4 Bottom-up estimating .5 Project management software	.1 Activity resource requirements .2 Resource breakdown structure .3 Project documents updates

Estimate Activity Durations



Activity estimation (simple) math

- **Effort** = Quantity of Work/Productivity
- **Duration** = Quantity of Work/(Productivity x Availability



Estimating Activity Durations

- Expert judgment
- Analogous estimating
- Parametric estimating (algorithm is used to calculate cost or duration based on historical data and project parameters)
- 3-point estimating (**PERT** - Program Evaluation and Review Technique)
- Group Decision-Making Techniques
- Reserve Analysis

PERT 3-point duration estimating

- **Most likely (tM)** This estimate is based on the duration of the activity, given the resources likely to be assigned, their productivity, realistic expectations of availability for the activity, dependencies on other participants, and interruptions (in many cases mean duration)
- **Optimistic (tO).** The activity duration based on analysis of the best-case scenario for the activity
- **Pessimistic (tP).** The activity duration based on analysis of the worst-case scenario for the activity

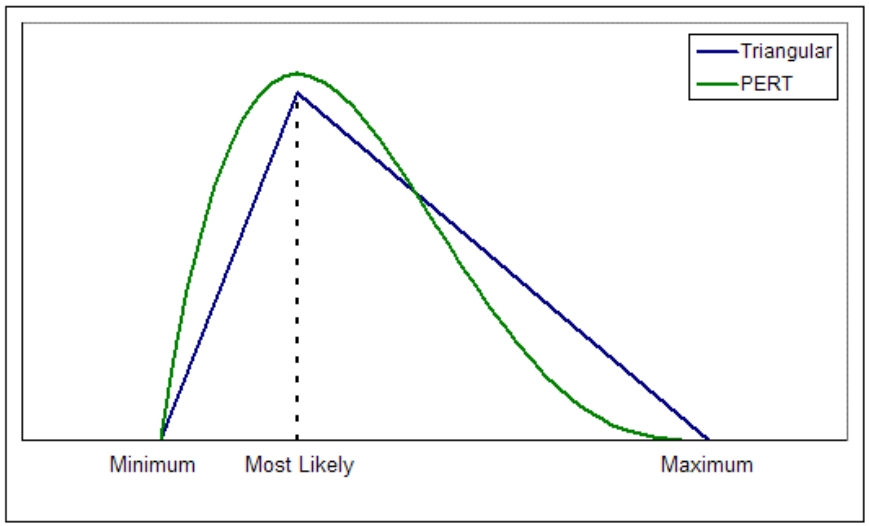
Calculating expected duration

- To calculate expected duration - **tE** we have to assume **distribution** of values (Triangular or beta - original PERT) within the range of the three estimates

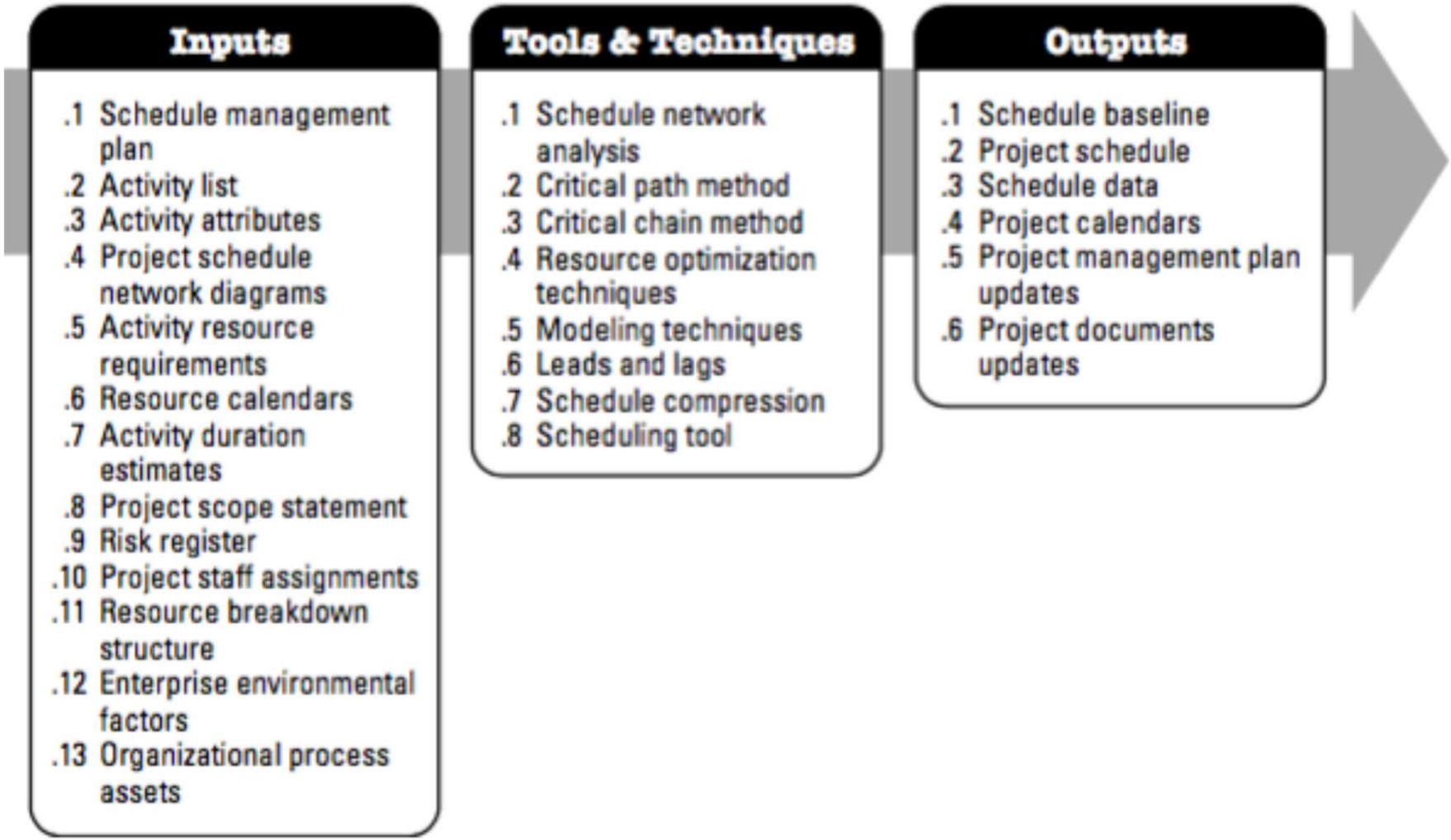
$$tE = (t0 + tM + tP)/3 \text{ Triangular}$$

$$tE = (t0 + 4tM + tP)/6 \text{ Beta (PERT)}$$

The PERT distribution interprets parameters (the same three like in Triangular distribution) with a smooth curve that places less emphasis on the furthest extreme



Develop Schedule

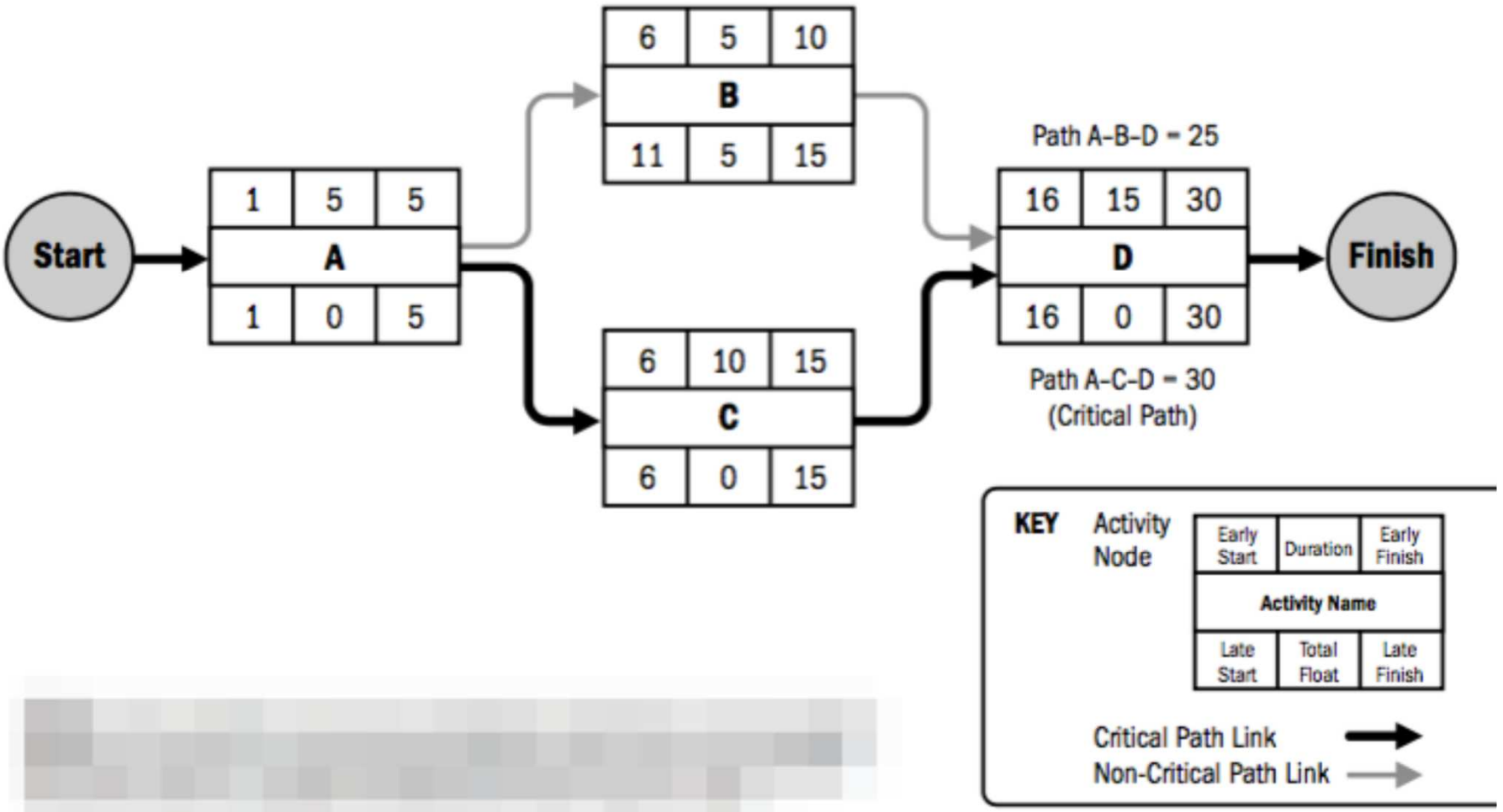


Tools and Techniques for schedule development

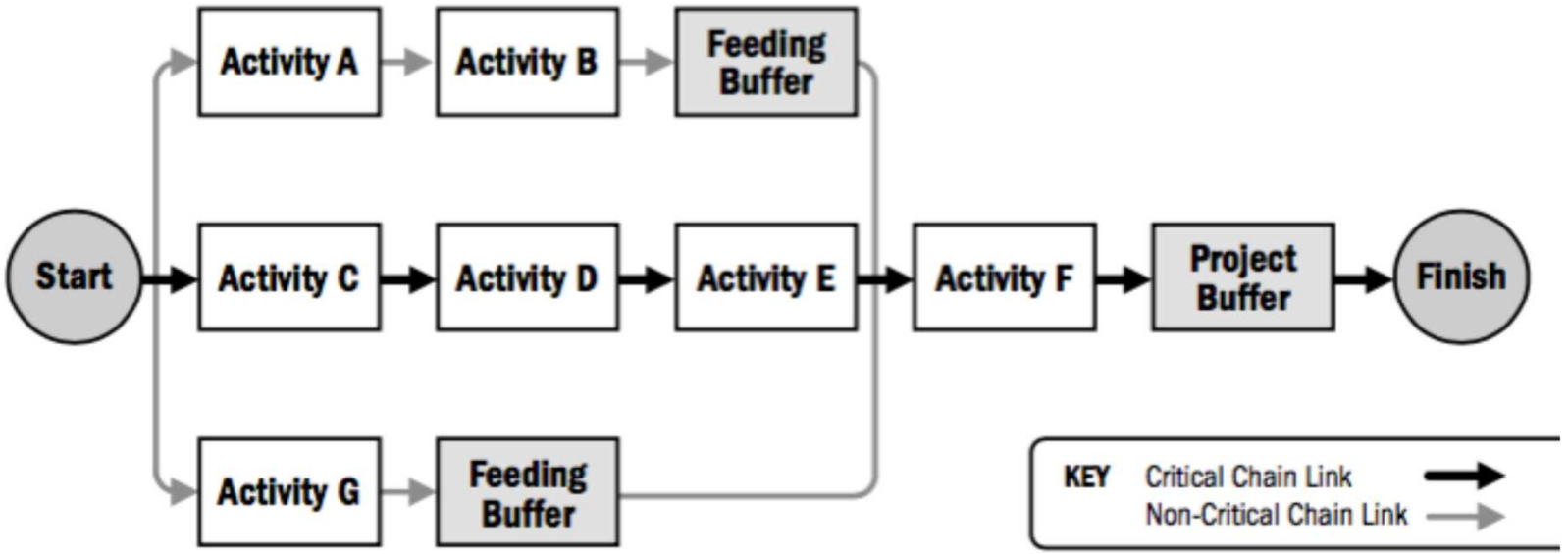
Schedule Network Analysis:

- Critical Path Method (CPM)
- Critical Chain Method (CCM)
- Resource Optimization Techniques (levelling and smoothing)

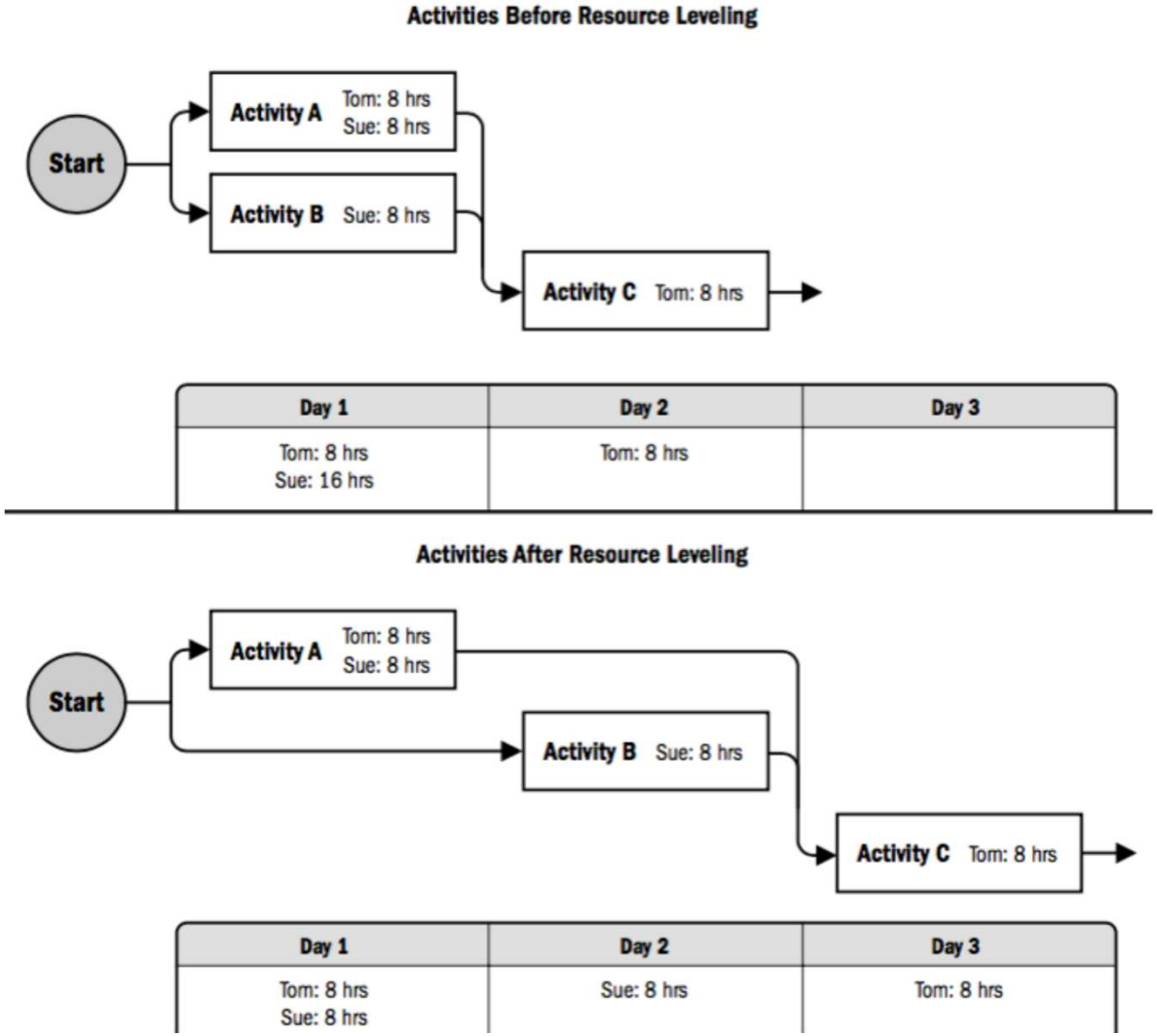
Critical Path Method (CPM) example



Critical Chain Method (CCM) example



Resource Optimization Techniques - example of resource levelling



Two typical modelling techniques used in project time management

- Using **what-If Scenario Analysis** we can evaluate scenarios in order to predict their effect (positive or negative) on project objectives (using Murphy Law - “What if the situation represented by scenario ‘X’ happens?”)
- Schedule network analysis is performed to **compute the different scenarios**, such as: delaying a major component delivery, extending specific engineering durations, or introducing external factors, such as a strike or extreme weather conditions
- **Simulation** - calculation of multiple project durations with different sets of activity assumptions, usually using probability distributions constructed from the three-point estimates to account for uncertainty (e.g. Monte Carlo analysis)

Presenting and reporting project schedules

The project schedule is an output of a schedule model (tabular or graphical) that presents linked activities with planned dates, durations, milestones, and resources

Techniques for presenting project schedules

- **Bar charts** (Gantt charts) - represent schedule information where activities are listed on the vertical axis, dates are shown on the horizontal axis, and activity durations are shown as horizontal bars placed according to start and finish dates
- **Milestones charts** - similar to Gantt but only identify the scheduled start or completion of major deliverables and key external interfaces
- **Project schedule network diagrams** usually presented in the activity-on-node diagram format showing activities and relationships without a time scale, sometimes referred to as a pure logic diagram

Techniques for presenting project schedules

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	Begin New Product Z	0	◆				
1.1.1.M1	Complete Component 1	0			◇		
1.1.2.M1	Complete Component 2	0			◆		
1.1.3.M1	Complete Integration of Components 1 & 2	0					◇
1.1.3.MF	Finish New Product Z	0					◇

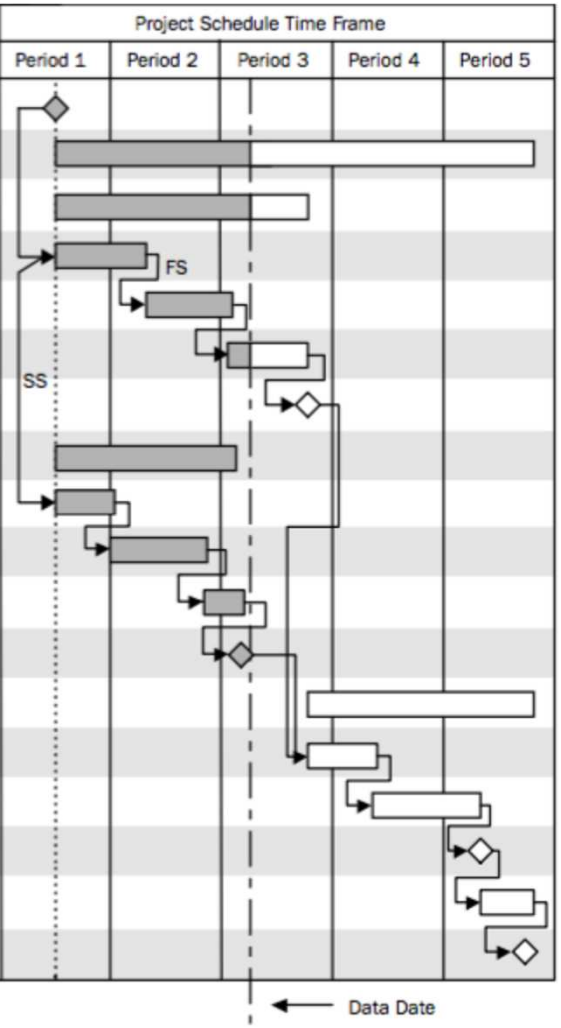
Data Date

Summary Schedule

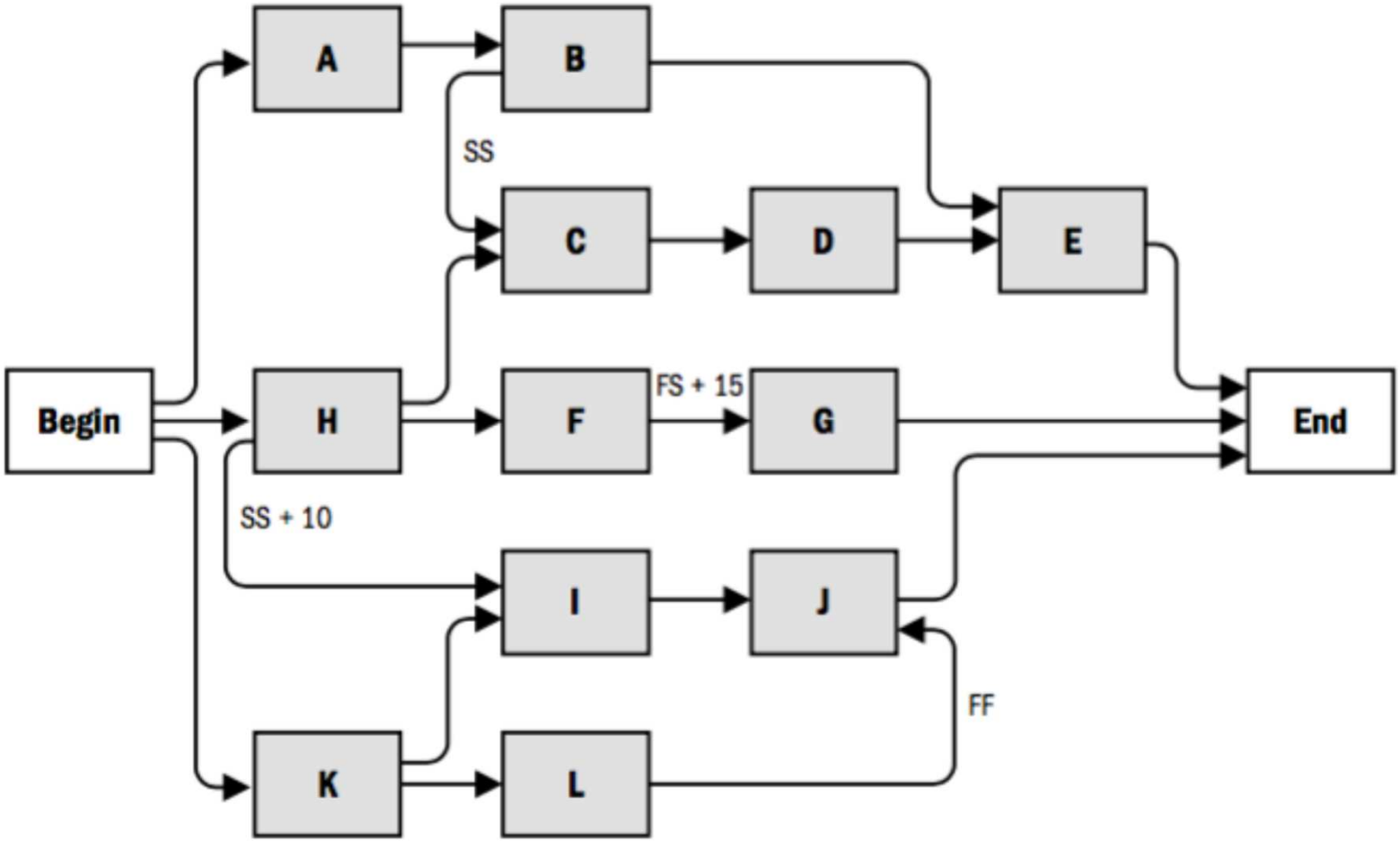
Activity Identifier	Activity Description	Calendar units	Project Schedule Time Frame				
			Period 1	Period 2	Period 3	Period 4	Period 5
1.1	Develop and Deliver New Product Z	120	■	■	□		
1.1.1	Work Package 1: Component 1	67	■	■	□		
1.1.2	Work Package 2: Component 2	53	■	■			
1.1.3	Work Package 3: Integrated Components 1 and 2	53			□	□	□

Techniques for presenting project schedules

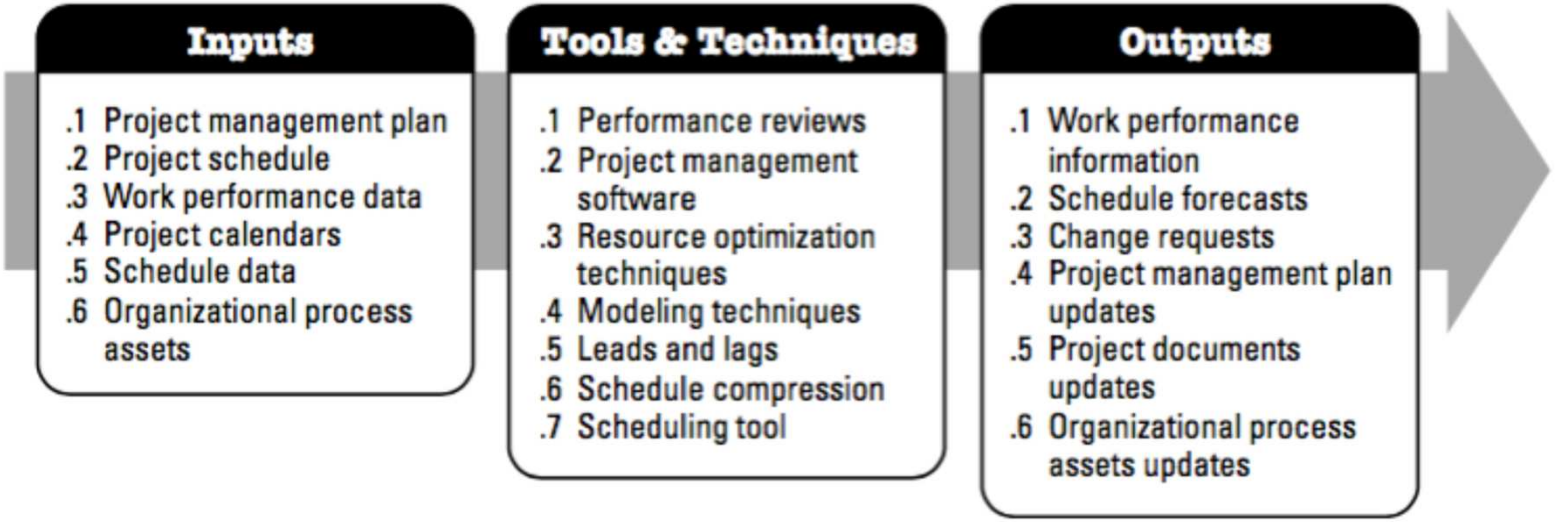
Activity Identifier	Activity Description	Calendar units
1.1.MB	Begin New Product Z	0
1.1	Develop and Deliver Product Z	120
1.1.1	Work Package 1: Component 1	67
1.1.1.D	Design Component 1	20
1.1.1.B	Build Component 1	33
1.1.1.T	Test Component 1	14
1.1.1.M1	Complete Component 1	0
1.1.2	Work Package 2: 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	Complete Component 2	0
1.1.3	Work Package 3: Integrated Components 1 and 2	53
1.1.3.G	Integrate Components 1 and 2 as Product Z	14
1.1.3.T	Complete Integration of Components 1 and 2	32
1.1.3.M1	Test Integrated Components as Product Z	0
1.1.3.P	Deliver Product Z	7
1.1.3.MF	Finish New Product Z	0



Project schedule network diagram



Control Schedule



Sydney Opera House

PM triangle

- **Time** = 250% overrun (10 years late)
- **Cost** = 1457% over estimated budget – the original estimated cost was **$AUS 7 million** vs actual construction cost **$AUS 102 million.**
- **Quality** = scope heavily modified over construction time

Sydney Opera House

Construction began in 1957. and lasted about 15 years. At the project employed 10,000 builders. The huge structure is made mainly of steel, glass and concrete, and covers an area of 1.8 hectares. The roof of the building is a huge weight of 161 thousand tons, which maintains about 350 kilometers of connections. The original ceiling of the building is covered with over a million ceramic tiles, the effect of reflecting light on sunny days, which in Sydney quite a few. The building has 6225 square meters of glass and 645 kilometers of electric cables. There were numerous difficulties caused by the atypical form of shell vaults and more. It turned out that the substrate was not well studied at the stage of location selection. Preparation of the foundations required strengthening and creating a proper substructure of concrete columns with a diameter of nearly 1 meter. At the stage of interior finishing the building, many problems were encountered. As a result, construction costs have repeatedly exceeded the original cost estimate, and commissioning of the building on the national holiday on January 26 shifted from 1965 to 1973.

In June 2007, the building was inscribed on the UNESCO World Heritage List.