

Key features of projects (revised)

Corporate strategy & projects

- Why are projects incepted?
- Projects are not an end by themselves, they are a means to an end



Stimuli from environment to company in the form of

• Energy

• Information

• Material

➤ Environmental:

- Opportunity
- Threat

➤ Organizational

- Strength
- Weakness

SWOT analysis

➤ Response:

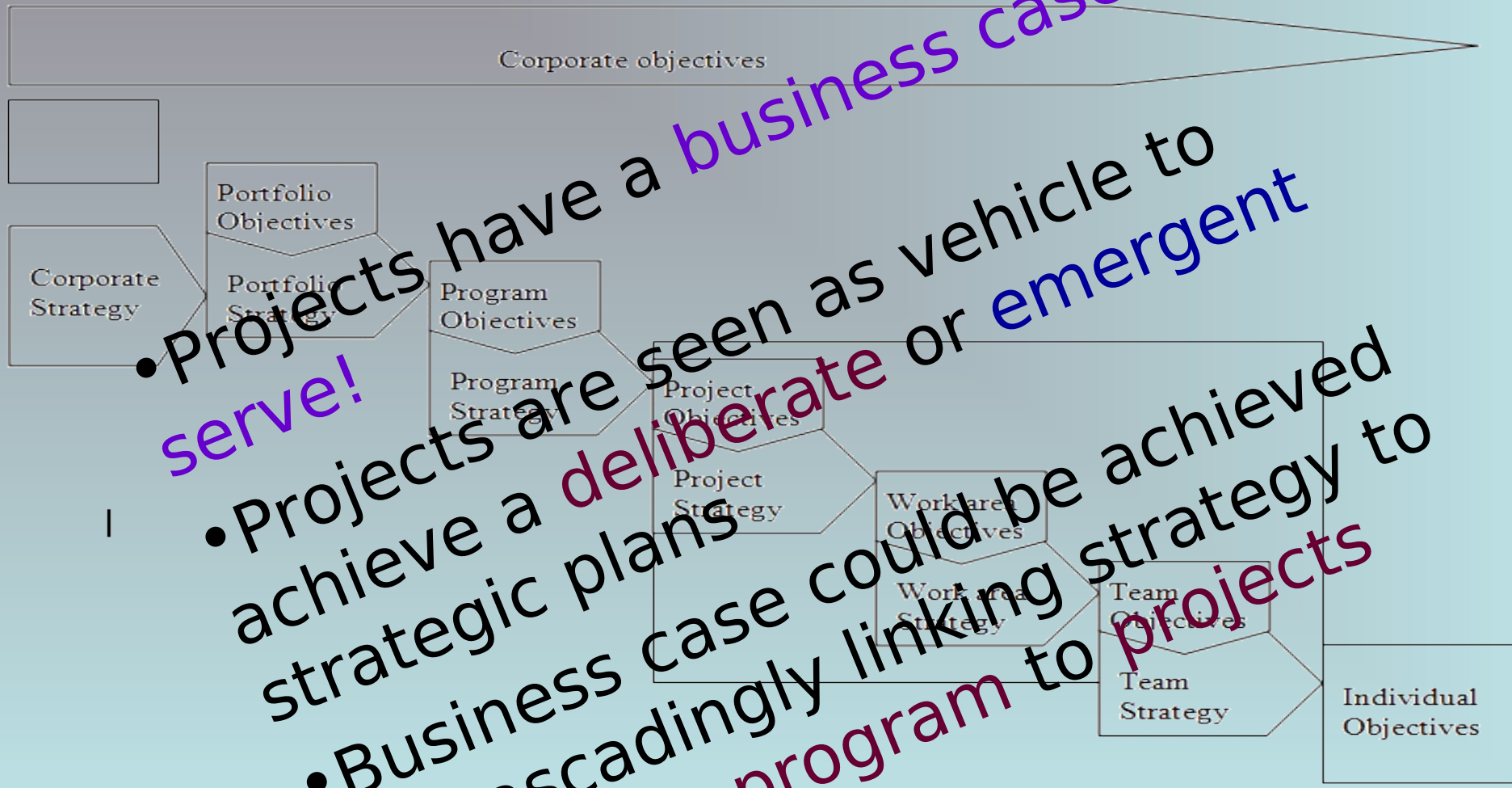
- Project response?
- Or other response?

• The **kind** and **degree** to which the company responds depends both on the **kind of stimuli** and level of **incentives** (opportunity) or **threat** the environment



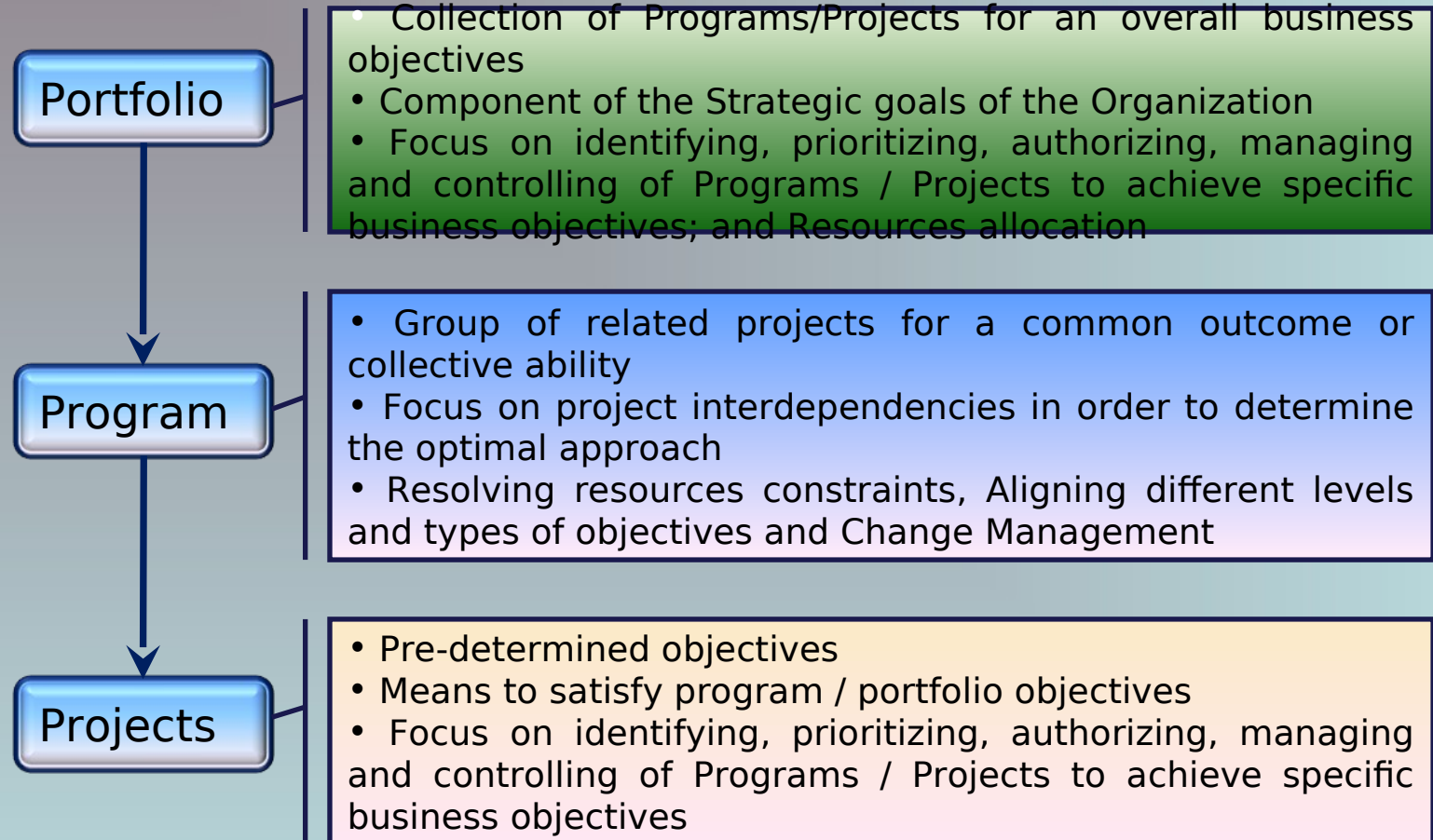
Corporate strategy & projects

Strategic planning, tactical planning and operational planning



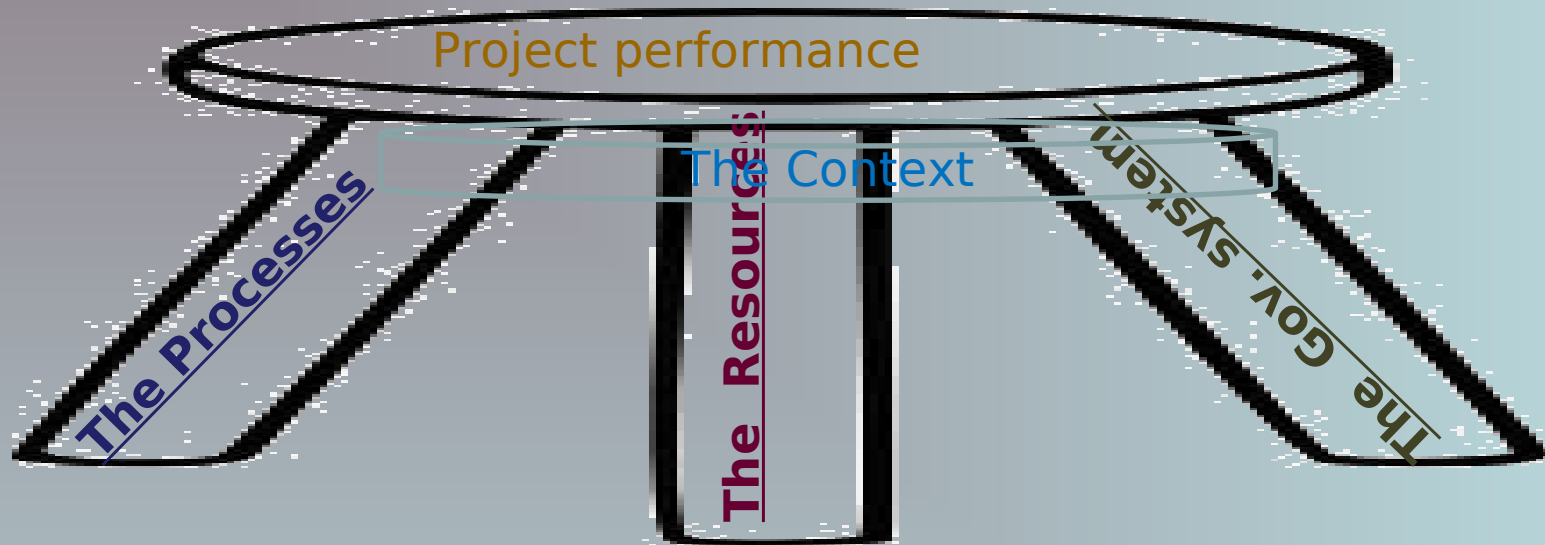
Corporate strategy & projects

• Project, Program & Portfolio Management



Construction Project

Key components

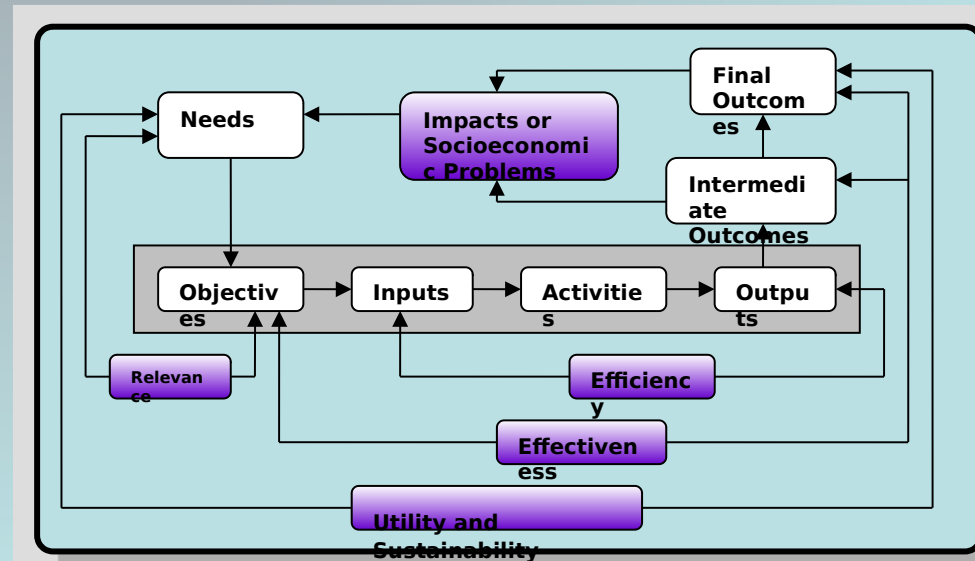
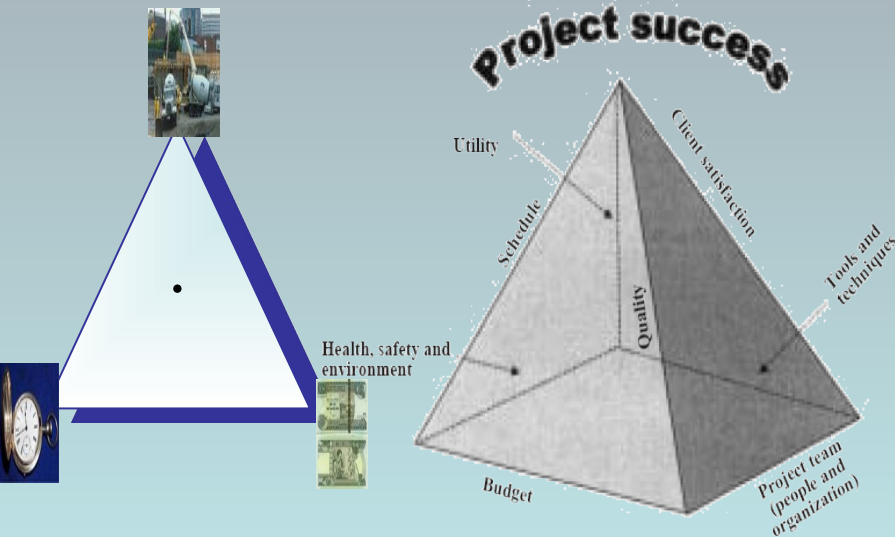


Practices, Methods and Tools [the organization & processes of]:

- Pre- project phase
- The construction project phase
 - Project conception processes
 - The development and [procurement] process
 - Implementation processes
 - Commissioning and closing processes
- Product operation phase
- Product disposal /recycle phase

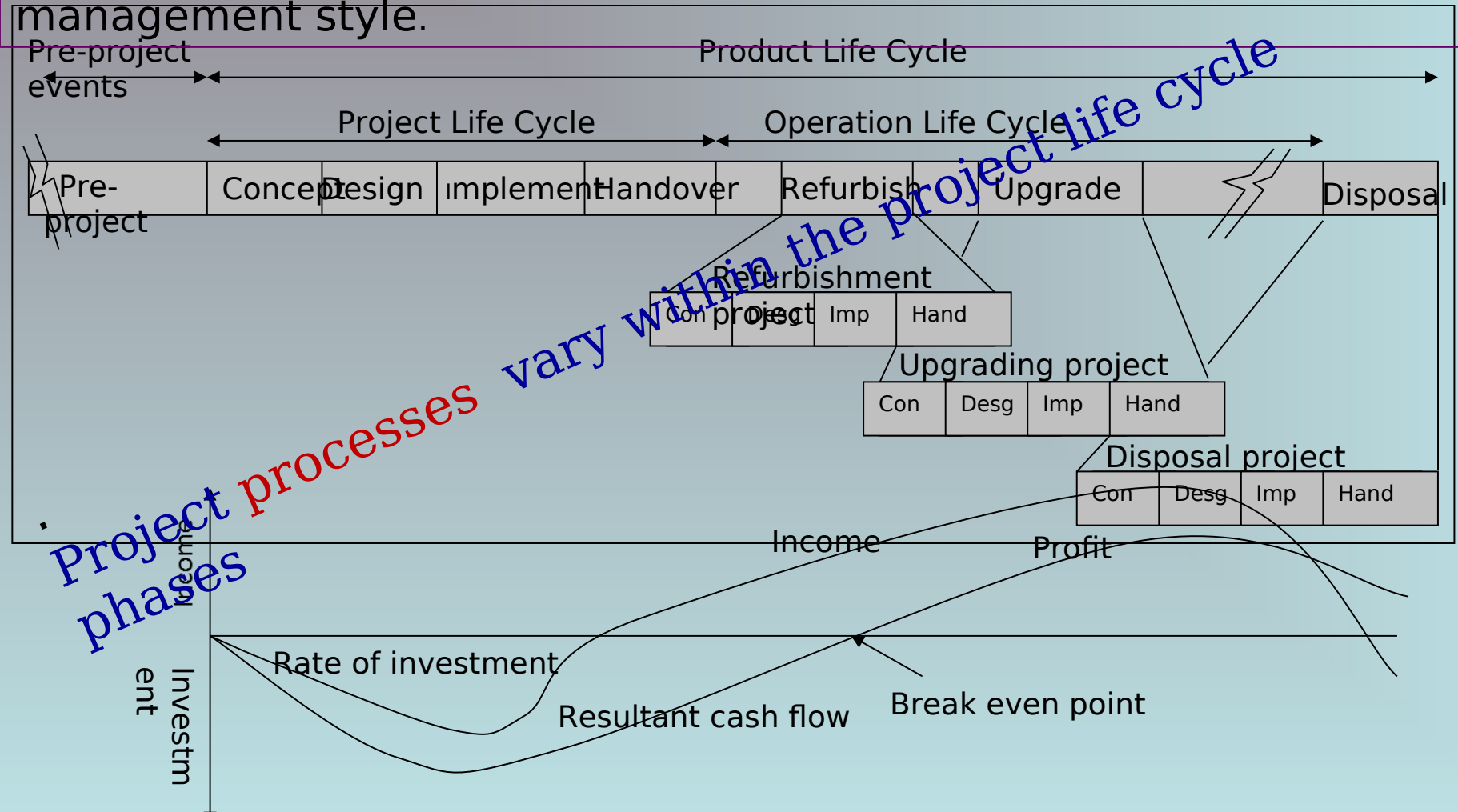
Project performance [KPI]

- Success criteria often used
 - The conventional 'iron triangle' of Time-Cost-Quality (Performance);
 - The **optimality** of the above three factors is critical
 - Edges of a square pyramid;
 - Policy and strategic management success criteria

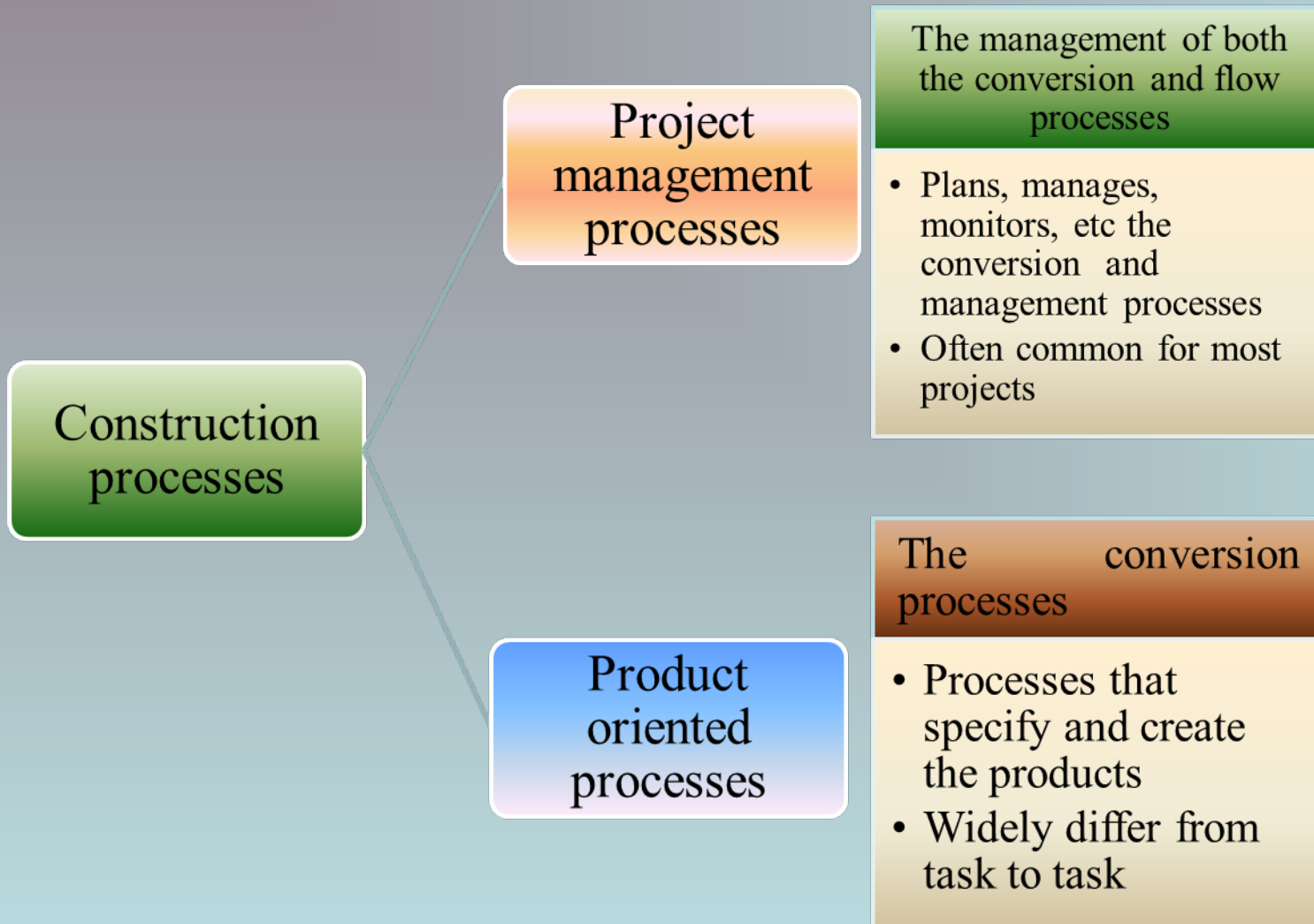


Project/Product Phases

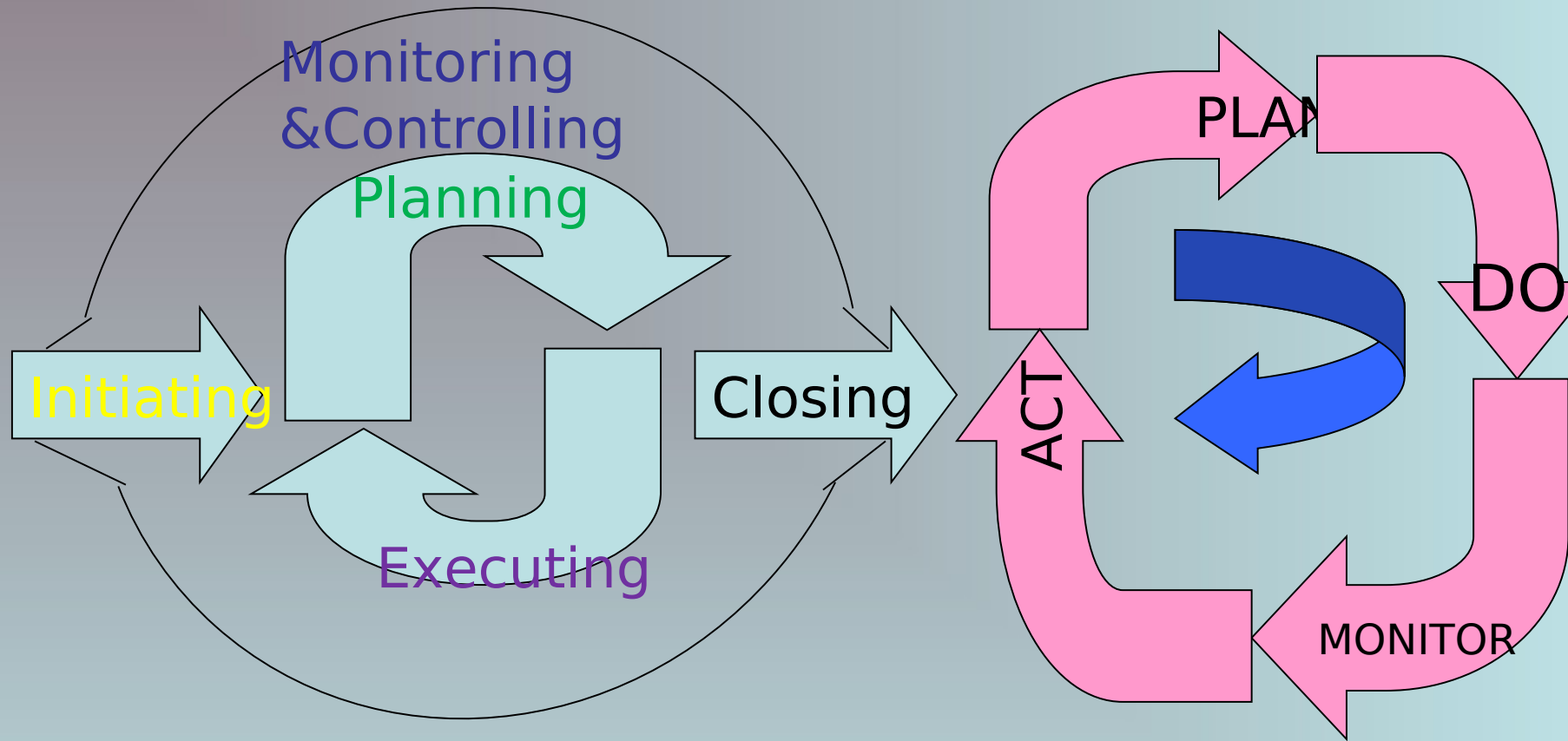
Project phases are characterized by different mission, technology, processes involved and these differences create/demand their own particular different characteristics of work, competence and management style.



Construction processes

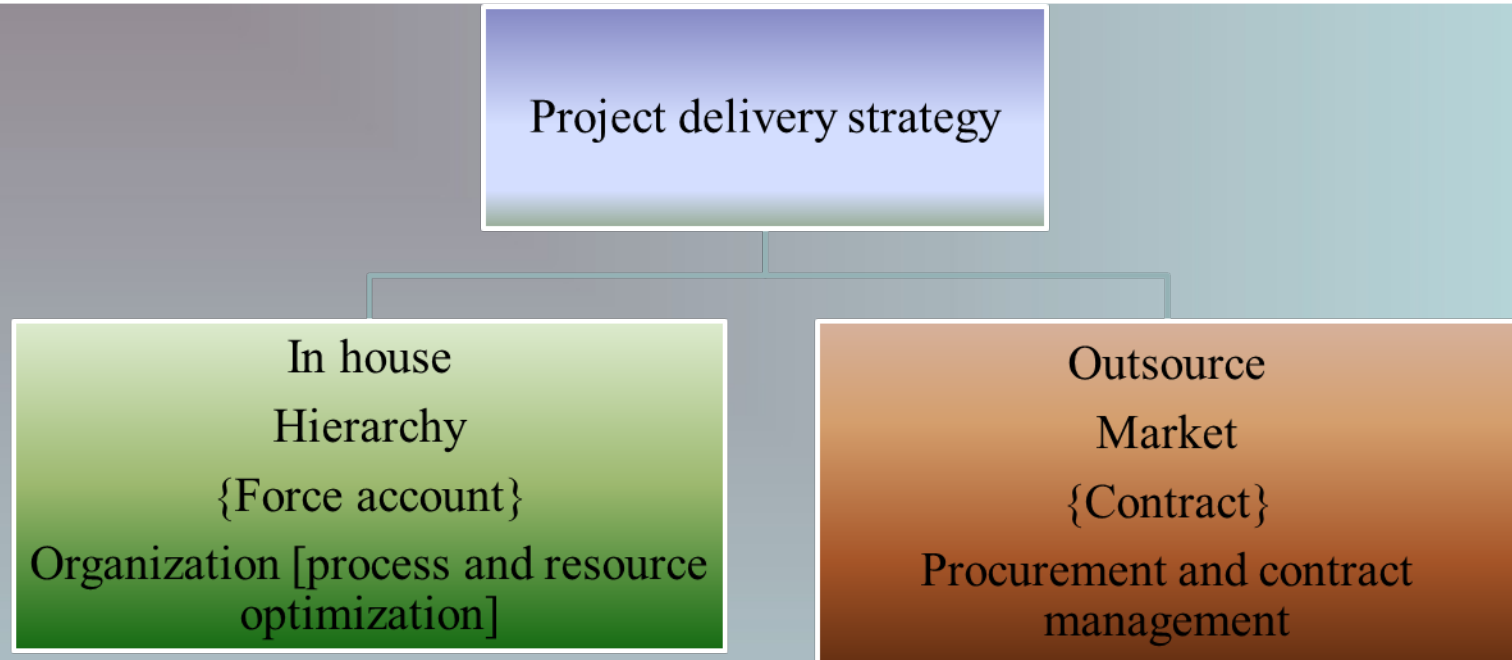


PM processes: Groups



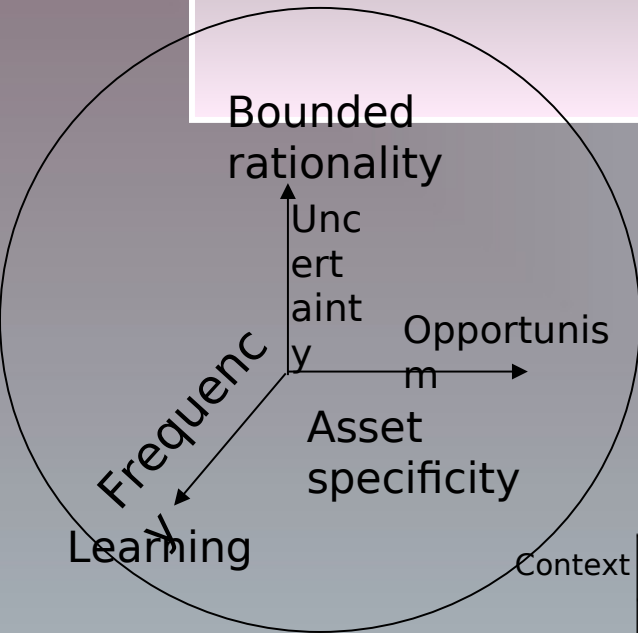
Tools such as Software like Ms project and Primavera mainly facilitate the “**planning**” and “**monitoring and**

Governance and organization of projects



- Given the **nature and characteristics** of construction outputs, processes, economics, etc, the market option is often the preferred one;
- However, generally, most markets options end up in hierarchy [team], at production level, to deliver services and products

Governance and organization of projects



When to **outsource** or when to construct **in-house** and **best governance structure**
(The **Transaction Cost Economics (TCE)** justification)

		Asset specificity of investment		
		None specific	Mixed	Idiosyncratic
Frequency	Occasional	Market Governance (Classical Contracting)	Trilateral Governance (Neoclassical Contracting)	
	Recurrent		Bilateral Governance (Relational Contracting)	Unified Governance
		Uncertainty decrease Uncertainty increase		

Various **delivery options** (DBBs, DBs, CMs, PPPs) and (often) **trilateral governance** (Client-Consultant-Contractor)

Often **neoclassical contracting** using General Conditions and Standard

Governance and organization: Structures

- Hierarchy

- Industry level
 - » Divisional (?)

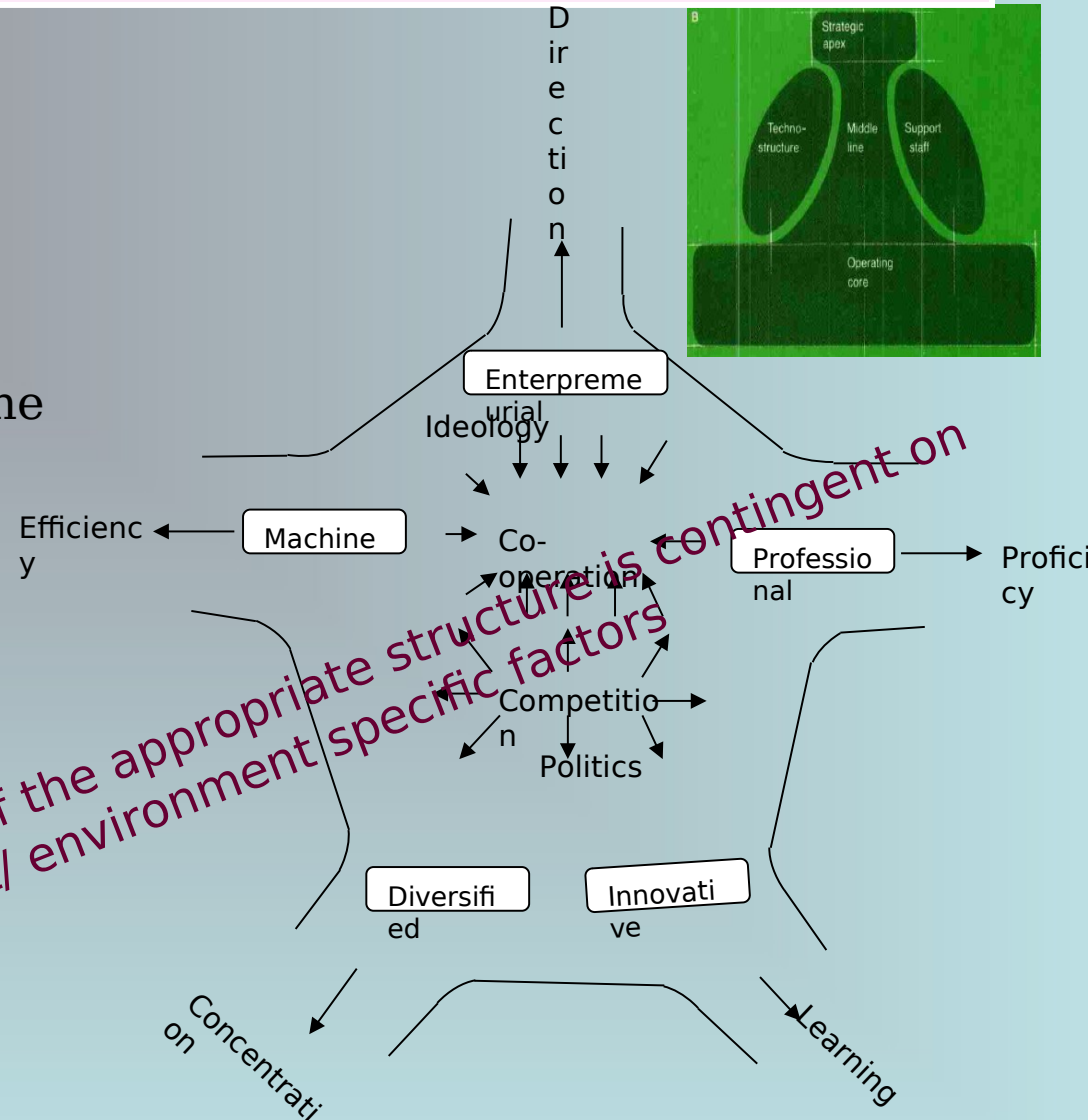
- Firm level

- Contractors
 - » Simple, Machine bureaucracy, Divisional
- Consultants
 - » Professional bureaucracy

- Project level

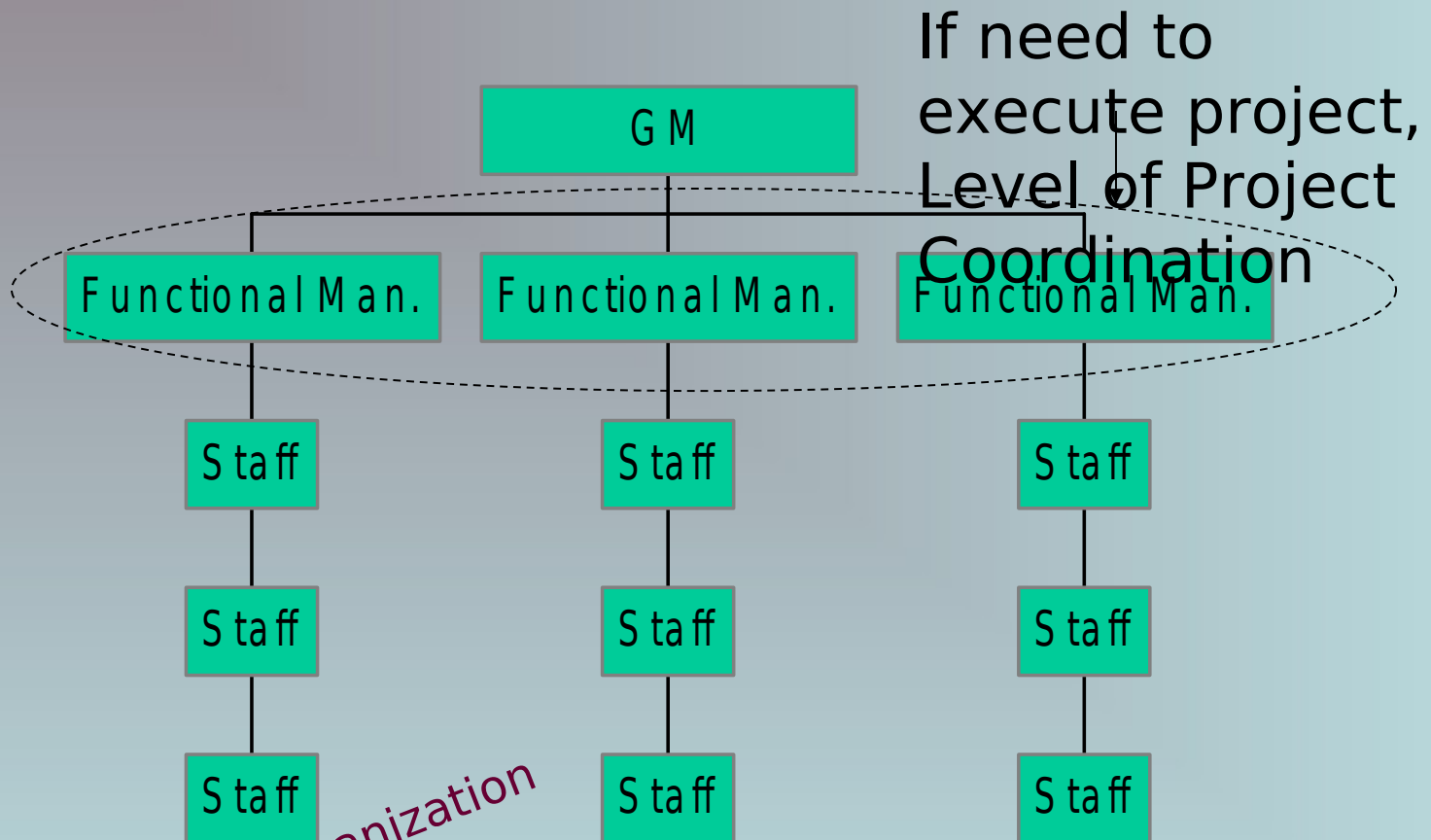
- » [administrative] adhocracy (?)

- Phase integration

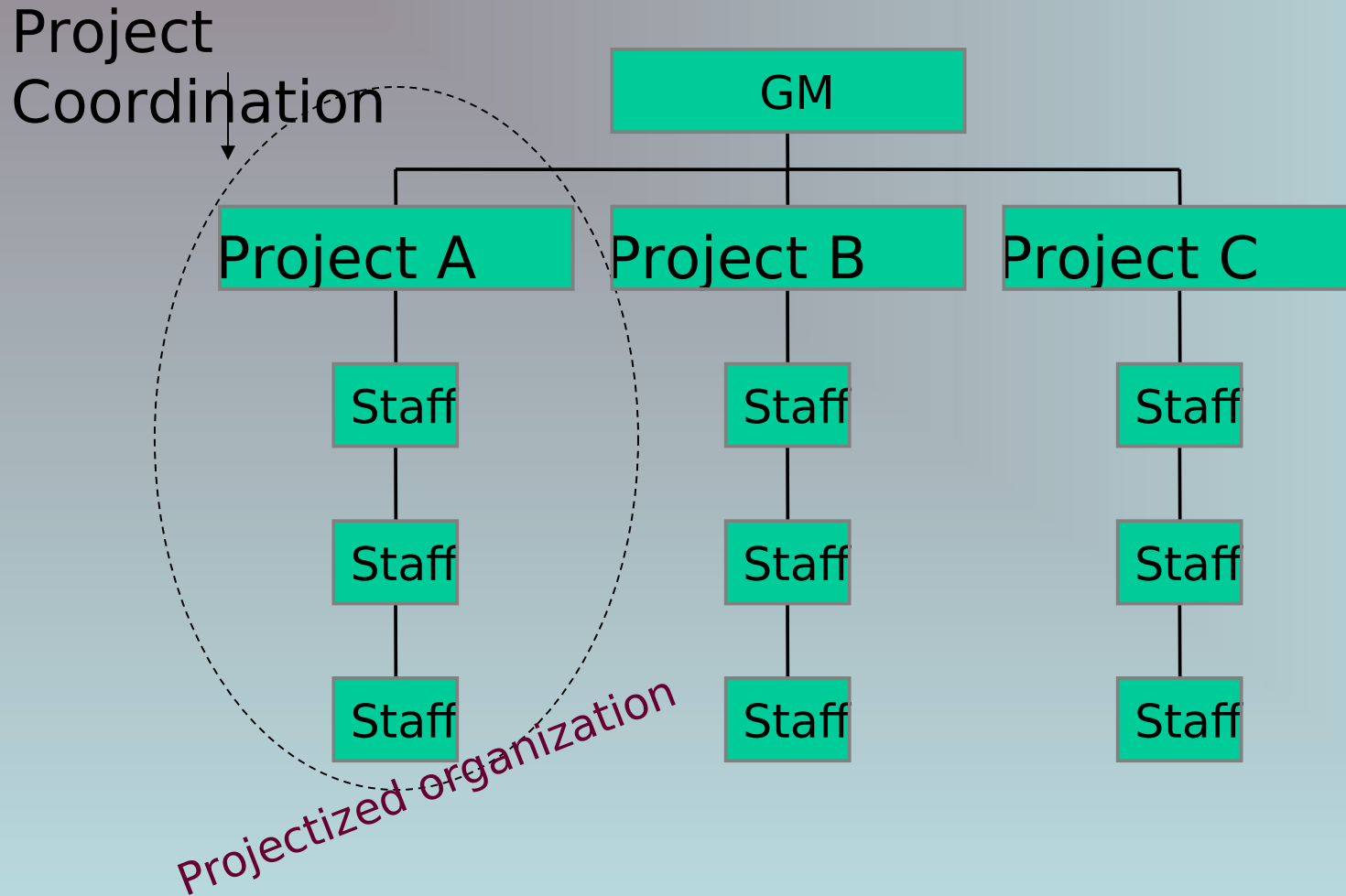


Governance and organization: Structures

(Functional)

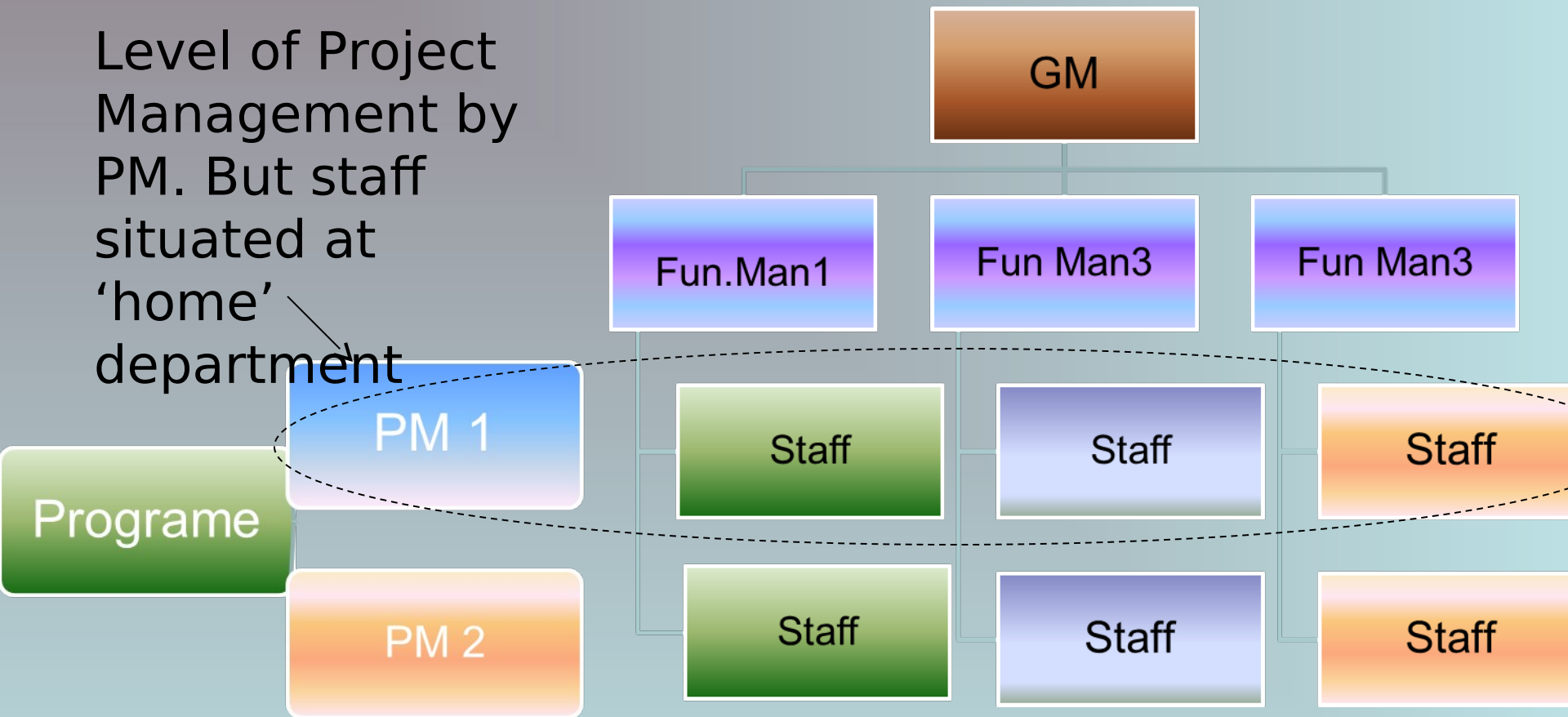


Governance and organization: Structures (Projectized)



Governance and organization: Structures (Matrix)

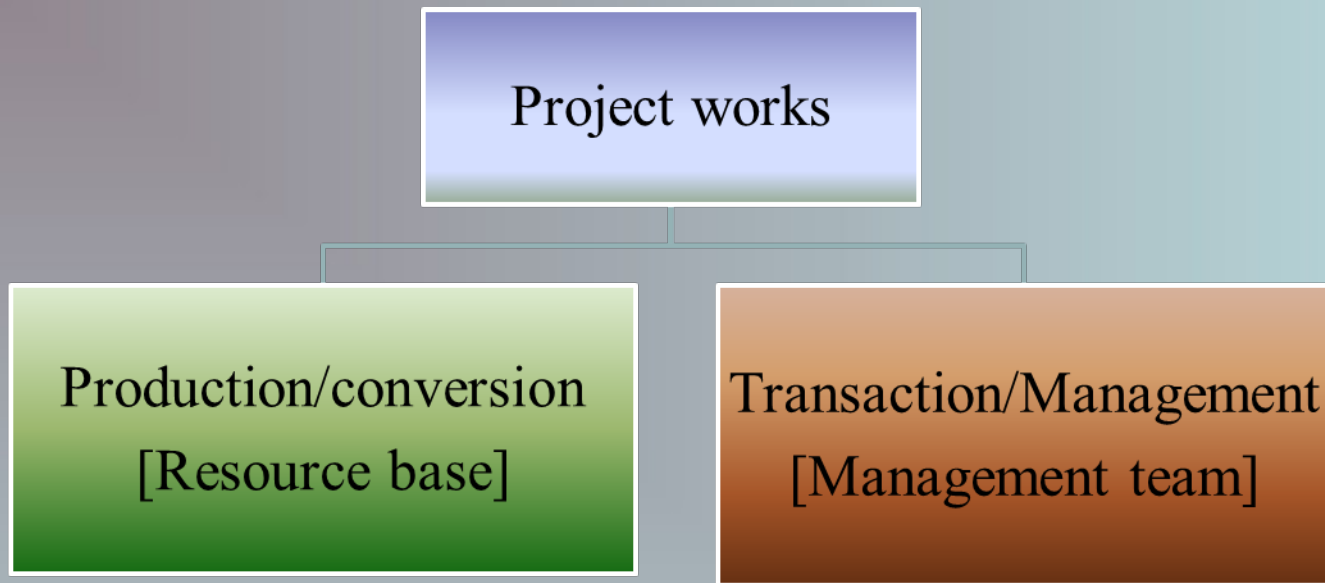
Level of Project Management by PM. But staff situated at 'home' department



Matrix organization

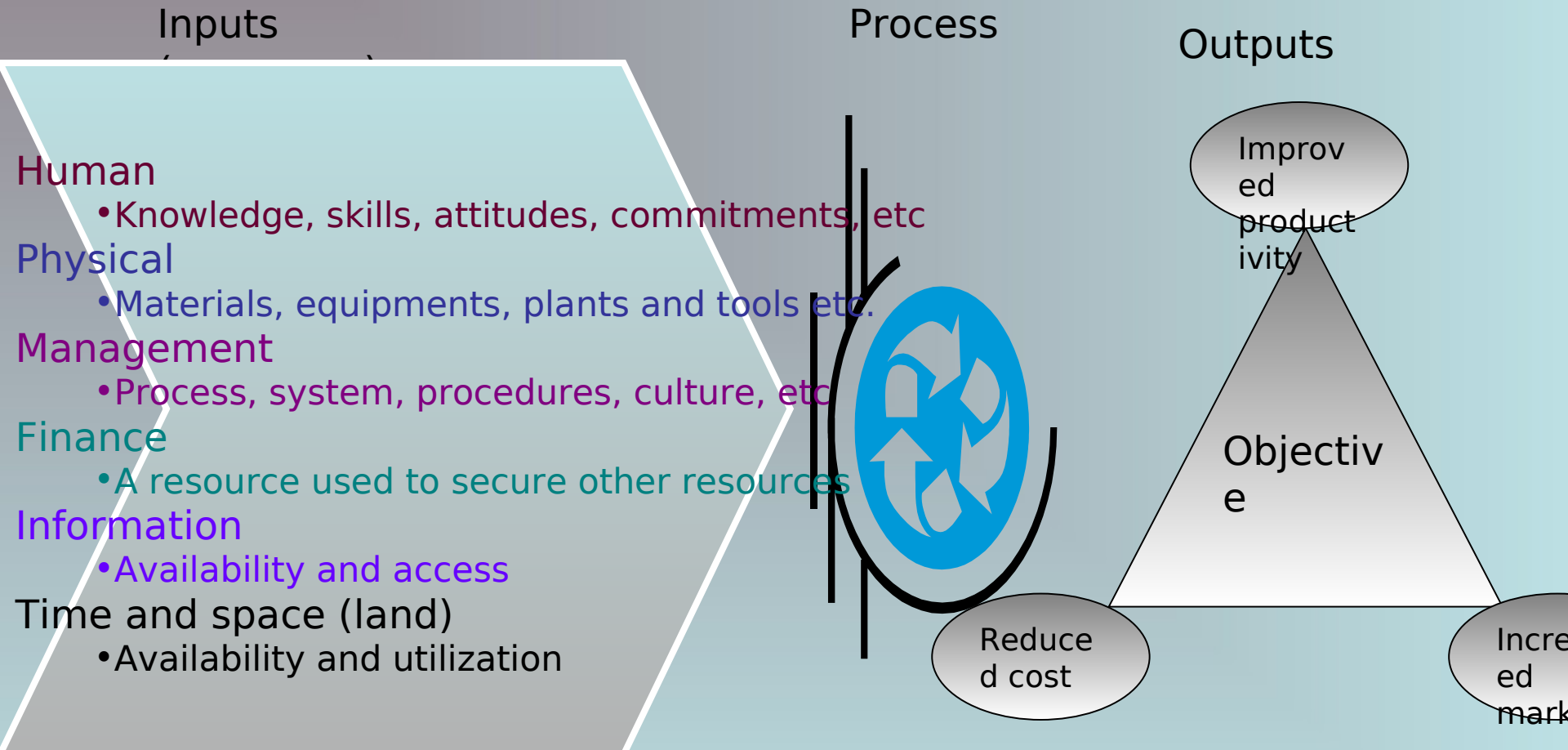
Depending on level of Authority of PM relative to Functional Manager, it is classified as Weak, Balanced and Strong

The resource base and constraints



- The **information/knowledge**, **material** or **effort/energy** needed in project works come from the myriads of the **physical**, **human** and **institutional** resources;
- Good project management in construction must vigorously pursue the efficient utilization of resources deployed both for the **coordination/management** and the execution of the **processes/operations**.

The resource base and constraints



Particularly the **machineries**, the **materials** and the **man powers** and **money** (4M) are very important resources in

The project environment

- Enterprise environmental factors refer to both internal and external environmental factors that surround or influence the successful completion of a Project.
 - The management of projects is history-dependent and organizationally-embedded
 - Contextual and environment forces of political, legal, institutional, sociological, technological, and economic affect performance
- Enterprise environmental factors include, but are not limited to:
 - Organizational culture, structure, and processes;
 - Government or industry standards (e.g., regulatory agency regulations, codes of conduct, product standards, quality standards, and workmanship standards);
 - Infrastructure (e.g., existing facilities and capital equipment);

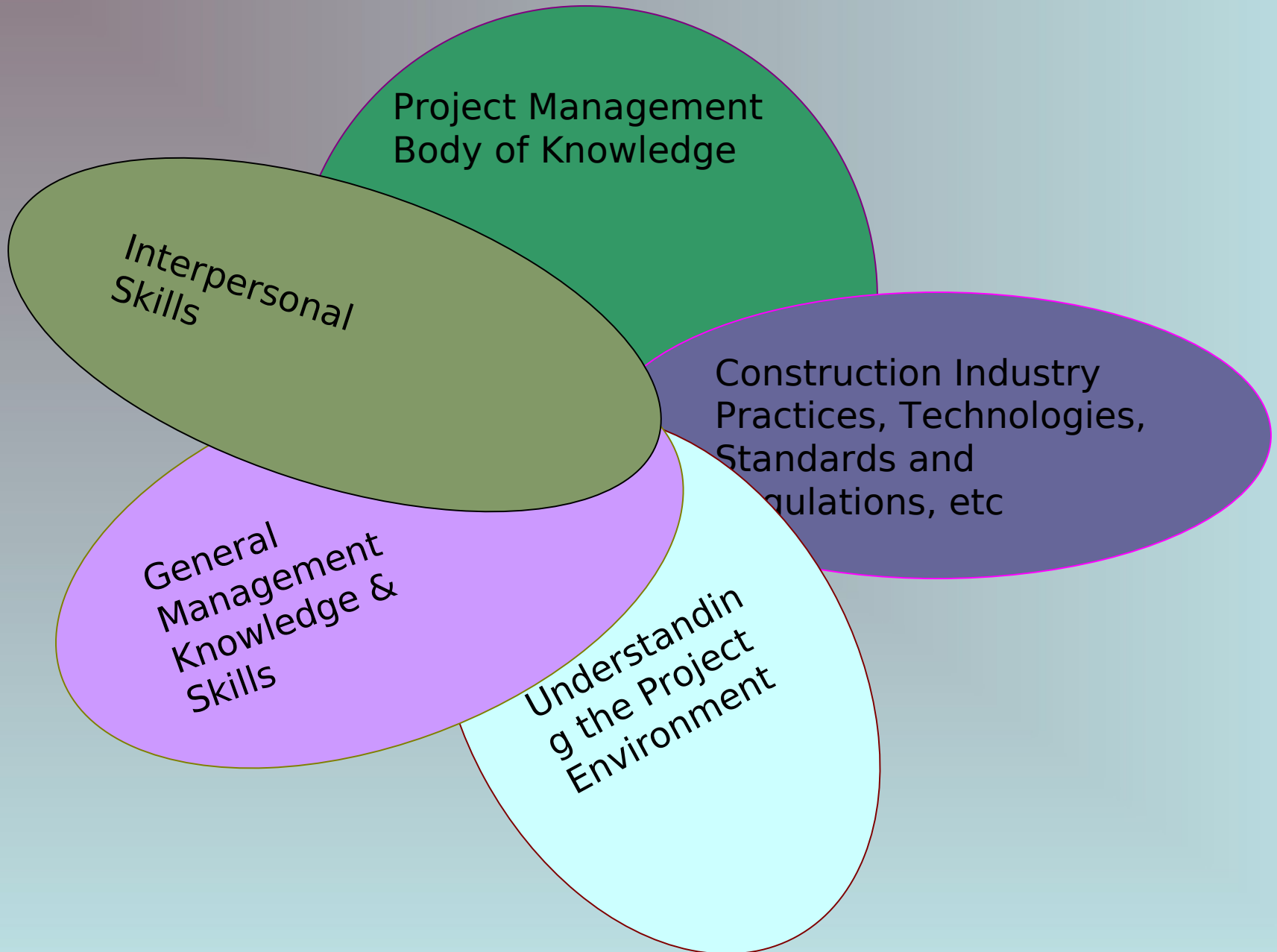
• Managing the situations!!!

The project environment

- Enterprise environmental factors include, but are not limited to:
 - Existing human resources (e.g., skills, disciplines, and knowledge, such as design, development, law, contracting, and purchasing);
 - Personnel administration (e.g., staffing and retention guidelines, employee performance reviews and training records, overtime policy, and time tracking);
 - Company work authorization systems;
 - Marketplace conditions;
 - Stakeholder risk tolerances;
 - Political climate;
 - Organization's established communications channels;
 - Commercial databases (e.g., standardized cost estimating data, industry risk study informal risk databases); and
 - Project management information systems (e.g., an automated tool, such as a scheduling tool, a configuration management system, an information collection and distribution system, interfaces to other online automated systems).

Chapter Four

Knowledge, skills, techniques
and tools for project
management



Construction Area Knowledge

Construction Technology

- Construction Methods
- Construction Processes
- Construction resources

Construction industry (experience)

- Construction governance
- Construction industry practices
- Stakeholders/ Supply chain;

Context (Ethiopian adaptation)

If you cannot understand it, you cannot manage it efficiently
Technical operations as like construction works are better managed by personnel versed in the technique and practice

Understanding the project environment

- The general (national) business context
- Cultural and social environment
- The political and legal environment
- The international dynamics
- Physical environment

• Managing the situations!!!

General management

- Financial management and accounting
- Strategic planning, tactical planning and operational planning
- Organizational behavior
- Logistics and supply chain management
- etc

Interpersonal skills

- Effective communication
- Influencing the organization
(Authority, Power and Politics)
- Leadership
- Motivation
- Negotiation and conflict management
- Problem solving

Management is getting things done through others!

Project Management

Project Integration Management

- Develop project charter
- Develop preliminary project statement
- Develop project management plan
- Direct and manage project execution
- Monitor and control project work
- Integrate change management
- Close project

Project Cost Management

- Cost estimating
- Cost budgeting
- Cost control

Project Communication Management

- Communication planning
- Information distribution
- Performance reporting
- Manage stakeholders

Project Scope Management

- Scope planning
- Scope definition
- Create WBS
- Scope verification
- Scope control

Project Quality Management

- Quality planning
- Perform quality assurance
- Perform quality control

Project Risk Management

- Risk management planning
- Risk identification
- Qualitative risk analysis
- Quantitative risk Analysis
- Risk response Planning
- Risk monitoring and control

Project Time Management

- Activity definition
- Activity sequencing
- Activity resource estimating
- Activity duration estimating
- Schedule development
- Schedule control

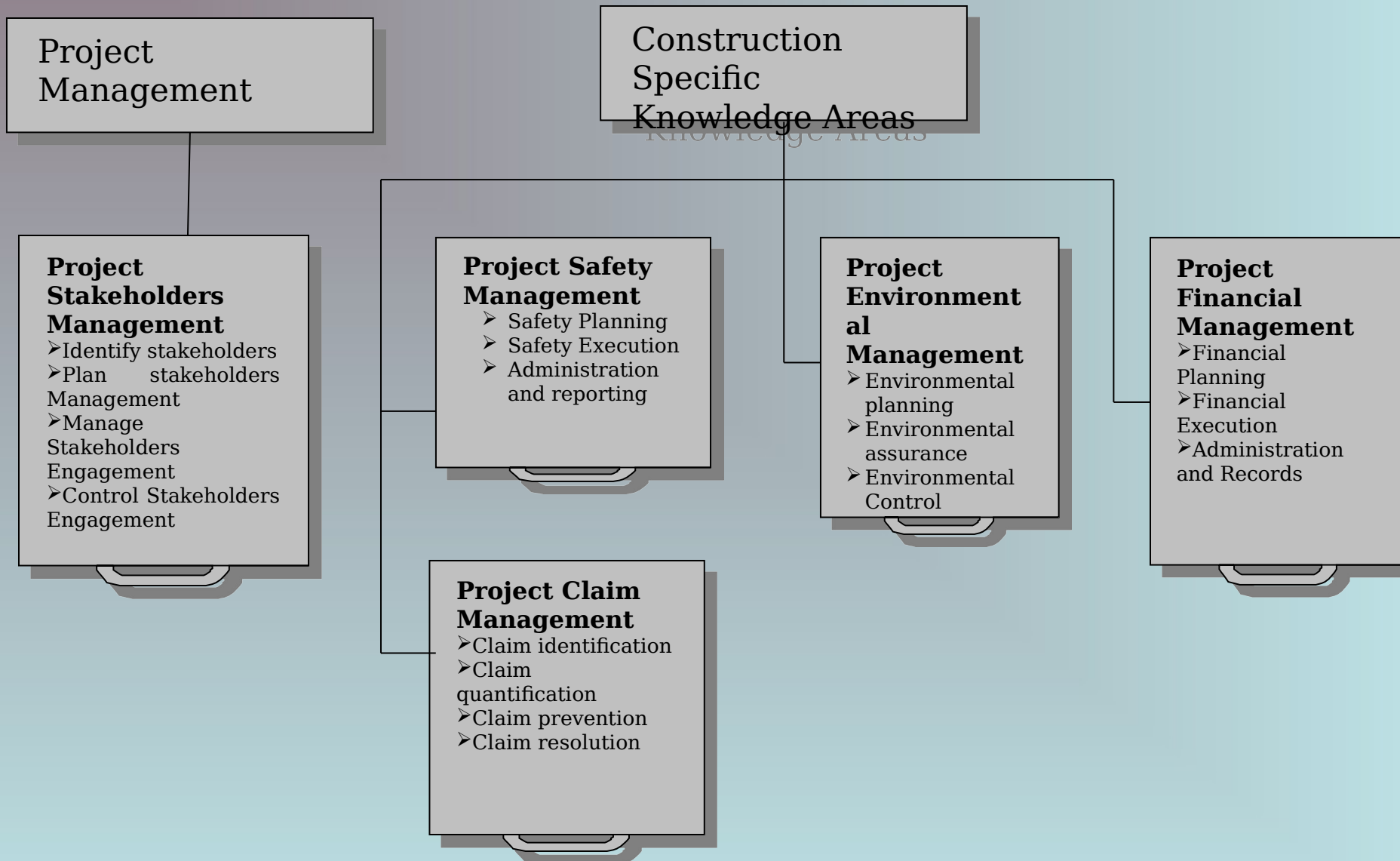
Project Human Resource Management

- Human resource planning
- Acquire project team
- Develop project team
- Manage project team

Project Procurement Management

- Plan purchase and acquisition
- Plan contracting
- Request seller responses
- Select sellers
- Contract administration
- Contract closer

Project management knowledge areas: Construction Extension



Project Scope Management

- **What?** process required to ensure that the project includes *all the work required and only the work required* to complete the project successfully
- **How?**
 - *Scope planning*
 - *Scope definition*
 - *Scope verification*
 - *Scope control*

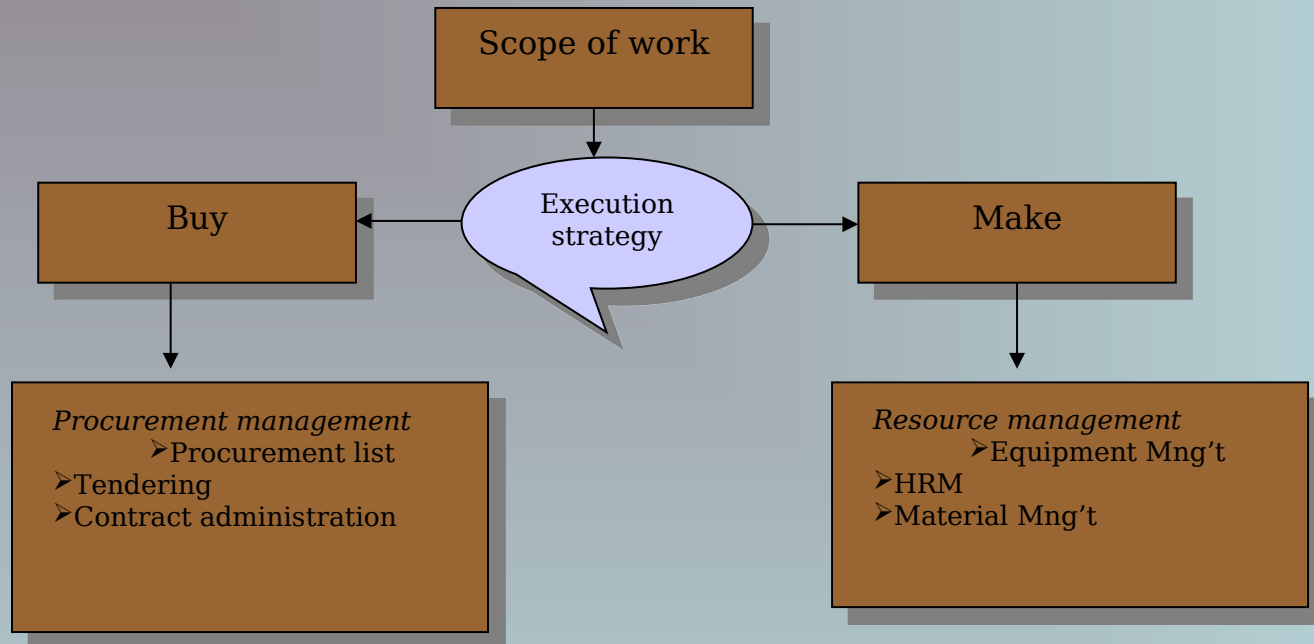
Scope Planning

- Process of creating the project scope management plan that enable to define, verify, and control the project scope

Scope definition

- **What?** Process of developing **detailed project scope statement** that enable guide the project work
- **How?** Determines **execution strategy** and conducts **product analysis** to create **WBS** and **build method**
 - Mostly done in **design and specification** in construction experience;
 - *Drawings, Specifications, Statements of Work, Work Methods, Engineering Design Report, etc.*
 - WBS give a **systematic decomposition** of the overall job into smaller chunks which are **easily manageable**

Execution strategy



Build Method

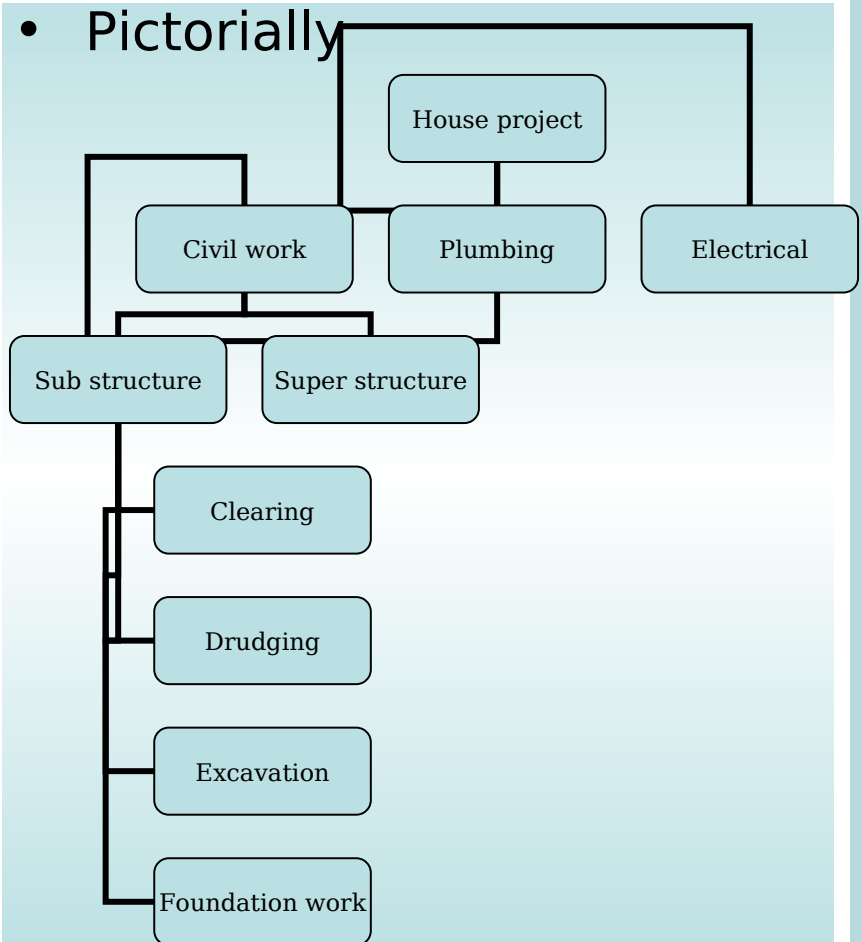
- Outlines how the product will be assembled or implemented via
 - *Drawings, specifications, statements of work, work methods, Engineering Design (Review) Report, etc.*

WBS

- **What?** a deliverable-oriented hierarchical **decomposition of the works** to be executed by the project team to accomplish the project objectives and create the project deliverables
- **How?** via *systematic decomposition* of the overall job into smaller chunks which are **easily manageable**
 - By category of work as distinguished by materials such as concrete, timber, steel etc,
 - By category of work as distinguished by craft or crew requirements (formworks slab, formwork footings)
 - By category of work as distinguished by equipment requirements,
 - By area of responsibility. Work items done by the general contractor and each of his sub-contractor should be separated,
 - By distinct structural elements such as footings, walls, beams, columns and slabs, etc
 - With regard to owner's breakdown of the work for bidding or payment purposes,
 - With regard to contractor's breakdown for estimating and cost accounting purposes.

Formats of WBS

- Text Indentation
 - A house project
 - Civil work
 - Sub structure
 - » Clearing
 - » Drudging
 - » Excavation
 - » Rebar fixing
 - » Concert casting
 - Super structure



WBS: Level of divisions

- To the level that **estimates and forecasts** about the resources required, durations and activity relationships are **realistically estimated for each activity**;
 - **Sub-project level**: Sub projects are derived by dividing a large project, usually termed *a programme*, into independent large-volume mini projects.
 - **Task level**: A task is an identifiable and deliverable major work which can be performed without major interference from other tasks.
 - **Work package level**: A work package contains a sizeable, identifiable, measurable, costable and controllable package of work.
 - **Activity level**: An activity is a sub division of a work package and is defined as a work which has a definite start and end and consumes resources.
 - **Operations level**. Operations are sub-divisions of activities and generally are comprised of particular types and a fixed group of resources associated with it

Construction projects are best **programmed for day work** by using **operational level**, best **planned and monitored by using the activity level** while **best controlled by the work packages**

Mega project
(Programme)

Real Estate
Development

Residential Buildings

Service Buildings

Recreation Centers

Sub projects

Educational
Buildings

Health Centre

Shopping centre

Tasks

Sub structure

Super Structure

Roofing

Finishing

Work package

Base
construction

Footing Con

Plinth wall
Con

Ground floor
Con

Activities

Earth work

Base
preparation

Blinding

Layout

Excavation

Leveling/
compacting

There are various norms in common use about construction work
WBS

Scope verification

- Process of formally accepting the project deliverables
 - Design check, Design reviews, etc;
 - Gate (transition go/no go decision) reviews such as constructability review;
 - Major target it to avoid unnecessary change orders later or forget it all together

Scope control

- Process that is concerned with influencing those factors that could have resulted in scope change and containing its impacts
 - All the scope controlling processes conducted by the performing organization
 - Change management/ configuration management will help track changes and incorporate into project

Changes in construction projects

Change

Enterprise focuses

- Usually time dependent
- Demand strategic decision

Project focused

- Construction changes are common
- Causes and sources do vary

- Contrary to popular believes that changes are 'bad', changes meant to improve, adapt, etc of **the business plan** (intended purpose) of the project should be sought after and incorporated;
- The major problem with an **ex-post Contract** **changes** to projects is **opportunism** from the contracting partner

Changes and Contracts

- Due to various reasons, construction works are bound to have **change to the conditions** of the Contract.
- Causes could be:
 - Errors or omissions
 - Design
 - Construction
 - Differing conditions (couldn't reasonably be anticipated)
 - Physical
 - Social
 - Economical, etc
 - Post bid decision by client to change
 - For different reasons (eg. Business change)
 - Defaulting by one of the parties
 - Client
 - **Contractor** (can't be compensated or excused)
 - Designer
 - Public security & Safety reasons

Quality Management

Quality

- What? 'the degree to which a set of inherent characteristics of a certain construct fulfills requirements'.
- Quality Vs Grade
 - A grade is a category assigned to a product with different technical specifications
- Quality Vs life cycle costing

Quality Management

- *How?*

- *Quality planning*

- Specifications, drawings, manuals, standards

- *Quality assurance*

- Eg. Quality assurance by the performing personnel

- *Quality control*

- Quality control by (eg supervisors)

Can't inspect quality into a product. Necessary to shift paradigm

Various standards are available which can be used in construction works

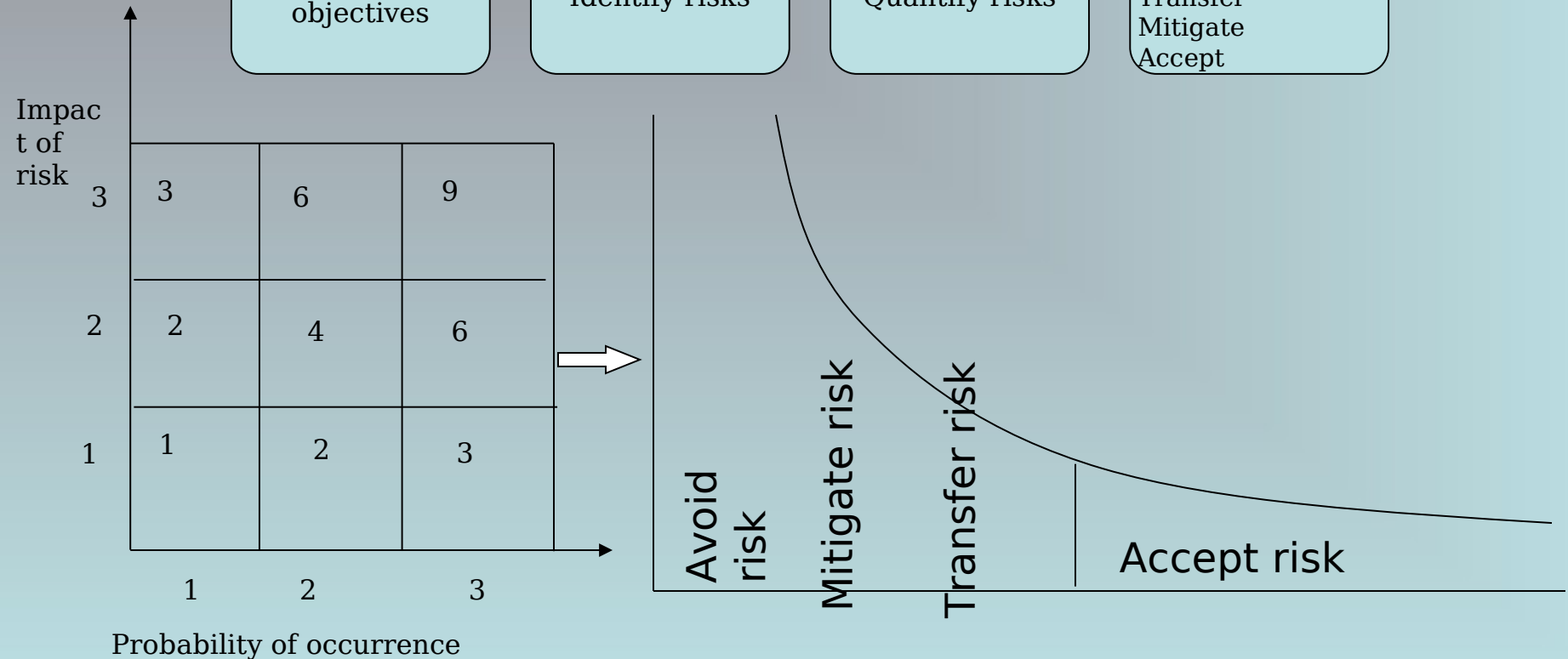
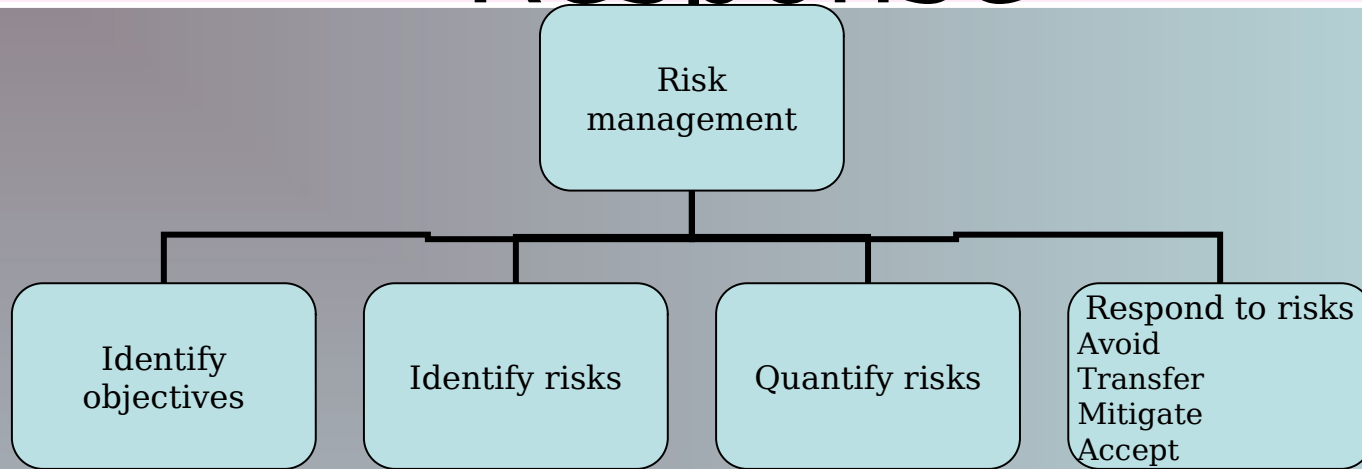
Basics of Total Quality Management (TQM)

- ISO 9000:2000
 - Customer focus
 - Leadership
 - Involvement of people (Training & Empowerment)
 - Process approach
 - Continuous Improvement
 - Mutual beneficiary supplier relationship
 - Factual approach to decision making
 - Systems approach to management

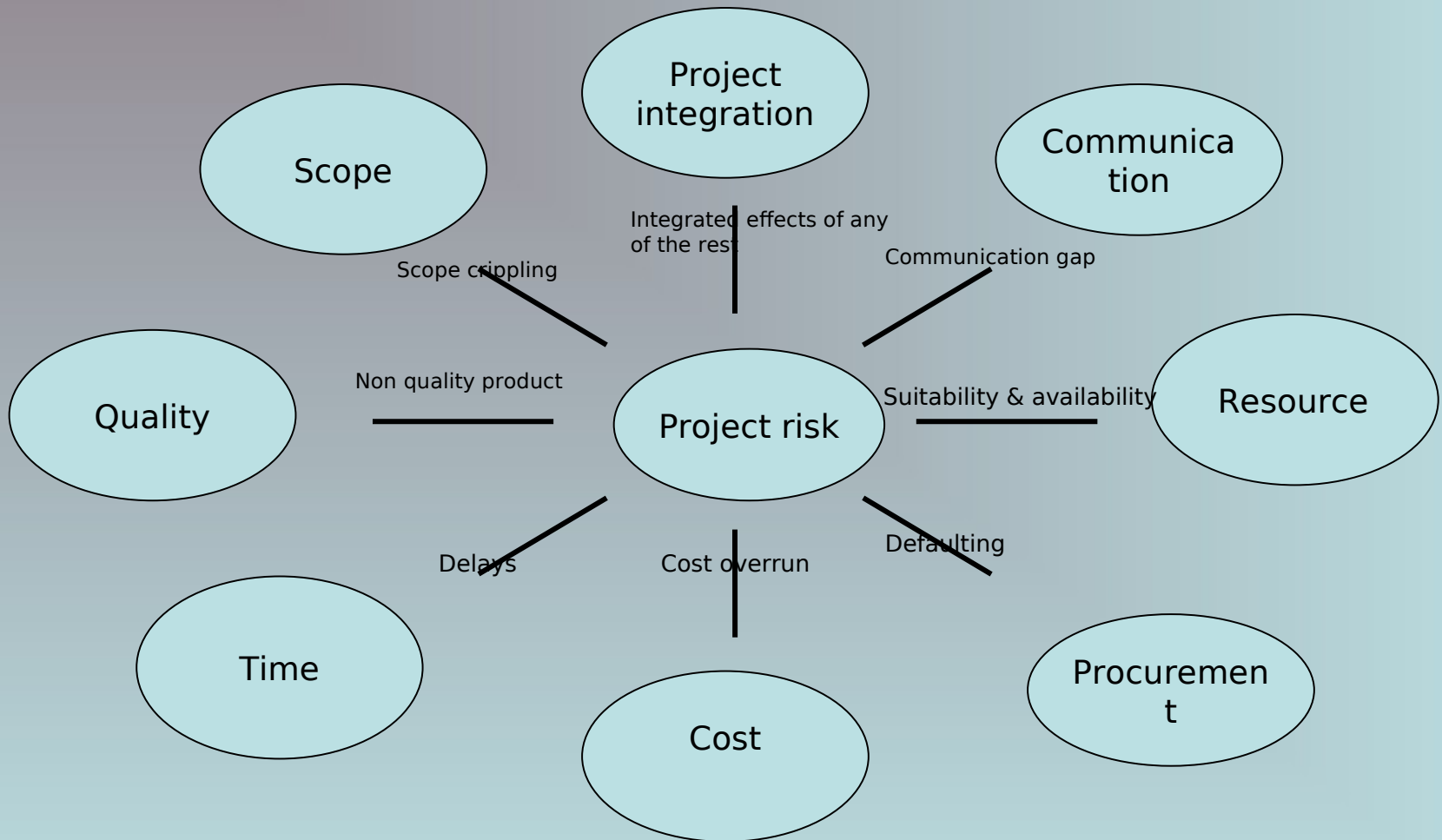
Project Risk Management

- **What?** A process of identifying potential risks ahead of time and devising ways of dealing with them.
- **How?** Through
 - Objective identification
 - Risk Identification
 - Risk Quantification
 - Risk Response
 - Risk Control

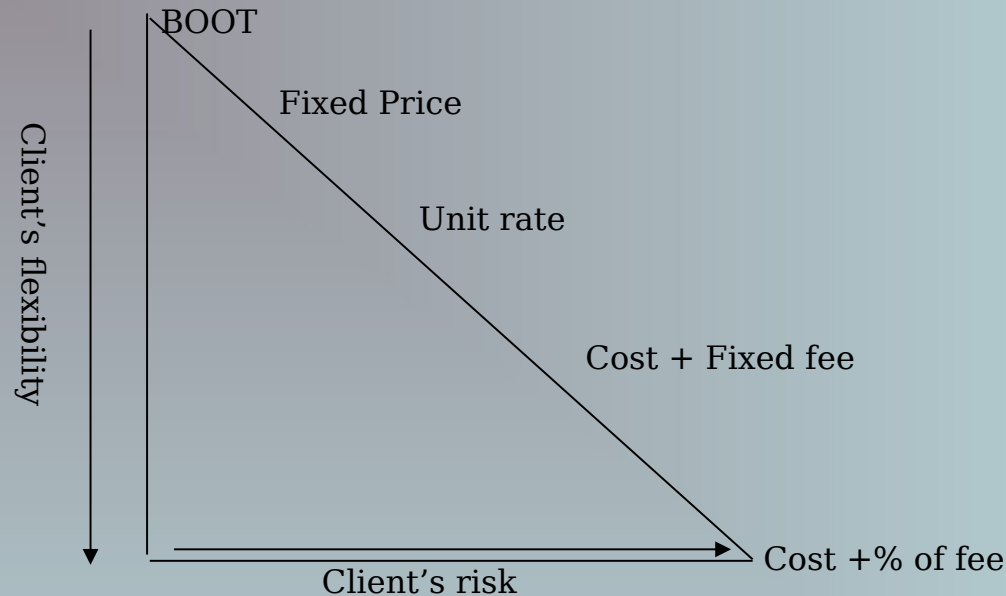
Risk Quantifications & Response



Risk Identifications



Risk quantification



Often via Monte Carlo Simulation

Risks response: Transfer



Risks response: transfer via contracts

Contracts are the main tools of transferring risk

Risks shall better **be managed** by the party better **equipped** to manage them .

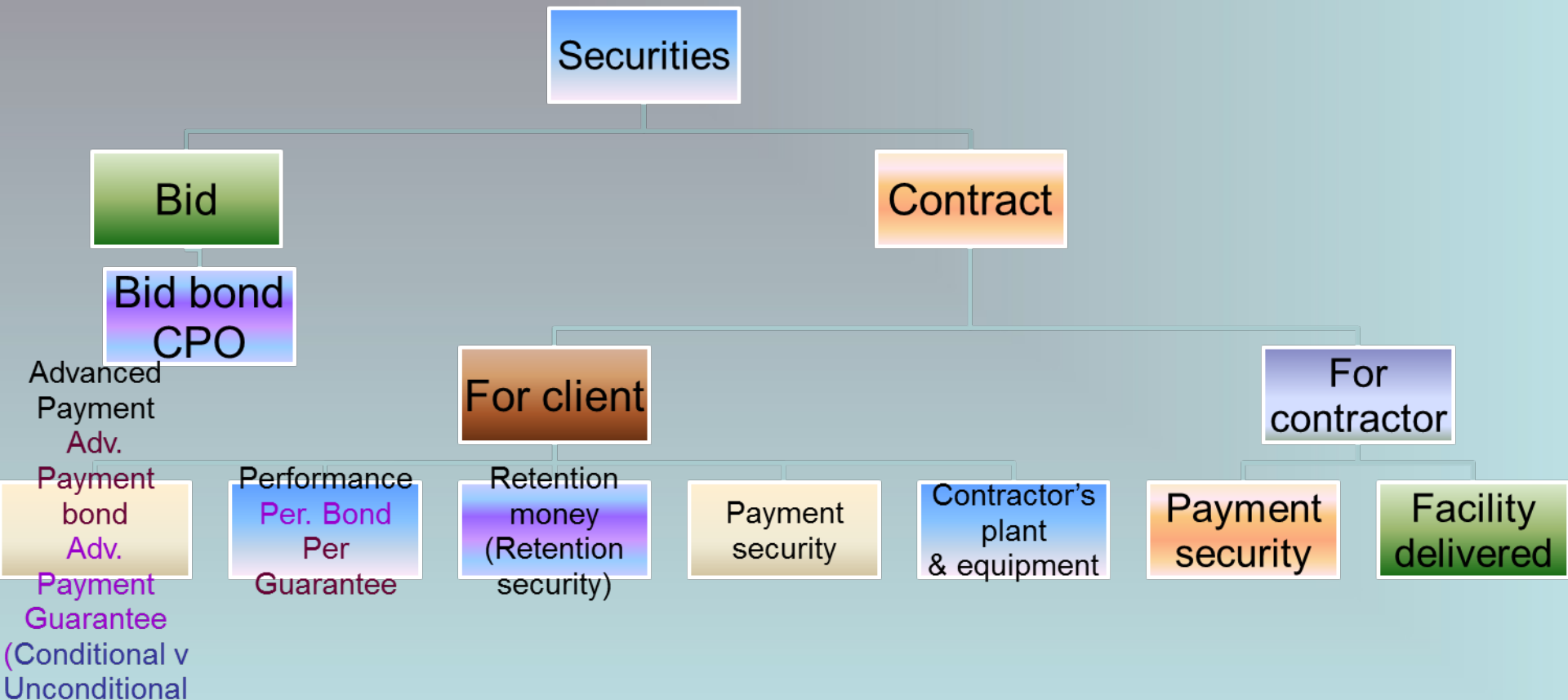
If risks are not explicitly transferred to the **contractor** (or could be implied), they will be the risk of the **Employer**

➤ The apportioning, allocation, management, etc of **risks** is the major **underpinning** **principles of Contracts**, and hence should be formulated and administered with such **purposes and intentions**

➤ Well developed **standard forms of contracts** (e.g. **FIDIC**) are formulated on these

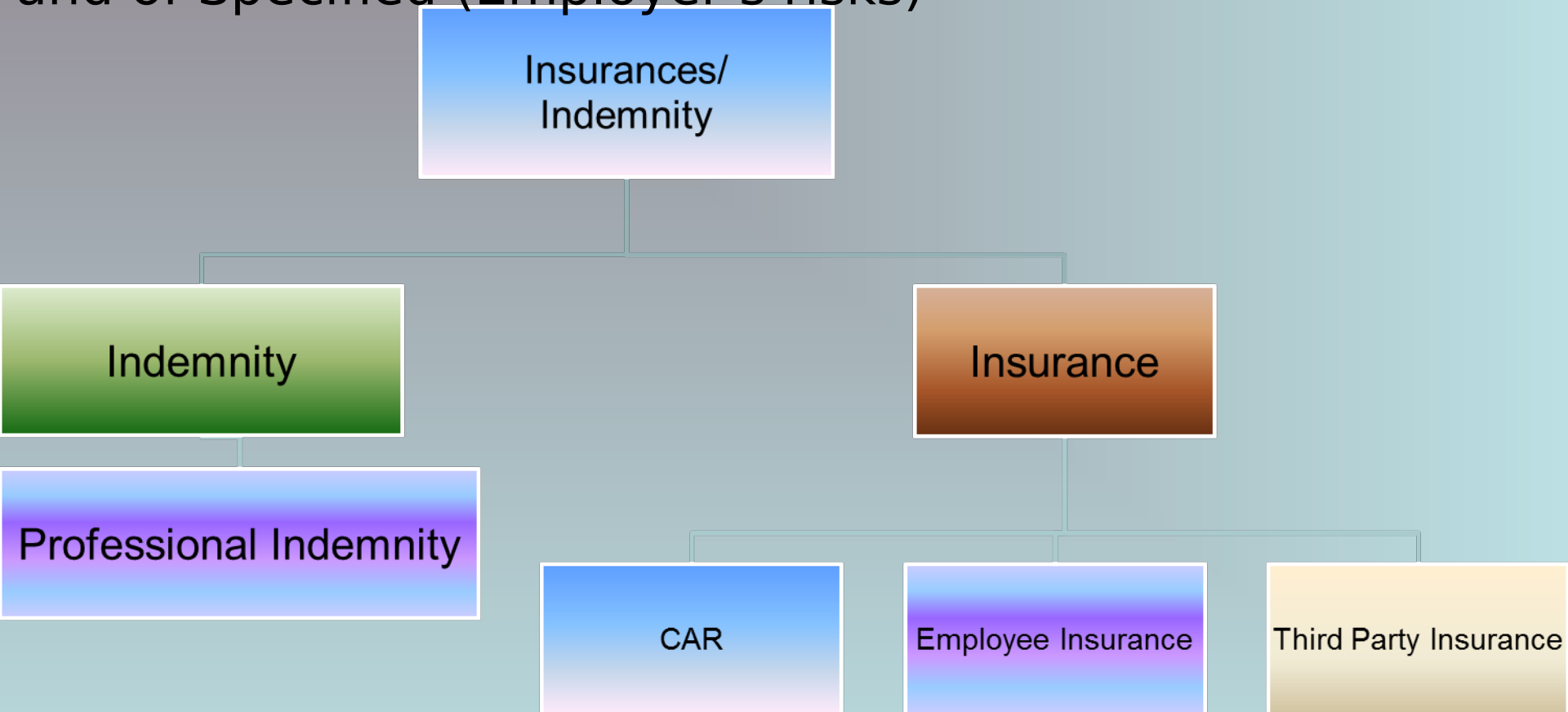
Risks and Securities in Construction Contracts

Principle: To cater against defaulting by their contracting partner, parties should have another security;



Risks and Insurances in Construction Contracts

Principle: For non-expected risks of the Contractor and of Specified (Employer's risks)



Risk control

Time Management

Time management

- **What?** all the processes that need to be adopted to ensure the timely completion of the project
- **How?**
 - Activity definition
 - Activity sequencing
 - Activity duration estimating
 - Schedule development
 - Schedule control

Activity definition

- **What?** the processes of determining the specific activities that need to be executed to achieve objectives.
- **How?**
 - WBS

Activity sequencing

- What? processes of determining the job logic
- How?
 - Mandatory requirements (hard logic)
 - Discretionary requirements (preferred (soft)) logic
 - External requirements
- Relationship types (in PDM)
 - S-S
 - F-S
 - F-F
 - S-F
 - Lead/lag time and their determinations

Activity duration estimation

- **What?** Determination of duration of time that an activity's execution takes
- **How?**
 - A_{ij} – Amount of work to be done
 - From BOQ, Scope of Work etc
 - P_{ij} -(Optimum) Productivity of one unit of the resource crew (combination of resources to optimally execute an activity)
 - Past experience
 - Norms and standards
 - Manufacturer's manual (Machines)
 - Trial test
 - N_{ij} - Number of crews to be deployed
 - Methodology
 - Time constraint

$$D_{ij} = \frac{A_{ij}}{P_{ij} N_{ij}}$$

Duration Estimation Methods

- One time estimate (the most common estimate in construction)

- Three time estimate method

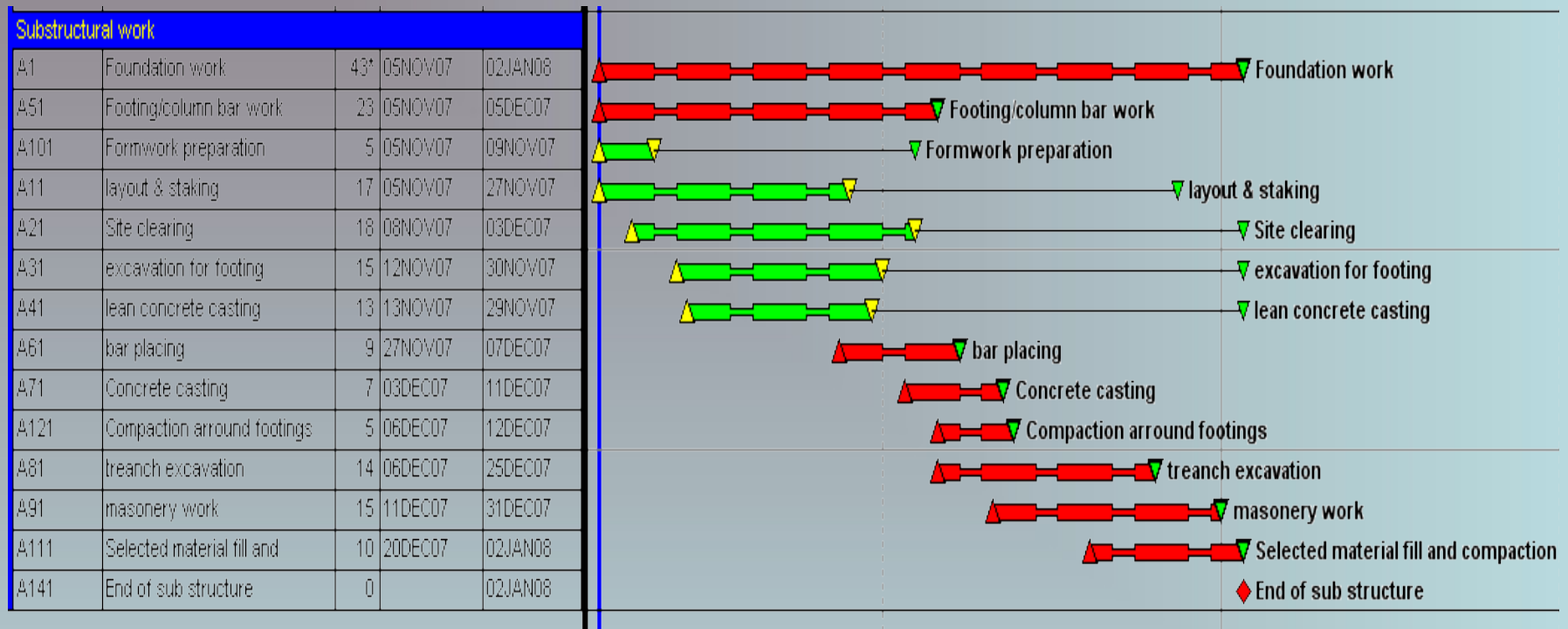
$$Te = \frac{To + 4Tm + Tp}{6}$$

- Non linear time estimate (takes learning curve into consideration – Eg. Trapezoidal)

Schedule development

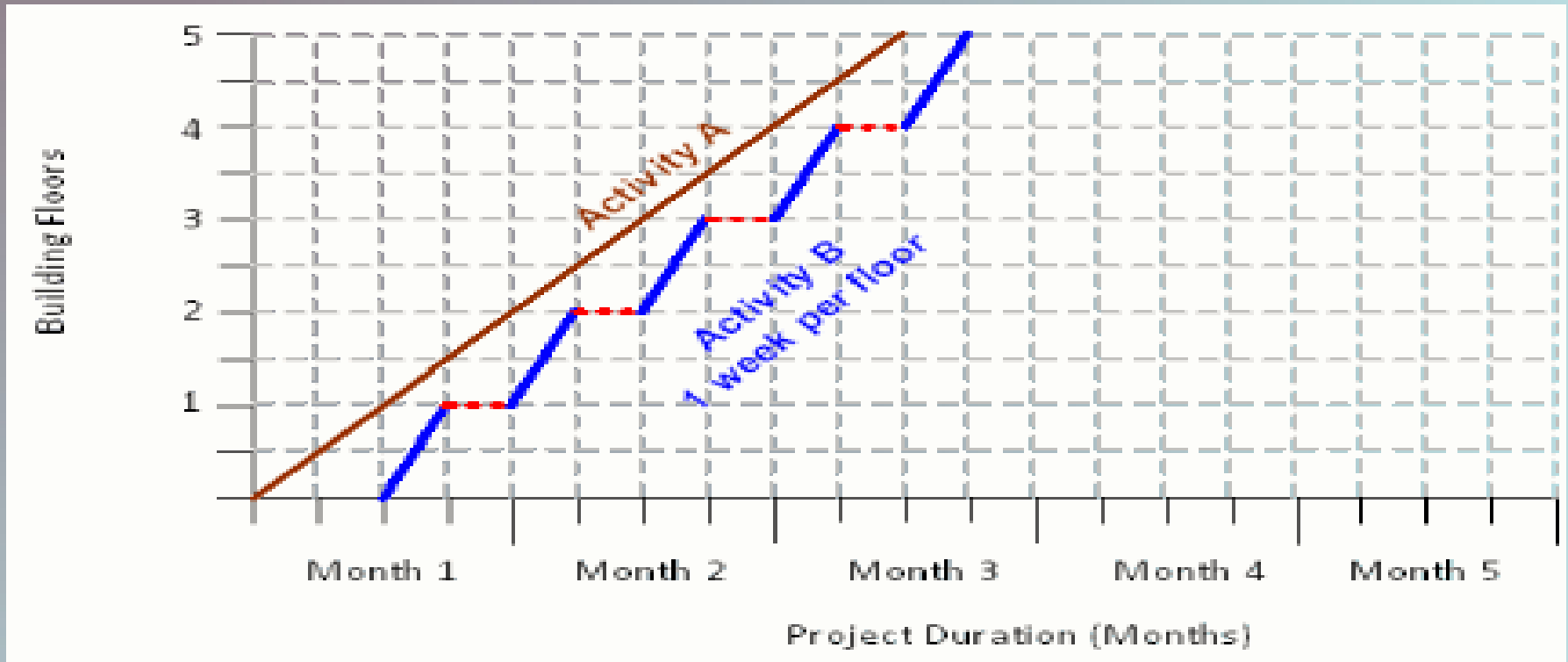
- **What?** The processes that involve determining the period of time each activity is executed.
 - In essence determines the projects duration and any milestone event that there may be
 - The final output depicts the **sequence of accomplishment of the various activities** plotted against time scale.
- **How?**
 - The Bar Charts
 - Line of Balance Chart
 - The Networking Schedule Technique
 - The Critical Path Method (CPM),
 - The Performance Evaluation & Review Technique (PERT)
 - Critical Chain Method

BAR/Gant chart



- Activities represented on horizontal bars
- Horizontal axis is time
- Off times could be shown through necking of bars
- Bar length could be to time-scale

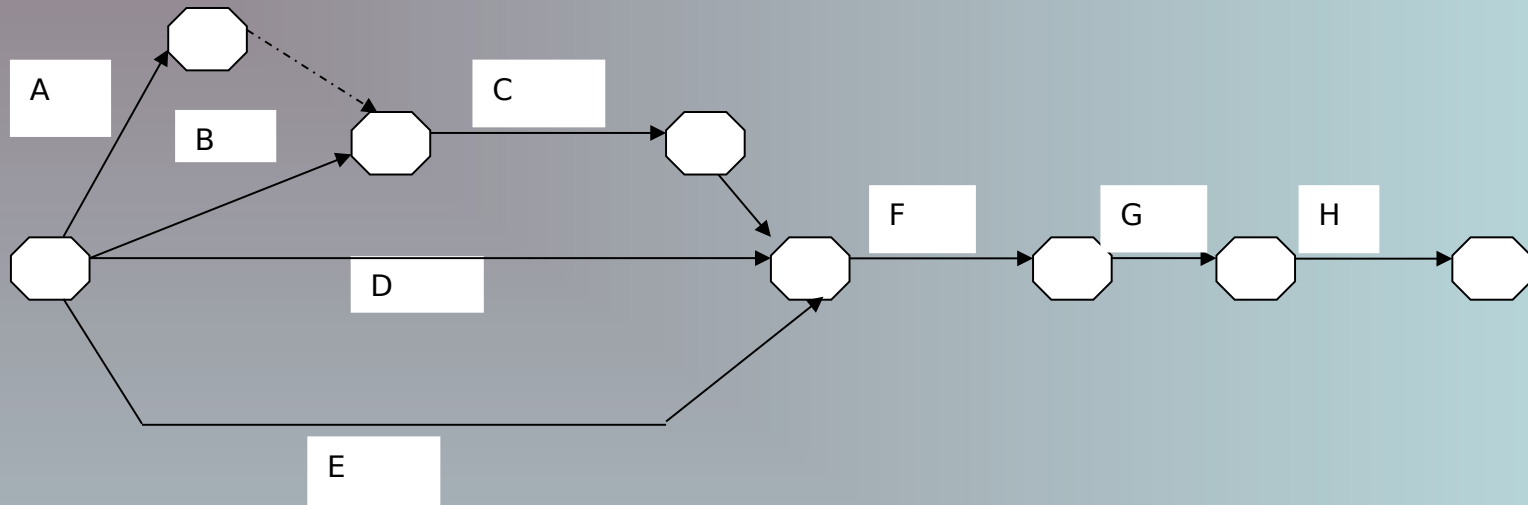
Line of Balance



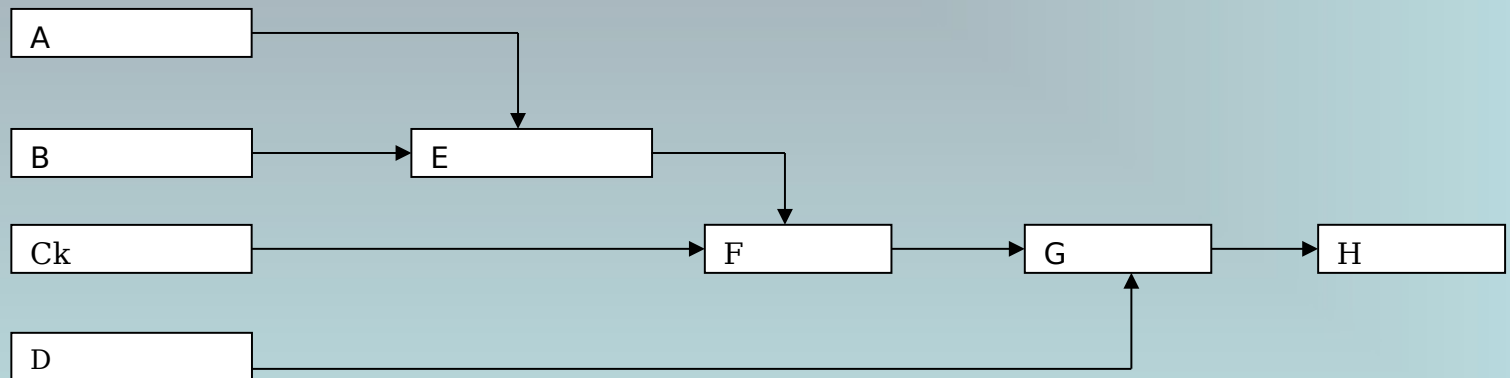
- Slope of indicates **productivity rate**
- If logic indicates precedence interdependence, **lines can't cross** each other
- Helps present **duration Vs location** (floor, station etc) of works

BASICS OF NETWORK ANALYSIS

CPM & PERT



Activity on arrow diagram (AOA)



Activity on node diagram (AON) Otherwise called Precedence Diagram Method (PDM)

BASICS OF NETWORK ANALYSIS

CPM & PERT

- Any project has a definite start and finish and can be broken down to definite activities each has its own start and finish.
- Events are denoted by a circle (on AOA)



There are some guidelines in event numbering techniques

BASICS OF NETWORK ANALYSIS

CPM & PERT

- **EVENT:** is a significant point at the start or completion of a task
 - » **Has no duration**
- **Event times**
 - EET_i - The **earliest time that an event can happen (determined via forward pass)**
 - LET_i - **the latest time that an even can happen without affecting the on time completion of the project (Back ward pass)**
 - A *milestone* is a key event time when some decisive event (s) happen

BASICS OF NETWORK ANALYSIS

CPM & PERT

- **Activity:** is an operation that consumes resources and takes time for its execution
 - **Activity types**
 - *Dummy activities (for CPM on AOA)*
 - *Hammock or a summary of activity*
 - **Activity designations in software**
 - Independent(P6)
 - Meeting (P6)
 - Recurring activity (MS project)
 - fixed unit, fixed duration, fixed work (Ms project)

BASICS OF NETWORK ANALYSIS

CPM & PERT

- **Activity times** (most only for conventional CMP where strict sequence is obeyed)
 - **EST_{ij}** - the earliest time that an activity can start provided that all the activities leading to it are completed
 - » $EST_{ij} = EET_i$
 - **EFT_{ij}** - the earliest time that the execution on an activity can be completed
 - » $EFT_{ij} = EST_{ij} + d_{ij}$
 - **LST_{ij}** - the latest time that an activity can be started w/o affecting the early finish of the project
 - » $LST_{ij} = LET_j - d_{ij}$
 - **LFT_{ij}** - the latest that an activity can finish w/o affecting early finish of project
 - » $LFT_{ij} = LET_j$

BASICS OF NETWORK ANALYSIS

CPM & PERT

- **Total Float (TF):** Maximum period of time that the earliest start of an activity can be floated without leading into overall project delay
 - $TF_{ij} = LST_{ij} - EST_{ij} = LET_j - EET_i - d_{ij}$
- **Free Float (FF):** Maximum period of time that the earliest start time of a given activity can be delayed without affecting the earliest start time of the subsequent activity
 - $FF_{ij} = EST_{jk} - d_{ij} - EST_{ij} = EET_j - d_{ij} - EET_i$
- **Interference float (IF):** the overlap time b/n LFT of an activity and EST of the subsequent activity
 - $LET_j = EET_j$
- **Critical Activity:** an activity on the critical path. An activity with zero TF
- **Critical Path:** is the longest path in the network diagram
- **Non Critical Activity:** activity out side the critical path

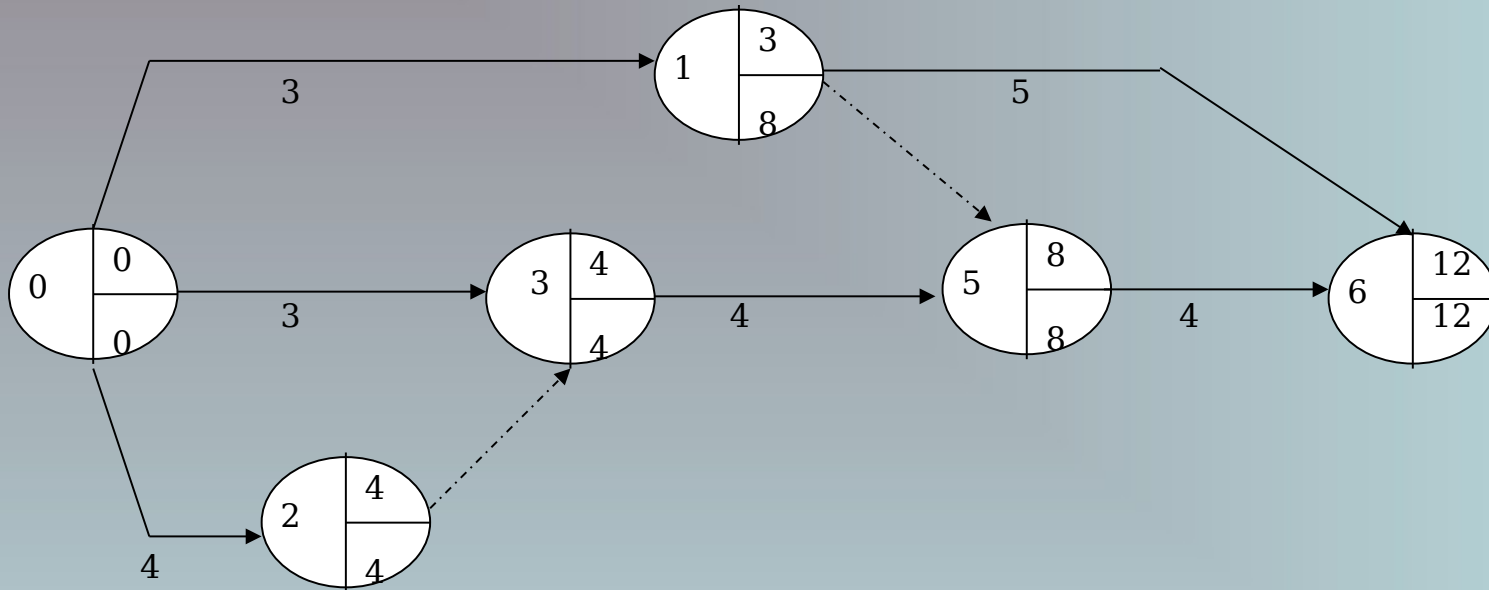
BASICS OF NETWORK ANALYSIS

CPM & PERT

- Modern day scheduling techniques use PDM-where strict sequential relationship is not a requirement.
- CPM uses a deterministic time estimate while PERT uses a stochastic one.
- Major use of the floats will be in resource optimization: will be discussed later.
- Sensitivity ranking: The activities with the lowest TF are the most sensitive, then those with low IF. If equal, rank them based on the chain of activities after the one referred to or criticality of resources deployed.

BASICS OF NETWORK ANALYSIS

CPM & PERT



BASICS OF NETWORK ANALYSIS

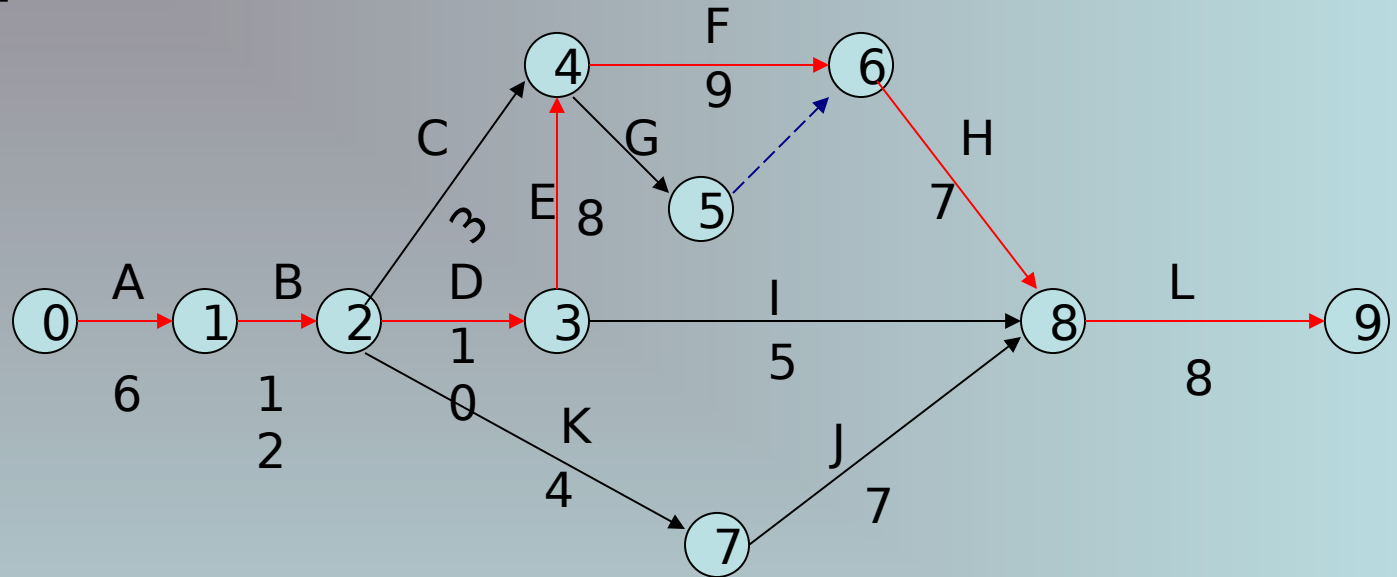
CPM & PERT

Si No	Activity	Duration	Event timings			Activity timings				Floats		Sensitivity ranking
			EET _i	EET _j	LET _j	EST _{ij}	EFT _{ij}	LST _{ij}	LFT _{ij}	TF	FF	
1	0-1	3	0	3	7	0	3	4	7	4	0	
2	0-3	3	0	4	4	0	3	1	4	3	1	
3	0-2	4	0	4	4	0	4	0	4	0	0	
4	2-3	0	4	4	4	4	4	4	4	0	0	
5	1-5	0	3	8	8	3	3	8	8	5	5	
5	3-5	4	4	8	8	4	8	4	8	4	0	
6	1-6	5	3	12	12	3	8	7	12	4	4	
7	5-6	4	8	12	12	8	12	8	12	0	0	

BASICS OF NETWORK ANALYSIS

CPM & PERT

- Example



Critical chain method

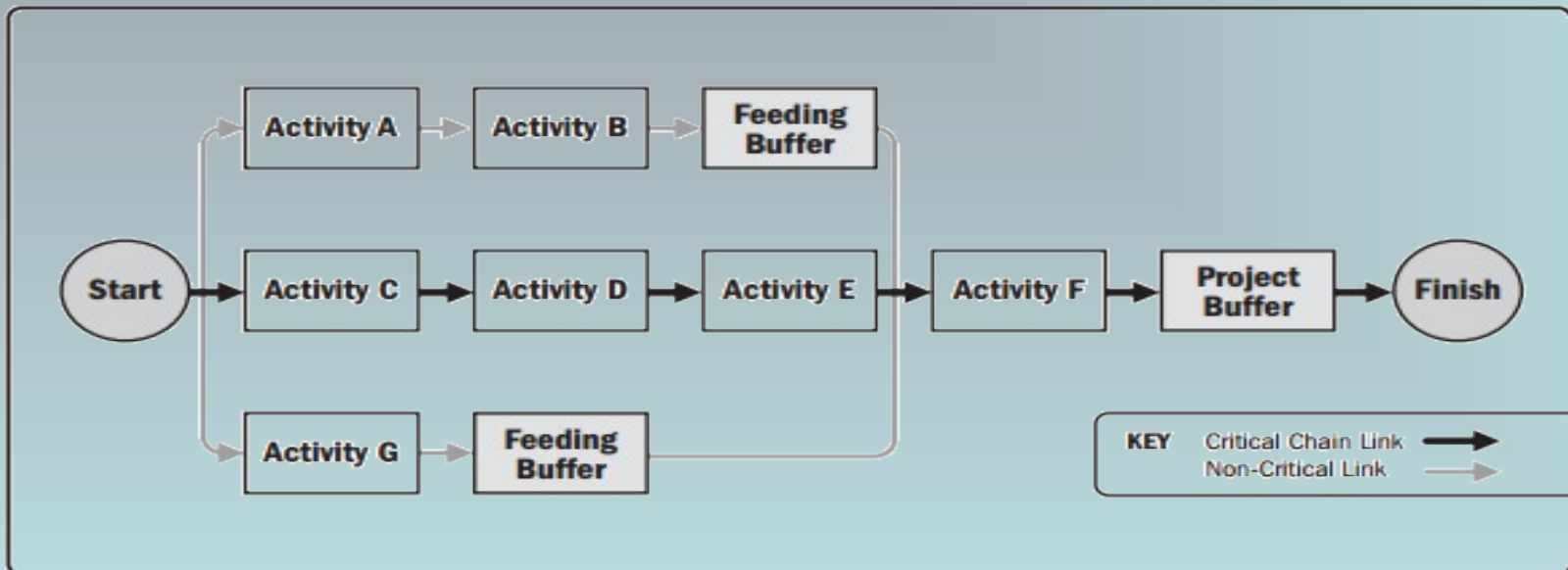
- It is a scheduling technique that emphasizes **resource utilization** as opposed **to task ordering** of critical path method.
- It strives to keep resources level throughout:
 - Takes the notion that people execute activities, not computers that do the algorithm of scheduling
- Factor of safeties embedded in schedule are consumed due:
 - **Student syndrome** (things will be done late anyways)
 - **Parkinson's law** (work expands so as to fill the time available for its completion);
 - **Multi-tasking** (avoid multi tasking and concentrate in prioritized sequential execution) i.e. avoid organized chaos and efficiency losses

Critical chain method

- Planning backwards from specified completion date
- Using as late as possible completion of tasks
 - Helps optimize resources (through reducing **works-in-progress**) and drive by criticality;
 - No cost incurring as late as possible
 - Helps to increase production by scheduling tasks as late as possible as **impetus develops** and **learning curve** will be achieved
 - Insert **buffer** to cater for problems of being all tasks critical and avoid project delay if tasks are delayed.
 - **Project buffer** (given all tasks are scheduled as late as and at optimistic estimate it may lead to problem-add buffer)
 - **Feeding buffer** (Non-critical chain tasks may affect project completion -add buffer)
 - **Resource buffer** (companies are inclined to release resources late -add buffer)
- Task duration estimate based on optimistic time estimate -there

Critical chain method

- In essence, CCPM removes built in 'safety in task estimation' and 'floats in scheduling' and changes them into known buffers and attempts to cater for resource demands (which is also done in resource smoothing in critical path) and the behavior of organizations and people;
- It is a method based on uncertainty principle



Resource Management

Resource Management

Major resources in construction:

Material, Labor (HR), Equipment

Level of Mechanization (based on relative input of **work resources** (Labor

- | • Low (labor Intensive) & Equipment | • High (Machine intensive) |
|---|--|
| <ul style="list-style-type: none">• Used in light constructions<ul style="list-style-type: none">- Low rise buildings- Small structures in road constructions- Small irrigation projects, etc• Very useful in creating job opportunities | <ul style="list-style-type: none">• Used in heavy constructions like<ul style="list-style-type: none">- High rise buildings- Road projects- Hydropower projects- Mining projects- Mechanized irrigations, etc• Help achieve high quality efficient execution of tasks |

Resource Management: Procedure

- Resource estimation and selection

- Is a functions of:

- Scope of work;
 - Method of work;
 - Productivity of resource;
 - Optimum combination of resources;
 - Duration and time period work needs to be executed;
 - Etc

Identify potential resources and estimate the resource demand for at least one combination for a work of excavation of 10Mill cub meter of soil if the work is scheduled to be finished in

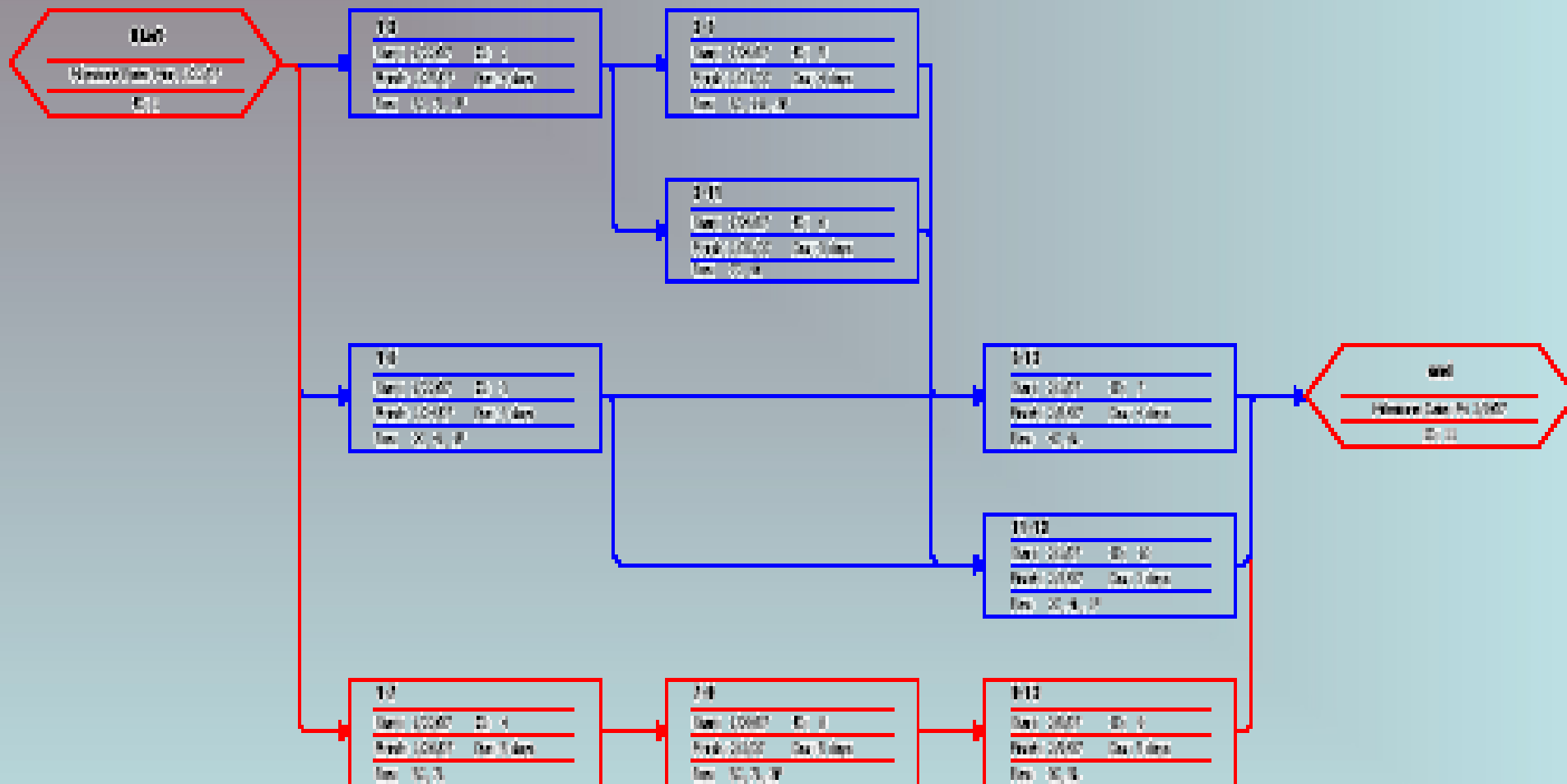
Resource Management: Procedure

- Resource **scheduling & checking resource availability**: Depends on:
 - Activity and resource schedule constraints
 - Production approach (methodology)
 - Availability should take into consideration
 - **In house** and possibility of **sourcing in** (lease, rent)
 - Commitments (**industry wide** and **firm commitments**)
 - Off times
 - Maintenance, upgrading, etc for equipments
 - Sick, holiday, annual, etc leaves for human resource
 - Low production times for materials

Resource Scheduling (ex)

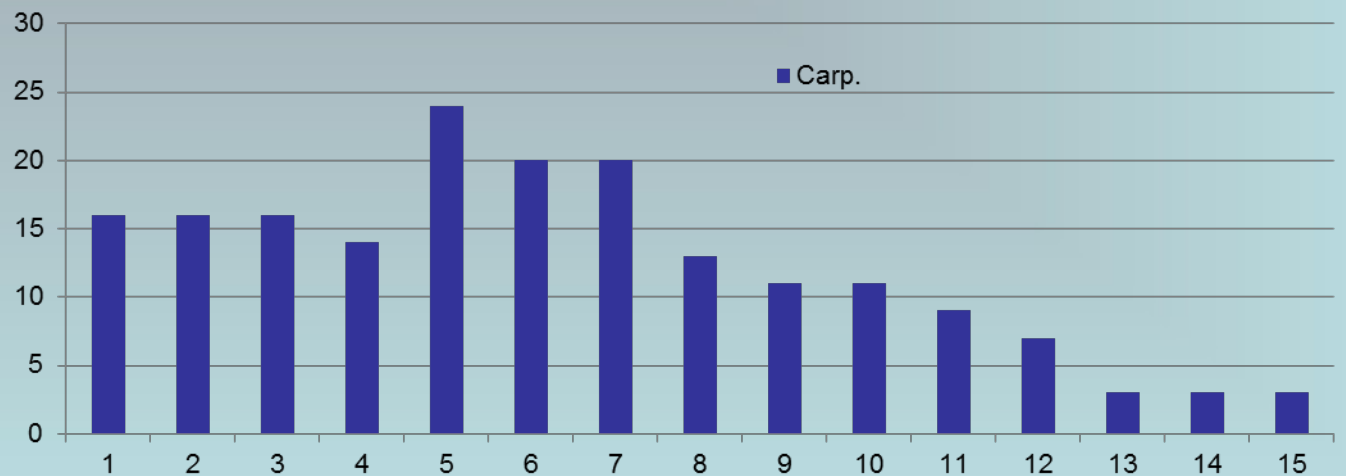
Si N o	Activity	Duration	Predecessor	Resource
1	1-3	4		5C,7L,2F
2	1-5	3		2C,4L,1F
3	1-7	5		5C,7L
4	3-5	4	1-3	8C,11L,3F
5	3-11	3	1-3	7C,9L
5	5-11	0	1-5,3-5	
6	5-13	4	1-5,3-5	4C,6L
7	7-9	5	1-7	5C,7L,3F
8	9-13	5	7-9	3C,5L
9	11-13	2	3-11,5-11	2C,4L,1F

Resource scheduling: Resource Loaded Diagram



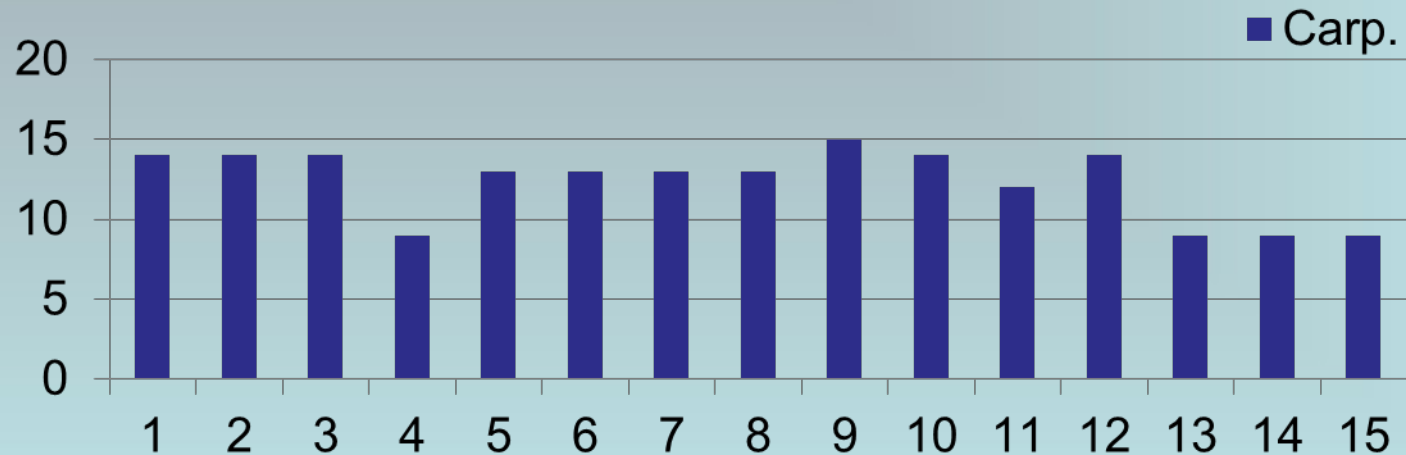
Resource scheduling (Carpenter)

Act.	EST	LST	TF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-3	1	4	3	5	5	5	5											
1-5	1	9	8	2	2	2												
1-7	1	1	0	9	9	9	9	9										
3-5	5	8	3					8	8	8	8							
3-11	5	11	6					7	7	7								
5-13	9	12	3									4	4	4	4			
7-9	6	6	0						5	5	5	5	5					
9-13	11	11	0											3	3	3	3	3
11-13	9	13	4									2	2	2				
Total				16	16	16	14	24	20	20	13	11	11	9	7	3	3	3

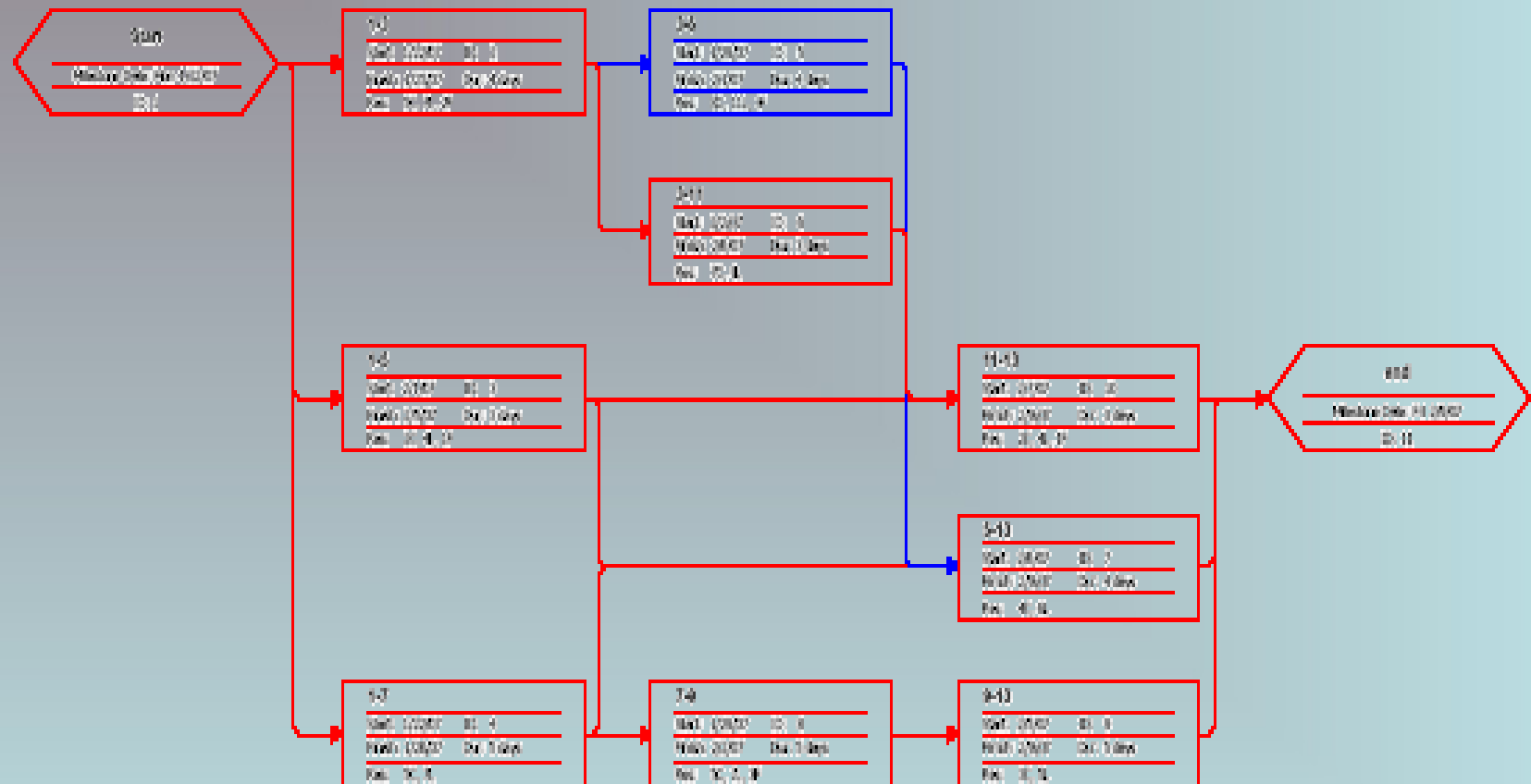


Resource leveling (Carpenter)

Act.	EST	LST	TF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-3	1	4	3	5	5	5	5											
1-5	1	9	8									2	2	2				
1-7	1	1	0	9	9	9	9	9										
3-5	5	8	3						8	8	8	8						
3-11	5	11	6										7	7	7			
5-13	9	12	3												4	4	4	4
7-9	6	6	0						5	5	5	5	5					
9-13	11	11	0											3	3	3	3	3
11-13	9	13	4													2	2	2
Total				14	14	14	9	13	13	13	13	15	14	12	14	9	9	9



Schedule after smoothing



- Note that all except one activity have become **critical**

Scheduling and resource leveling

- **Resource smoothing** is the leveling of the peak and trough of resource utilization demands
- Smoothing is usually done for:
 - Most expensive resource
 - Most loaded resource
 - Least flexible resource
- Leveling one resource affects schedule of other **combined resources** and the **schedule of activities**;
- Some resources need **lead time** before actual use;
- Floats used in early phases render **remaining activities critical**;
- Aside from smoothing within float, changing **productivity rate** (**overtime work** etc - hence resource requirement), changing the **job logic** or **relaxing time constraint** can be used in reducing resource requirement.

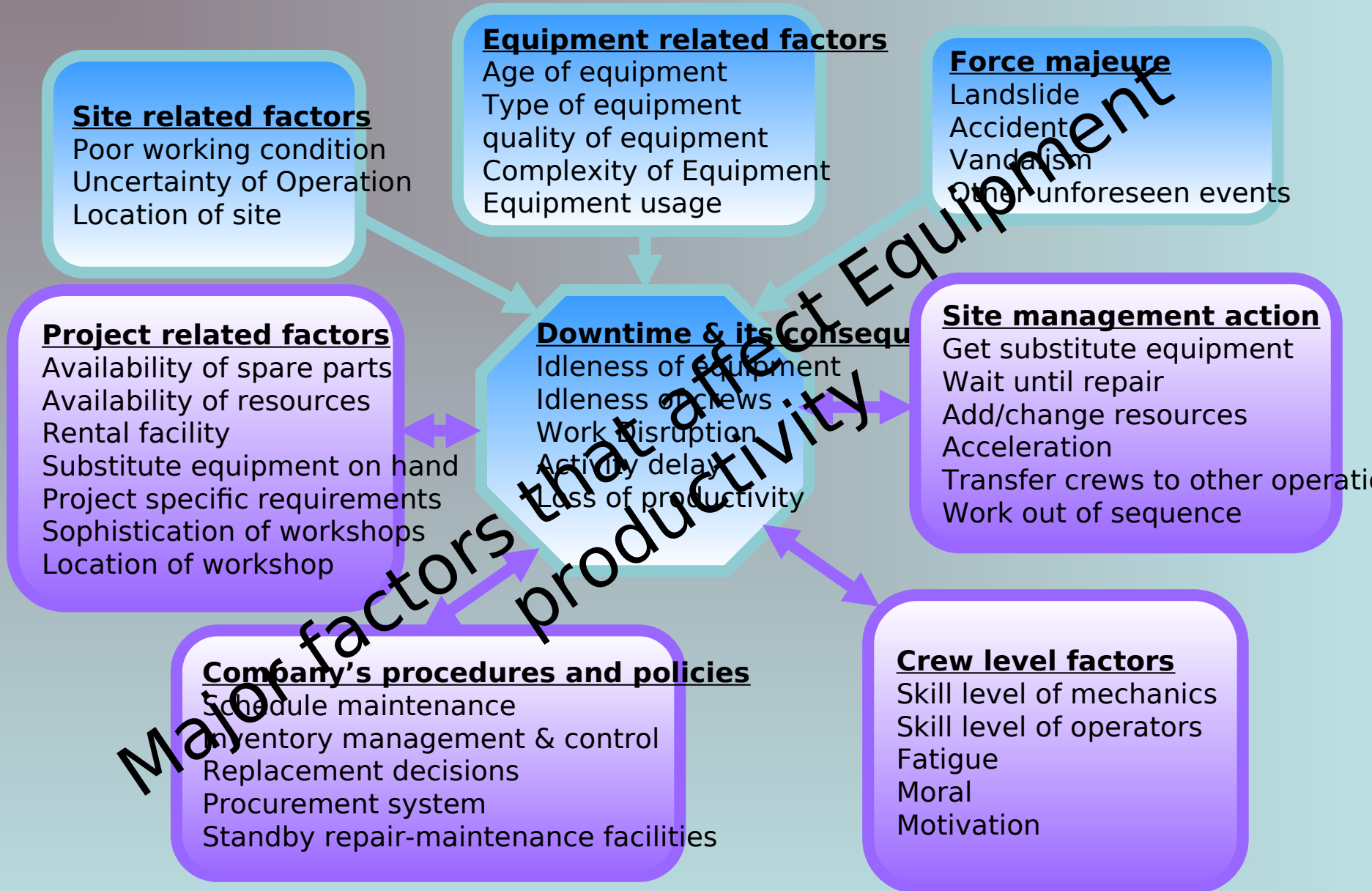
Resource Management: Procedure

- Resource deployment
 - Most, particularly machineries, demand lead time if to be purchased
 - Options of just in case stocking and just in time delivery needs to be compared

Resource Management: Procedure

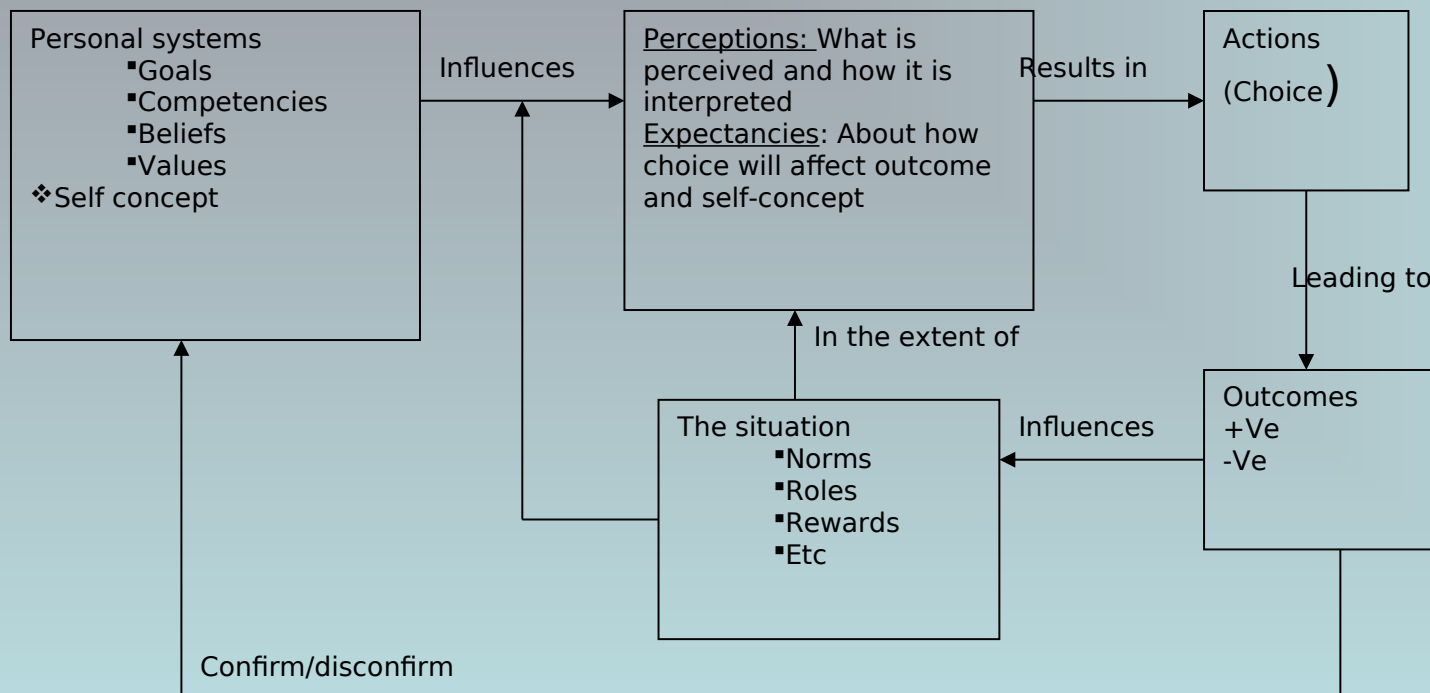
- Resource utilization
 - Down time of work resources
 - Resources at their most productive works
 - Right combination of dependent resources
 - Appropriate maintenance schemes
 - Proper inventory
 - Motivational and leadership traits
 - Waste of materials
 - Company wide resource trade-off for portfolios of projects

Resource Management-Equipment Utilization



Resource Management: Human resource utilization

- **Content** theories of motivation
 - What motivates employees?
- **Process** theories of motivation
 - How can employees be motivated?



Resource Management: Procedure

- Resource demobilization and human resource discharging

Project cost management

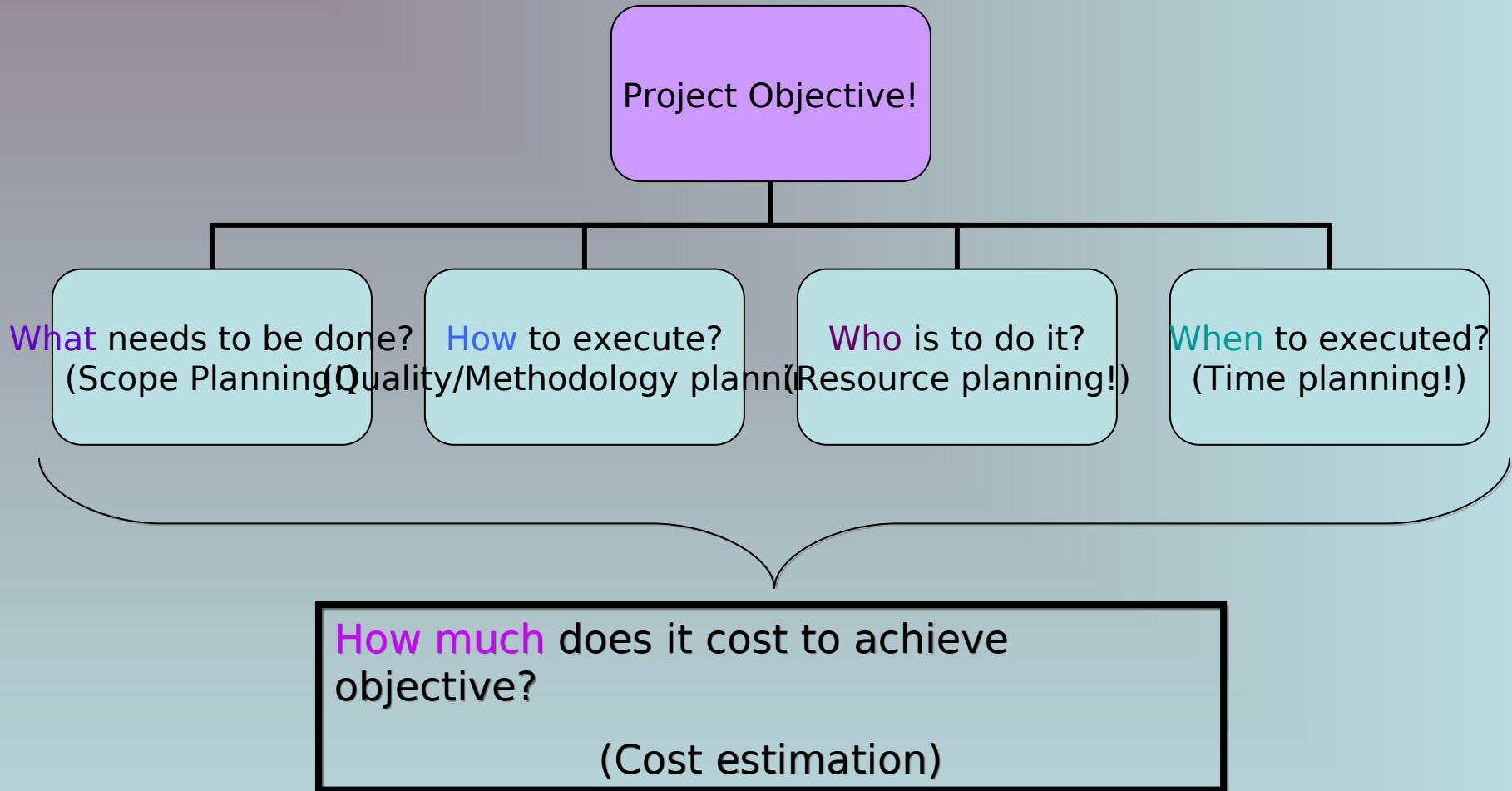
Project cost/financial management

- **What?** all the processes needed in planning, estimating budgeting and controlling of costs so that the project is finished within budget

How?

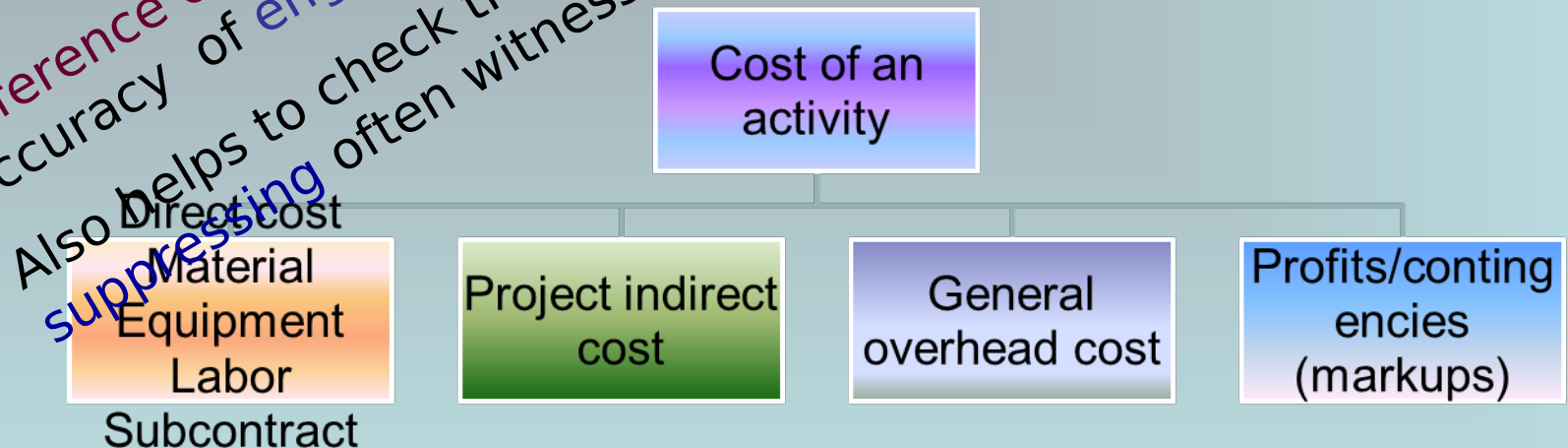
- Cost estimation (financial planning)
- *Income forecast* (cash flow forecast and tracking)
- *Cost control* (financial recordings)

Cost estimation

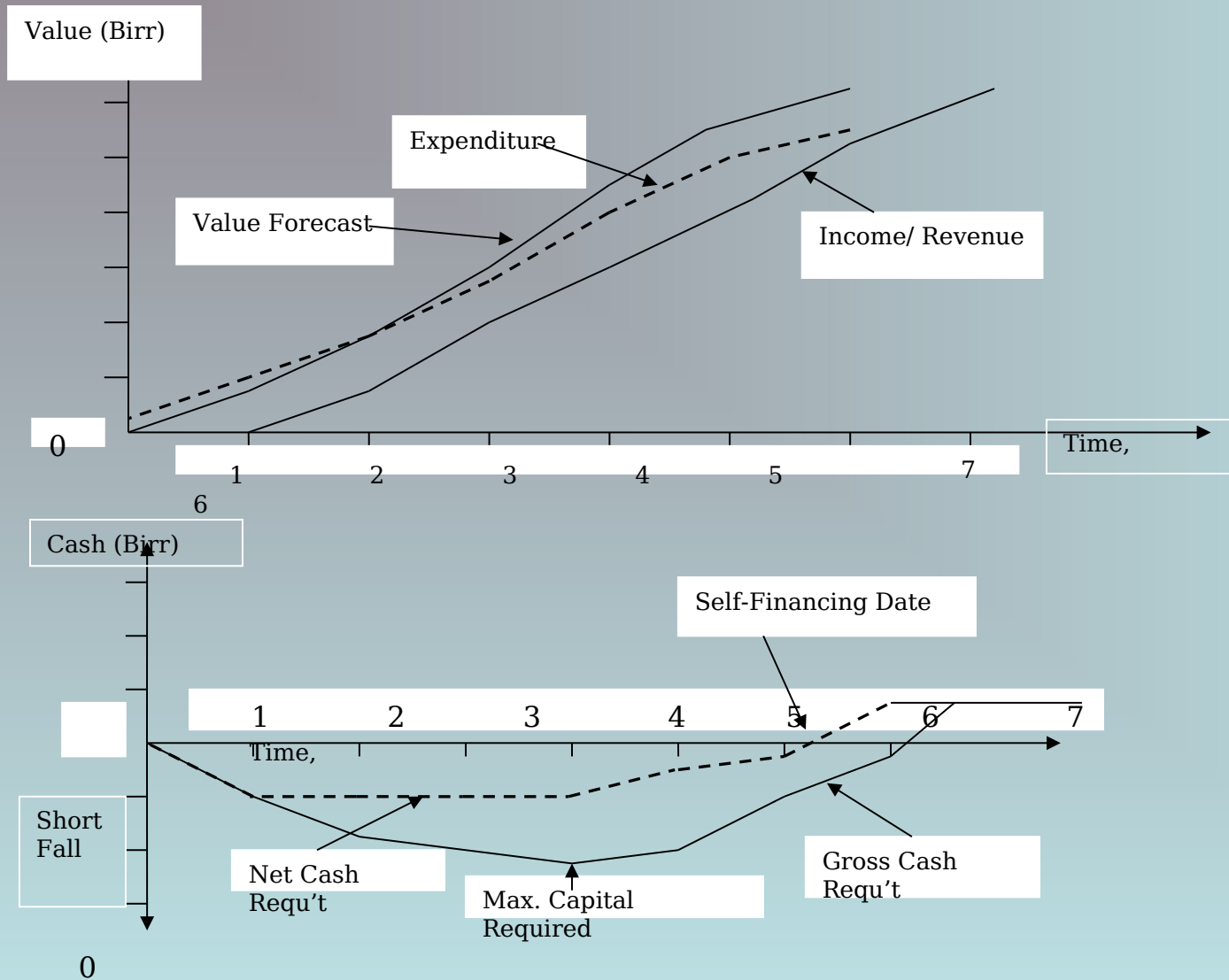


Cost estimation

- Types:
 - **Conceptual estimates (reference class)**
 - **Feasibility estimates** (parametric)
 - **Detailed estimates** (Cost Breakdown Structure)
 - Inflation
 - Economies of scale, etc.

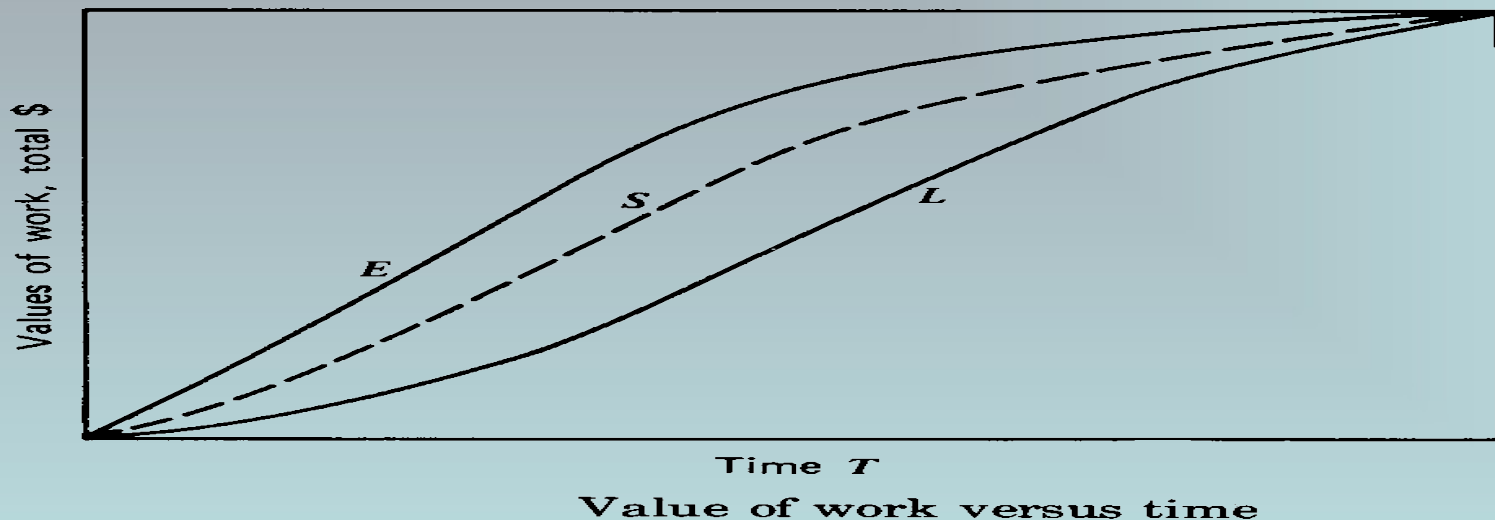


Cash flow forecasting

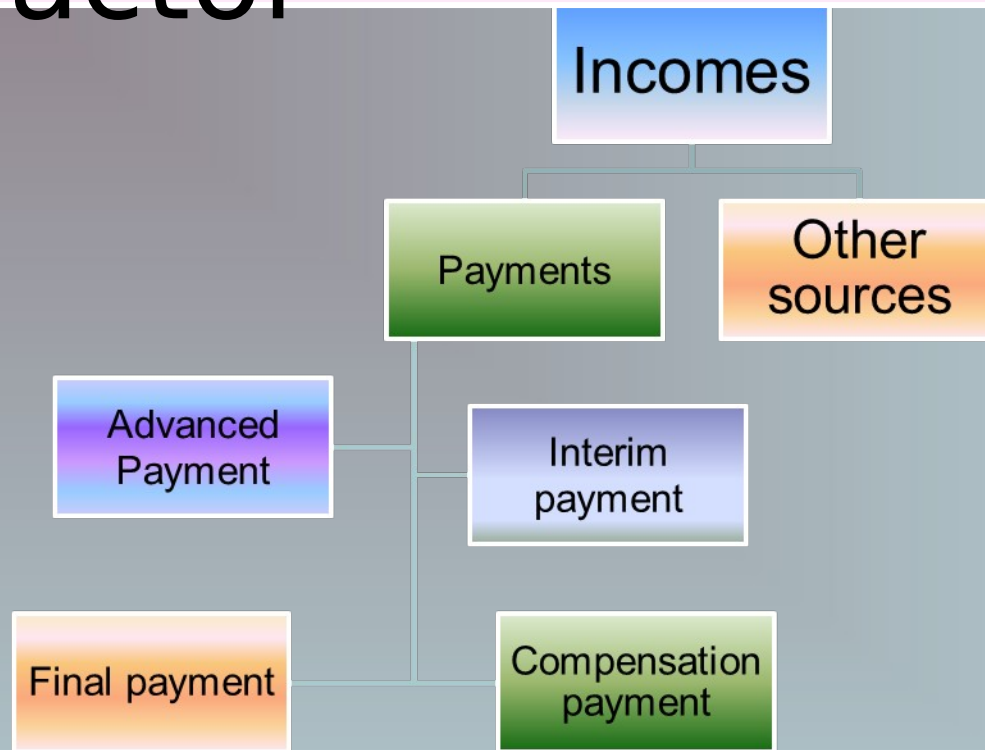


Cost estimations: Cumulative cash flow diagrams

- A diagram that **sums** the time tailored cash outflow to provide the cumulative. Commonly referred to S-curve
- Depends on **schedules and accrual** mechanisms

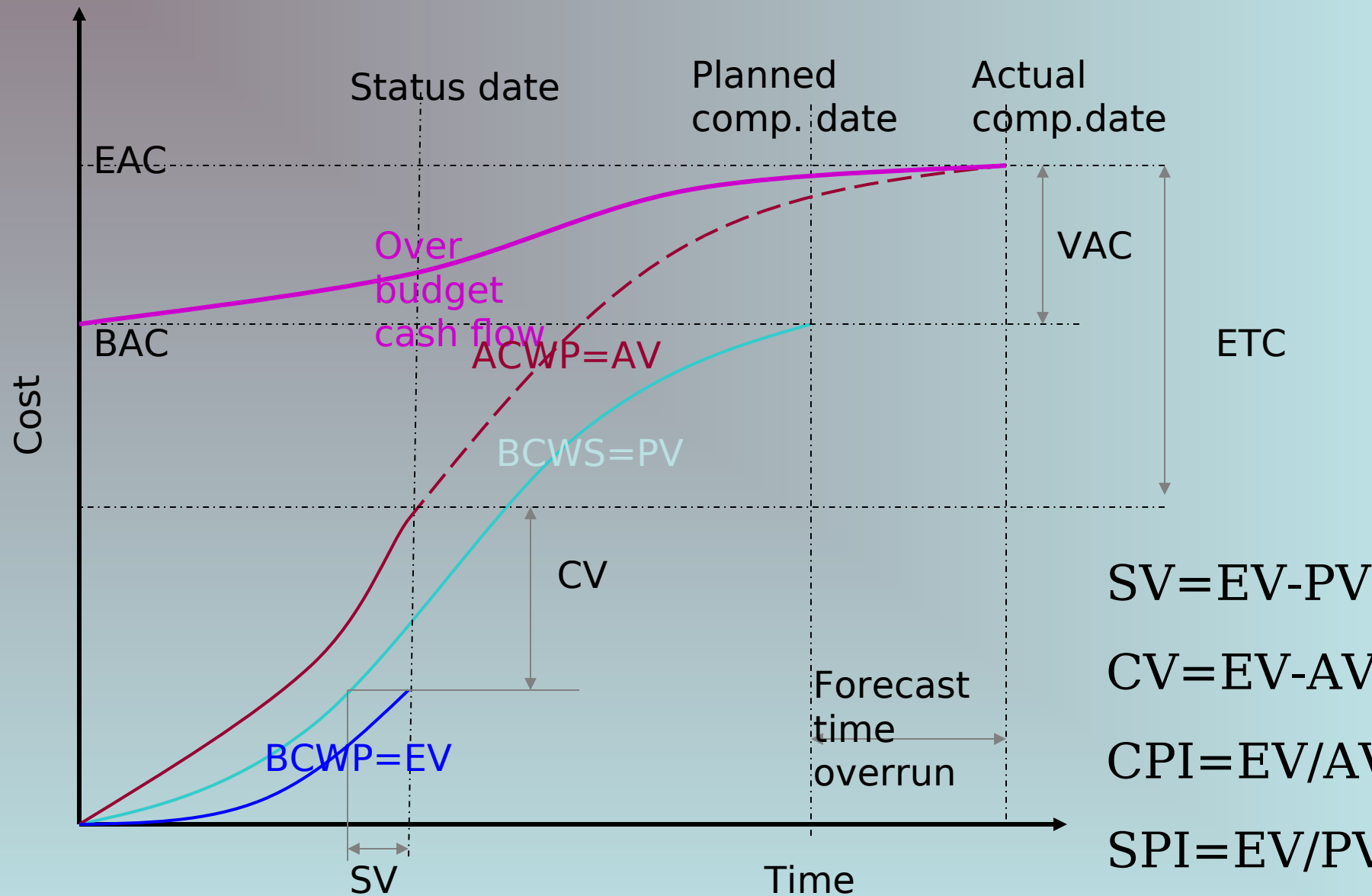


Payment cash inflows for contractor



- It is important for contractor (Employer) to clearly identify financial sources and follow up their materialization
- **PPP** options give relief to public employers but contractor's have to find full financing options

Project cost control: the EVA



Cost-time trade off

- Normal schedules: **Optimum** resource deployment
- Cases that demand to finish projects earlier: **Crashing** may be needed
- **Objective**: least expensive way of reducing the cost

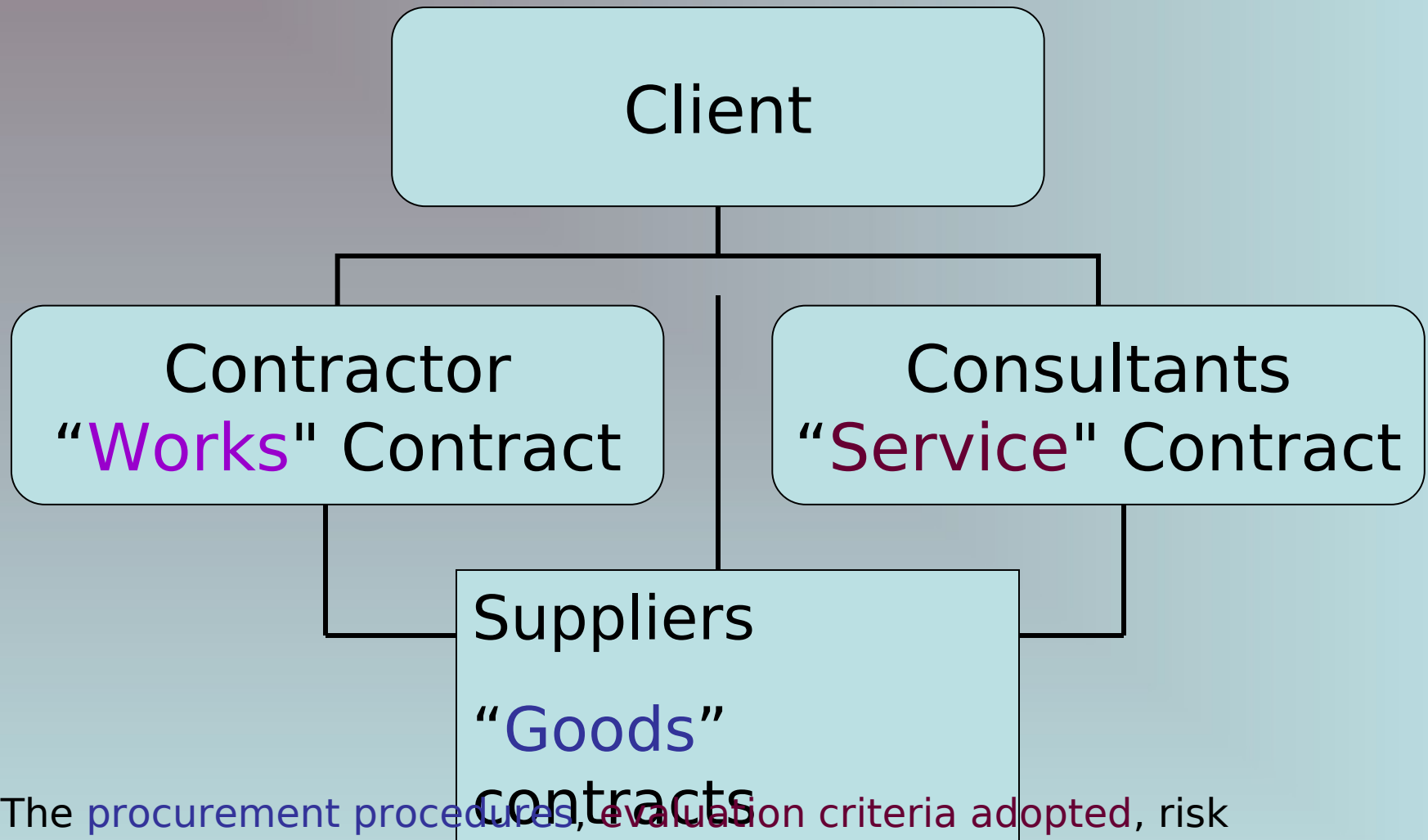
$$\text{Crash cost per unit time} = \frac{\text{Crash cost} - \text{Normal cost}}{\text{Crash time} - \text{Normal time}}$$

Project Procurement Management

Project Procurement Management

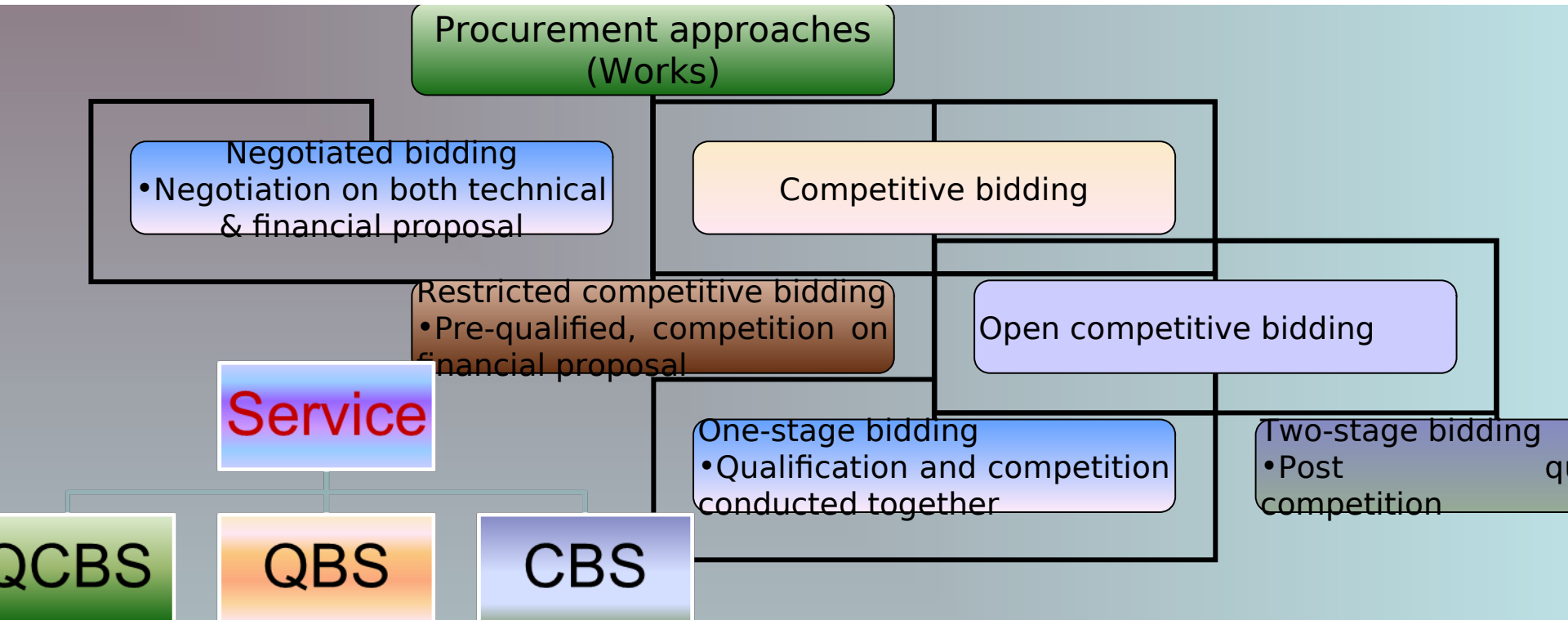
- **What?** The processes required to producer project goods, services and works as well as the administration of the contracts entered thereafter
- **How?** Through
 - Procurement planning
 - Conducting procurement
 - Controlling procurement
 - Contract closure

Procurement practices in construction: Types



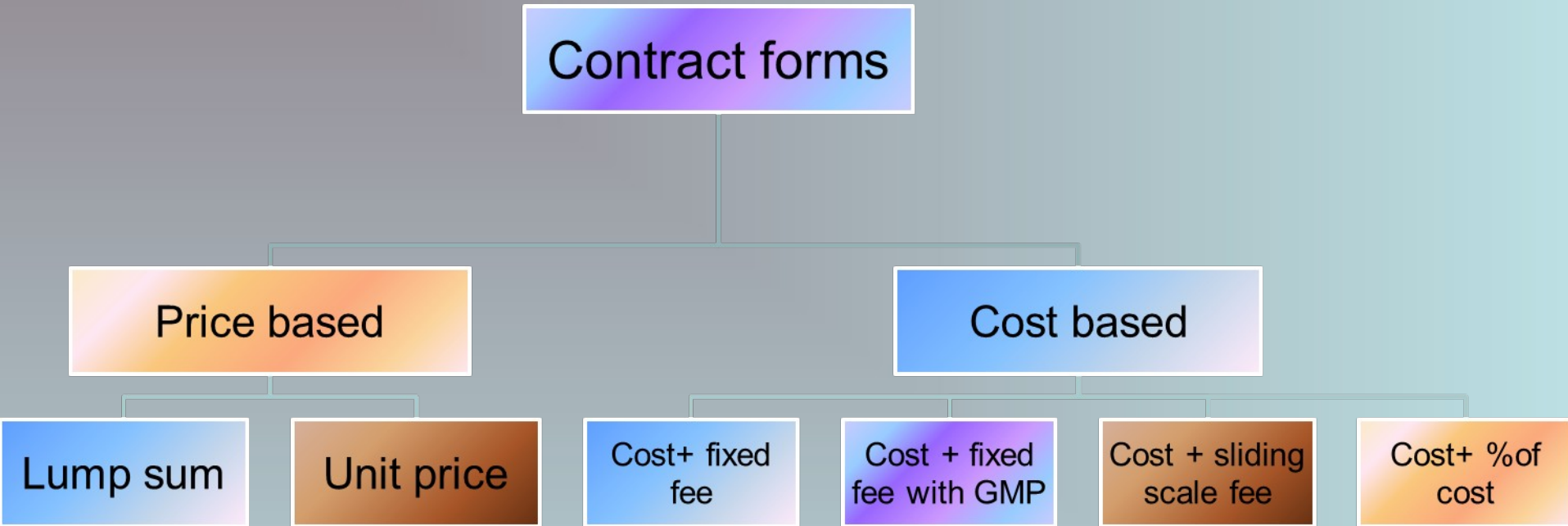
The procurement procedures, evaluation criteria adopted, risk allocations, administration procedures, etc differ among the above procurements

Procurement practices in construction: Approaches



- Ethiopia (public works procurement)
 - Least evaluated bidder
 - Other countries use other approaches such as long term collaboration
- Service procurement
 - Quality and Cost Based Selection (QCBS) (effectively competition)

Procurement practices in construction: Pricing



- **Risks on the Employer** increase as pricing goes from price based to cost based;
- Conventional projects (such as most in construction) are normally **price-based** but some items can be **cost based** (such as using **Day works**)

Procurement practices in construction: Processes

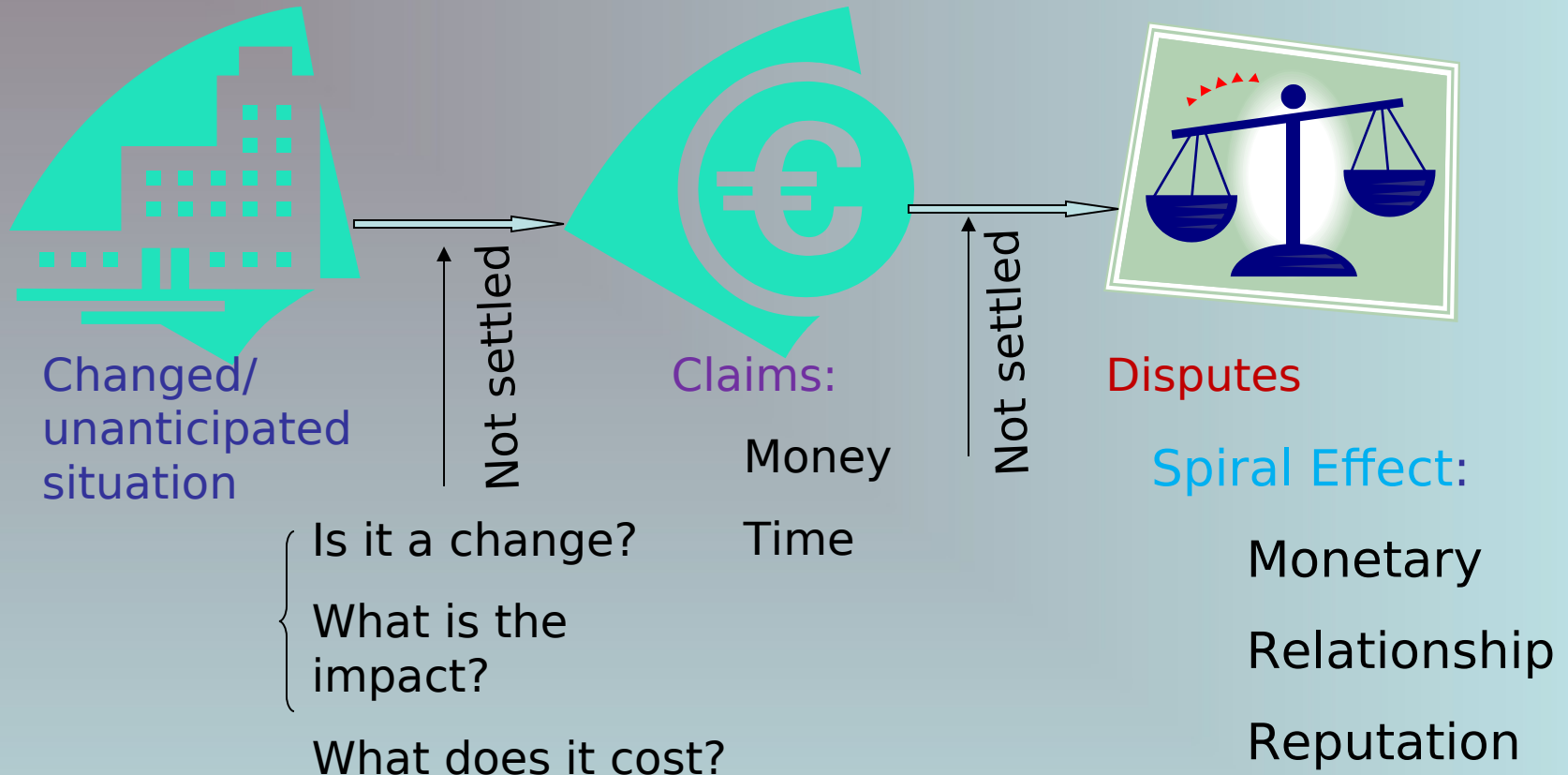
- Processes in tendering (works)
 - Invitation to bid;
 - Preparation and Issue of Bidding Documents;
 - Bidding Period and Bid Receipt;
 - Bid Opening;
 - Bid Evaluation & Selection of Bidders;
 - Negotiation, Bid Acceptance, Contract Award and Placement; and
 - Contract Administration

Project Claim and Dispute Management

Project Claims and Disputes Management

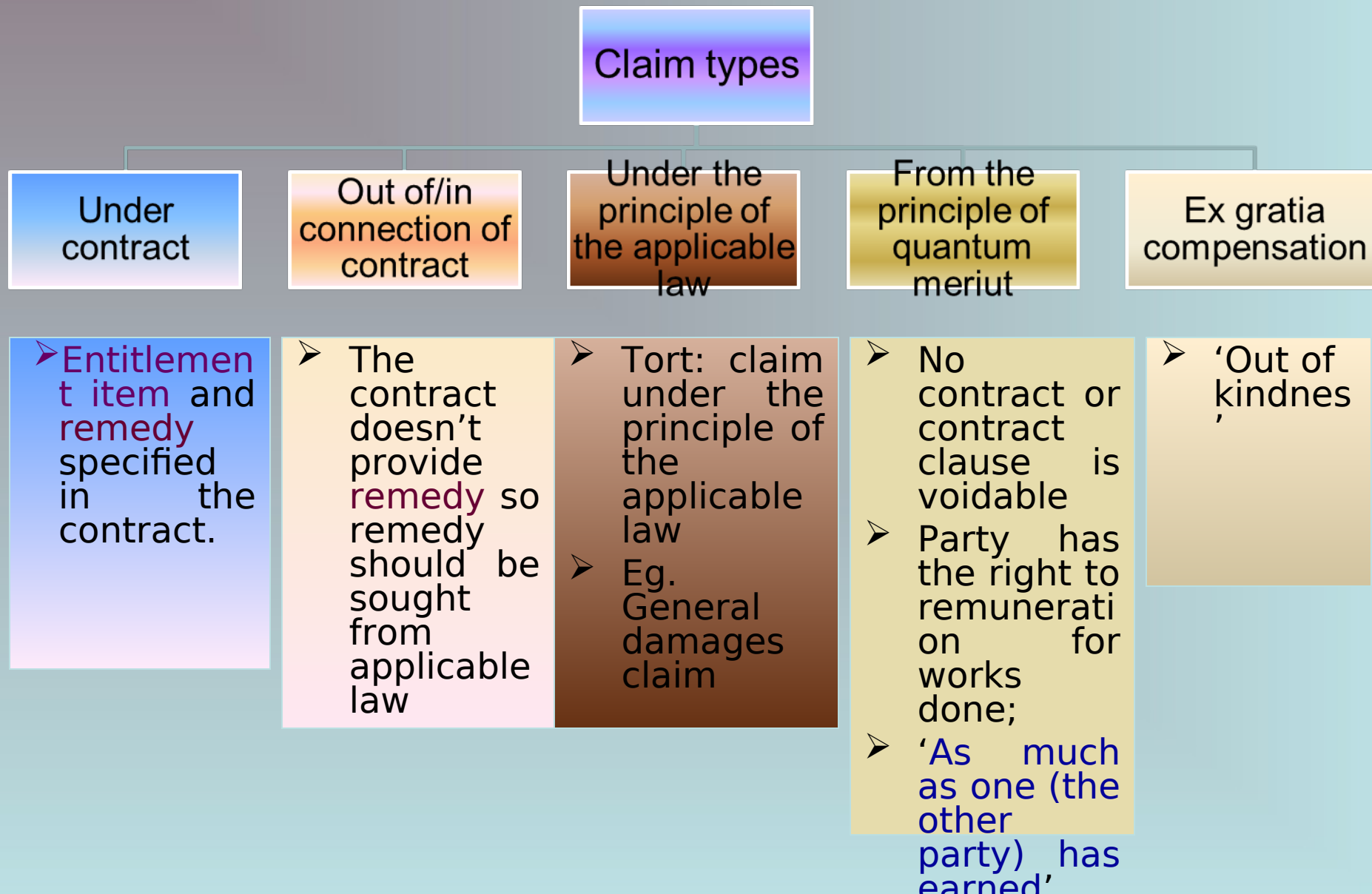
- **What?** The processes required to eliminate or prevent construction claims from arising and for the expeditious handling of claims when they do occur.
- **How?** Through
 - Claim identification
 - Claim quantification
 - Claim prevention
 - Claim resolution

Changes Vs Claims Vs Disputes



- In most cases, **Disputes** arise due to unsettled **claims**

Compensations (claim) - Types



Compensations (claim)- Principles

- **Principle 1:** A party who has defaulted on his contractual responsibilities and so incurred damages or losses on his contractual partner should compensate the injured party **to the amount equivalent to the damages and losses**;
- **Principle 2:** A party who has defaulted in his contractual obligation **shall not gain advantage**, at the expense of the other party, **due to his defaulting**;
- **Mitigation of losses:** a claimant has a duty of **mitigating losses and damages** (at least for those he is claiming for) on himself or his contractual partner;
- **Global claim** is a claim that rolls-up claimable items and presents them together. It is generally applied when damage is attributed to two or more items but it is impractical/impossible to divide between the items. It is generally a last resort of claim as it also opens a way for contractor to claim for losses due to his incompetence

Compensations: Major causes

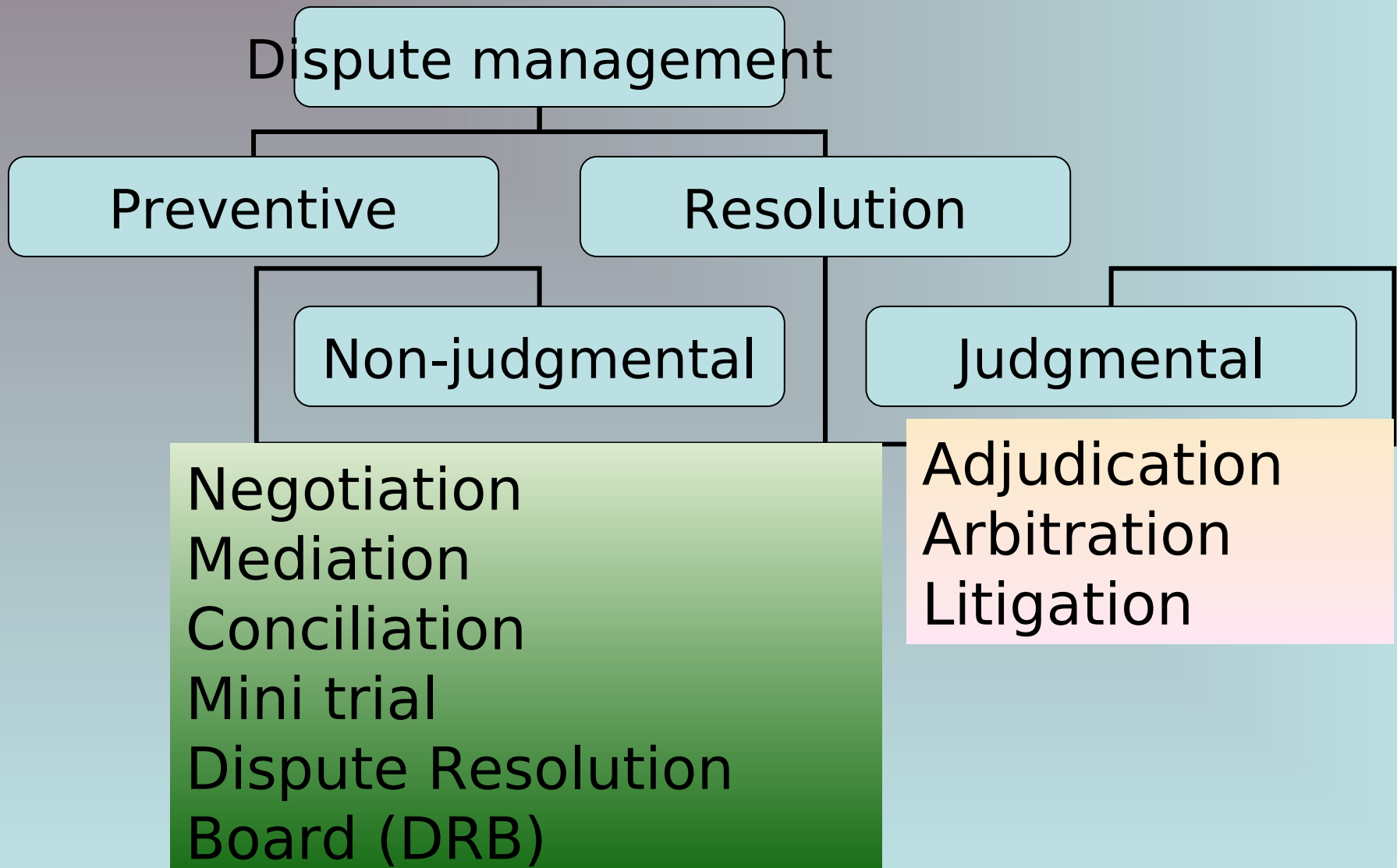
Major causes of Claim

- Change in condition of contract
 - Design change
 - Physical condition change
 - Market/anticipated condition change
- Right-of-way problem
 - Often taken as a cause because it is neither of the contracting party's responsibility
- Delay in payments
 - **Interest:** Charge on late payment of sum due
 - **Financial change:** The clamant has incurred expenses in financing the primary losses involved in the claim and hence needs to be compensated.
- Exceptionally adverse weather (time)

Compensations: Procedure

- Should provide the **justification** for the claim;
 - The Contractual/legal provisions for the entitlement of the compensation
- Should provide **evidences** for the claim;
 - The evidences that show the materialization of the compensable items and the extents and implications of same
 - “The three most important things in Contract Management are **records**, **records** and **records**”
- Should provide appropriate **mechanism for quantification** of claims.
 - Quantifying procedures should be mathematically sound, contractually reasonable and should clearly indicate only the losses and damages incurred (no consequential damage)
 - In the absence of a clear quantifying mechanism, compensation may be based on ‘**Quantum Meruit**’ - what is a deserved due amount.

Alternative Dispute Resolution



Project Environment Management

Project Environment Management

- **What?** The processes required to ensure that the impact of the project execution to the surrounding environment will remain within the limits stated in legal permits.
- **How?** Through
 - Environmental planning
 - Environmental Assurance
 - Environmental Control

Environment and Contracts

- Clause for Protection of banks and slopes against erosion and land slide effects
- Clause for Protection and safety of Water resources and wetland ecosystems
- Clause for Vegetation and wildlife protection measures
- Clause for air quality control measures
- Clause for Traffic safety and human health
- Clause for Material production sites management
- Clause for Spoil soils disposal & work in urban areas
- Clause for Preservation and protection of cultural heritages
- Clause for Preparation of site environmental plan
- Clause for quarry site re-instatment

Project Safety Management

Project Safety Management

- **What?** Processes required to assure that the construction project is executed with appropriate care to prevent accidents that cause or have the potential to cause personal injury or property damage.
- **How?** Through
 - Safety Planning
 - Safety Planning and Execution
 - Administration and Reporting

Contracts and Safety and security of Site

- Contractor often required to keep operations and the Site safe and secure
 - Contractor is required to keep the site clear all the time and remove debris and leftovers from site upon completion;
 - Health and **safety regulations** may require (put obligation on) different party and hence same should be consulted. **As obligation can't be transferred**, an Employer may not transfer some of such obligations set on it;
 - HIV/AIDS protection and counseling provisions
 - First aid provisions