Project Management for Industrial Plants

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What is a Project?

Organizations make Works; these works generally are divided into:

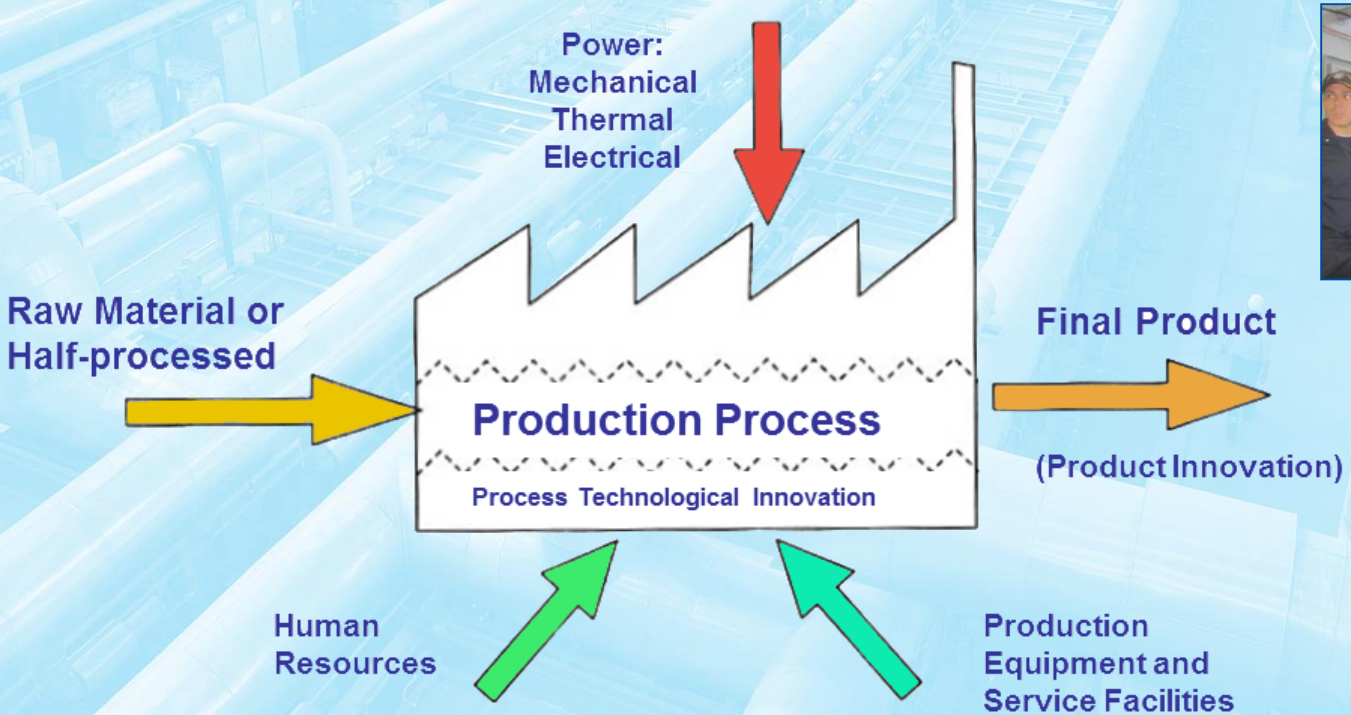
- Projects
- Operations

They share resources constraints, need of planning, execution and control, people empowerment.
While Operations are in a such way continuative and repetitive, Projects are *exclusive* and *temporary*

A Project is a sequence of temporary activities devoted to the creation of a single product/service.
(Project Management Institute)

What is an Industrial Plant?

- The Industrial Plant is a complex system including Machines, Equipment and Services devoted to allowing the processing of Raw Materials or Derivatives into Final Products and/or Goods.

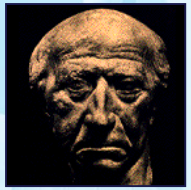


Industrial

Industrial: Consisting in industry; pertaining to industry, or the arts and products of industry; concerning those employed in labor, especially in manual labor, and their wages, duties, and rights.

magna industria bellum apparavit

Cornelii Nepotis, (55 BC) de viris illustribus



4 M for a Plant Creation

Plants are often the result of the classic 4M synergy:

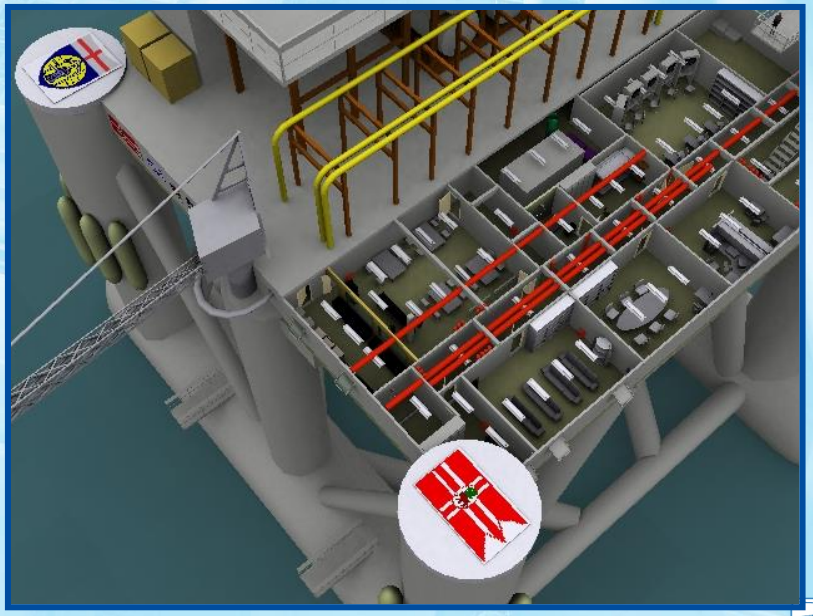
- **Money**
- **Machinery**
- **Men**
- **Materials**

Project Management goal is to finalize the Development of an Industrial Plant

A Plant as Summary of Many Elements

The Plants are characterized by a Systemic Vision of the different elements that are usually organized in terms of:

- Systems
- Subsystems
- Components



What is an EPCC?

Engineering, Procurement, Construction and Commissioning (EPCC) **are Projects covering the whole development process of an Industrial Plant.**

Often these Projects are simply called EPC (Engineering, Procurement and Construction) and indeed there are other kind of contracts regulating Industrial Plant Construction extending the life cycle (e.g. Operations & Management, Construct Build Operate

EPC Projects

- EPC Engineering Procurement & Construction: the contractor provides engineering, procurement and construction services. Think Design & Construct style contracts, where the project is largely Contractor managed and the cost risk and control are weighted towards the Contractor and away from the Owner.

- EPCC: Engineering Procurement Construction and Commissioning
- EPCI: Engineering, Procurement, Construction and Installation (e.g. off shore installations)

- EPCM: Engineering , Procurement , Construction, Manage: Contractor is responsible for total construction right from conceptual design to Final handing over to owner; Other companies are contracted by the Owner to provide construction services and they are usually managed by the EPCM contractor on the Owner's behalf.

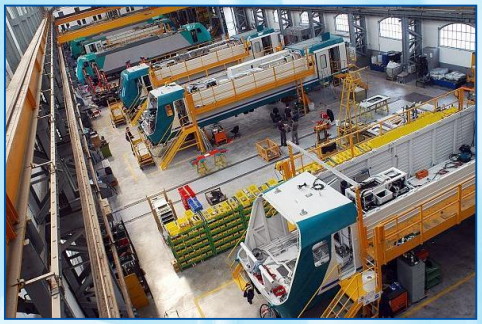
Projects vs. Labels

- EPMC: Engineering, Procurement & Management of Construction; the executor will be someone else deputed in consultation with owner

- BOOT: build Own Operate Transfer (usually after 7 years or as contract with owner)
  DBOOT: Design Build Own Operate Transfer (usually after 7 years or as contract with owner)

- OM: Operation and Maintenance
- LSTK: Lump Sum Turnkey

- PFI: Private Finance Initiative
- PPP: Public Private Partnership



- PMC: Project Management Consultant: the manager of a project in behalf of the Client. The PMC handle the contracts issued by the Client to perform a project such as EPC's, Services.

Some Definitions of Project

The Project is:

A) The set of all activities required for achieving a not continuous and not repetitive specific objective, obtained by coordinating specialized relationships, and by controlling the achievement of the objective at specific conditions during all the period of realization. (G.F.Aragozzini)

B) A combination of human resources not joined into a temporary organization in order to achieve a defined objective with limited resources (Project Management Institute 87)

C) A temporary process devoted to the production of one or more units of a single product or service whose features are gradually elaborated (Project Management Institute 92)

Project Management and other Activities

Projects Management have aspects in common with other disciplines:

General Management: common aspects are staff management, resources planning, operations control and others (i.e. law, statistics, logistics, human resource management, information technology)

Applicative Areas: projects management often requires specific skills and experiences in applicative sectors related to:

- *Technical Elements* (i.e. Pharmaceutics, Automotive)
- *Management Elements* (i.e. Service to Society, Military, etc.)
- *Industrial Groups*

Typical Characteristics of a Project

The Project has some common properties:

Well Defined Objectives
Unique (not replications)
Temporary
Multidisciplinary
Limited Resources

For these reasons it is fundamental to use Project Management techniques in order to achieve the objectives of complex projects with limited time, money, people and knowledge

General Project

Projects can concern a single division of a structure or more companies, they can be developed by a single person or by thousands, they can require few hundred hours or tens of millions

The Projects deal with different fields and activities:

- New Products or Services Development
- Structure, Staff or Organization Change
- New Transportation System Development
- New Informatics System Development or Acquisition
- Realization of a new Building
- Industrial Plant Design and Realization
- Development of an Election Campaign for the politic office
- Implementation of a new Methodology of Affairs

Temporariness Concept in Project Management

Temporary means that each Project has a well defined starting and ending time.

The end is reached when final objectives are achieved.

Independently of a project duration, a project is an activity designed with a deadline and not a continuous effort.

Often the Project aims to the realization of continuous activities that survive obviously to the project itself (i.e. project of a new product type) and have a continuous nature. Because of their innate nature:

- Projects have limited time frame in which they are feasible to financial, resources or market constraints.
- The Project team is created ad hoc and decommissioned at the end of the project.

Concept of Product/Service Uniqueness

The Project is devoted to the development of something unique (never developed before); if sometimes the category is very wide (i.e. power plant) this doesn't mean that each realization is equal to the previous.

Because each project is unique, it is necessary that it is elaborated progressively.

'Elaborated' means analyzed in detail and carefully, '*Progressively*' means by proceeding step by step subsequently

Project Example

A Chemical Plant starts from the definition of process characteristics.

These specifications are used as support for designing the main parts of the plant.

These basis are used for the engineering design of the process, of the mechanical components of plant units and auxiliary services and infrastructure services.

These projects are the base for constructive designs development

During the construction, the designs are evaluated and customized based on the needs and changes concurrently approved.

During test and check, new elaborations of characteristics are managed and final calibrations are provided

Internal Projects and Projects for Third Parties

Projects are classified in *internal Projects* and *Projects for third parties.*

In the first type the counterpart is the *client/committing part*, while in the second we define *sponsor* people that promote the Project Development (generally, part of company management or directors). Internal projects generally concern with activities in:

- R&D, BPR (Business Process Re-engineering) Reorganizations
- Reengineering, new systems installation (i.e. introduction of a orders management DBase)
- procedures (i.e. introduction of ISO14001 certification)
- new plants realization (i.e. building a warehouse in Port), etc..

External Projects for third parties are devoted to provide a product/ service.

Project Management

Project Management means:

Application of Knowledge, Experience, Skills, Tools and Techniques in order to design activities for satisfying specifications, requirements and expectations of a Project.

Objectives achievement requires to compensate opposing factors:

Skills, Time, Costs, Quality, different Customers Requirements, Explicit and Implicit Specifications (Needs & Expectations)

Project vs Design: 2 Words 2 Concepts

Design	**Technical/Artistic Project of a product/ service/ component**
Engineering	**Technical Product Design, focusing on implementation phases and product functions**
Drawing	**Technical Drawings including a formal representation of the Technical Project**
Project	**A set of activities devoted to the achievement of a specific objective and including even technical project development of components/products**

Project vs Design: Different Concepts

We consider a new vehicle model development.

Design	Development of technical features of the new vehicle: appearance, motorization, structural analysis, functional analysis, sizing etc.
Engineering	Project Revision in order to make the new vehicle feasible on existing production lines and in efficient way
Drawing	Technical Drawings of the new vehicle
Project	Project devoted to the development of a new vehicle: market analysis, engineering team management, development time planning, production process development, new technologies development, cost and feasibility analysis, new vehicle production and commercial systems implementation.

"Control" Word

Control will be used with the *English meaning*

In Italian "Control" refers to:

1. **Observation of system evolving and its status (i.e. check about start-up pump power)**
2. **Observed System regulation (i.e. combined cycle control system)**

In English Language 'Control' means the second definition (regulate, command) and this is the meaning we will use (i.e. Cost Control: observe and regulate/ maintain costs during the project)

PM Areas

Project Management Activities

Project Integration Management

1.1 General Plan development
1.2 Project Plan Execution
1.3 Control of Project Changes

Project Scope Management

2.1 First Analysis
2.2 Objectives Planning
2.3 Objectives Definition
2.4 Objectives Verification
2.5 Control of Objectives Changes

Project Time Management

3.1 Activities Definition
3.2 Activities Sequence
3.3 Duration Activities Estimation
3.4 Scheduling Development
3.5 Scheduling Control

Project Management Activities

Project Cost Management

- 4.1 Resources Planning
- 4.2 Costs Evaluation
- 4.3 Costs Budget
- 4.4 Costs Control

Project Quality Management

- 5.1 Quality Planning
- 5.2 Quality Policies Implementation
- 5.3 Quality Control

Project Human Resources Management

- 6.1 Planning of Project Organization
- 6.2 Staff Hiring
- 6.3 Team Work Development

Project Management Activities

Project Communication Management

- 7.1 Communications Planning
- 7.2 Information Distribution
- 7.3 Continuous Report on measured Performances
- 7.4 Administrative Close of Documentation

Project Risk Management

- 8.1 Risks Identification
- 8.2 Risks Quantification
- 8.3 Risks Solutions Development
- 8.4 Control of Applied Countermeasure

Project Procurement Management

- 9.1 Suppliers Contracts Planning
- 9.2 Proposals Acquisition Planning
- 9.3 Offers and Proposals Acquisition
- 9.4 Suppliers Selection
- 9.5 Contracts Management and Administration
- 9.6 Contracts Closure

Project Management Similar Conditions

Program Management: **set of coordinated Projects in order to achieve additional advantages (i.e. program of new Swiss defense system development: new aircraft Gripen project, new radar project, production system development project etc.)**

Other meanings of *Program:*

- **Annual Revision of On going Projects**
- **Set of continuative activities and not repetitive**
- **Project Synonymous**
- **Meta Project or Sub Projects**

Sub-projects: **derive from project subdivision in sub-components that are manageable independently**

Project Development Phases

Since the Projects are affected by Stochasticity it is convenient to divide them into *Project Phases* in order to semplify its analysis and connection.
The different phases compose the *Project Life Cycle*.

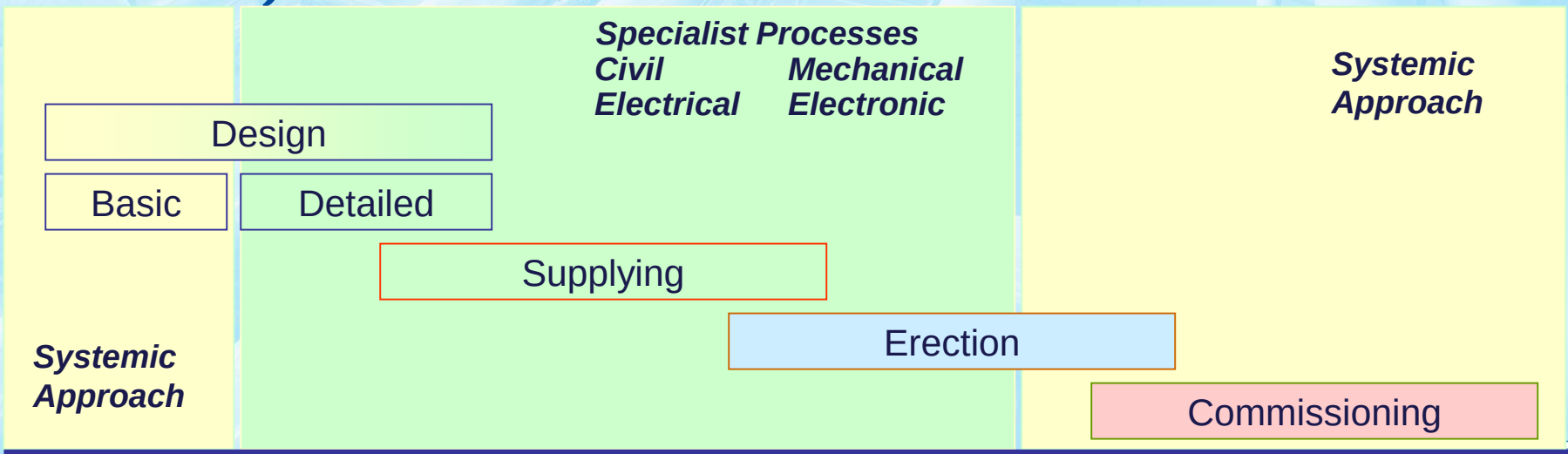
Each Phase ends with a *Deliverable* development. The *Deliverable* refers to a tangible and valuable objective (i.e. feasibility study, checks start up etc.).
At the end of a phase it is possible to proceed with the result analysis to verify if it is possible to go to the next step and to apply eventual changes or corrective activities.
The Project ending is often defined :*Stage Gate* o *Kill Point*

Project Development Phases for a Plant

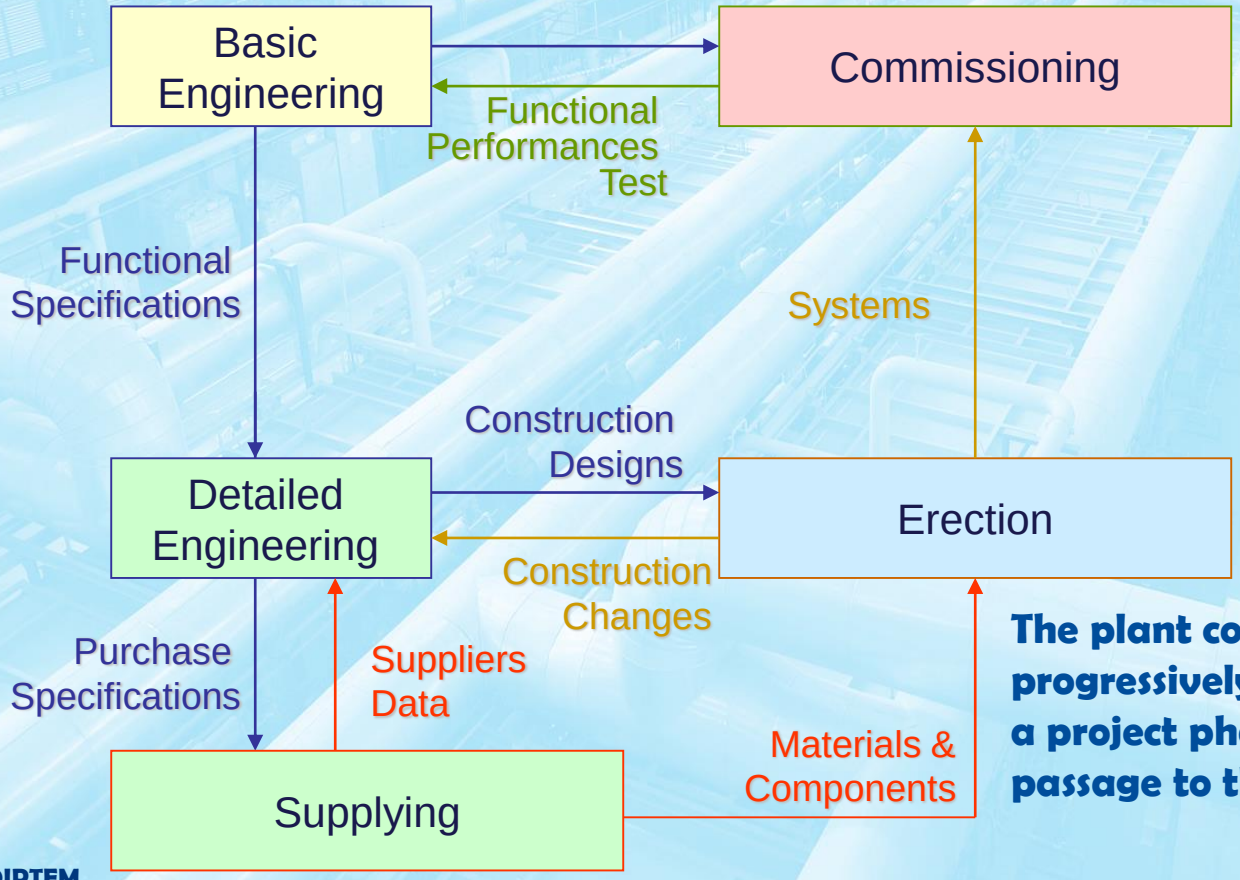
Often in Constructions sector, it is considered the following classification:

Ingegneria	**<=>**	***Engineering***
Approvvigionamenti	**<=>**	***Supplying***
Montaggi	**<=>**	***Erection***
Avviamento e Collaudo	**<=>**	***Commissioning***

Generally Engineering is divided into *Basic Engineering* (systems and functional units of the plant) and *Detailed Engineering* (specialized tematics)

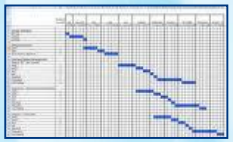


Interactions among the different Plant Project Phases



The continuous interaction among the different phases requires a dynamic feedback.

It is very important that the project is *Robust* (capable to easily adapt to the changes).



The plant configuration is progressively developed, by freezing a project phase to guarantee the passage to the next one

The Project Life Cycle

The Project Life Cycle allows to define the outlines of the plant project and eventual links to current activities or activities intended to continue after the project conclusion.

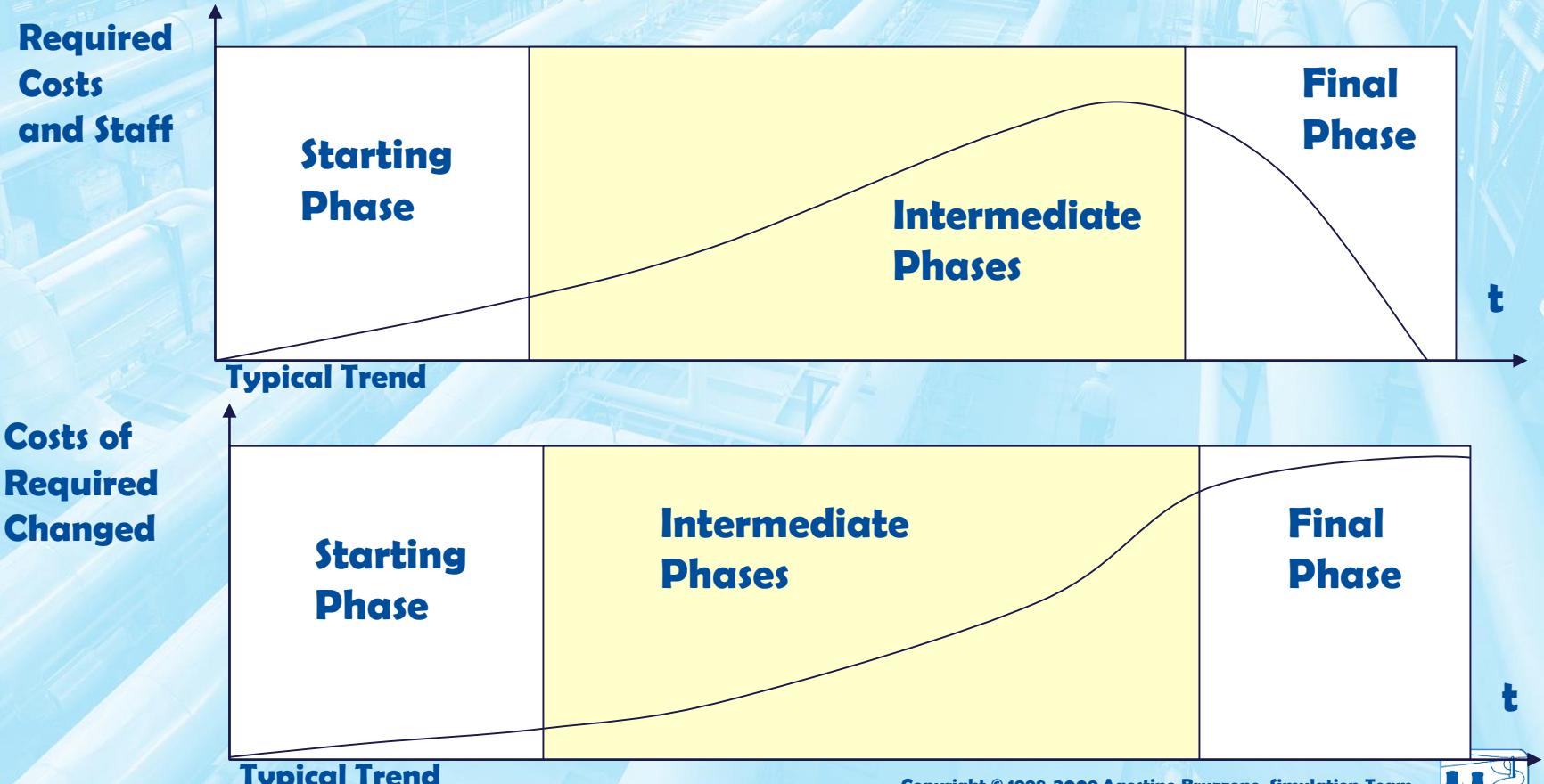
The Project Life Cycle has to define the entities and the deliverables for each phase and it could be more or less detailed.
Normally it takes into account the following Considerations :

Costs and required Staff are reduced compared to the middle stages and they go down in the terminal phase

The chances of Success are low at the beginning of the Plant Project and they increase during the project

The Customers Influence in defining product changes and costs decrease during the project development and the cost for eventual changes increases progressively.

Some Examples of General Concepts in the Life Cycle



Development Phases in the Plant Life Cycle

It is possible to identify four main phases:

Conceptual

Very High Influence on the plant costs; it works on a project configuration only set up and to be defined, it requires invention and creativity capabilities

Definition

High Influence on the Plant Costs, it works on a detailed project configuration still being defined, it requires analytical capabilities

Development

It has a direct influence on the Plant Costs, this influence decreases very fast, it works on a *frozen* configuration and requires management capabilities

Delivery

Low influence on the costs, fixed configuration, it requires management capabilities

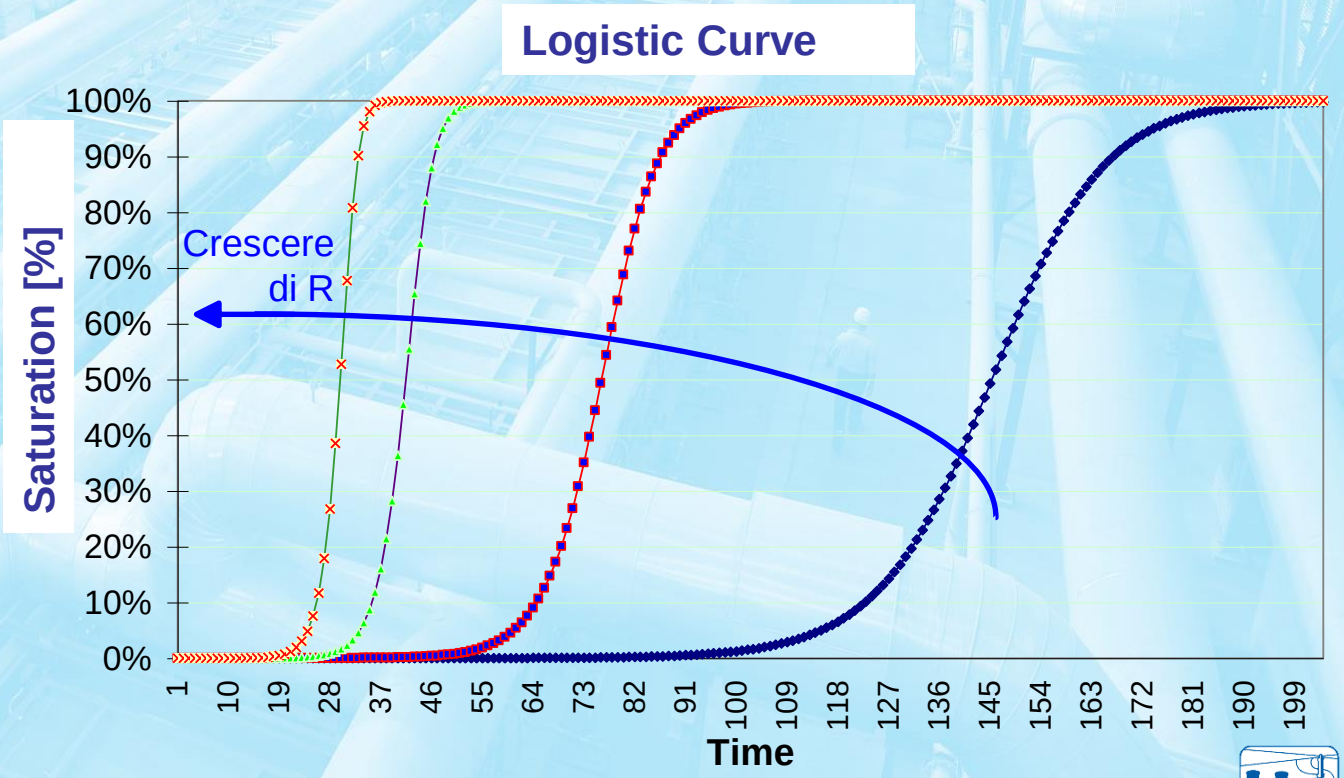
The Logistic Curve or "S" Curve

The *"S"Curve* or *Logistic Curve* reproduces the cumulative trend of the Plant Project (in term of costs, working progress, etc.). This obviously means to integrate resources employment curves in the time that correspond to instead bell curves..

P.F. Verhulst (1845)

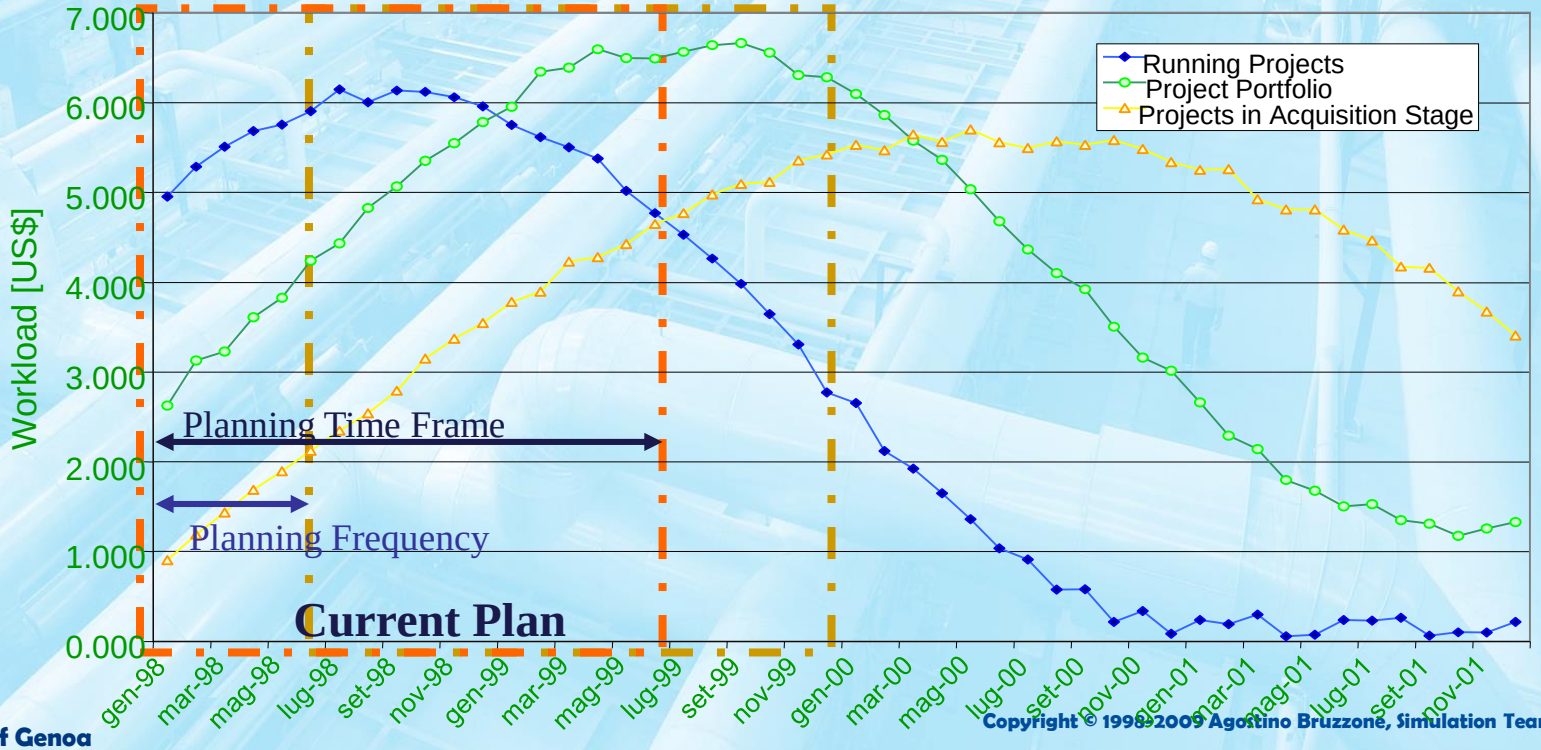
$F(x) = R \times (1 - x)$

$x(t+1) = x(t) + F(x)$



Rolling Wave for Strategic Analysis

Often more projects are managed in parallel; in the strategic planning it is possible to use a periodic technique operating in a limited temporal frame that allows constant updates ("rolling wave") so that it is possible to identify the different tasks of the different projects.



Life Cycle Representation

An Example is the American Defence Minister Acquisition System that includes the phases and the deliverables of each milestone.

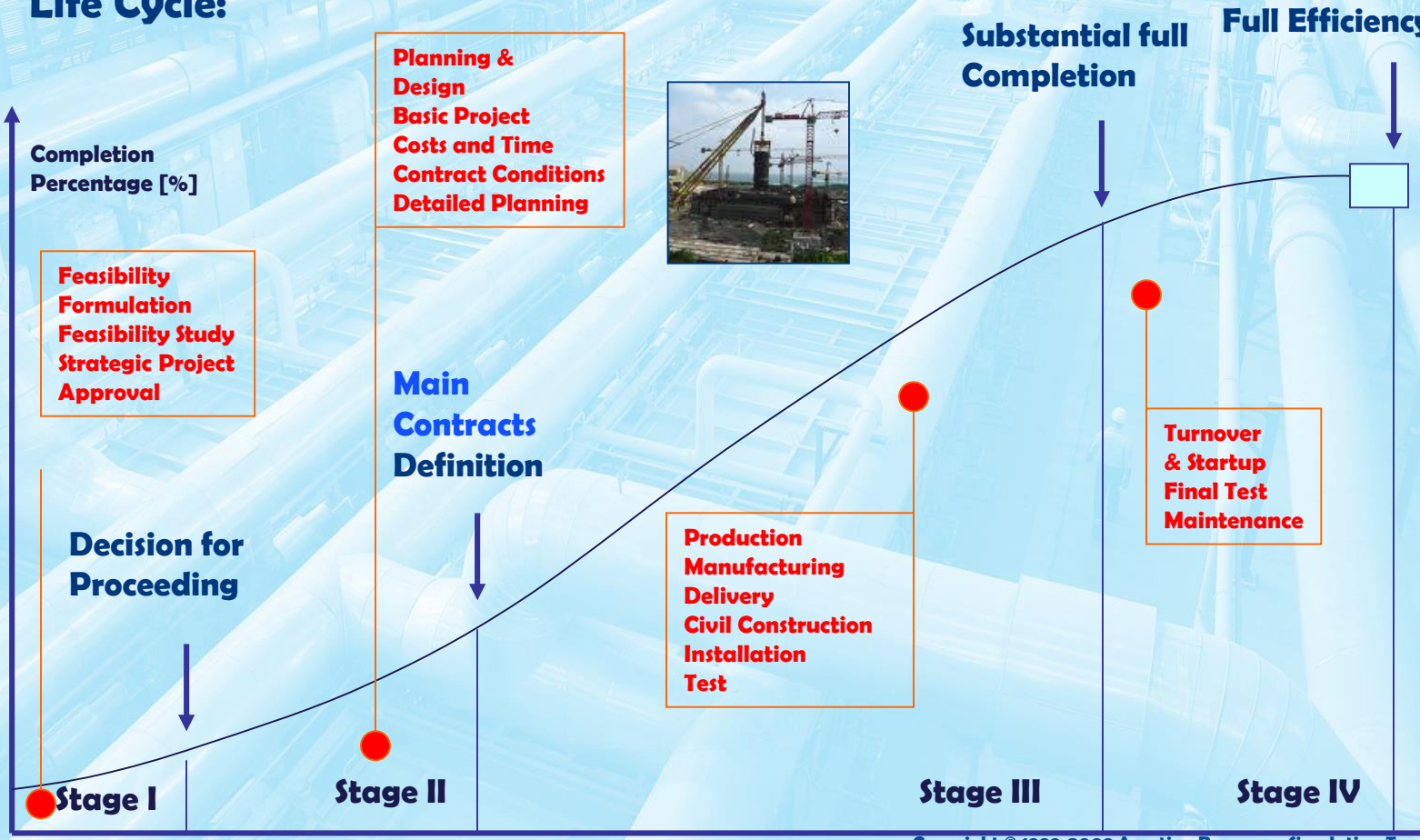
Life Cycle for Defense Acquisition US DoD 5000.2 (rev 2/26/93)

	Phase 0	Phase I	Phase II	Phase III e Phase IV	
Needs Mission Identification	Concepts and Ideas Exploration and Definition	Demonstration and Validation	Engineering Development and Manufacturing	Production and Deployment	Operations and Support

Milestone 0 New Concepts Study Approval	Milestone I Demonstration Approval	Milestone II Technical Project Approval	Milestone III Production Approval	Milestone IV Main Required Changes Approval

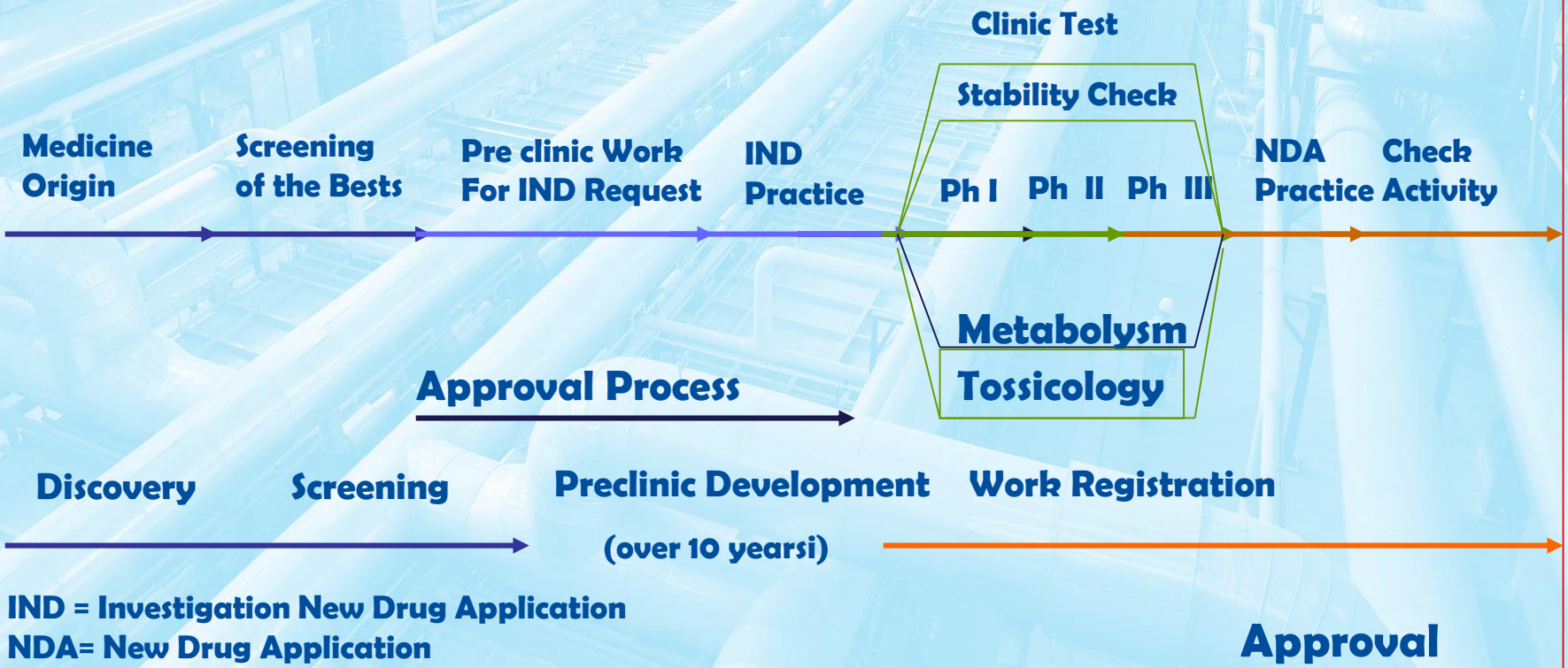
Morris Representation of the Life Cycle

For Construction Projects it is often proposed the Morris vision of the Project Life Cycle:



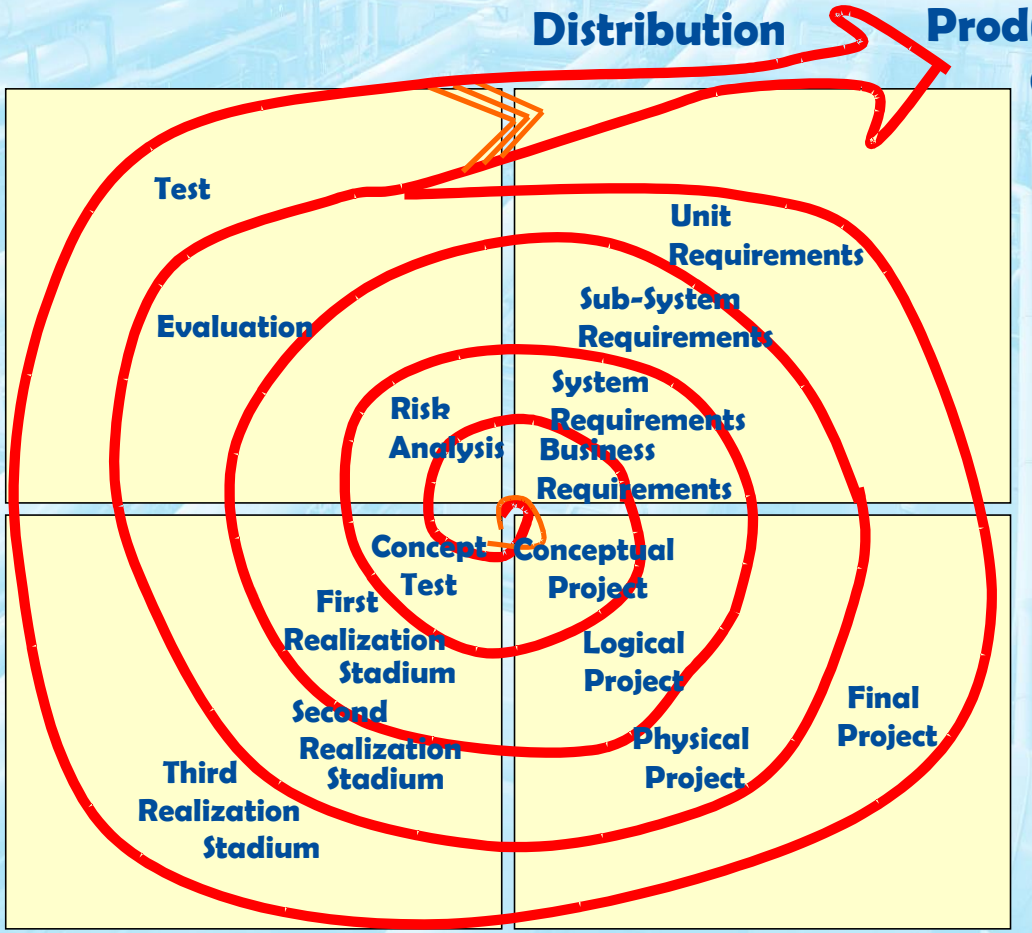
Murphy Representation

For Pharmaceutic Projects it is proposed the Murphy representation of the Project Life Cycle:

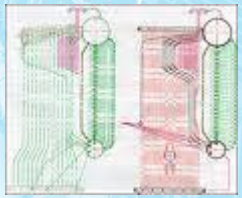


Muench & Co. Representation

For Software Projects it is visualized Muench Representation



Nested Life Cycles for plant Management



Plants have several feasible life cycle linked among that are nested each other

Company Investment Life cycle

Strategic Planning	Identification Needs	Feasibility	Investment Achievement	Return on Investment	Investment Conclusion

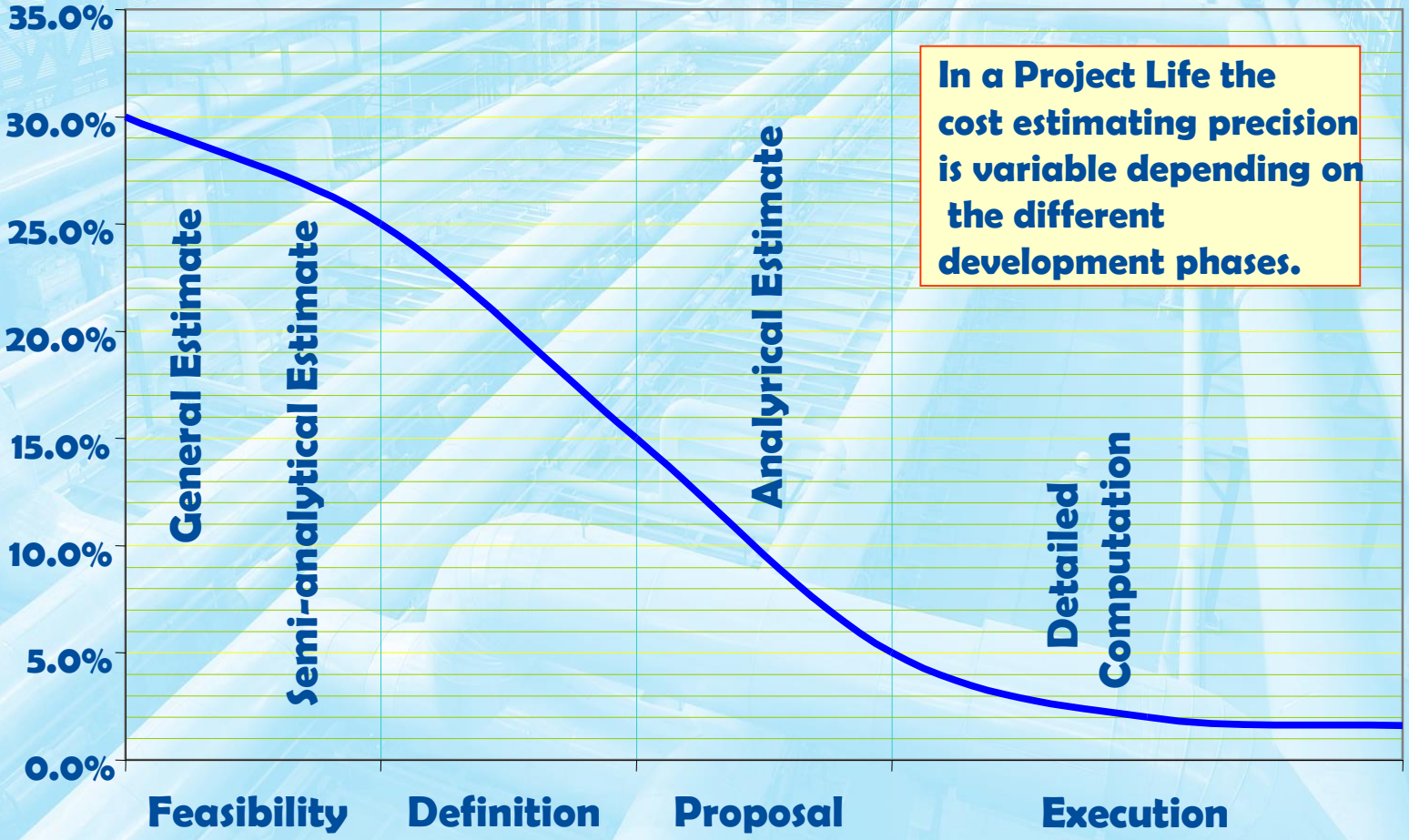
Basic Design	Acquisition	Plant on going	Dismantling

Plant Life Cycle

Conceptual phase	Planning and Definition	Accomplishment	Start up and Delivery

Plant Project Life cycle

Curve of the Precision along Time



In a Project Life the cost estimating precision is variable depending on the different development phases.

The Stakeholder Concept

Stakeholders **are all the people actively involved in the project and their satisfaction influences the Project success.**
Among the others (i.e. Project Team families), there are:

- **The Project Manager**
- **The Customer it is necessary to remark the presence of different types of customer (i.e. doctor and patient for a new medicine)**
- **The Involved Structure in the Project**
- **Sponsors (supporting the project in different ways)**

It is difficult to satisfy their requirements and their expectations of:

The subjects are different and often the objectives are not clear for the subjects themselves, often they are in conflict, etc .
Normally the Customer requirements prioritize, but it is not possible to disregard those of the other subjects.

Project Participants

User: using the product; it could be or not the customer (i.e. ICI commits desulphurization plant vs. Stuttgart City builds a Hospital); it is the reference for operational specifications

Customer: supporting an investment for an external project

Commissioner: announcing the proposal request; he is responsible of the Project during its duration and he is an interface to the contractor.

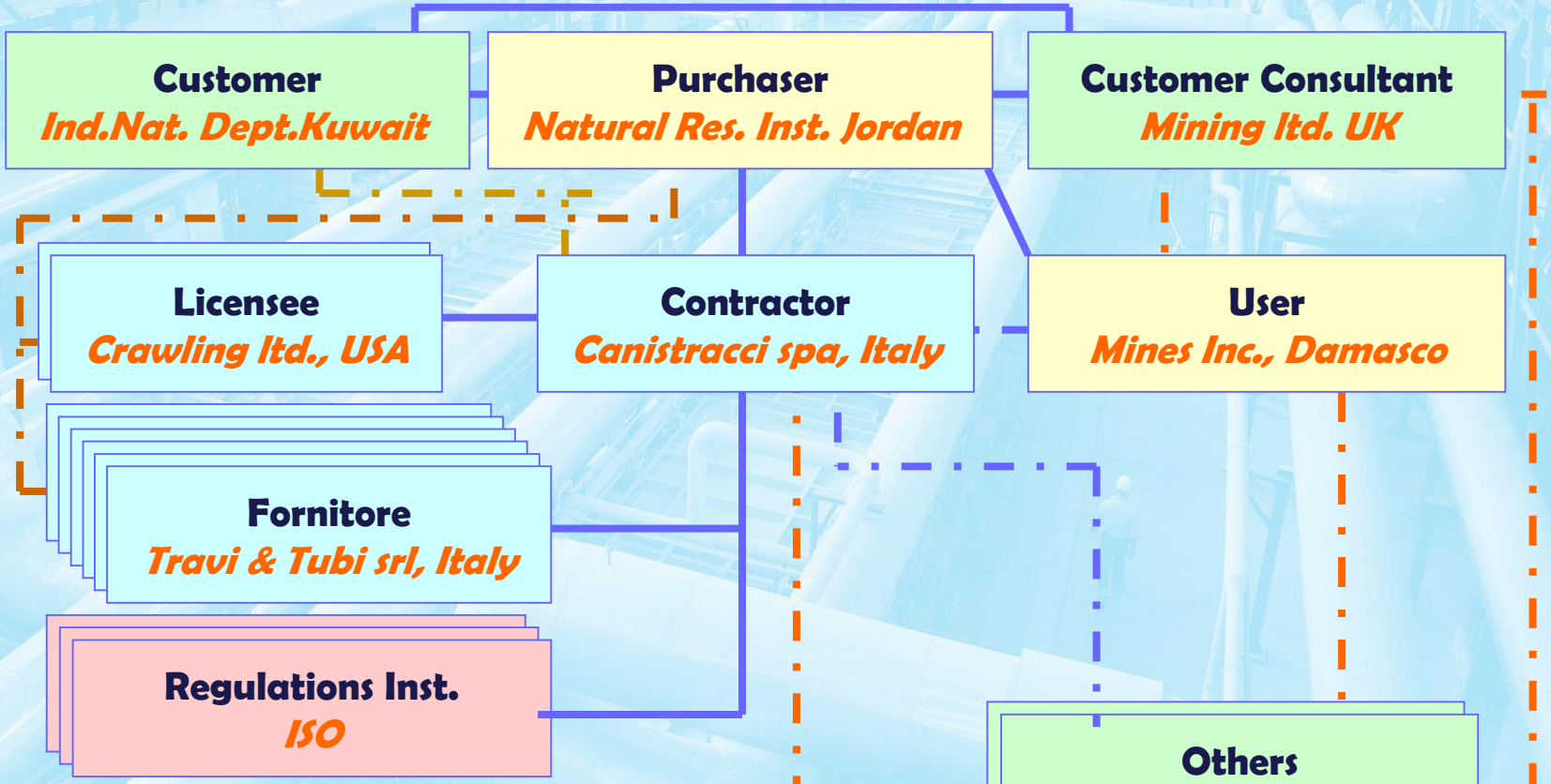
Contractor: company contracting for the project realization; generally, for big orders there is a *main contractor* and a set of contractors and sub-contractors. Sometimes the customer identifies directly a *managing contractor as* contractors coordinator.

Licensee: who provides the license to use patents/ external technologies (i.e. Siemens to Ansaldo on Turbo Gas).

Supplier: supplying services, products, components or raw materials.

Regulation Institutions: all the institutions defining standards and regulations impacting on the project

Project Stakeholders and mutual Relationships



An Example about a Mine funded by Kuwait in Jordan

Contracts Acquisition

In the Engineering Companies the Plant Project is established with the contract acquisition normally through a competition; the engineering companies offer many different services:

- Preliminary Studies
- Detailed Engineering
- Education and Training
- Supplying and Expediting (documents and materials delivery on site)
- Electromechanical Erection
- Technical Assistance
- Operation & Maintenance
- Basic Engineering
- Customer Service
- Civil Constructions
- Start up and test
- Marketing Assistance

During the acquisition process often three different figures are involved: *Marketing Manager* (identifying market), *Proposal Manager* (preparing and presenting proposals to the contract signature), the *Project Manager*.

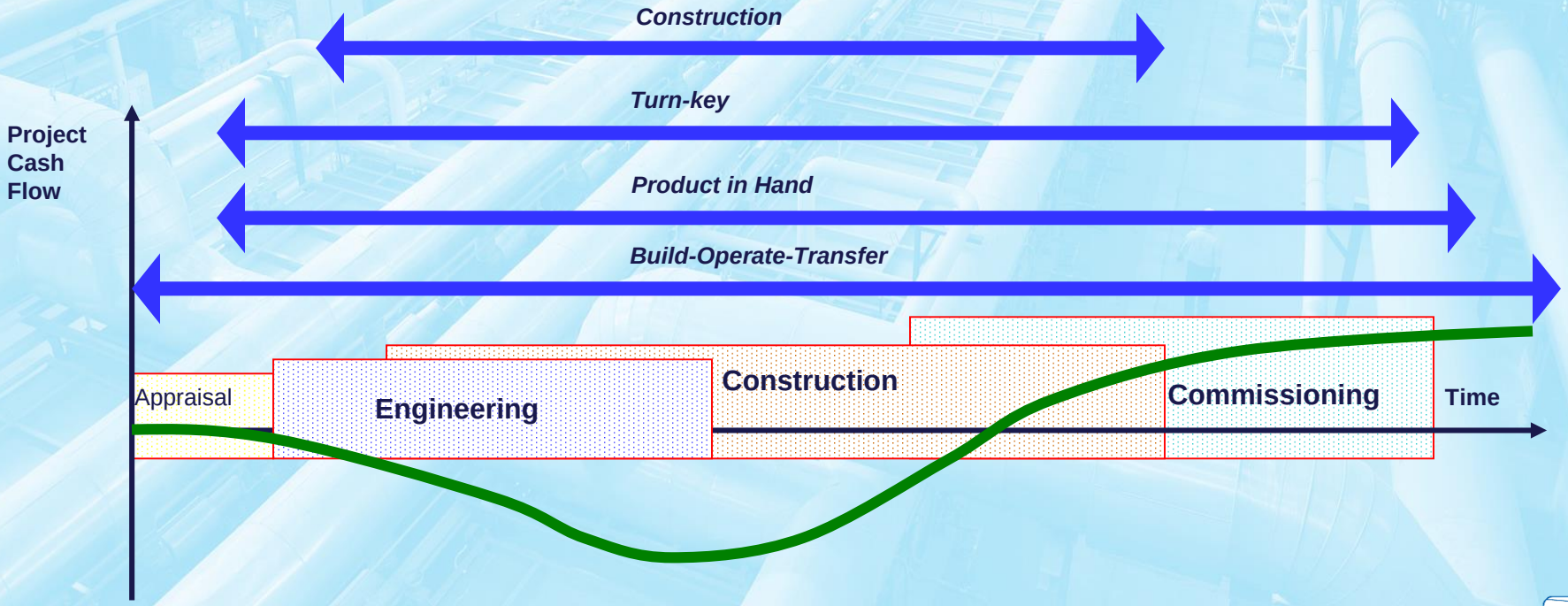
Often in a Company there is personnel from the different functional divisions intended to serve as Marketing Manager and Proposal Manager institutionally.

Often the lack of connection between Contract Marketing / Proposal and Project Manager affects the efficiency of the PMT (project conditions unknowing, client relationship, personnel demotivation).

Plants Development Contracts Types

There are different Contracts types for plants development.
Obviously their nature impacts on the relative project management.

Construction Contract	**Construction**
Turn-key Contract	**Turnkey Construction and start up**
Product in Hand Contract	**Plant Facility with construction and use**
Market in Hand Contract	**Product Plant Marketing**
Operation & Maintenance	**Support Service for management and Maintenance**



Marketing for a Plant Construction

The marketing is devoted to identify the potential markets and to a preliminary contact with the customer in order to identify his needs and expectations.

It is possible to summarize the Plant marketing phase as:

Customer General Requirements Definition
Information Searching
Preliminary technical indications
Preliminary proposals
Preliminary Definition of the Customer Specific Needs
Preliminary Proposal (Intervention Magnitude Order)
Preliminary Testing of Financing Modes
Pre-feasibility Evaluation

After the specific needs definition, it is possible to develop the project feasibility study and th normally includes:

Market Analysis
Production Cycle/Process
Location
Layout
Costs Analysis
Times Analysis
Structural Analysis
Financial Analysis
Risk Analysis
Sensitivity Analysis
Economic Evaluation
Recommendations
Potential Funding Sources Research

Feasibility Study Example

1. Summay
2. Background e Project History
3. Market Size and Plant Capability
   - 3.1 Market Analysis
   - 3.2 Sales Forecast. Sales Network. Marketing
   - 3.3 Production Plans
   - 3.4 Plant Capability
4. Input Materials and Other Elements
   - 4.1 Required Input
   - 4.2 Supplying Plans
5. Plant Location
   - 5.1 Localization
   - 5.2 Local Conditions
   - 5.3 Environmental Impact
6. Design
   - 6.1 Process/ Technology Choice
   - 6.2 Equipment Choice
   - 6.3 Basic Design. Constructive Solutions
7. Plant Organization and Production Costs
   - 7.1 Production Costs
   - 7.2 Administration Costs (Overheads)
   - 7.3 Mortgage
   - 7.4 Financial Expenses
   - 7.5 Sales Costs
   - 7.6 Other Costs
8. Human Resources: Technical and Management Staff
   - 8.1 Organization Chart
   - 8.2 Specific Requirements of each Workplace
9. Project Development Plan
   - 9.1 Planning
     - Terrain Acquisition and Correlated Operations
     - Know-How Acquisition
     - Authorizations
     - Specifications Study
     - Supplying (materials and equipment
     - Commissioning, Start-Up and Check
     - Design
     - Specifications Requirements
     - Contracts
     - Erection
10. Financial Evaluation
    - 10.1 Options Evaluation Elements
      - Investment Useful Life
      - Investments
      - Incomes
      - Operational Costs
      - Fluid Assets
      - Funds
      - Inflation and Rates
    - 10.2 Evaluation
      - NPV(net present value), IRR(internal rate of returns), TPBP (time pay-back period) and other indicators
      - Sensitivity Analysis & Risk Analysis
11. Not Quantifiable Factors Estimation
12. Risk Management
13. Final Decision
    - 13.1 Conclusions
    - 13.2 Strategies Spectrum
    - 13.3 Final Decision
14. Project Objectives System
    - 14.1 Objectives
    - 14.2 Critical Parameters
15. Control and Monitoring System
    - 15.1 Data Collection
    - 15.2 Periodicity
    - 15.3 Monitoring and Control Procedures
    - 15.4 Decisional Process

Marketing Phase in a Plant Development Project

Often the Contracts Assignment requires the participation to specific competitions (tenders); the Proposal Manager develops the project of proposal preparation, presentation, negotiation.

The tenders are often organized as follows:

Pre-qualification of the Potentials Bidders

Participation of the bidders to the Competition

- Bidders Instructions Issuance (tender documents)
- Bidders Qualification
- Preliminary Meetings (Bidder Meetings)
- Proposals Preparation
- Proposals Presentation
- First Selection

Proposal Evaluation

- Preliminary Report
- Competitors Selection (short list)
- Proposals Completion
- Commercial Technical Evaluation
- Final Report

Negotiation

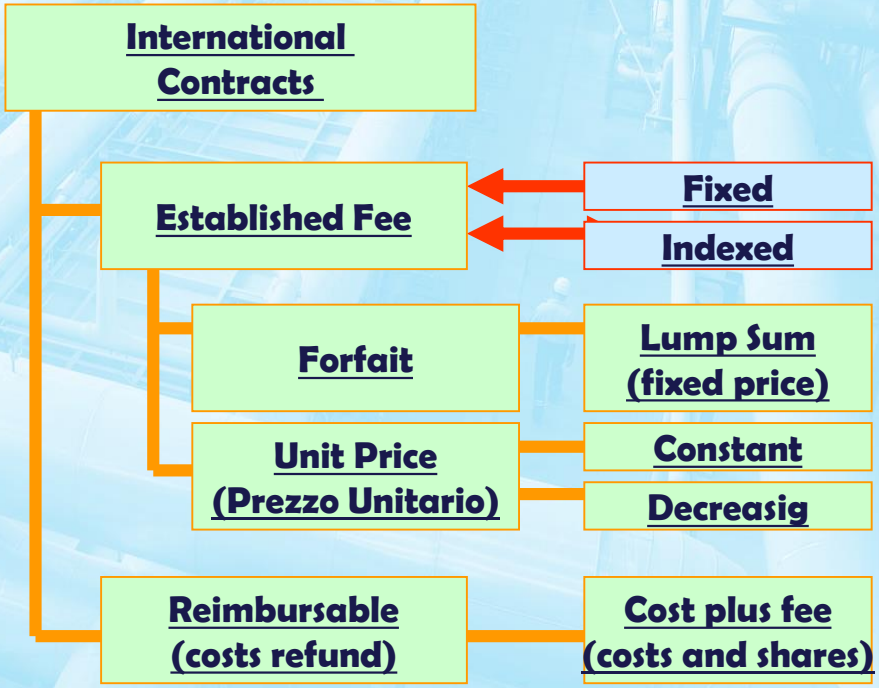
- Commissioner Intentions
- Final Technical & Commercial Negotiations
- Financial Package Approval
- Authorities Approval
- Contract Assignment
- Signature

Prices and Payment Terms,
Process Technology, Technology Transfer
Industrial offsets (countertrade),
Nationalization degree, delivery times,
Company stability, recent experiences in similar fields,
partners, proposal deviations from the tender documents

Proposal Competitiveness & Evaluation Criteria

The Contract for Plants Project

The contract defines all the technical, commercial, financial, legal aspects of the project, among the main types for Plants Project notice:



Often the Contracts include incentives, penalties (i.e. 100,000 USD/day) Prices could be predefined as fixed or indexed.

Contractual Typologies based on Risks Repartition

The contract varies from refundable to fixed cost:

Agreed Price | Quotation | Contractor Margins

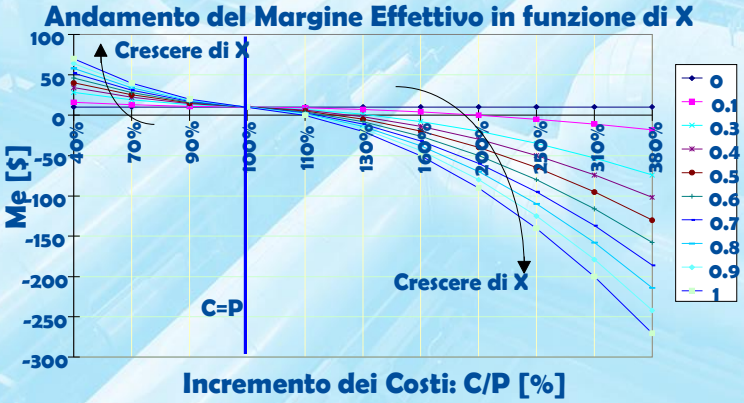
$$C_t = x P + (1 - x) C + M$$

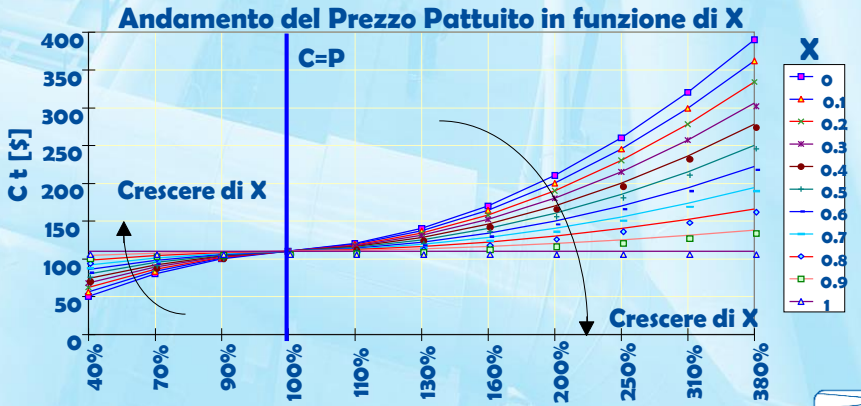
Risk Repartitio between Contractor and Commissioner

Final Cost

Refundable Contract x = 0
Lump sum Contract x = 1

Effective Margin → $Me = C_t - C = x (P - C) + M$



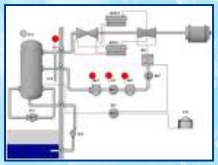


Project Budget

Budget Plan Development is based on historical data and on general "parameterizations" according to a cost index (ie USD / kW per power plants). The cost assessment often takes into account a "scale factor"

$$C = C_0 \left(\frac{P}{P_0} \right)^M$$

C, P	Cost and Capability of the plant in exam
Co, Po	Cost and Capability of the reference Plant
M	Scale Factor (typically between 0.6 e 0.9)

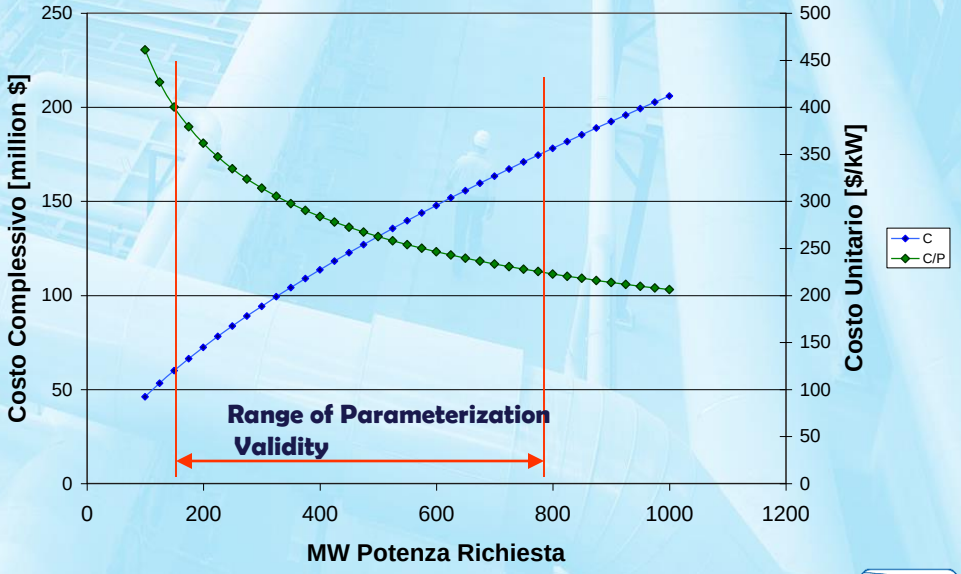


$$\frac{C}{P} = C_0 \frac{P^{M-1}}{P_0^{M}}$$

$$\log \frac{C}{P} = \log C_0 - M \cdot \log P_0 + (M+1) \cdot \log P$$

$$M < 1$$

C / P = Unit Cost



This allows to evaluate the Unit Cost based on a historical data linear regression by applying logarithms (parametric-statistic approach)

Plant Cost Estimation

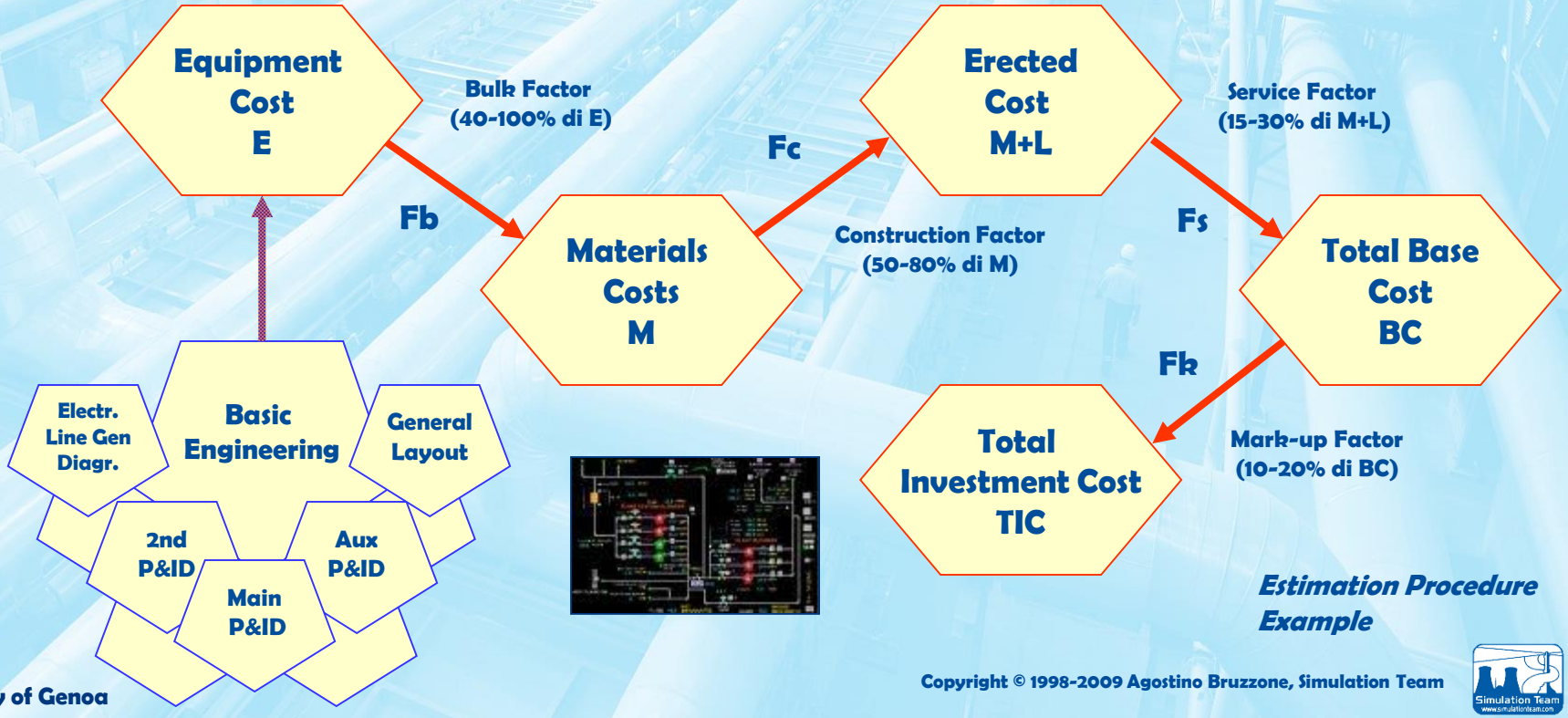
It is based on plant type and size and takes into consideration as reference similar plants already developed by using the "scale factor" and by applying some corrective parameters:

Location Factor (position influence)
Escalation Factor (increases due to time dilation)
Contingency Factor (Unexpected events influence)
etc.

It is possible to estimate with a level of subdivision for the next refinement stage: Mechanical Plants (cost per ton), Power (kW) and Instrumentation (Control Loops), by considering then the different realization costs (services, transport, civil works etc. .) as percentages on the materials.

Semi-Analytical Evaluation

It is used for the feasibility study and is based on an branched analysis of the costs that studies the major plant components (items) costs in an analytical way and the remaining entries (ie, bulk materials, services) in a parametric-statistical one; it is based on a default configuration, and then on the basic engineering work.



Estimation Procedure Example

Analytical Estimation

It is necessary for preparing the commercial proposal and requires a complete and correct definition of the basic engineering; so for power plants it is possible to refer to Main, Secondary, Auxiliary P&IDs (Process & Instrument Diagrams), General Layout and the Electric One Line General Diagram, as well as to the major components (generator, turbine, boiler, DCS) sizing.

Examples of Costs are:

- ***Engineering***
- ***Materials (bulk materials)***
- ***Plant Components (items)***
- ***Transportation***
- ***Civil Constructions***
- ***Electro-Mechanical erections***
- ***Erection Supervision***
- ***Sites Different Costs***
- ***Sub-contracts***
- ***Technological Licenses***
- ***Maintenance Equipment***
- ***Start up Costs***
- ***Spare Parts***

Transportation	Personnel	Equipment	Materials
Weights and volumes estimation of the material to be transferred	Estimation of the activities to be carried out as standard hours and as Expected Man Hours with yield coefficients.	An evaluation of the amortization costs is estimated from purchase cost and useful life	Possibilities a) Parametric b) Based on quantities provide by th engineering team (“material take-off”)

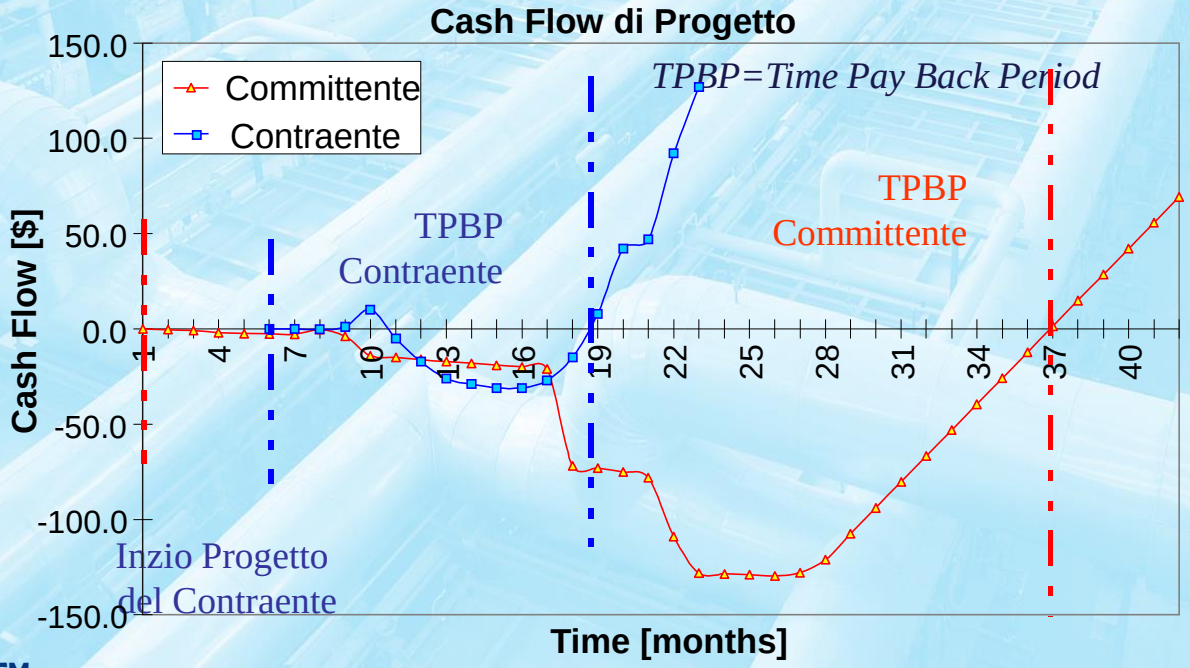
COST

Escalation
Contingencies
General Costs
Financial Costs
Sureties
Taxes
Foreign Exchange
Revenue
etc.

PRICE

Plant Project Cash Flow

The contract provides the payment structure, corresponding to the cash-flow (both of the customer both of the supplier); obviously it is regulated by strong financial leverages for big projects due to the time size, to the currency exchanges, materials costs and inflation phenomena. For projects where the user is a private provider of services / goods produced by the plant, the cash flow is strongly influenced by time (i.e. build a fast ferry for a private company or a power plant for a private supplier vs. build a ship for the Navy or a Power Plant for ENEL)



Financial Leverages are used to guarantee less financial expenses.
For a project of 150 milion$ three year duration the financial expenses trend is generally about 3-4% (maybe with a margin of 2-5%)

Different Project Typologies

	Lum Sum	Reimbursable	Cost Plus Fee	Unit Price
Pricing	Very Competitive	Competitive	Competitive	Competitive
Contracting Time	Long	Short	Short	Medium
Scope of Work	Detailed Fixed Scope	General Scope Variable	General Scope Variable	Semi-Detailed
Risk of Extra Costs for the Customers	Very low	High	Moderate	Moderate
Opportunity to Refund by Claims	High	Very Low	Low	Moderate
Market Characteristics	Competitive	None	None	Moderate-Competitive
Efforts required for finalizing the Negotiation	High	Low	Moderate	Moderate
Efforts required for Administration & Control	Low	High	Moderate-High	Moderate

Cooperation for the Project Realization

In the Plant projects there are different participation formulas devoted to the risk subdivision, to the competition reduction, to the integration of different technologies and skills and / or to enter specific markets.

These collaborations exist in many forms:

Virtual Company

Legal Company created ad hoc for the Project

Consortium

Entity pooling Institutions and Companies

Joint Venture

Cooperation Agreements for specific Projects

Sub-Contracting

Commitments Signature from suppliers directly with the Customer

Supplying

Traditional Supply to the Contractor

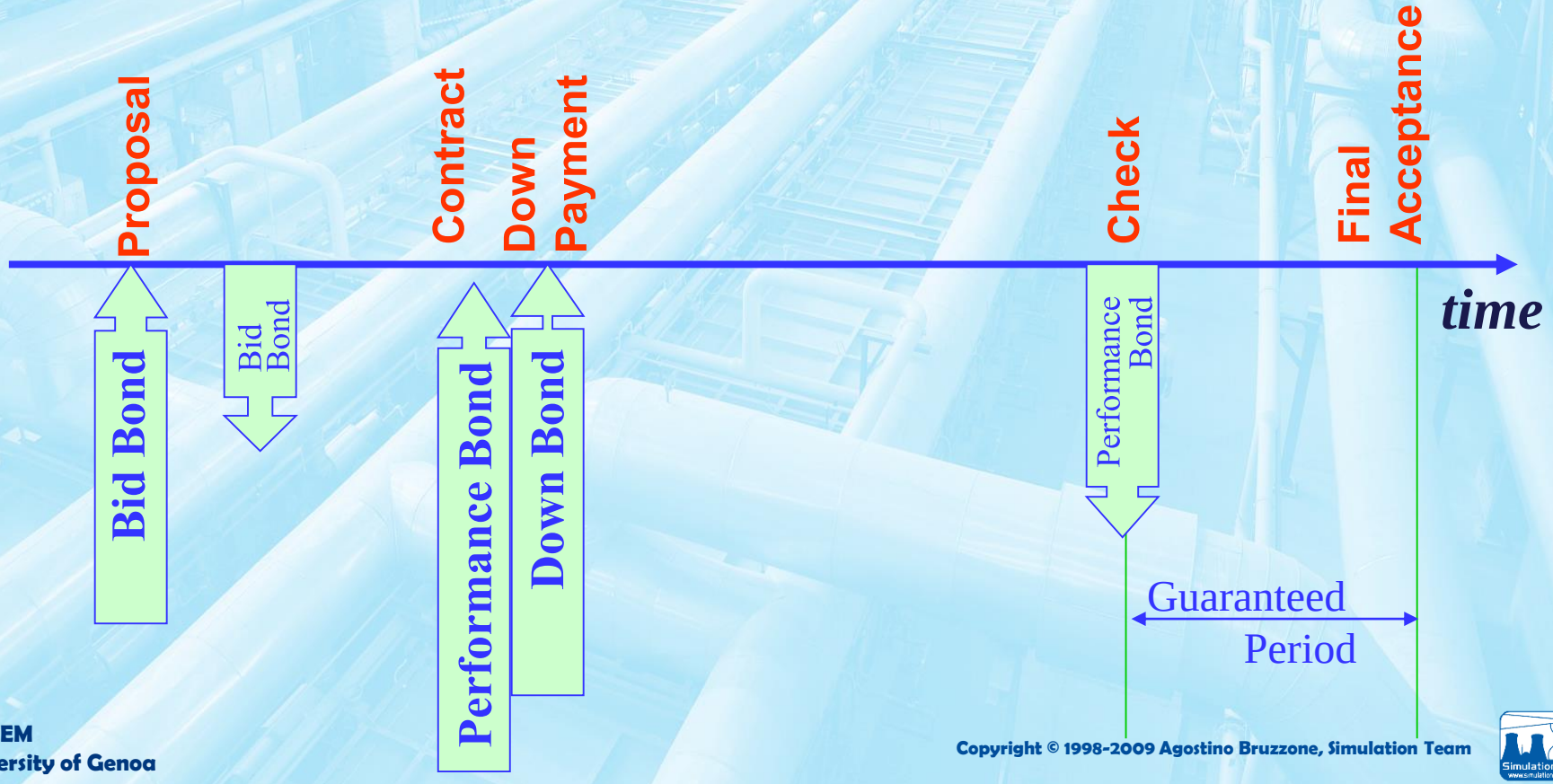
Plant Projects: Contract & Milestones

A Contract for a Plant could be really complex (i.e. contract for a Power Plant can overcome 20 volumes and include ten of thousands of pages) and generally includes a set of *milestones* for instance:

- *Preliminaries*
  - *Authorities Approval*
  - *Performance Bond (Contractor)*
  - *Letter of credit (Commissioner)*
  - *Down Payment (Commissioner)*
  - *Down Payment Bond (Contractor)*
- *Contract Effective Date*
- *Basic Engineering*
  - *Commissioner Intermediate Approvals*
  - *Final Approval*
- *Detailed Engineering*
  - *Commissioner Approval*
- *Procurement*
- *Manufacturing c/o Suppliers*
- *General Training and Exercise Staff Specification*
- *Shipping & Sped Documents Issuance.*
- *Yard Start up*
- *Transportation*
- *Civil Works*
- *Electromechanical Installations*
  - *Mechanical Completion Certificate*
- *Maintenance Staff Training*
- *Testing & Check*
  - *Pre-test*
  - *No Load Test (Prove in Bianco)*
  - *Setting to Work*
  - *Start-up*
  - *Taking Over Test (Performance Test)*
  - *Provisional Acceptance Certificate*
- *First Operational year (under warranty)*
  - *Workers Training on Field*
  - *Final Acceptance Test*
  - *Final Acceptance Certificate*

Guarantees per for Plant Project Contracts

To Guarantee Customers bank guarantees are emitted during the project development



Control Tools in the Plant Contract

These Control Tools expected in the contract include:

- *Intermediate and Final payments*
- *Payment Completion Postponement*
- *Assignments of Next Contracts*
- *Certification by External Institutions*
- *Inspections and Testing*
- *Technical Guarantees*
- *Extra work*
- *Sureties*
- *Contractor Report*
- *Expediting Interventions*
- *Insurance*
- *Technical Supervision from Suppliers*
- *Incentives*
- *References*
- *Approvals*
- *Quality Control & Assurance*
- *Auditing Interventions*

In the phase of Project management for The *control* of the Plant Project There are the following steps:

- *Billing Advance*
- *Variations (change orders)*
- *Objections to the contractor for Execution deficiencies*
- *Additional Contracts*
- *Claims*
- *Contract Closure*

Plant Project Processes and their Phases

Progettazione

Engineering

Engineering Team

Purchasing

Purchasing Office

Acquisti

Manufacturing

Manufacturing Dept.

Realizzazione

Trasporti

Expediting

Construction

Construction Team

Costruzione

Avviamento e Collaudo

Commissioning

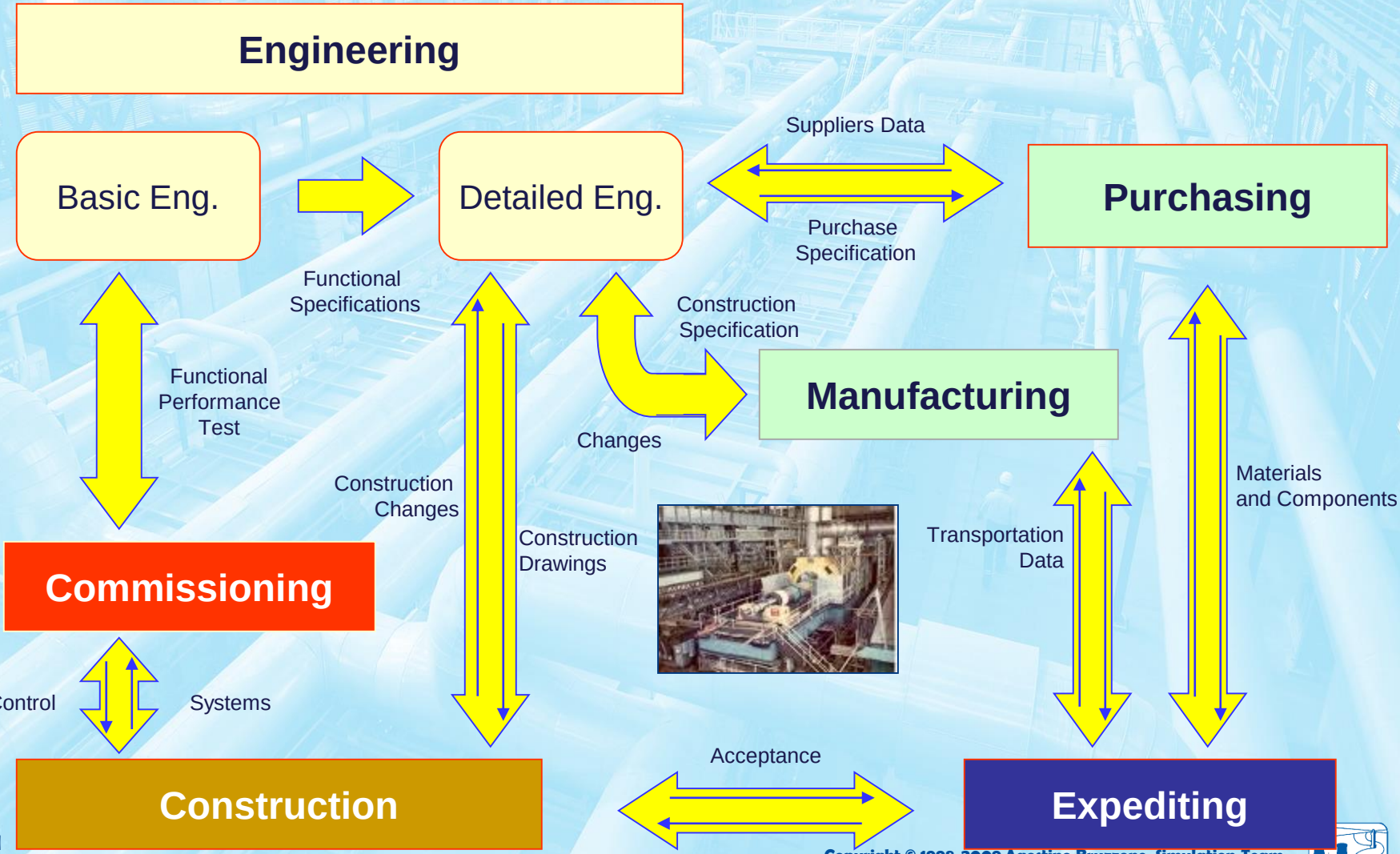
Commissioning Team

t

The Plant Project Operational Phases Are summarized in the figure; the manufacturing is often very limited if not entirely absent in the vision of the Contractor because it is managed normally by components providers.

Ovviamente l'incertezza su tempi e costi diminuisce al procedere del Progetto

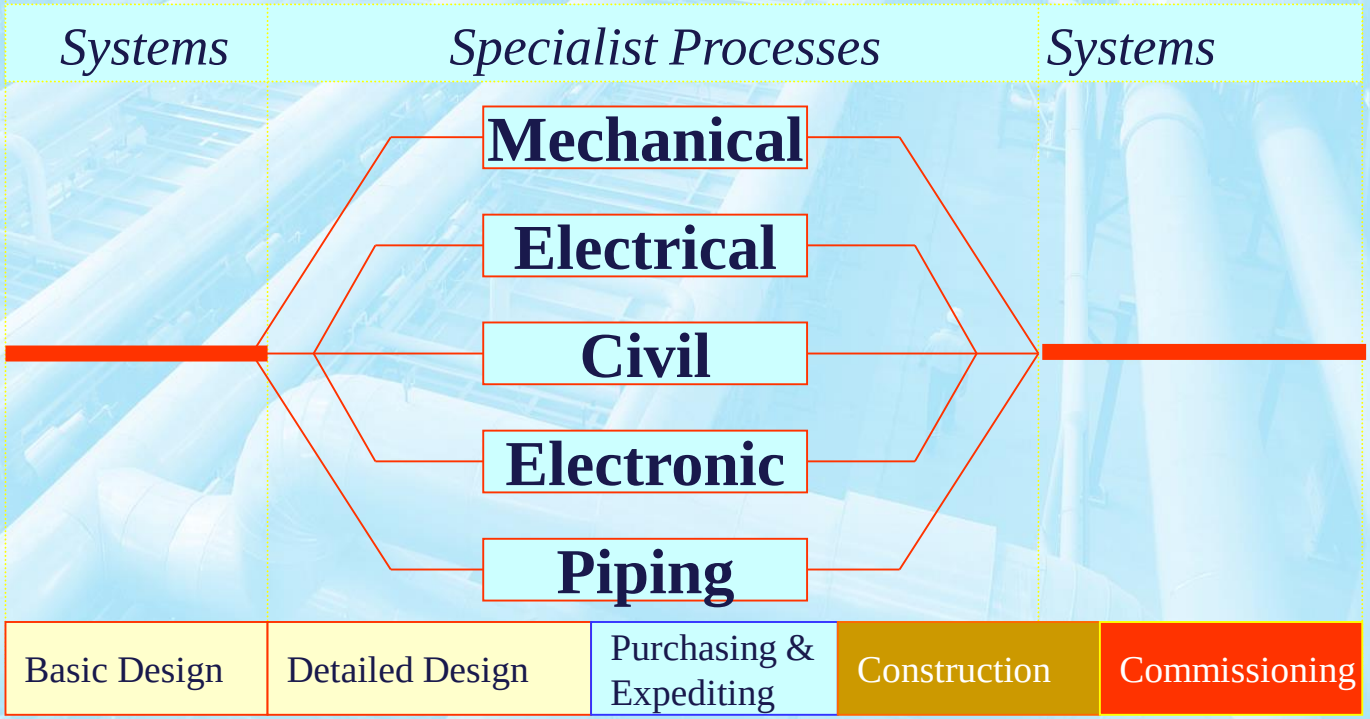
Project Phases & Correlations



Systems and Specialist Processes for Plants

Due to the strong Project uncertainty and complexity, it is important to proceed by successive approximations and to aim to *robust* solutions (less sensitive to randomness) than optimal.

The process requires a continuous Configuration Control allowing to keep low the times and costs due to engineering changes and proceeding gradually by freezing project parts.



The Project-Oriented Organization Structure

Projects are typically part of more extensive organizational structures (services, government agencies, institutions, corporations, companies, etc..). However, sometimes the project is itself an organization (i.e. Joint Venture, Partnering etc.), But obviously the organizational structure affects the Project performance.

The oriented projects Organizations are those for which the ordinary operations consist mainly of projects, then:
Organizations working mainly in Projects
Organizations using a Project Management.
Non-oriented projects have management systems for project management (i.e. Manufacturing companies); sometimes these are less effective and create sub-Oriented Project organizations

Concepts and Problems related to PM-Oriented Structures

The Project Management expects to have figures that operate as CEOs, even if with engagements restricted to specific application areas and timelines.
It is evident that this implies :

Project Manager High Freedom of Action
then constraints in top-down structures

Careful Performance Monitoring and Evaluation Procedures; so operational procedures and effective tools

A proper balance between Power, Responsibility in order to guarantee a faster decision making process and weighed choices

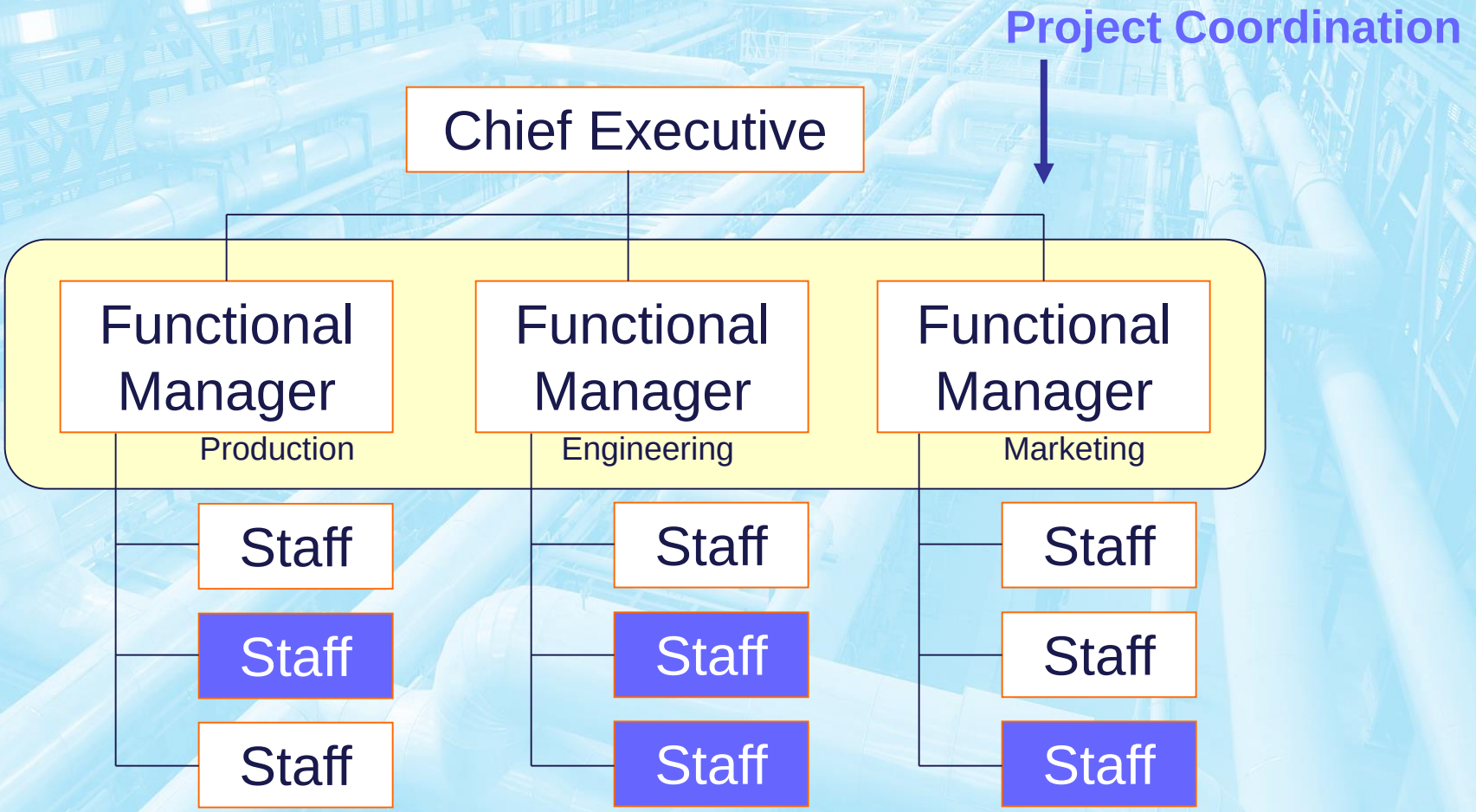
Functional Organization vs. Design Engineering

Functional organizations are typically hierarchical and every employee has a supervisor; the staff is grouped by specialties (i.e. production, marketing, engineering, etc); Projects in these areas are managed in separate phases where communication spreads in a hierarchical way to cross the structure.

A Project-oriented organization is exactly the opposite, the staff is redistributed based on the projects and responds to the Project Manager, any existing divisions are often devoted to be a service and still the referent is the Project Manager.

There are special matrixes: weak, balanced and strong, that combine features of both approaches

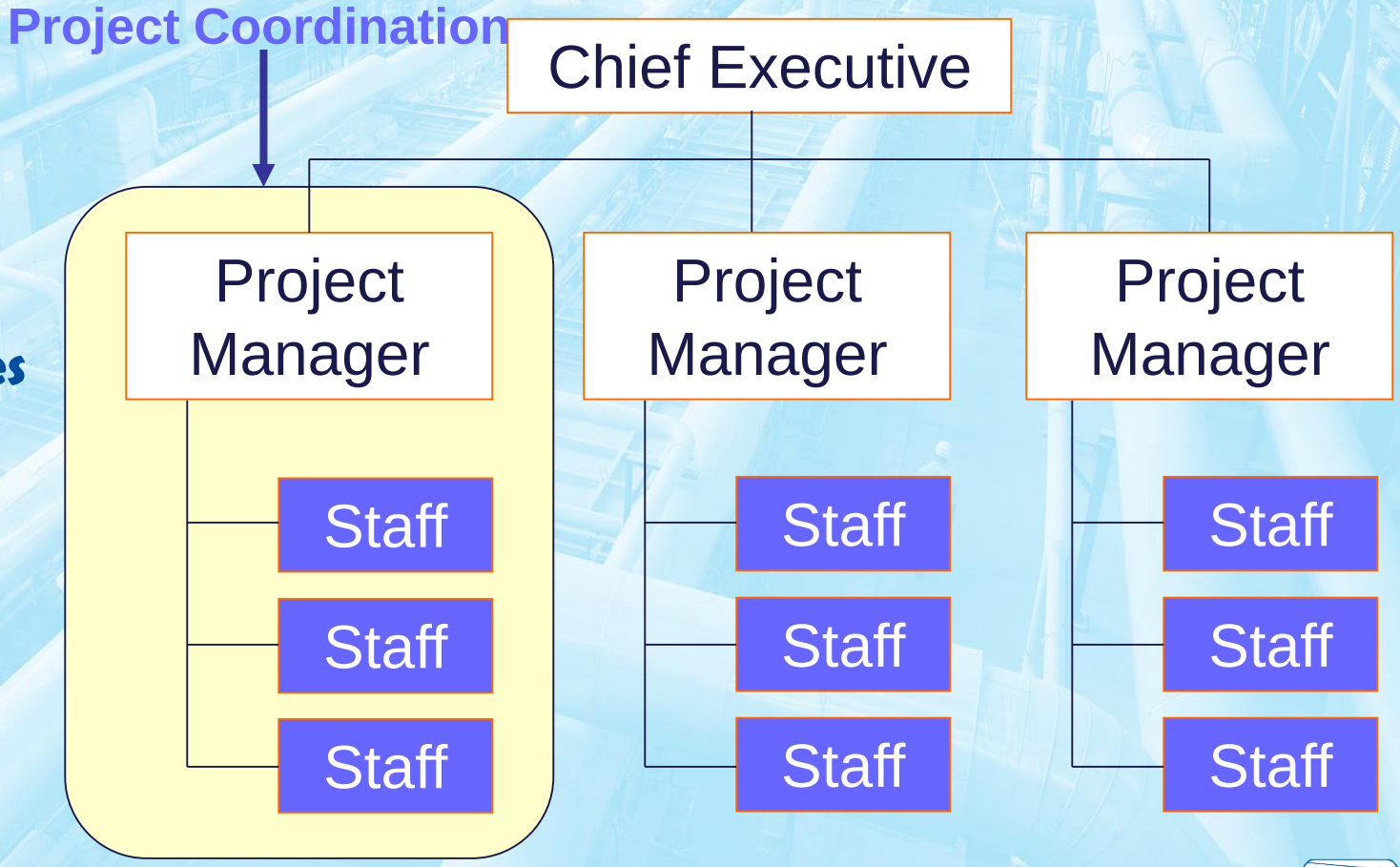
Functional Organization and PM



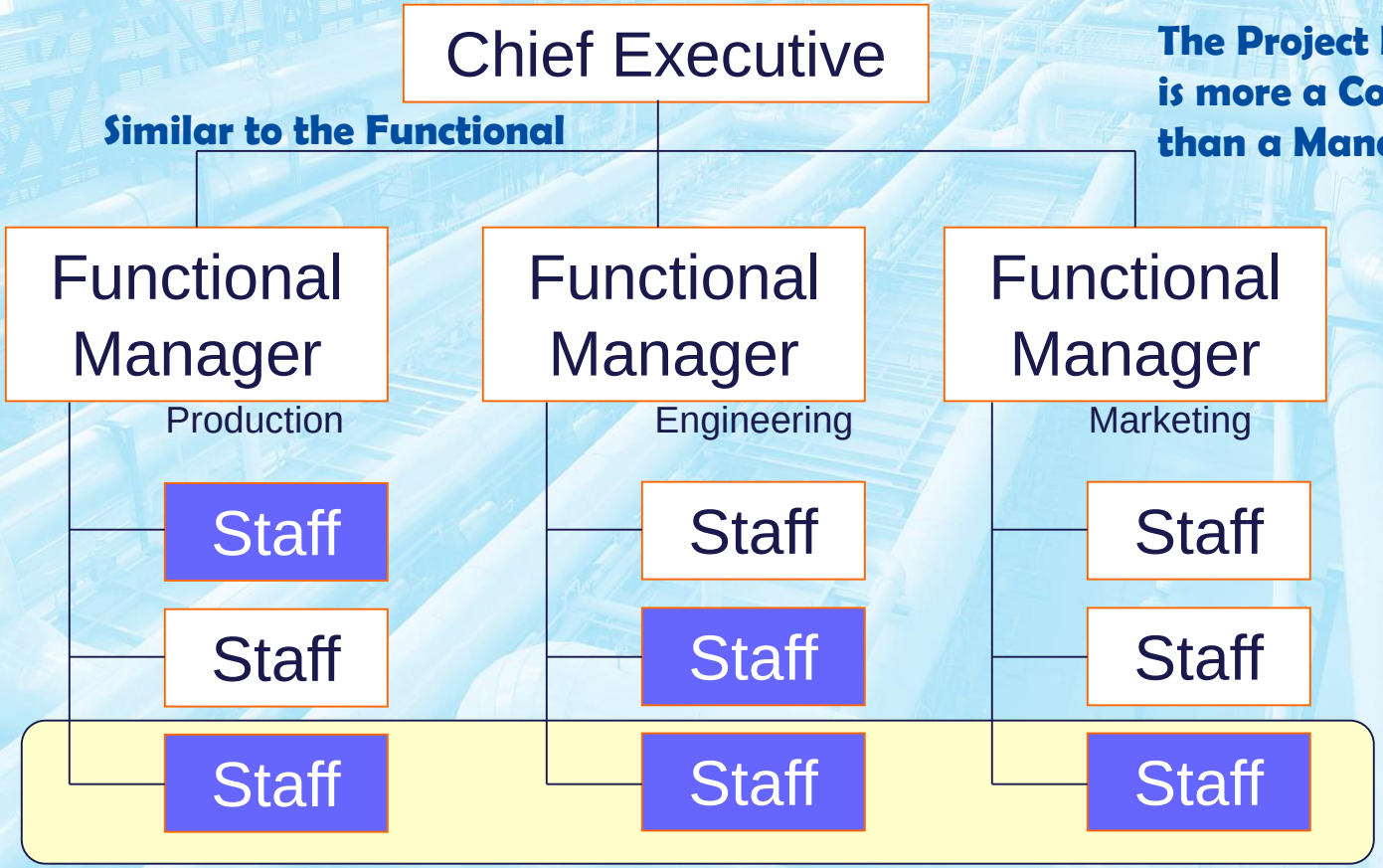
Staff in colored boxes refer to Project Activities affiliation

Project-Oriented Organization and PM

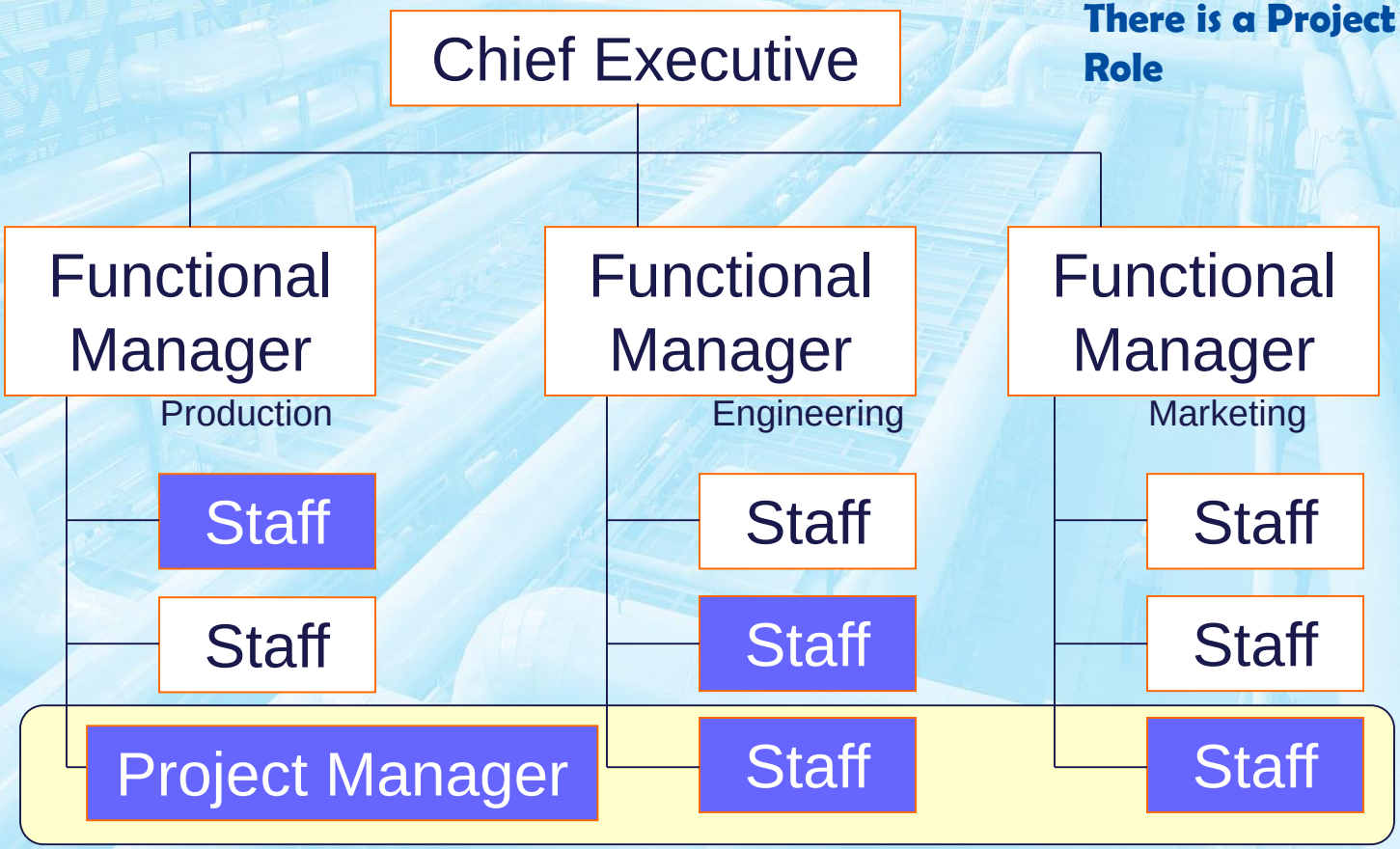
Staff in colored boxes refer to Project Activities affiliation



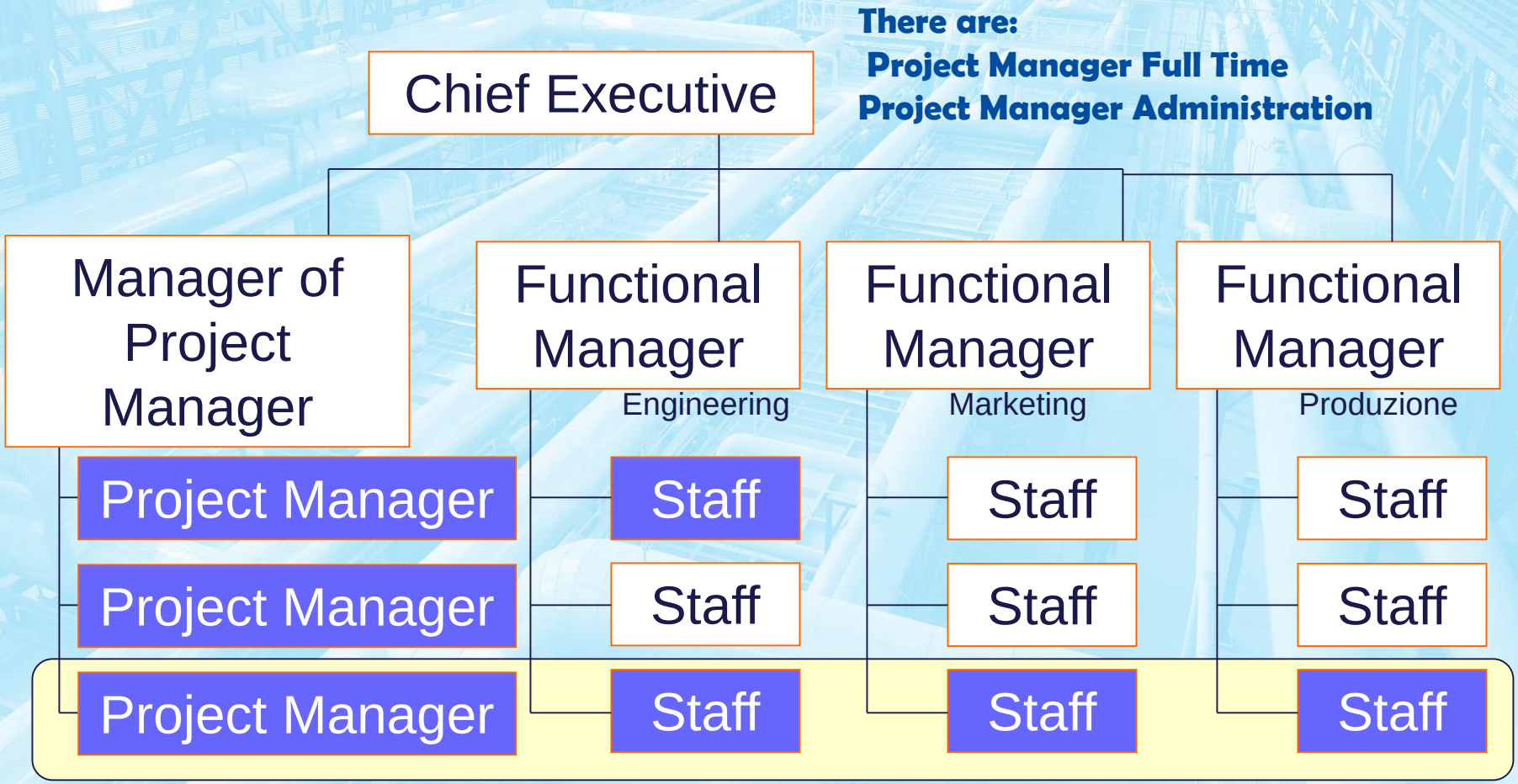
Weak Matrix Organization



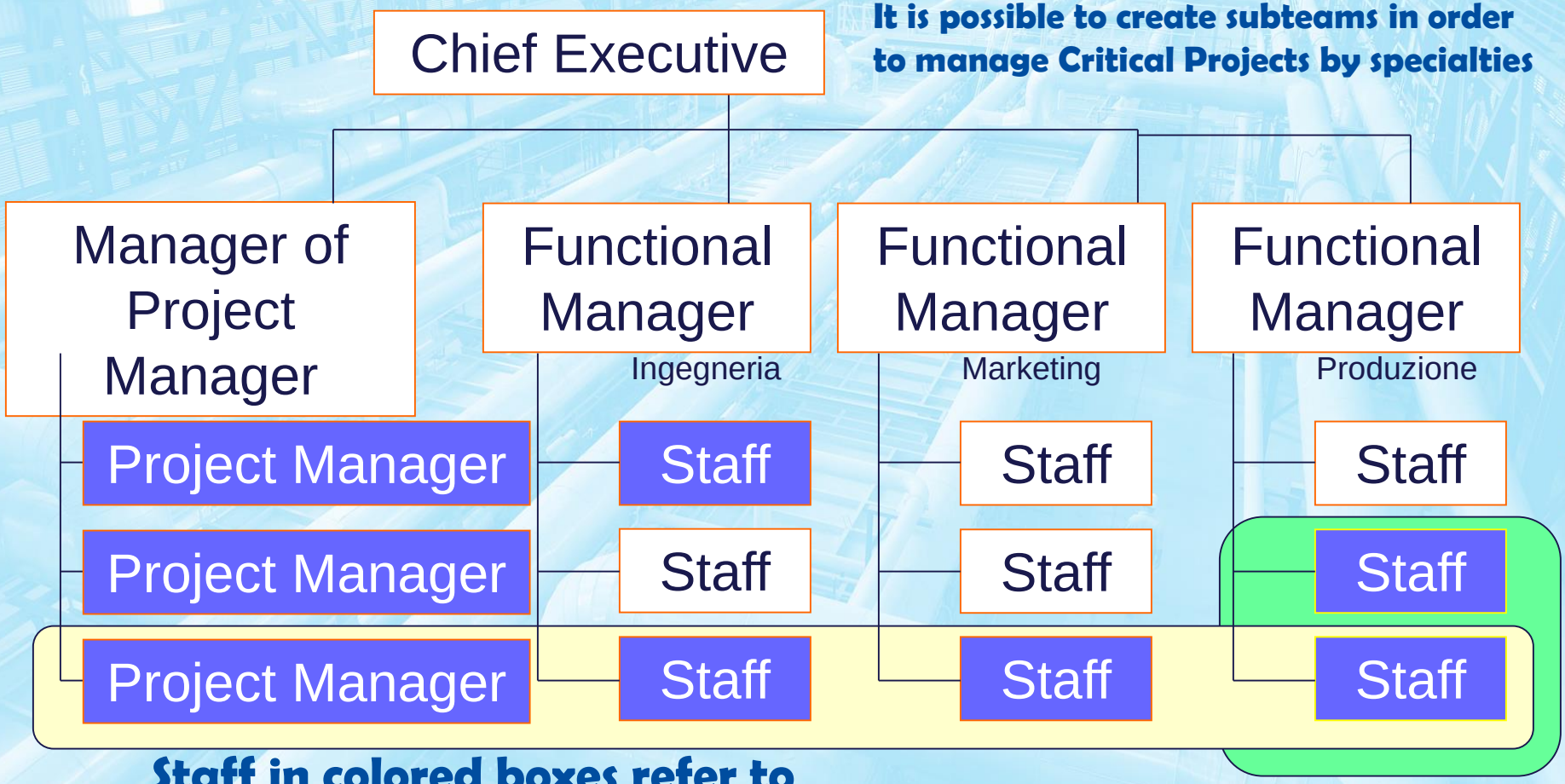
Balanced Matrix Organization



Strong Matrix Organization



Combined Organization



Organization Structure Influence on the Projects

Project Features	Organization Type				
		Matrix			
	Functional	Weak	Balanced	Strong	Project Oriented
PM Autority	Limited or None	Limited	Medium/Low	Medium/High	Very High
Workforce Rate on the Projects	About 0%	0/25%	15-60%	50-95%	85-100%
Project Manager Task	Part-Time	Part-Time	Full Time	Full Time	Full Time
Regulation & Stardards used by Project Manager	Project Coordinator / Project Leader	Project Coordinator / Project Leader	Project Manager/ Project Officier	Project Manager/ Program Manager	Project Manager/ Program Manager
Project Management Administration Staff	Part-Time	Part-Time	Part-Time	Full Time	Full Time

Project Manager Skills and Features

The Project Manager needs to have experience and good knowledge about the following sectors:

Finance and Accountability,
Commercial and Marketing,
Research and Development (R&D),
Manufacturing and Delivery
Strategic, Tactical and Operational Planning
Companies Organizational Structures,
Human Resources Management,
Benefits and Career Orientation
Skills to manage the work by motivating people, by supervision and delegation, team building, conflicts management, etc.

Drive and Manage a Project

The necessity of managing resources requires:

To define long term strategically lines for project development

To involve and align the staff, by keeping information about skills developments

Motivate, Coordinate and Inspire the involved staff; that requires technical and communication skills

Some schools (and companies) think that it is possible to train and educate Project Managers in this field (i.e. Aramco), while others expect to select as Project Manager only skilled people by distinguishing careers (i.e. SNAM Projects).

Communications & Project Manager

Due to the projects size and complexity, Communications must be carefully managed and set up, the Project Manager is responsible for:

- Approval/Set up/Definition of Communication Models and Procedures
- Supports Identification and definition of situations for their use (i.e.when remarks, when oral report, when formal report)
- Set Up and Control Communication Style
- Presentation Skills
- Know and Apply Techniques to manage Meeting

Negotiation & Project Manager

In the Project Management contracts with customers and suppliers require continuous exchanges negotiation, changes etc.

The skills of people following the negotiation should include technical aspects in order to evaluate and exploit well all the impacts.

Project Management is responsible of guaranteeing that during these phases the following elements are clear:

Objectives, Costs and Times
Current Contact Time-Limits
Contracts Assignments
Resources Status
Changes Impacts on Project Times, Costs and aims

Problem Solving & Project Manager

Problem Solving techniques should be applied continuously in the complex projects management because of their not repetitive nature.
These techniques are based on two key issues:

Problem Definition: Distinguish Causes from Effects and Identify them Correctly

Decision Making: Critical Analysis of the situation and consequences enhancement

The Project Manager is responsible of the success in applying these techniques and to oversee the proper setting of techniques, methodologies and tools to achieve successfully the problem resolution

Influencing the Organization

As the Project Manager receives a mandate for a very independent resources and money administration, and considering the inevitable unexpected events during a project, it is essential to have *political* capabilities to ensure an effective influence on the structure in order to have support.

As highlighted by the experts, however, these activities may tend to spread completely unproductive and not paying cycles and "games" respect to the specific objectives for the overall organization.

In this case it is important to underline the necessity of the ability to influence and persuade the organization to support the policy to be implemented without triggering internal conflicts.

Socio-Political Aspects and Project Management

Due to their duration and size, many project are influenced by external factors.
Being evident the impossibility to control them, it is fundamental to observe them constantly in order to promptly react and reduce risks.

Today a really important factor is the *Internationalization* including the necessity to verify the project feasibility, during the set up and the development phases, and the capability of finding new resources.

The *Globalization* increases competition problems on one hand, but on the other it could provide an interesting and more convenient market of suppliers, skills, products and services.

Cultural Influence & Project Management

The Cultural Influences can't be forgotten (i.e. the American Manager going to Canada receive notes (breviari) suggesting different attitudes with executive English rather than French speaking : speaking distance, gifts for his wife for a diner, handshake type).

It is evident that these aspects both for customer relationships both for products/workforce suppliers must be carefully considered specially in case of projects to be developed in order to evaluate times costs, unexpected events and risks.

For instance Italy developed an effective relationship with both Middle East than many Asian coutries (Pakistan, Cina, etc.).

Standards & Regulations

ISO Standard defines :

Standard: **a document approved by a recognized institution, to be used repetitively and including commonly rules, guidelines and specifications for products, processes or services; for these is still not obligatory to respect these rules**

Regulation: **a document presenting products, processes or services identified by characteristics, including the applicable administrative procedures, for which compliance is mandatory.**

Obviously Projects discussions on standards and regulation are very important and affect time, cost, resources and trading. Fundamental question therefore is whether the standards are de facto Regulations, if they are devoted to become mandatory for certification institutions requests, etc..

Project and Processes

Due to the projects nature every action, or missed action, usually involves an effect on many other following actions; as often different stochastic factors, uncertainties etc. are involved, the impacts evaluation is not always immediate.

It is possible to identify some Project components in order to analyze it more easily:

Project Processes	Processi
Process Groups	Gruppi di Processi
Process Interactions	Interazione fra i Processi

Project Processes

Let's define the Processes by considering that the Projects are composed by Processes.
A *Process* is a set of actions leading to a result.
There are two types of process:

- Project Management Processes: related to the Process Activities Presentation and Organization
- Product-Oriented Processes: related to the Project product development.

These aspects are often overlapping (in fact the process Project purpose identification Process [PM process] can not be separated from the knowledge of how to create the product [Product-oriented process])

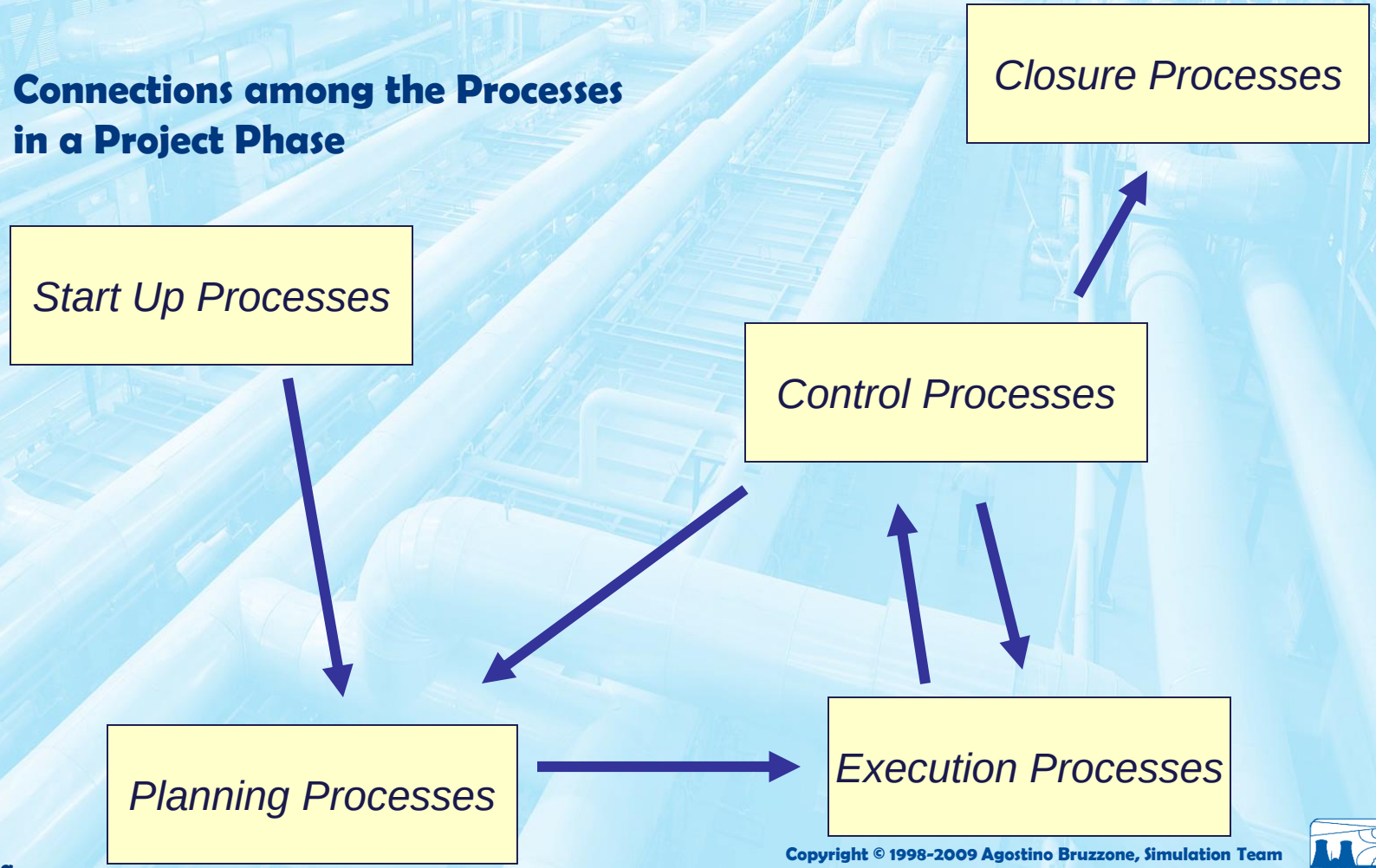
Processes Groups in Project Management

The Project Management Processes can be organized Into five *groups*:

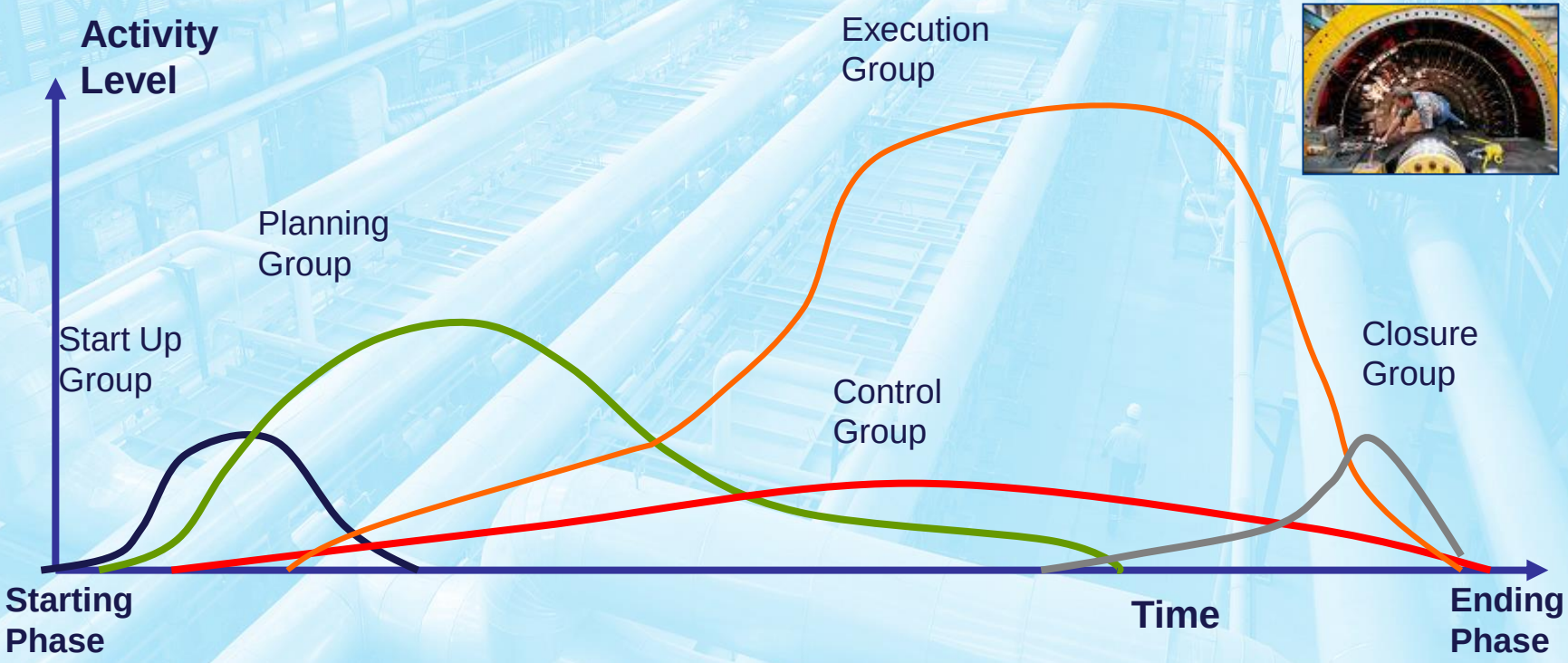
Start Up Processes:	**Identify that a project/phase can start**
Planning Processes:	**Planning organize a job schedule to achieve the objectives**
Execution Processes:	**Coordinate men and resources to operationally develop plans**
Control Processes:	**Measure performances and control the situation to know the current status and to control corrective actions**
Closure Processes:	**Formalize the developed Project/Phase acceptance**

The Five Processes Groups for a Plant Project Development

Connections among the Processes in a Project Phase



Processes Groups Overlapping

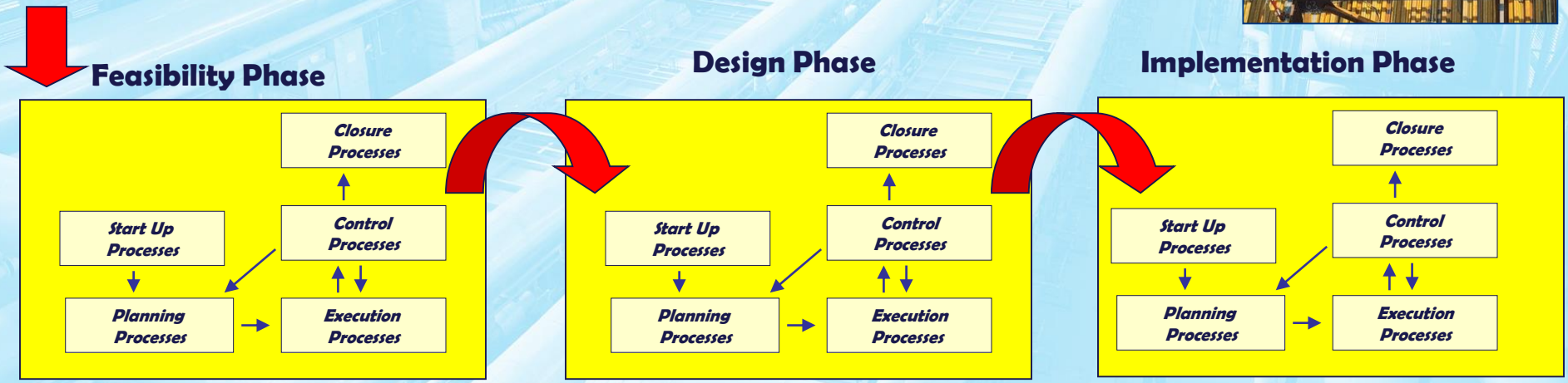


Design Phase

The processes are not point discrete events, but develop stochastically over time and so it is necessary to evaluate their overlap

Interaction among the Different Phases: an Example for Better Understanding

Previous Phase



In the reality the system is more complex due to the fact that the different internal groups exchange information each other.

Next Phase

Often it is adopted the *rolling wave planning technique:* detailed planning of the current phase and a draft of the next one

Groups Interactions

Groups or single processes interactions are based on the direct connection of:

Input: required documents, materials to start the process

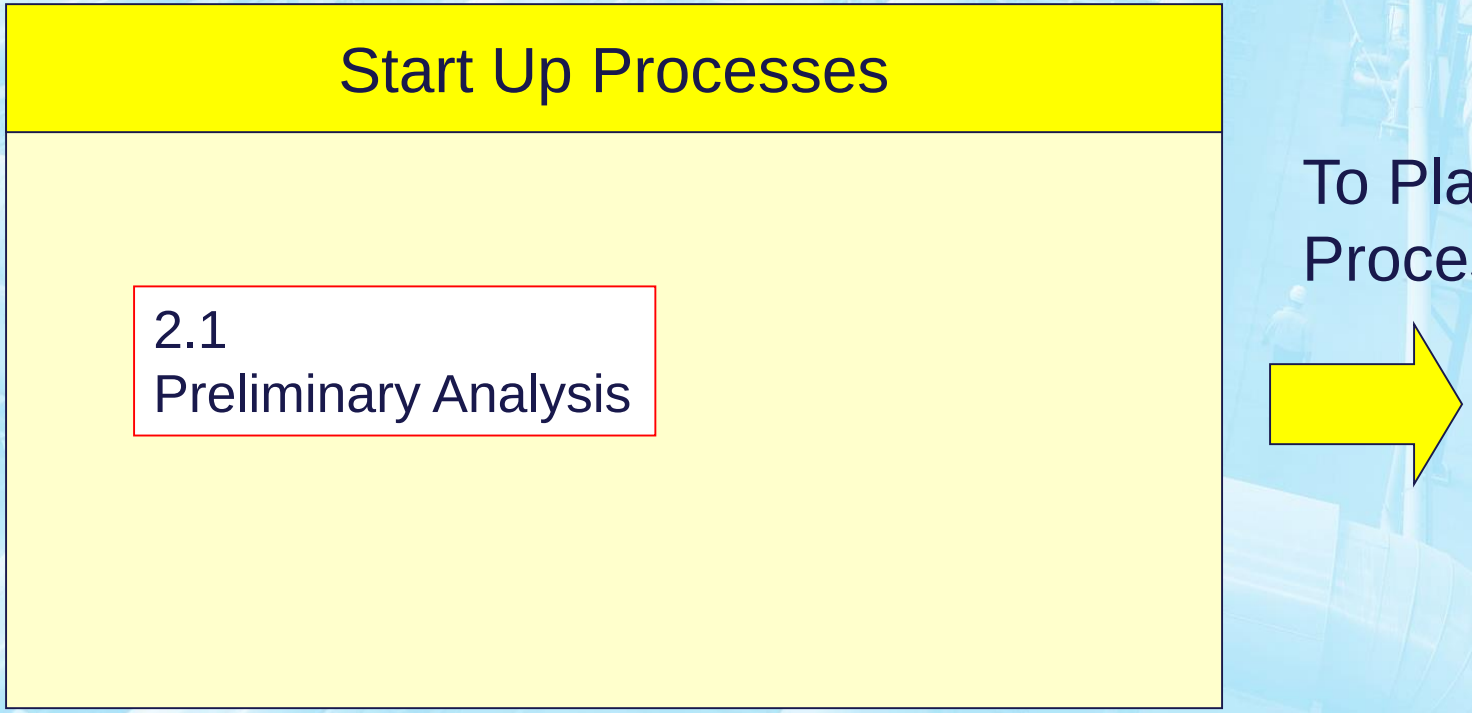
Output: documents, works made by the process

Tools & Techniques: mechanisms providing outputs from input

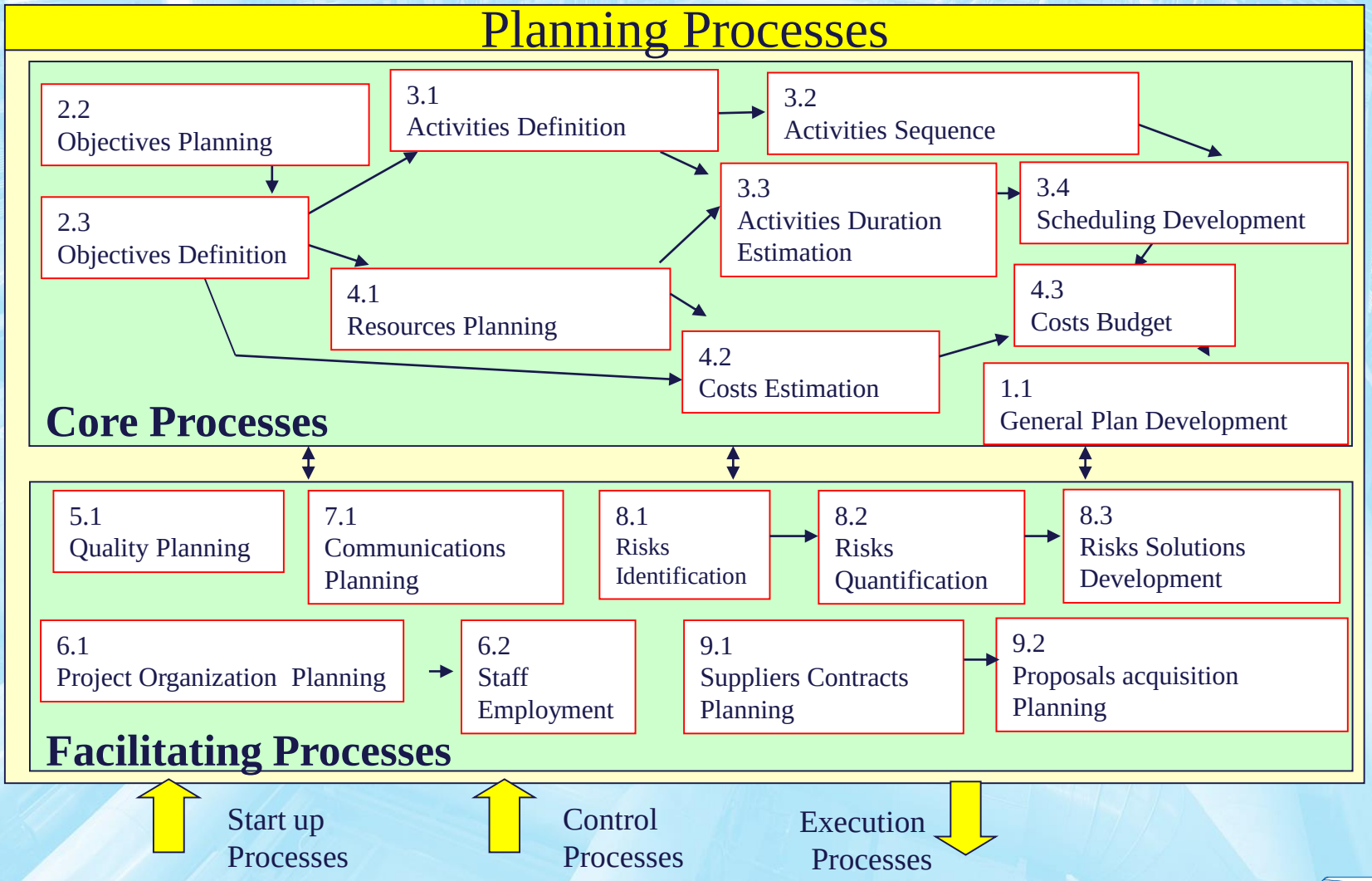
It is fundamental to know that there are different processes and techniques, even if the team multidisciplinary allows to keep specific technical skills to everybody

Start Up Process

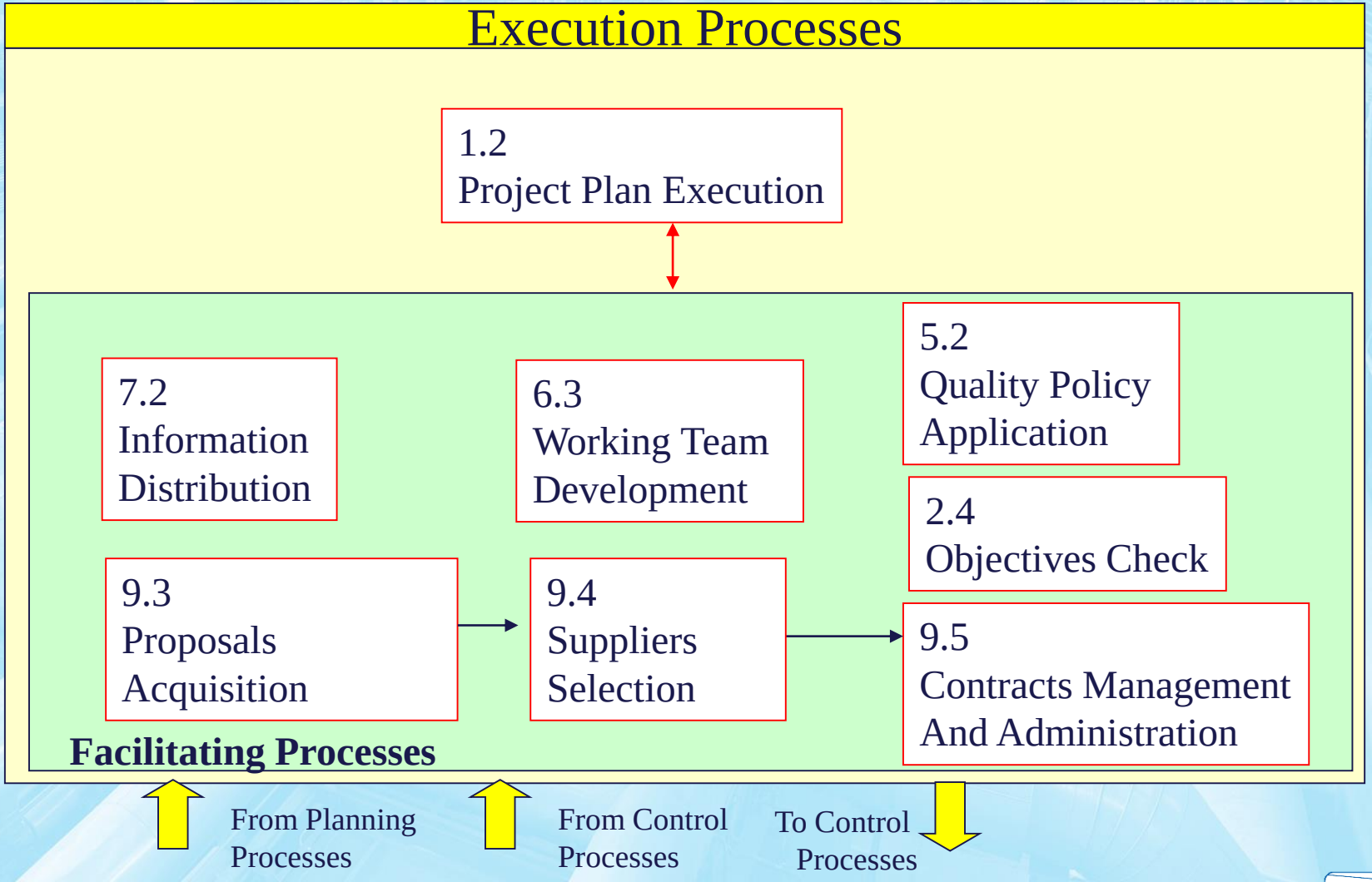
Let's see some details about Start Up Processes Group Interactions by focusing on the most famous processes:



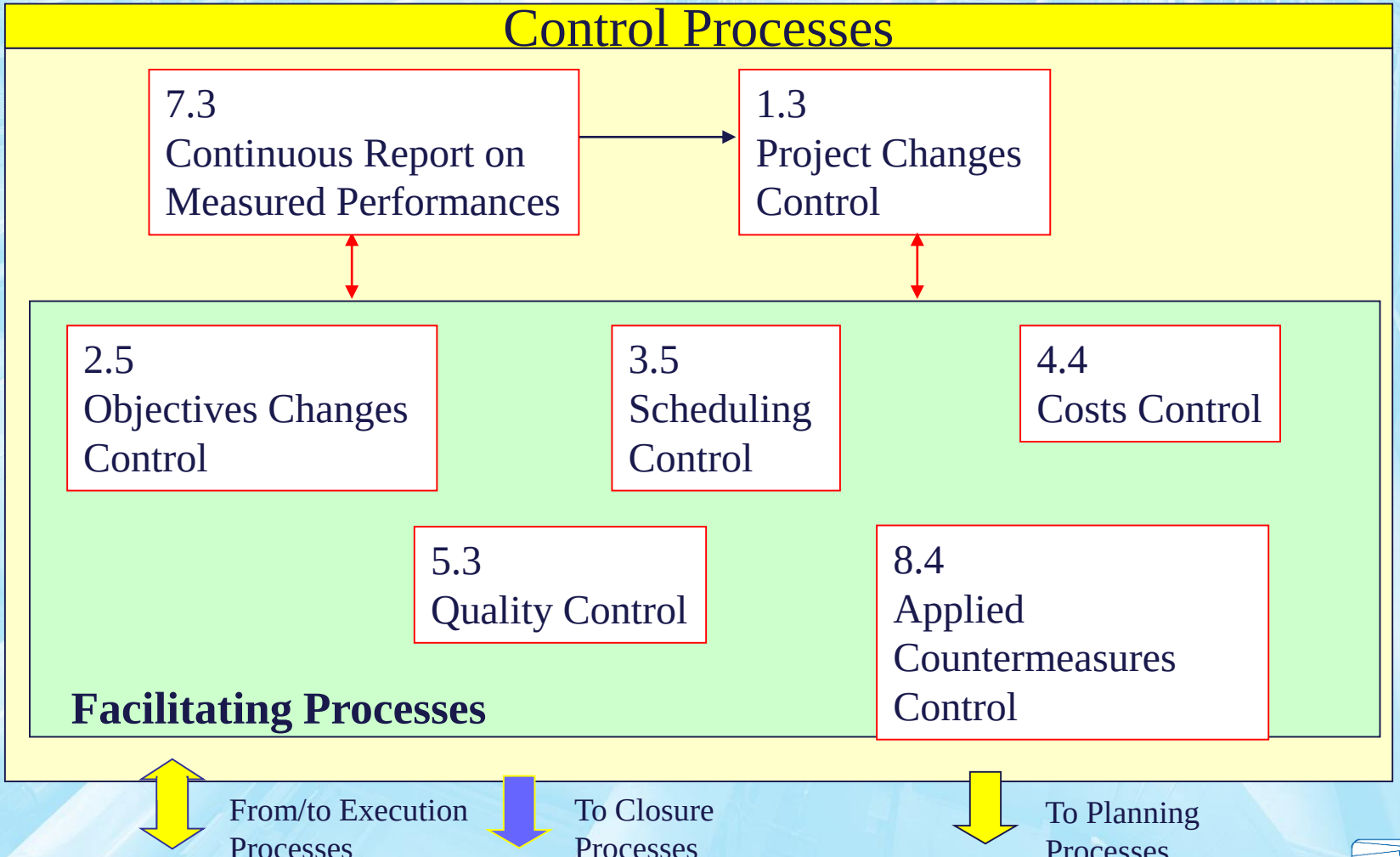
Planning Processes Group



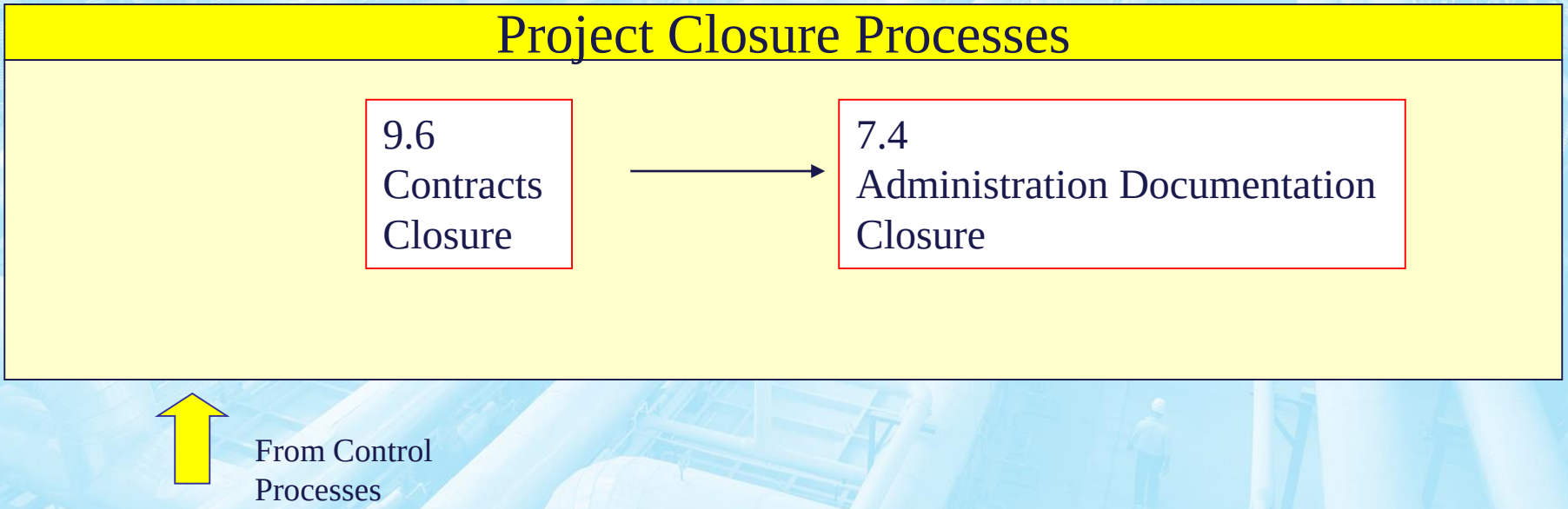
Execution Processes



Control Processes



Closure Processes



Let's see in detail the Project Closure Processes Interactions directly connected to Control Processes Group

Start up and Closure Processes

Start up Processes

2.1 Preparation Analysis

Organization activation to start Project Phases

Closure Processes

7.4 Documentation Administration Closure

Documentation Development and Distribution for the different phases completion

9.6 Contracts Closure

Closure of contractual terms and open points resolution

Planning Processes: Core Processes

2.2 Objectives Planning

Develop a Document related to Project Objectives

2.3 Objectives Definition

Elaborate Objectives and Main Alternatives in deliverables

3.1 Activities Definition

Identify activities to be set up to achieve the deliverables

3.2 Activities Sequences

Identify and Produce Documents about Dependencies and Interactions

3.3 Activities Duration Estimation

Estimate work period required by activities

3.4 Scheduling Development

Analyze sequences, duration and objectives and create scheduling

4.1 Resources Planning

Allocate Resources to each activity

4.2 Costs Estimation

Estimate costs for each activity

4.3 Costs Budget

Allocate total costs to the different jobs/sectors

1.1 General Plan Development

Collect Results of the Different Planning Processes into a single Coherent and Full Document

Planning Processes: Facilitating Processes

5.1 Quality Planning
Identify quality standards for the project and the instruments to be used to apply them

7.1 Communications Planning
Define the needs and the communications means with stakeholders

8.1 Risks Identification
Identify risks affecting the Project and study their features

8.2 Risks Quantification
Evaluate the Risks and their interactions and their impact on the project

8.3 Risks Solutions Development
Define Procedures and activities to face Project Risks

9.1 Suppliers Contracts Planning
Define what to acquire and when

9.2.Proposals acquisition planning
Collect information about specific components and identify potential suppliers

6.1 Project Organization Planning
Enroll people for the Project, Define Responsabilities, report methodologies and identify documentation and modules

6.2 Staff Employment
Acquire Human Resources to develop the Project

Execution Processes and their Components

1.2 Project Plan Execution
Proceed with Project Development based on predefined activities

2.4 Objectives Check
Formalize the Project Objectives acceptance

5.2 Quality Policies Application
Control the qualitative level and apply corrective actions

6.3 Working Team Development
Develop Individual and Group Capability to improve the Project

7.2 Information Distribution
Share the useful information with customers and stakeholders

9.3 Proposals Acquisition
Acquire proposals based on Needs

9.4 Supplier Selection
Select Suppliers among the potential ones

9.5 Contracts Management and Administration
Manage Contracts with Suppliers

Control Processes

1.3 Project Changes Control

Coordinate the changes along the project

2.5 Objectives Changes Control

Control the final objectives evolution

3.5 Scheduling Control

Control Scheduling respect

4.4 Costs Control

Control Budget Changes

5.3 Quality Control

Continuous Parameters Monitoring in order to evaluate Quality Level and define Corrective Policies facing noncompliance

7.3 Continuous Report on Measured Performances

Control Results Collection and Distribution

8.4 Control of countermeasures applied for Risks

Adapt the Risks Management during the Project Life

Processes and Interactions: Tailoring

The proposed scheme, even if general, has not to be considered an indispensable reference; different project needs or plant types may require to change the proposed structure by adding or reorganizing the processes structure.

However, it is clear that the planning phase is critical for the proper project execution, but also the auxiliary phases need to be carefully conducted, based on the technical approach, in order to properly meet the end users.

The Nature of the Processes

The processes require normally:

- Human Resources with specific competencies
- Times affected by uncertainties
- Technical and Operational Requirements

Since the projects are not characterized by repetitive behavior it is difficult to identify typical behaviors without any experience in the application area.

The implementation of techniques of analysis and calculation, however, allows to express quantitatively the correlations between processes and resources making easier the planning and reorganization process.