- Resource constrained
  - → level of resources available cannot be exceeded
  - → Resources fixed, time is flexible.
  - → Resource levelling: attempt to even out demands on resources by using slack to manage resources

Resource levelling:

PMBOK: " Any form of schedule network analysis in which schedule decisions are driven by resource constraints "

- → activities can be split (jump between activies) = negative impact
- → reducing overloading / difficult to manage fluctions of one resources leads to overloading another resource.

Network Sensitivity:

- the likelyhood that the orginal critical path will change once initiated

Function of:

- → Number of critical paths
- → Amount of slack across critical activities
- → Uncertainty of time duration of activities.

#8 Cost Estimating & Budgeting

- Estimating:
  - → process of approximating the time/cost of completing project deliverables
  - → task of balancing expectations of the stakeholders and need for control

Types:

- → Top-down: analogy, group consensus, mathematical relationship
- → Bottom-up: estimates of elements of WBS.

Methods:

- → detail cost planning on work packages – accurate but expensive
- → industrial standards
- → functional staff members
- → Three times method

$$\text{Duration} = \frac{a + b + 4m}{6}$$

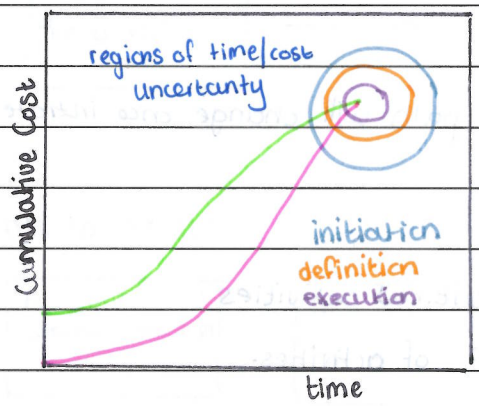
Typo

Cost increase:

- Uncertainty and little definition makes estimation difficult
- Ratio of cost to estimate → Cost escalation
- ±20% normal on projects

Sources:

→ Uncertainty and shortage of acurate information
→ Changes in design and requirements
→ Economic and social factors
→ Ego of the estimator
→ Ineffective, bad communication and shortage of control
→ Project contract.



Life Cycle Cost (LCC):

- cradle to grave costs
  → cost during Definition & Execution phase
  → plus operation and disposal.

- Target costs for operation/maintenance/disposing
- Design system to meet target costs

* Estimating Process

Estimate: a realistic assesment based upon known facts, work, the resources, constraints and environment
Target: desired outcome, commitment or purpose
Accuracy: the closeness of the estimated value to the auctual value
Precision: number of decimal places in the estimate.

* Methods:

Top down approaches:

1. Expert opinion
2. Analogy + compensation differences.

$$\text{Cost, Engine A} = (\text{cost, Engine B})\left[\frac{\text{Thrust, engine A}}{\text{Thrust, engine B}}\right]^{0.7}$$

* 3. Parametric: formula or cost function.

eg.

$$\text{Cost} = 150A + 300\sqrt{\#\text{rooms}} + 150(\#\text{floors})$$

Bottom up approch:

4. Cost engineering
   - detailed cost break down of labour, materials, etc

3 & 4 are the best methods. Rule of thumb, the smaller the work package the better the estimate.

Procedure for large projects:

1. PM: uses the WBS to identify work packages
2. FM: Subdivide work packages into identifiable tasks - determine labour materials, facilities ....
3. Supervisior: estimates the labour hours and material quantities
4. FM: check and aggregate time/material estimates
5. FM: convert time estimates to costs
6. PM: approves the estimates, agregates costs, add in Overhead costs

$$\text{Project cost} = \sum \text{direct costs} + \sum \text{overhead costs}$$

7. PM: adds contingency amounts
8. PM: compares bottom-up estimates to top-up target.

*	Top-down Estimate	Bottom-up Estimate.
Intended use	Feasibility study, rough time/cost estimate fund requirement, recource capacity.	Budgeting, Scheduling, Resources fund timing
Preparation Cost	1/10 to 3/10 of total projected cost	3/10 or 1 %. of total projected cost

Typo

Accuracy	Minus 20 %. to Plus 60 %.	Munus 10 %. to plus 30 %.
Method	Concensus, Ratio, Apportion Functional points, learning curves	Template, Parametric WBS packages

Direct Costs:
* Direct management
* direct labour
* direct materials
* direct Equipment
* direct Expenses

the same counts for indirect costs.

- Direct Costs
  - → costs clearly chargeable to a specific work package
- Direct Overhead Costs
  - → Costs directly tied to an identifyable project deliverable
- General / Adminstrative Costs
  - → organization costs indirectly linked to a spesific package

A. Direct Cost

→ directly related to work
→ costs are spent as the project needs it: direct deliveries
→ labour, materials, Equipment

B. Direct Overhead Costs

→ Organization resources used in project
→ related to the project deliverables
→ determined by basing on a spesific %
→ payment of PM, rent of property
→ changes with time duration

C. General Overhead Costs

→ Organization costs indirectly linked to a specific package
→ Organization costs of all products/ projects
→ advertising, book keeping
→ strategic decision of head office

* Project Cost Accounting System

- Enables budget information to be aggregated / disaggregated according to work packages
- Project budget: subdivided into control accounts

Cost monitoring:
→ Weekly expenses and Cumulative Expenses
  * Created from work packages budget
  * Expenses occur uniformly through work package duration
  * Analogus to resource loading profile
→ Cumulative expenses shows the Budgeted Costs of the Work Schedule, which is expected expenditure growth through out project.
→ Planning and control:
  * weekly and cumulative expenses are adjusted to accomodate cash-flow capital constraints

Level of detail:
* different for different levels of management
* level of detail in WBS varies with complexity
* Excessive detail is costly - unproductive paperwork
* Insufficient detail is costly - lack of focus on goal