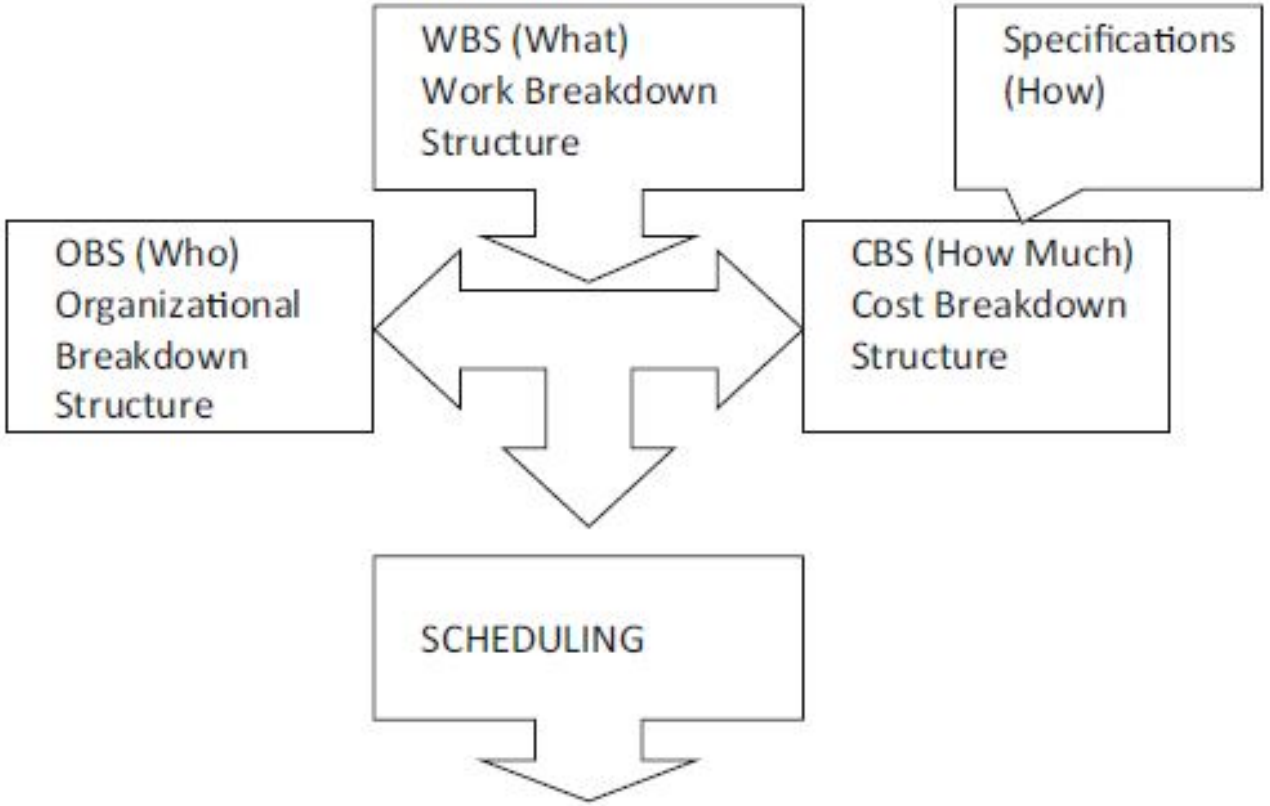
Introduction to Planning

Project Planning

Construction project planning is a method of determining

- "What" is going to be done (Work Breakdown Structure)
- "How" things are going to be done (Specifications)
- "Who" will be doing activities (Organizational Breakdown Structure)
- "How much" activities will cost (Cost Breakdown Structure)

General Framework for the Planning Process



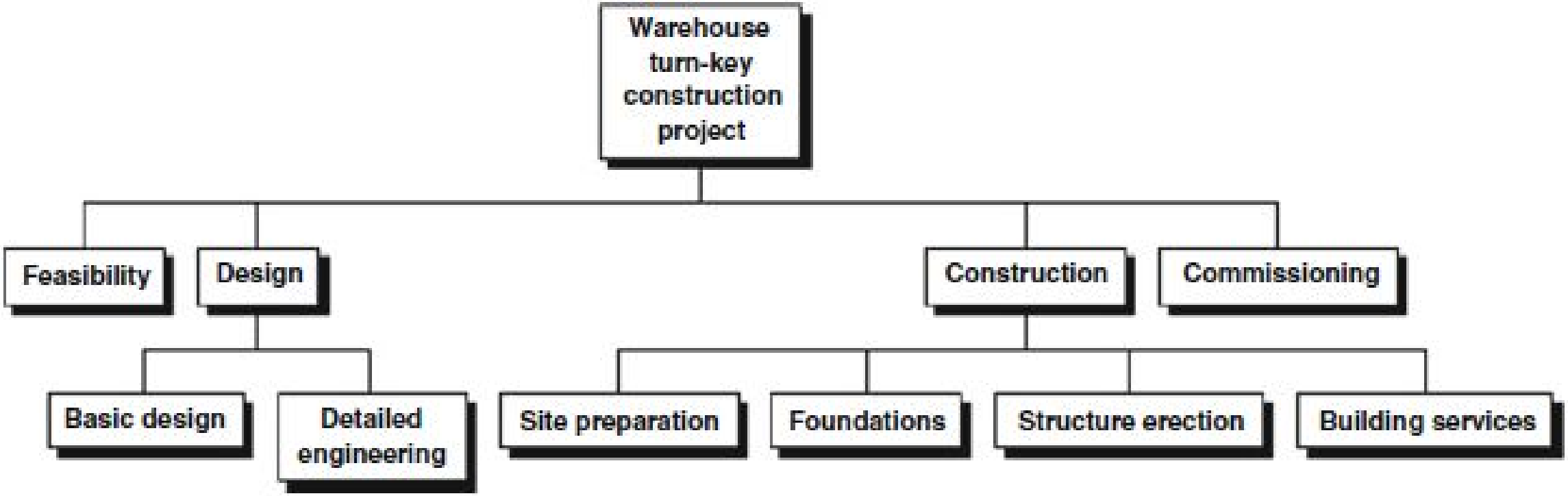
Once planning is complete, scheduling can be done, which addresses the "When"

Scope (WBS) - “What”

A work breakdown structure (WBS) is a decomposition of the entire scope of work into work packages and elementary activities

The WBS divides and subdivides a project into different components, whether by area, phase, function, or other considerations.

Scope (WBS) - “What”



Should include 100% of the work contained in the project scope

Provides a hierarchical decomposition of elements to the level necessary to plan and manage the work

WBS

Level 1	Level 2	Level 3	Level 4
Building project	PM	Project start-up	
		Project coordination	
		Project control	
		Project closure	
	Planning and management		
	Verification and validation		
	Connections	Connection, water and sanitation	
		Connection, electricity and district heating	
		Broadband	
		Television	
		Phone	
	External	Land acquired	
		External plumbing	
		Roads	
		Garden	
		Foundation	Excavation
			Concrete
			Other foundational work
	Main Building	Ground floor level	Slab work

Scope (WBS)

Product Breakdown Structure

4 CONSTRUCTION

- 4.3 Super Structure
  - 4.3.1 Slab Structure
    - 4.3.1.1 Column
    - 4.3.1.2 Shear Wall
    - 4.3.1.3 Slab
  - 4.3.2 Grouting
    - 4.3.2.1 Grouting connections

Location Breakdown Structure

B01 RESI.BLDG.PROJECT	B01.1 Ground Floor Level	B01.1.A Zone A	B01.1.B Zone B	B01.2 First Floor Level	B01.2.A Zone A	B01.2.B Zone B	B01.3 Second Floor Level	B01.3.A Zone A	B01.3.B Zone B	B01.4 Third Floor Level	B01.4.A Zone A	B01.4.B Zone B

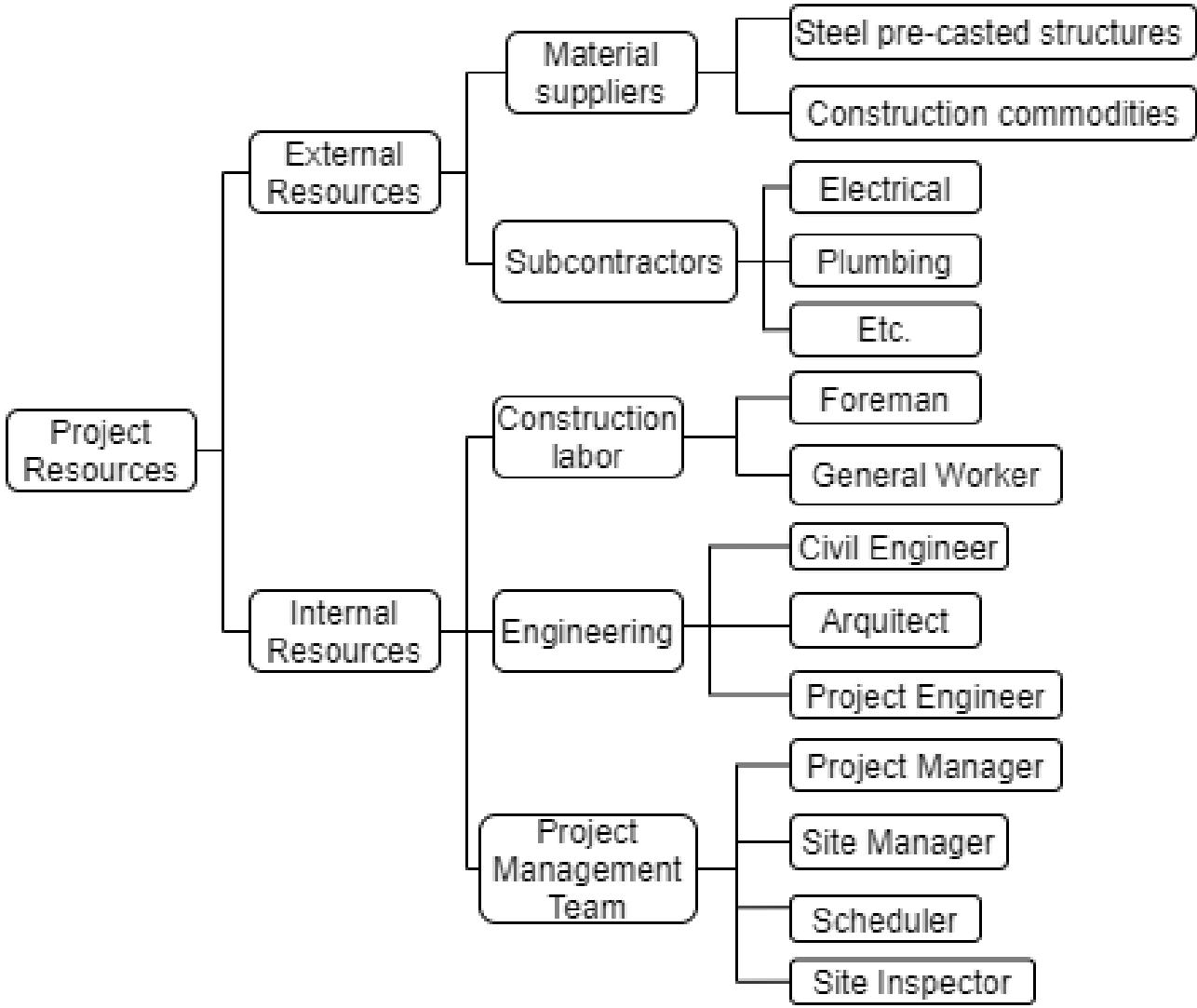
Scope (WBS)

Three creation approaches:

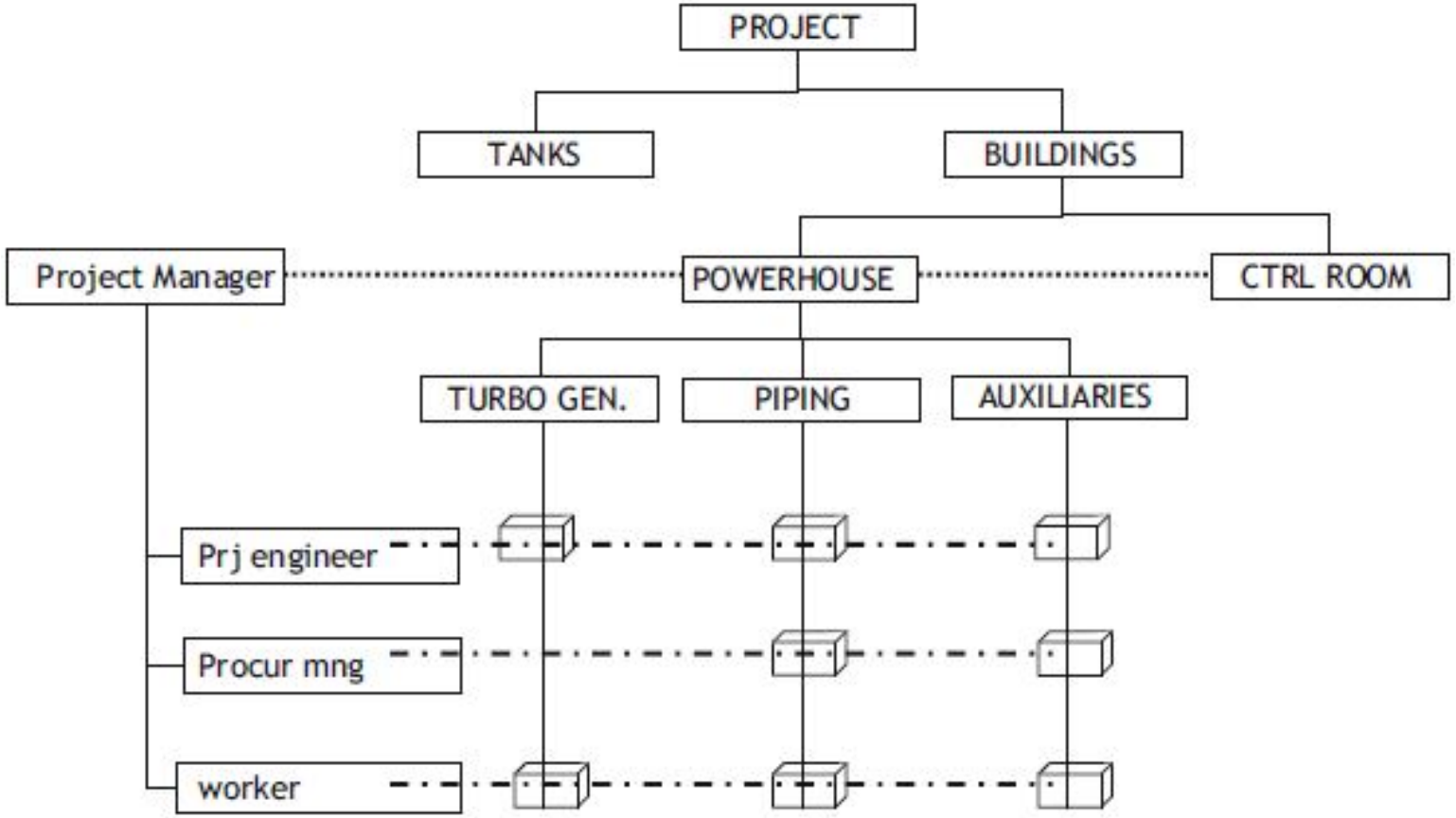
- **Top-down:** Identification of the end deliverable, subdivision of the WBS elements into detailed and manageable units. (e.g., structure)
- **Bottom-up:** Identification of elements of scope and merging, categorizing and ordering those elements in a hierarchy (e.g., finishings)
- **Hybrid:** combination of top-down and bottom-up approach

Relationships (OBS) - "Who"

The Organization Breakdown Structure decompose the human resources needed to execute all of the tasks into different competence areas and then into project roles unambiguosly.

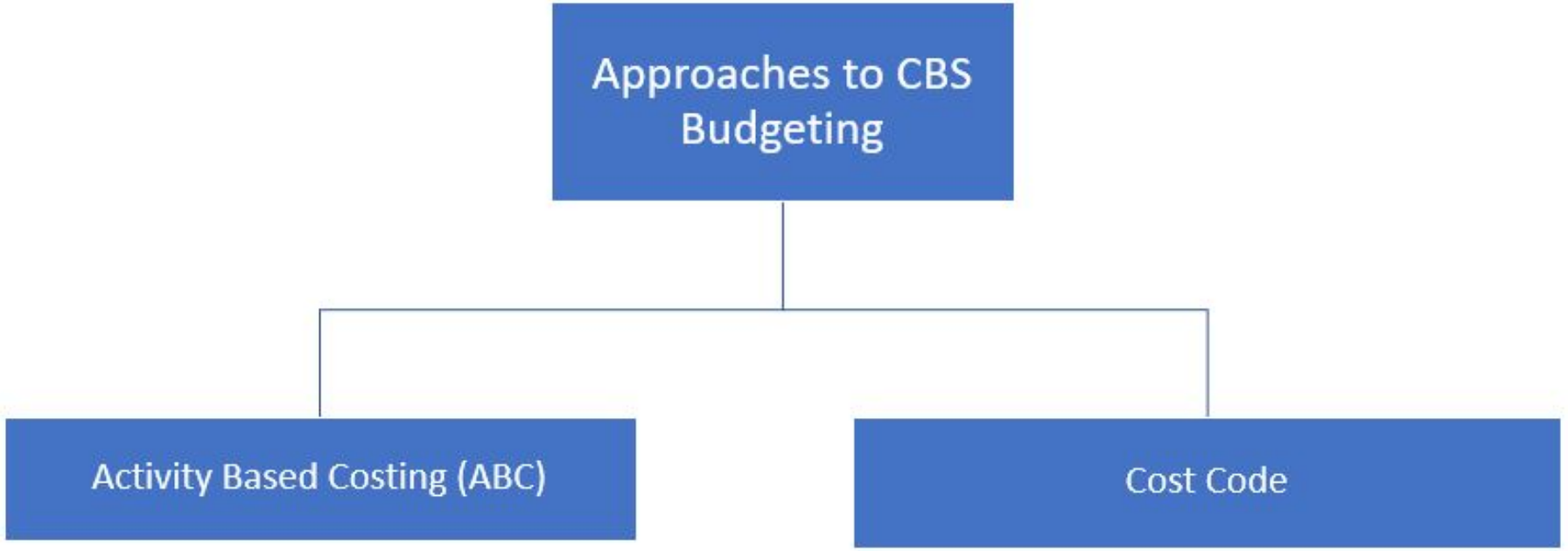


Scope + Relationships



Roles should be allocated to detailed tasks with a specified number of resources and related estimated work load required to perform the task.

Costs (CBS) - “How much”



The Cost Breakdown Structure is a hierarchical system that classifies resources into cost accounts, typically labor, materials, and other direct costs, it represents the economic breakdown of the project into budgets per work package.

Approaches to CBS Budgeting - 1. ABC

Total cost $= Q * (M + EM + W*L)

Where

Q= Quantity of material required,

M=Unit cost of material,

EM=Equipment rate of cost per unit of material,

W=Hourly wage rate. Affected by insurance, social security, benefits and premiums

L=Productivity, **learning curves**

Budgeting - 1. ABC

Real Case Office Project
56.000m2

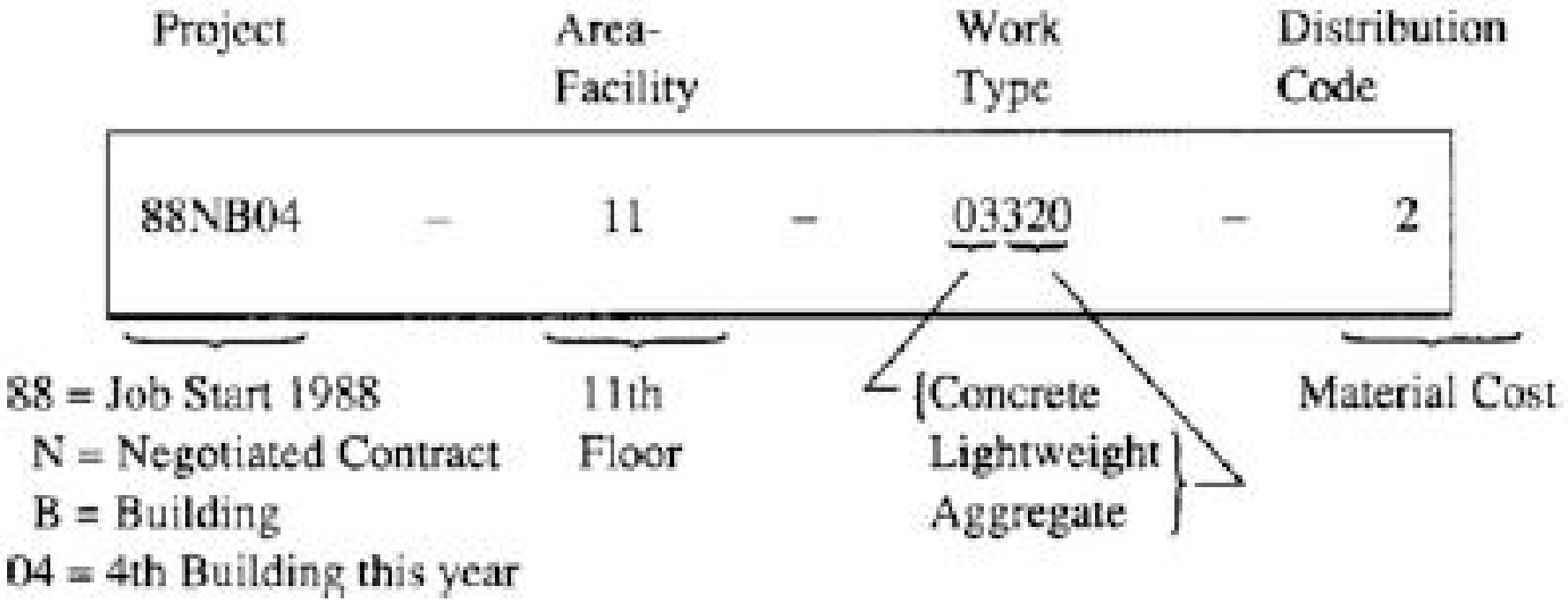
Approaches to CBS Budgeting - 1. ABC

PROJECT	CHAPTER	Subchapter	CODE	DESCRIPTION	un	COST PER UNIT	PROJECT AREA: 56.277 M2	
							QUANTITY	TOTAL COST
01	01			PROJECT BUDGET				36.638.023,23 €
01	05			CHAPTER No. 5 STEEL			2.633.206,38	2.151.418,16 €
01	05	01		FOUNDATION STEEL				227.848,92 €
01	05	01	40001	Foundation Slab Steel	KG	1,02 €	100.000	101.905,74 €
01	05	01	40001	Pile Steel	KG	1,02 €	123.588	125.943,18 €
01	05	02		COLUMN STEEL				764.291,67 €
01	05	03		WALL STEEL				91.729,84 €
01	05	04		SLAB STEEL				999.030,08 €
01	05	04		STAIRS STEEL				11.168,16 €
01	05	04		STEEL FOR NON-STRUCTURAL ELEMENTS				57.349,49 €

Approaches to CBS Budgeting - 1. ABC

FOUNDATION SLAB STEEL	KG				Unit Cost
Cost of Material	kg	1,000	2,00%	0,86 €	0,88 €
Wage rate (including productivity)	Kg	1,000	0,00%	0,10 €	0,10 €
Black wire	KG	0,030	10,00%	1,24 €	0,04 €

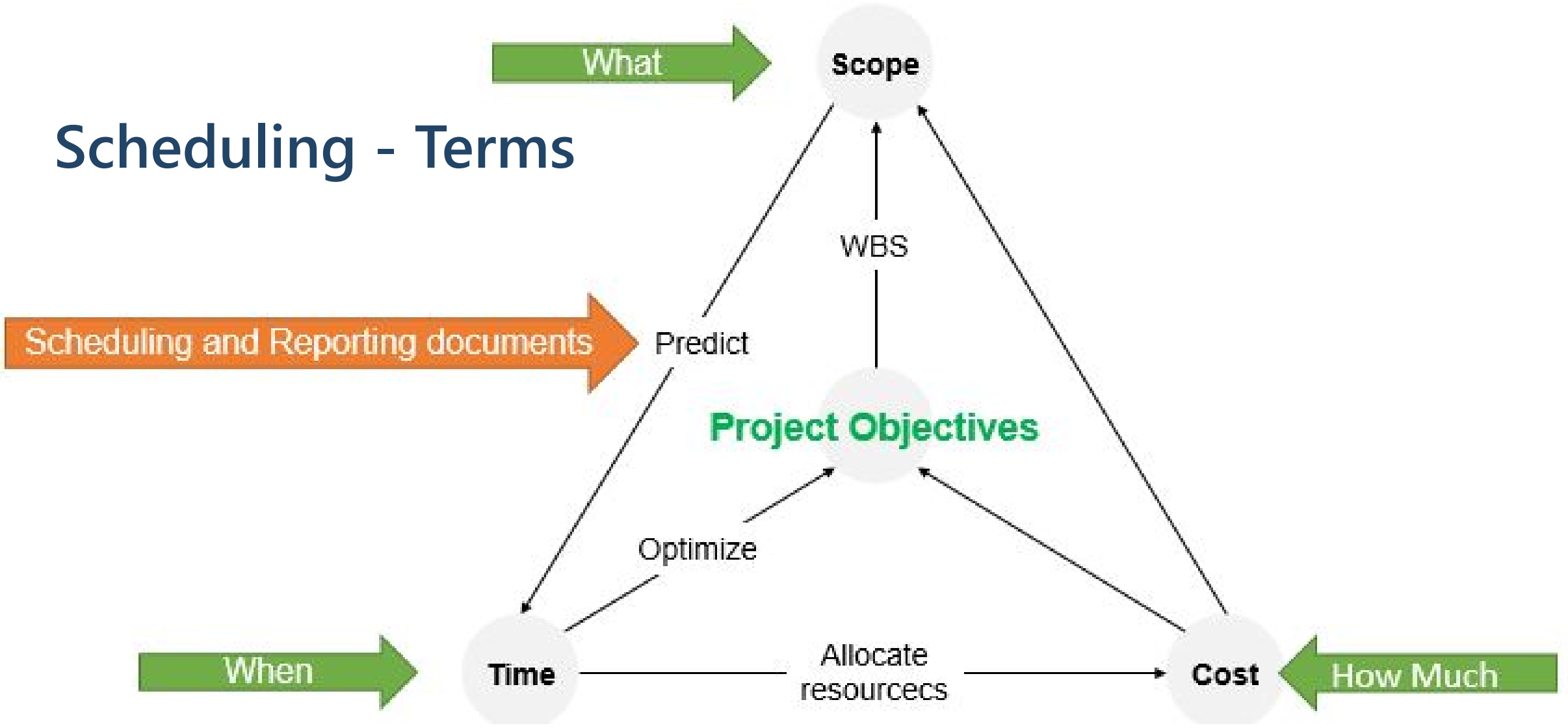
Approaches to CBS Budgeting - 2. Cost Code



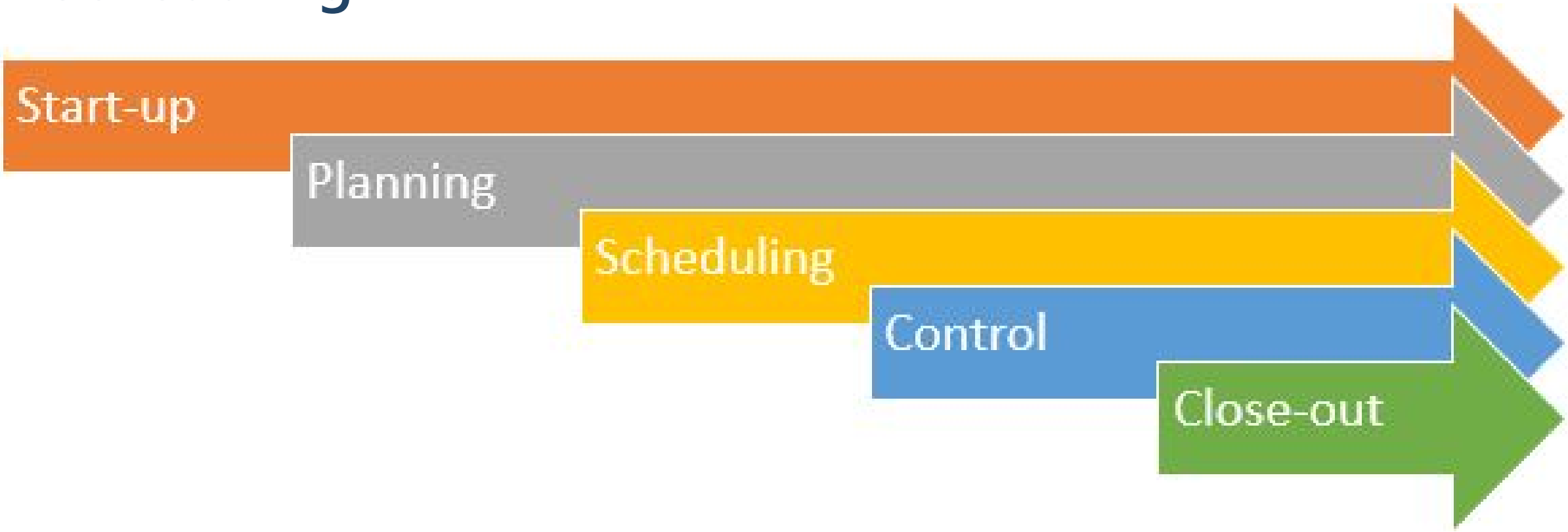
Scheduling

- Optimize the information available to the PM team
- Facilitate the likelihood of a successful project completion within the approved schedule baseline

Scheduling - Terms



Scheduling



Scheduling - Definitions

- Activity: Unique scheduled portion of work performed with a non-zero duration
- Milestone: Significant point or event in the project with a duration of zero time periods
- Resource: Skilled human resource equipment, services, supplies, commodities, materials, budgets, or funds required to accomplish the defined work
- Logical relationship: Dependency between two activities or between an activity and a milestone

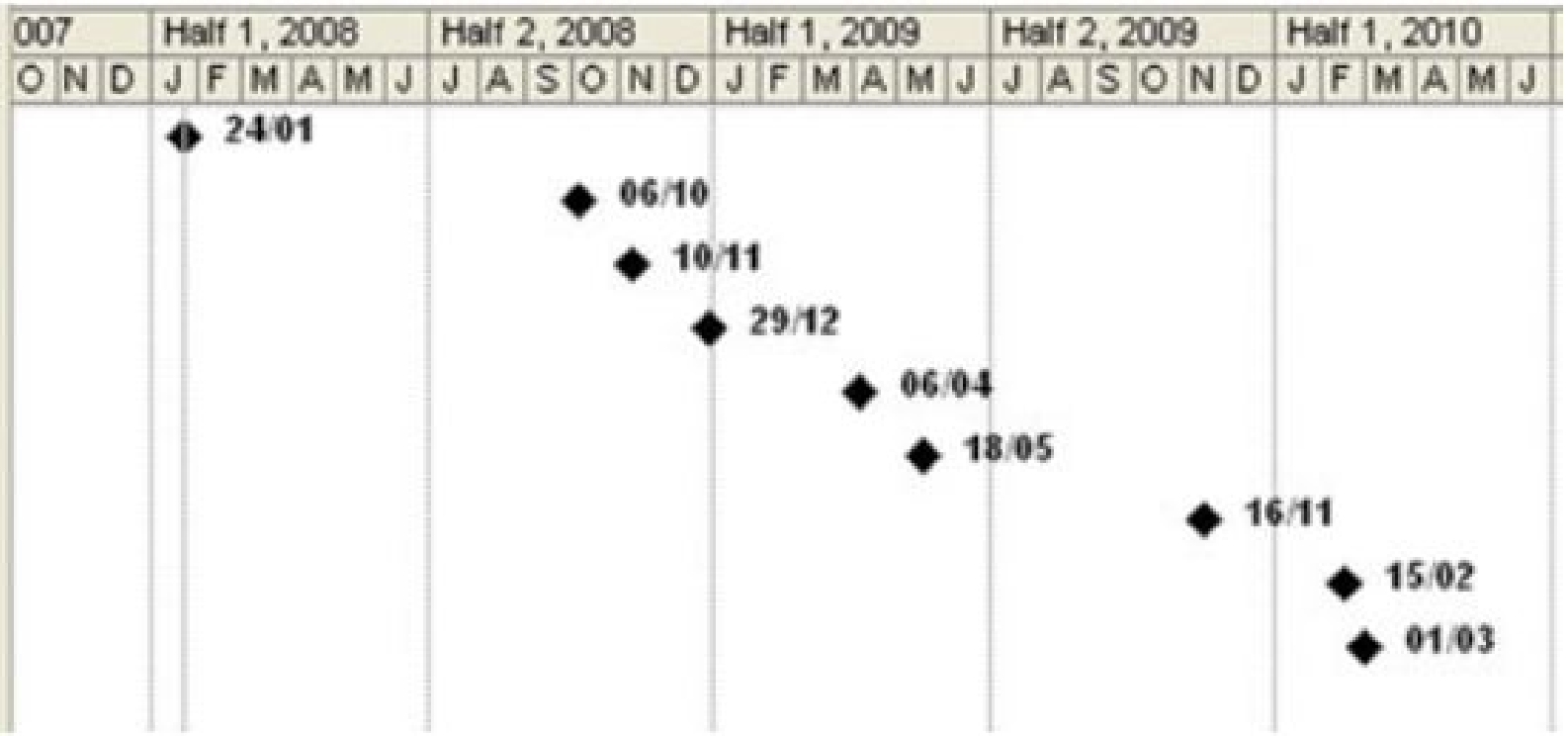
Overall Master Schedule

Represents the contractual baseline and can be updated according to change orders

- Fix the project objectives
- Report the contractual Milestones (key dates)
- Provide the guidelines to elaborate the detailed programmes and the official offer program

Overall Master Schedule - Milestone Chart

WBS	Task Name
M1	Contract Signature
M2	Construction Site Installation
M3	Design Completed
M4	Foundations Completed
M5	Steel structure erection completed
M6	Roofing completed
M7	Bulding services completed
M8	Finishings completed
M9	Sbstantial completion



Project Schedule

Project timeline and is constantly updated

- Drafting of the program (generally with network technique)
- Report the project events, priorities, sequences and duration of activities
- Provide the dates for the preparation of the detail programs developed by the individual entities

Scheduling Tools/Methods

Activity lists/ Matrix Scheduling

Bar diagrams (Gantt chart)

Network techniques

- CPM Critical Path Method
- PERT Program Evaluation Review Technique
- PDM Precedence Diagramming Method

Scheduling Tools - Activity lists/ Matrix Scheduling

ACTIVITY	Control Point Timing (day, week, etc.)			
	Original Program	Review 8 Sept	Review 16 Sept	Actual Sept 22
Start mechanical drawings	1	1	-	-
End mechanical drawings	10	10	-	-
Start electrical drawings	8	8	-	-
End electrical drawings	16	16	18	-
Start software development	14	14	16	18

Scheduling Tools - Gantt Chart Scheduling

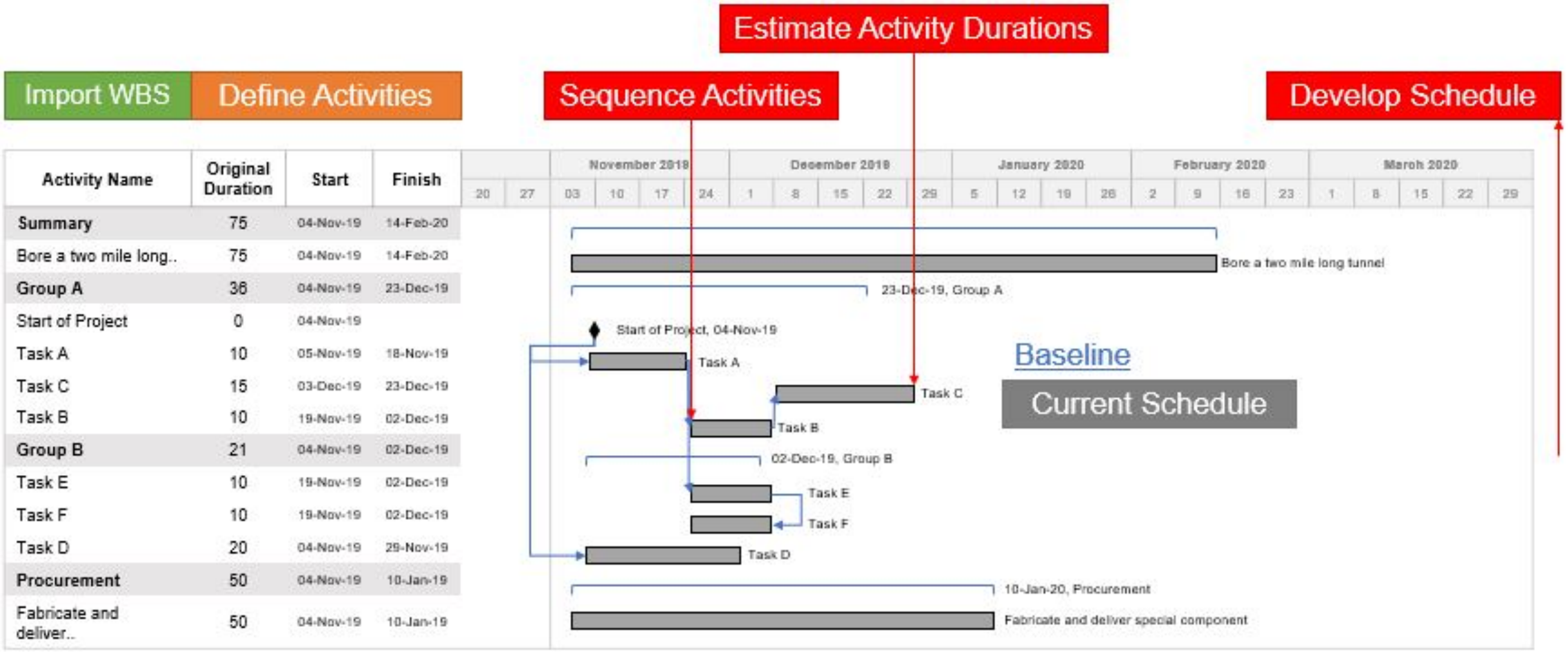
Breakdown into the fundamental operations corresponding to the WBS activities

Assignment of the foreseen duration to each activity

Representation of operations with segments or bars of lenght proportional to their duration

The sequence of the segments must respect the real development of the works over time

Scheduling Tools - Gantt Chart Scheduling



Scheduling Tools - Gantt Chart Scheduling

PROs

- Immediate visual understanding
- Quickly highlights the positioning over time of the many activities
- Visualizes anticipations and delays

CONs

- Difficulty in updating the program
- The project logic is not explicit

Scheduling Tools - Network Techniques

A quantitative model to Sequence activities: Use of graph theory to model interdependencies between tasks

Activity: Necessary act to achieve a certain objective characterized by a duration

Event: Instant by which it is possible to start the next activity characterized by positioning over time

Precedence constraint: It is the logical link that conditions the temporal sequence of carrying out the activities

Scheduling - Good Practices

Define milestones

a milestone

- has zero duration
- has no resources assigned
- is used as a benchmark to **measure progress**
- represents the start or completion of a portion or deliverable of the project
- may also be associated with external constraints, such as approvals or deliverables
- each project should have a start milestone and a finish milestone.

Scheduling - Good Practices

Activity owner

Multiple resources may be required to accomplish the activity; however a single person is responsible and accountable for its performance (e.g., subcontractor, stakeholder, project engineer, etc.)

Scheduling - Good Practices

Activity description

Describes the work that needs to be accomplished

Starts with a verb and contains a unique, specific object

Adjectives may be helpful to clarify ambiguities

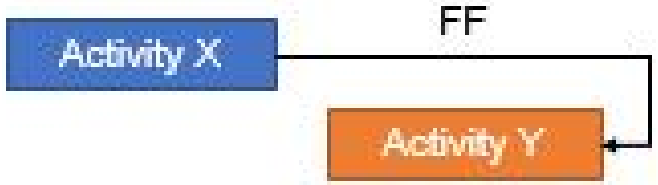
Each activity description should be unique and leave no room for confusion.

Scheduling

Finish to Start

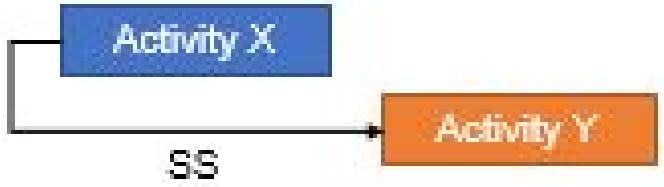
Activity X must be complete before Activity Y can begin

Finish to Finish



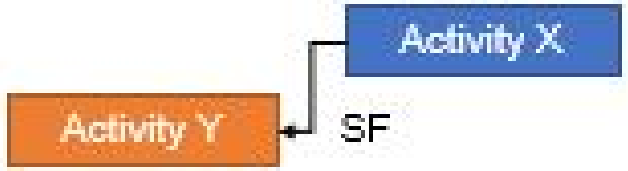
Activity X must be complete before Activity Y can finish (e.g., lay the steel and place the form)

Start to Start



Activity Y can start after Activity X has started (e.g., place the form and pour the slab)

Start to Finish



Activity Y cannot complete until Activity X has started (e.g., upper slab form removal and brick walls)

Scheduling - Good Practices

Sequence Activities

Scheduling - Good Practices

Estimate Activity Resources determinates the type and quantities of material, labor, equipment, or infrastructure required to perform each activity

When a project is constrained in terms of resources, they should be incorporated into the schedule model

The hours needed for a senior designer versus a junior designer to perform the same activity could be considerably different, thus impacting the duration and quality of activity outputs and ultimately the cost of the project

Scheduling - Good Practices

The duration is an estimate of the working time necessary to accomplish the work represented by the activity

The duration is determined by the number of resources that are expected to be available to accomplish an activity and their productivity.

Other factors influencing are the type or skill level of the resources available to undertake the work, resource calendars, the risk associated with the work, and the intrinsic nature of the work

Schedule Models

Deterministic schedule models

Networks of activities connected with dependencies that describe the work to be performed, **static duration**, and planned date to complete the project if everything goes according to plan

Probabilistic schedule models

Networks with all elements of a deterministic schedule model, where the activity duration of the tasks are **random variables** with assigned **minimum and maximum durations** and an appropriate **probability distribution**

Resource-levelled schedule

There is a trade-off between allowing the levelling solution to extend the project total duration and allowing the use of more resources than initially allowed

Resource availability may be increased by adding more resources to the team or by using overtime.

Techniques to compress the schedule

Crashing

Adding resources to critical activities to shorten their durations (which may or may not increase cost).

Should only be performed on activities on the critical path and then on only those activities that yield the most cost-effective result typically increases project costs by some factor

Fast tracking: Increases the risk of rework because activities are started before their initial predecessors are completed

Tracking progress

Step 1

Save a baseline schedule model that contains the dates against which progress is compared

Step 2

Report schedule progress as of a specific data date (including time of day) through which the project status and progress is determined and reported.

The reported progress, as a minimum, should include actual start and actual finish dates, remaining durations or work, and percent complete.

Scheduling Deviations

Identify and explain

- Cost and schedule variances
- Quantifiable deviations
- Divergences away from a known baseline or expected value
- Use variance thresholds and identify acceptable ranges defined in the schedule management plan to determine which activities and conditions require reporting and further analysis

Critical Path

Is the sequence of activities that predicts or defines the longest path and shortest duration calculated for the project starting at the earliest milestone and ending at project completion

It determines the duration of the project

Critical Path

A project can have multiple critical paths provided it has multiple critical sublevel milestones

A project with multiple critical paths* has a higher level of risk since the failure to meet any of these might result in failure to complete all project milestones

Activities that fall on the critical path are critical path activities

Critical Path

Critical path activities: Activities contained in the critical path(s)

Critical activities: Activities vital to the success of a project, even when they are not on the critical path or critical chain

critical activities are normally high risk in terms of scope, schedule, resources, safety, environment, and/or cost and can cause a delay in the project end date and an increased likelihood of project failure

All activities contained within any critical path are critical path activities and are also considered critical activities

Estimate Durations

When there is a great deal of uncertainty in activity duration, a commonly used estimating technique is the three-point estimate

These three points correspond to activity durations defined as optimistic, most likely, and pessimistic durations, which are inputs for the PERT (program evaluation and review technique)