ÂMBITO DE TRABALHO E PLANEAMNTO EM ESTALEIROS NAVAIS

SCOPE OF WORK AND PLANNING IN SHIPYARDS

T2_1

3. SHIP BUILDING AND REPAIR SCHEDULING

1. THEORETICAL APPROACH

1. THE PROJECT SCOPE AND OBJECTIVES
2. PROJECT STRATEGIC
3. PRELIMINARY PLAN
4. RESPONSIBILITY ASSIGNMENT MATRIX (RAM)
5. WORK ANALYSIS
6. RESOURCE ASSIGNMENT
7. WORK BREAKDOWN STRUCTURE WBS

1. HOW TO ORGANIZE THE WBS

8. WORK PACKAGES
9. MILESTONES
10. PROJECT ORGANIZATION (OBS)

1. STRUCTURAL INTEGRATION
2. ACTION PLAN
3. PHASE APPROVAL STEP FORWARD

2. SCHEDULING

1. CONCEPT

1. STRATEGIC AND OPERATIONAL PLANNING
2. WHY WE PLAN
3. HOW WE SHOULD PLAN
4. A GOOD PLANNING

2. PLANNING METHODOLOGIES

1. "GANT" BARS
2. NETWORK DIAGRAMS; GERT; CPM; PERT
3. TASKS AND DEPENDENCIES
4. LEADS, LAGS, AND CRITICAL PATHS
5. ASSIGNMENT AND RESOURCE LEVELLING
6. WORK LOAD CONTOUR

3. GLOSSARY

4. PRACTICAL EXAMPLES USING A SCHEDULING SOFTWARE

3. PLANEAMENTO DE REPARAÇÕES E CONSTRUÇÕES

1. CONCEITOS TEÓRICOS DE PLANEMENTO

1. PROJECTO ÂMBITO E OBJECTIVOS
2. ESTRATÉGIA DO PROJECTO
3. PLANO PRELIMINAR
4. MATRIZ DE RESPONSABILIDADES
5. ANÁLISE DO TRABALHO
6. DISTRIBUIÇÃO DE RECURSOS
7. ESTRUTURAÇÃO DO TRABALHO ARBORIZADA (WBS)
    1. PREPARAÇÃO DE UMA ESTRUTURA ARBORIZADA
8. PACOTES DE TRABALHO
9. TAREFAS DE DURAÇÃO ZERO “MILESTONES”
10. ORGANIZAÇÃO DO PROJECTO (OBS)
    1. INTEGRAÇÃO DE ESTRUTURAS
    2. PLANO DE ACÇÃO
    3. APROVAÇÃO PARA FASE SEGUINTE

2. PLANEAR EM ESTALEIROS NAVAIS

1. CONCEITO

1. PLANEAR
2. PORQUE SE PLANEIA
3. COMO SE DEVE PLANEAR
4. UM BOM PLANEMENTO

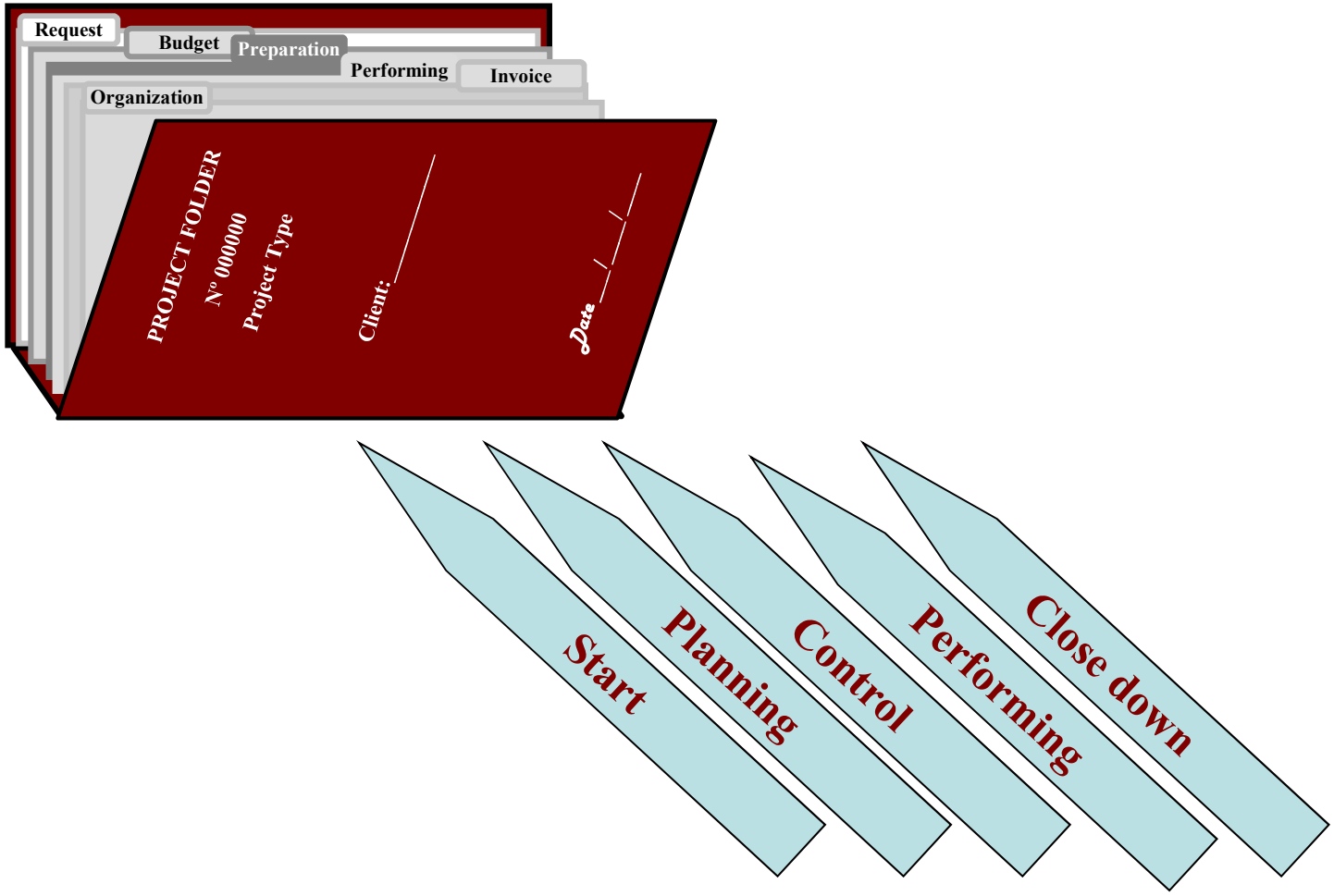
2. TÉCNICAS DE PLANEMENTO

1. BARRAS “GANT”
2. REDES; GERT; CPM; PERT
3. ÂMBITO DO TRABALHO

1. LIGAÇÃO DAS ACTIVIDADES
2. FOLGAS, MARGENS E CAMINHOS CRÍTICOS
3. AFECTAR E NIVELAR RECURSOS
4. PERFIS DE CARGA

3. GLOSSÁRIO DE PLANEMENTO

4. EXEMPLOS PRÁTICOS UTILIZANDO SOFTWARE DE PLANEAMENTO


Request
Budget
Preparation
Performing
Invoice
Organization
PROJECT FOLDER
Nº 000000
Project Type
Client: _____
Data __/__/__
Start
Planning
Control
Performing
Close down

❖ SCOPE OF THE WORK

THE SCOPE OF THE WORK (S.O.W.) COVERS THE SPECIFICATION OF THE FUNCTIONALITY OF THE FINAL PRODUCT AND IDENTIFIES THE EVOLUTIONARY STATES OF THE SYSTEM (TASKS)

IF NOT DELIMIT CORRECTLY THE CONTENT OF THE WORK AND NOT PROPERLY DOCUMENTED ITS EVOLUTION, THE PROJECT WILL TEND TO DRIFT

THE MANAGEMENT OF THE S.O.W. IS INTENDED TO ENSURE THAT THE WORK SCHEDULED IS ACCOMPLISHED AND SATISFIES THE PRE-AGREED REQUIREMENTS

- **CHANGES TO THE SCOPE OF THE PROJECT**
- **Someone sensible and knowledgeable enough about project management stated that there are at least 3 certainties in life**

☠ **THE DEATH**

€ **THE TAXES**

↗ **CHANGING THE SCOPE OF THE PROJECT**

It is practically impossible to carry out projects in which there is no *additional work* or *extras* to work initially set.

❖ OBJECTIVES

ARE QUANTIFIABLE MILESTONES IN QUALITY AND QUANTITY IN ORDER TO ASSESS THE STATE OF THE PROJECT

The objectives should be linked to the entire project or well defined areas

WITH THE OBJECTIVES CHARACTERIZED AND IDENTIFIED

- ✓ **the project definition is complete;**
- ✓ **It is possible to define the areas of work;**
- ✓ **To begin the process of splitting the work "Work Breakdown Structure" (W.B.S.).**

- **CLARIFICATION OF THE OBJECTIVES**

IN ORDER TO ACHIEVE THE OBJECTIVES IT IS NECESSARY TO:

- **THE CUSTOMER REQUIREMENTS ARE CLEARLY SET OUT;**
- **THE WORK TO BE PERFORMED MUST BE CORRECTLY IDENTIFIED**
- **THE WORK MUST BE PREPARED IN A WAY THAT CAN BE PERFORMED**

PROJECT STRATEGY

For the strategy of the project be clear it is necessary:

- **The Mission of the project is defined;**
- **In the long run, the decisions are consistent;**
- **The process of the plans have the collaboration of all the leaders of the Organization;**
- **The project has an impact throughout the Organization;**
- **To be concerned with the definition of the purposes of the Organization, the means to achieve them, and the way to perform and control the project,**

❖ PRELIMINARY PLAN

We start by fixing the type of Organization we want to in a preliminary draft. Define who does what, secure meetings, it examines the job listings, relate the resources with the activities through the preliminary operational plan, but without the detail necessary to its implementation and settling the: s

- **The Responsibilities Assignment Matrix (RAM);**
- **Internal and external meetings agenda;**
- **Work analysis (WBS, Mh; Materials and Services);**
- **Resource allocation and activities planning.**

➢ RESPONSIBILITY ASSIGNMENT MATRIX (RAM)

RESPONSIBILITY ASSIGNMENT MATRIX (RAM), ALSO KNOWN AS RACI DESCRIBES THE PARTICIPATION BY VARIOUS ROLES IN COMPLETING TASKS OR DELIVERABLES FOR A PROJECT OR BUSINESS PROCESS. IT IS ESPECIALLY USEFUL IN CLARIFYING ROLES AND RESPONSIBILITIES IN CROSS-FUNCTIONAL/DEPARTMENTAL PROJECTS AND PROCESSES.

Entity / Task	Function X	Function XY	Function XZ	Function XW	Function XT	Function XX
Act 1	A	R	C	C	I	C
Act 1.1	R	I	A	I	C	C
Act 2	C	C	R	I	A	I
Act 2.1	I	A	I	C	R	I

R - RESPONSIBLE; A - ACCOUNTABLE; C - CONSULTED; I - INFORMED.

Responsible

Those who do the work to achieve the task. There is at least one role with a participation type of *responsible*, although others can be delegated to assist in the work required.

***Accountable* (also *approver* or final *approving authority*)**

The one ultimately answerable for the correct and thorough completion of the deliverable or task, and the one who delegates the work to those *responsible*. In other words, an *accountable* must sign off (approve) work that *responsible* provides. There must be only one *accountable* specified for each task or deliverable

***Consulted* (sometimes *counsel*)**

Those whose opinions are sought, typically subject matter experts; and with whom there is two-way communication.

Informed

Those who are kept up-to-date on progress, often only on completion of the task or deliverable; and with whom there is just one-way communication. Very often the role that is *accountable* for a task or deliverable may also be *responsible* for completing it (indicated on the matrix by the task or deliverable having a role *accountable* for it, but no role *responsible* for its completion, i.e. it is implied).

NOTE: Outside of this exception, it is generally recommended that each role in the project or process for each task receive, at most, just one of the participation types. Where more than one participation type is shown, this generally implies that participation has not yet been fully resolved, which can impede the value of this technique in clarifying the participation of each role on each task.

WORK PREPARATION

- THE WORK LIST (WORK SPECIFICATION) MUST BE ANNALISE
- THE TASKS MUST BE ORIENTED ACCORDING THE SKILS;
- THE MAN-HOURS THE MATERIALS AND SERVICES MUST BE ALREADY STABLISHED;
- THE MAPPING OF THE PROCESSES AND METHODOLOGIES RELATED TO THE PROJECT, SHOULD BE PREPARED.

❖ PLANNING AND RESOURCES ALLOCATION

The preliminary plan shall be established with the main activities of the project, with the functions and specialties required for its performance (resources allocation) and referring the main known constraints (risk analyses)

THE PLAN SHALL INCLUDE:

- **The work must be divided but still at a high level (work packages);**
- **Reference to the Start and end dates even as a draft;**
- **Evidence of important milestones for the project**

The plan should contain resources (internal or external) and the tasks must have dependencies.

❖ THE HIERARCHICAL DIVISION

IN THE EARLY 60 WAS DEVELOPED A THEORY THAT ADVOCATED THE EXISTENCE OF A TOOL TO LIST THE PROJECTS WITH THE STRUCTURE NUMBERING OF THE COMPANIES, WHICH LED TO THE CREATION OF A HIERARCHICAL ENCODING

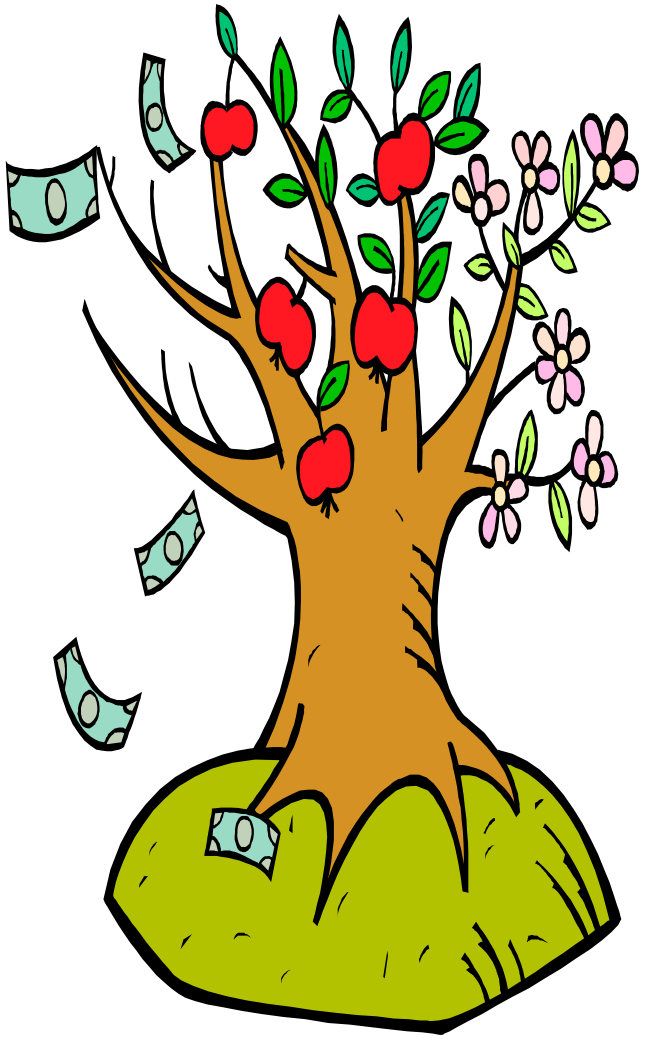
THIS ENCODING IS AN INTEGRATION TOOL THAT LISTS THE TASKS OF THE PROJECT, WITH THE DIFFERENT PARAMETERS AND DIFFERENT PROCESSES, ALSO SERVING TO DIFFERENTIATE THE VARIOUS PROJECTS WHICH TAKE PLACE IN THE ORGANIZATION.

HIERARCHICAL CONTROL STRUCTURE

Is an organized structure in tree, consisting of nodes, where each node represents a Hierarchical Node WORK

each node may be subdivided into lower-level nodes dependent on these and so on

Each node is characterized by a set of parameters that can be customized.



W.B.S". (WORK BREAKDOWN STRUCTURE)

"W.B.S" (Work Breakdown Structure) **is a code structure that divides the activities of an organised and hierarchical form.**

HIERARCHICAL CONTROL STRUCTURE

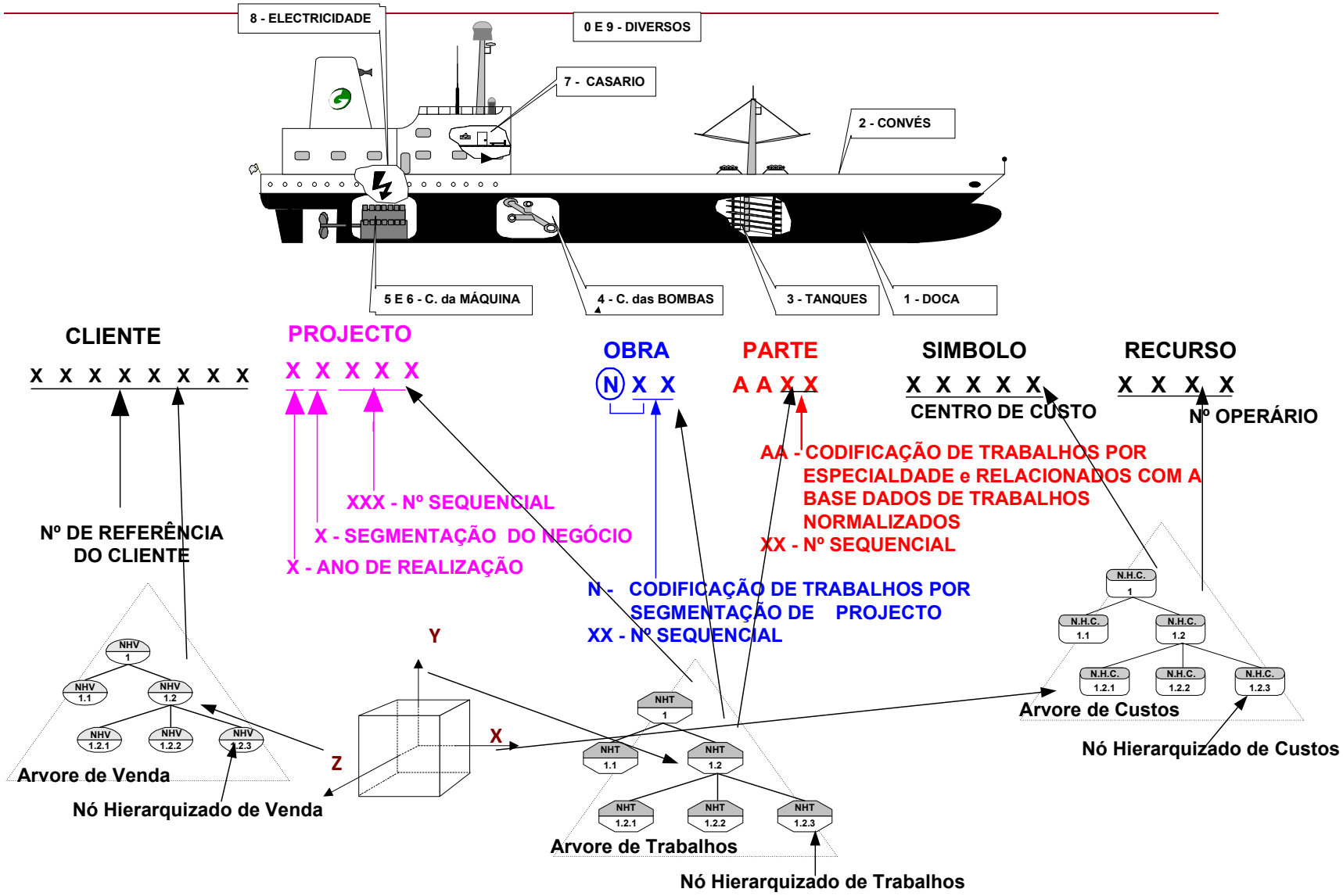
Structural Element	WBS levels	Output
Programe	0	Strategic implementation:
Project	1	Generation of wealth
Phase (Subset)	2	Value generation: (quality, cost, time limit)
Work package	3	*Milestone*
Activity	4	Measurable goals, dates (compliance, resource consumption)
Activity/Operation	5	Measurable goals (compliance technical requirements, time, cost)

NUMA ESTRUTURA *W.B.S*"." AS TAREFAS SÃO DIVIDAS EM ACTIVIDADES ELEMENTARES E RELACIONADAS ENTRE SI

ESTRUTURA	Nív.	Código W.B.S.
Activ.1 Programa	0	1
Activ.2 Projecto	1	1.1
Activ.3 Fase	2	1.1.1
Activ.4 Pacote	3	1.1.1.1
Activ.5 Activ	4	1.1.1.1.1
Activ.6 Oper	5	1.1.1.1.1.1
Activ6 Projecto	1	1.2
Activ.6 Pacote	3	1.2.1.1
Activ.7 Activ	4	1.2.1.1.1
Activ.8 Activ	4	1.2.1.1.2
Activ.9 Fase	2	1.2.2

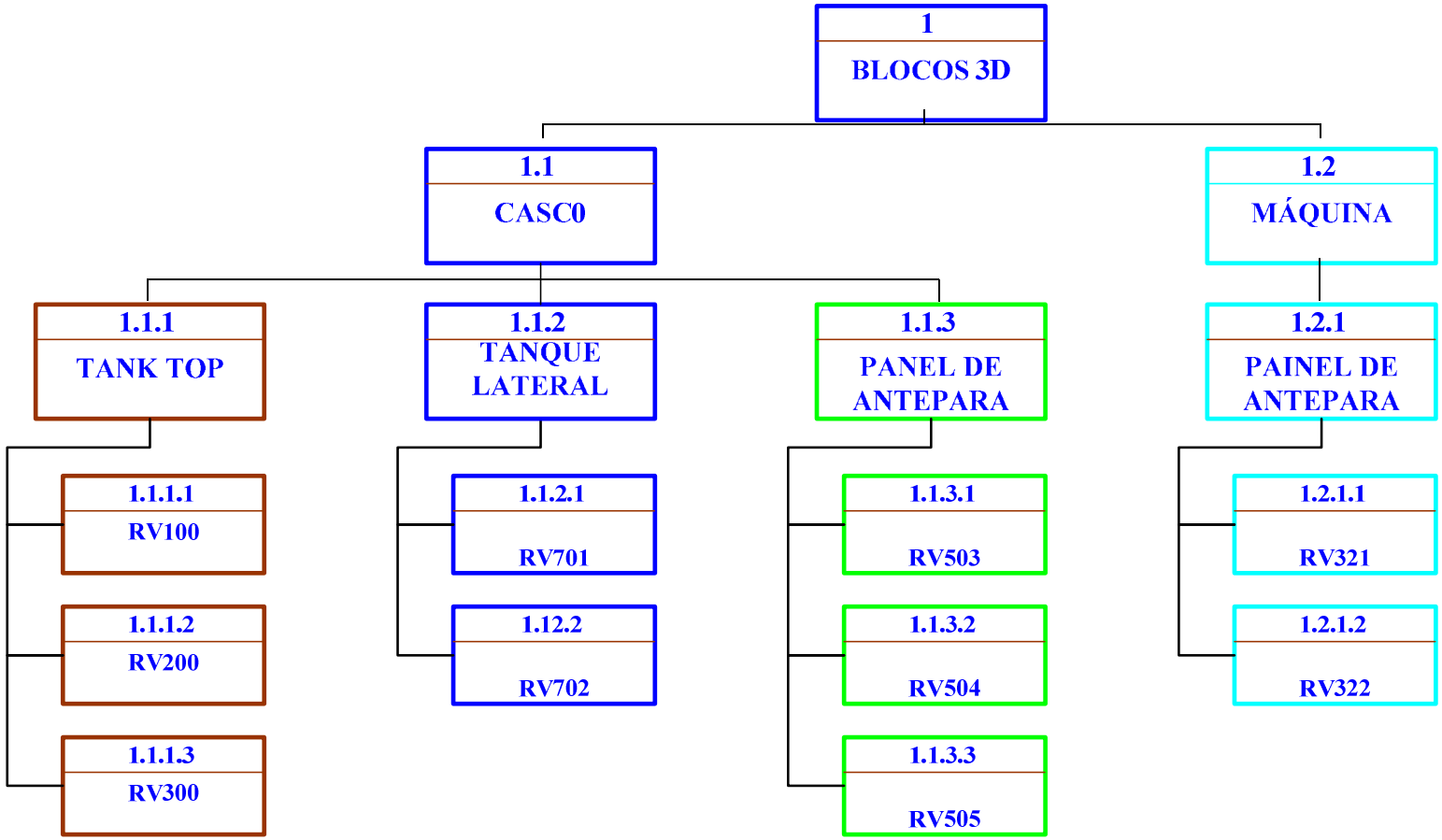
EXEMPLO W.B.S..

Exemplo real da codificação das obras do Segmento de Negócio Naval



W.B.S. DE ESTRUTURA DE BLOCOS

EXEMPLO W.B.S.



HOW TO PREPARE A WBS STRUCTURE

CRITERIA TO HAVE IN PREPARATION

- EASY TO UNDERSTAND;
- DON'T SUBDIVIDE THE ACTIVITIES WITHOUT REASONABLE PURPOSE BEARING IN MIND THAT THE GREATER THE NUMBER OF SUBDIVISIONS MORE DIFFICULT AND PAINFUL BECOMES THE CONTROL;
- MAINTAIN A CERTAIN FLEXIBILITY SO THAT YOU CAN GATHER ACTIVITIES DURING THE PROJECT;
- INSERT "MILESTONES" (ACTIVITIES OF LENGTH ZERO), SO THAT IT IS EASIER TO ACHIEVE CONCRETE TARGETS;
- ISOLATE THE RELATED EVENTS.

SFI GROUP SYSTEM

GENERAL CHARACTERISTICS OF A STRUCTURE *"W.B.S"*

- HIGHER LEVELS SHOULD NOT BE LINKED RESOURCES;
- INDENTATION OF ACTIVITIES SHOULD ONLY REPRESENT THE SET OF ACTIVITIES;
- EACH ELEMENT SHOULD BE ASSIGNED JUST ONE RESOURCE (LOWER-LEVEL ACTIVITIES);
- EACH ELEMENT OF THE STRUCTURE IS CONNECTED TO AN ACTIVITY AND MUST HAVE A GENERIC AND CLEAR DESCRIPTION.

WORK PACKAGE

IS A GROUP OF RELATED TASKS THAT ARE SET AT THE SAME LEVEL IN A HIERARCHICAL STRUCTURE AS THE WBS

EACH WORK PACKAGE HAS:

1. **START AND FINISH DATES;**
2. **A COST THAT EVOLVES AS TIME PASSES;**
3. **INDIVIDUAL TASKS WITH DURATION;**
4. **THE PLANNING IS INTEGRATED WITH HIGHER LEVEL TASKS;**
5. **DISTINCT CHARACTERISTICS FROM OTHER WORK PACKAGES.**

MILESTONES

Are zero duration activities that represent “milestones" to achieve, during the execution of the project and ensuring the achievement of the outcome(s) of the project, the time limit set (s) and envisaged date (s).

- **Determine the finalization of work packages, focus the objective (s) and not of the process (s) reach;**
- **Reach by checking the acceptance criteria;**
- **Are usually the points of Control and decision-making (e.g. approval and partial Invoice etc.);**
- **De um projecto não devem ultrapassar as duas dezenas, devem ser adequadamente intervalados (ex.: mensais) e registados no Plano de Milestones;**
- **From a project must not exceed the two dozens, must be adequately separate (e.g. monthly) and the Milestones recorded .**

PROJECT ORGANIZATION (O.B.S.)

AFTER DEFINING THE SCOPE, THE ESTABLISHMENT OF THE WBS *(WORK BREAKDOWN STRUCTURE)* AND MILESTONES PLAN, THE PROJECT ORGANIZATIONAL STRUCTURE MUST BE DEFINED O.B.S. (*ORGANIZATION BREAKDOWN STRUCTURE*)

The OBS is:

- ✓ **Negotiation;**
- ✓ **Power Delegation;**
- ✓ **Resource allocation;**
- ✓ **Adoption of a reporting system.**

❖ INTEGRATION OF STRUCTURES

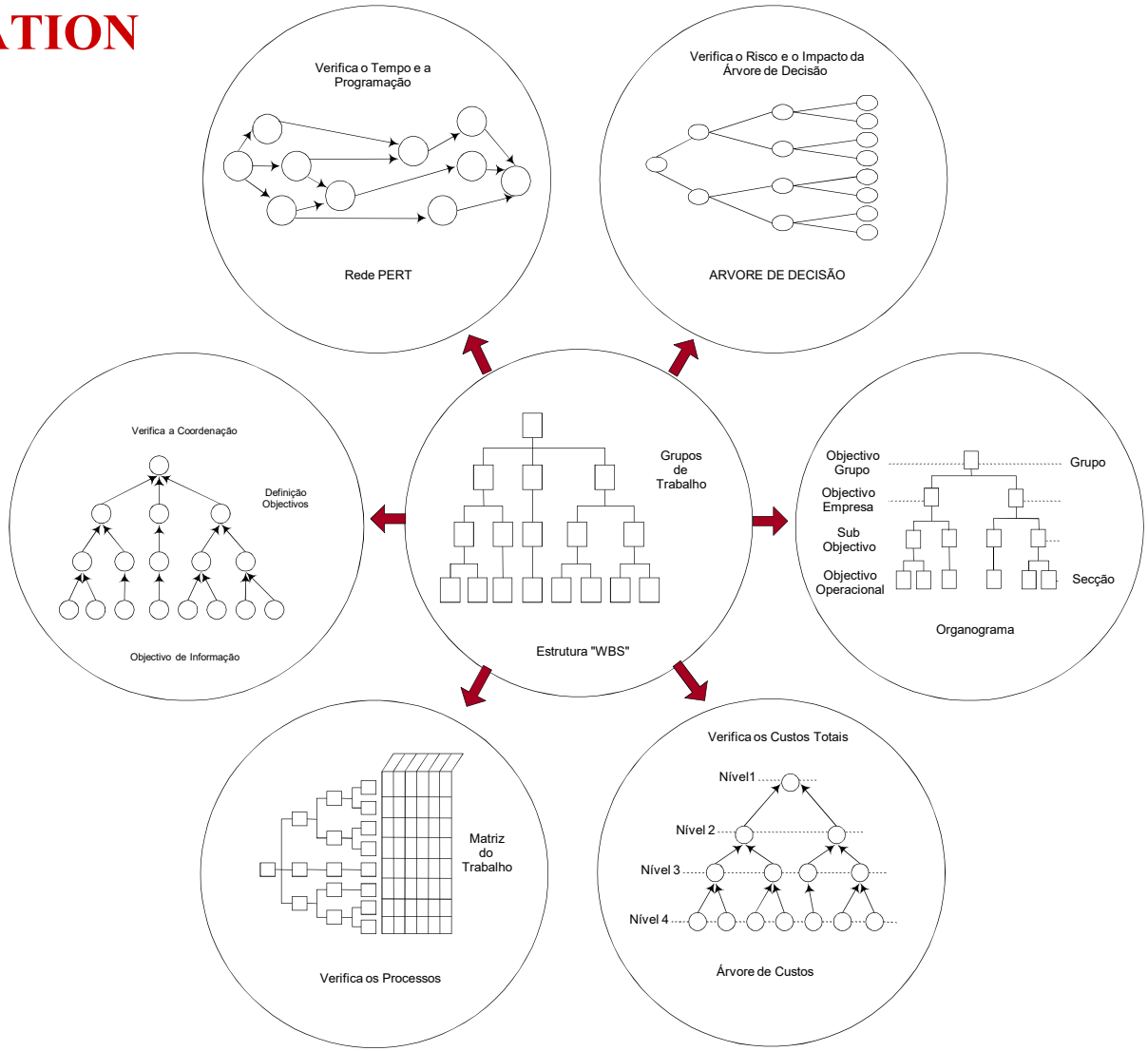
TO COMPARE, THE DURATION, THE COST AND THE PERFORMANCE OF THE PROJECT WITH THE VALUES CONSIDERED "BASELINE",

IT IS NECESSARY:

TO ESTABLISH THE CONNECTION BETWEEN THE ENCODING OF THE PROJECT ACTIVITIES (W.B.S.), WITH:

- CLIENT (S.B.S.);
- PROJECT ORGANIZATIONAL STRUCTURE (O.B.S.);
- SHIPYARD ACCOUNTING (C.B.S.).

STRUCTURAL INTEGRATION



☸ ACTION PLAN

After the team analize all the itens of the ship specification work the project manager the team prepar the action plan for the following project repair or building phases

A formal meeting should be convened not only to check that the start-up phase is finished, but also to discuss the future plan acceptance, including the resources required for the implementation of the project and report that the FORMAL ACCEPTANCE document will be submitted for approval PROJECT CHARTER

For this meeting must attend, in addition to the team members, the Project Sponsor (who depends on the approval of the project), the other Managers of the Organization, which will be responsible not only for the realization of the tasks but also for the assign resources.

☸ APPROVAL FOR THE NEXT PHASE

The project manager and the team must analyze the Budget coming from Commercials Department to see if there is need to strengthen funding and submit the plan for approval by the next phase

It is at this point that whether to decide or not to continue with the project. This "GO/no Go" decision is taken with data that is not in Control of the project manager.

The project manager must receive the authorization signed with positive or negative information.

PLANNING

IN

SHIPYARDS

❖ CONCEPT

THE PLANNING AND THE SCHEDULING CONSISTS IN SELECTING AND APPLYING THE MOST APPROPRIATE TECHNIQUES TO PRODUCE THE PLANS TO DEVELOP THE SHIP BUILDING OR REPAIR ACTIVITIES WHICH ALLOW TO ACHIEVE THE OBJECTIVES PROPOSED

THE SCHEDULE INVOLVES THE IDENTIFICATION AND PLANNING OF THE VARIOUS PHASES OF THE PROJECT, THE WORK PACKAGES AND THEIR *MILESTONES*, ACTIVITIES AND THEIR PRECEDENCE, THE NEEDS AND AVAILABILITY OF RESOURCES, TEMPORAL LIMITATIONS AND OF INTERNAL AND EXTERNAL CONSTRAINTS.

STRATEGIC PLANNING

DEFINES THE LONG-TERM ORIENTATION OF THE STRATEGIC POLICY OF THE SHIPYARD

STRATEGIC PLAN

IS THE MATERIALIZATION OF STRATEGIC PLANNING

OPERATIONAL PLANNING

PLANNING OF THE ACTIVITIES TO BE CARRIED OUT BY THE SHIPYARD, IN ORDER TO ACHIEVE THE GOALS SET IN STRATEGIC PLAN

OPERATIONAL PLAN

IS THE MATERIALIZATION OF OPERATIONAL PLANNING

PLANNING AND SCHEDULING

- DETERMINE WHAT NEEDS TO BE DONE
- AS IT SHOULD BE CARRIED OUT
- BY WHO
- WHEN
- WHERE
- IN ORDER TO ACHIEVE AN OBJECTIVE

WHY WE PLAN ?

- To HAVE A BENCHMARK For Monitoring And Control
- TO INCREASE WORK EFFICIENCY
- TO BETTER UNDERSTAND THE FUTURE OBJECTIVES

PLANNING PRINCIPLES

Good planning requires a methodical process that clearly defines the steps that lead to optimal solutions. This process should reflect the following principles:

- ***Comprehensive*** **– all significant options and impacts are considered.**
- ***Efficient*** **– the process should not waste time or money.**
- ***Inclusive*** **– people affected by the plan have opportunities to be involved.**
- ***Informative*** **– results are understood by stakeholders (people affected by a decision).**
- ***Integrated*** **– individual, short-term decisions should support strategic, long-term goals.**
- ***Logical*** **– each step leads to the next.**
- ***Transparent*** **– everybody involved understands how the process operates.**

HOW WE SHOULD PLAN AND SCHEDULE

THE TASKS SHOULD BE DIVIDED IN ORDER TO:

- ✓ Give possibility to assign responsibility and authority for each activity;
- ✓ The dependence of other activities should be the smallest possible;
- ✓ Can be measurable in terms of percentage of work done;
- ✓ The project can be described as the sum of elementary activities;
- ✓ O Planning e a rede de Planning possa ser estabelecida;
- ✓ The Budget can be established;
- ✓ The cost, the duration and the performance can be analyzed and followed;
- ✓ The deviation analyses can be performed;
- ✓ The project objectives can be achieved.

❖ PLANNING TECHNIQUES:

- **GANTT – BAR CHART**
- **GERT - *"GRAPHICAL EVALUATION AND REVIEW TECHNIQUE"***
- **CPM – *"CRITICAL PATH METHOD"***
- **PERT - *"PROGRAM EVALUATION AND REVIEW TECHNIQUE"***

❖ WHAT IS A GANTT CHART?

Gantt Chart is very familiar to us, was invented by H. L. Gantt in 1918 for Ford Engineering Company.

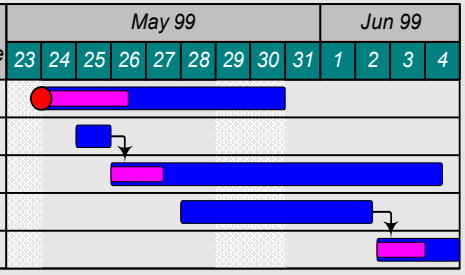
A Gantt chart, commonly used in project management, is one of the most popular and useful ways of showing activities (tasks or events) displayed against time. On the left of the chart is a list of the activities and along the top is a suitable time scale. On the right side of the chart, each activity is represented by a bar; the position and length of the bar reflects the start date, duration and end date of the activity, the activities are linked by lines reflecting the dependencies among them. This allows you to see at a glance:

- **What the various activities are and when each activity begins and ends**
- **The start and end date of the whole project, and how long each activity is scheduled to last**
- **Where activities overlap with other activities, and by how much**
- **To summarize, a Gantt chart shows you what has to be done (the activities) and when (the schedule).**

GANTT TASKS

REPRESENTAÇÃO POR BARRAS "GANTT"

ID	Task Name	Start Date	End Date	Dur	Percent Complete
1	Task 1	24-Mai-99	31-Mai-99	5d	50,00%
2	Task 2	25-Mai-99	25-Mai-99	1d	0,00%
3	Task 3	26-Mai-99	04-Jun-99	7d 4h	20,00%
4	Task 4	28-Mai-99	02-Jun-99	3d 4h	0,00%
5	Task 5	02-Jun-99	07-Jun-99	3d	50,00%



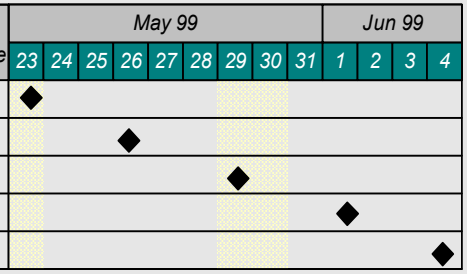
Legend: Scheduled | Actual | Current

GANTT TASKS
ZERO DURATION

MILESTONES

REPRESENTAÇÃO DE TAREFAS DE DURAÇÃO "ZERO"

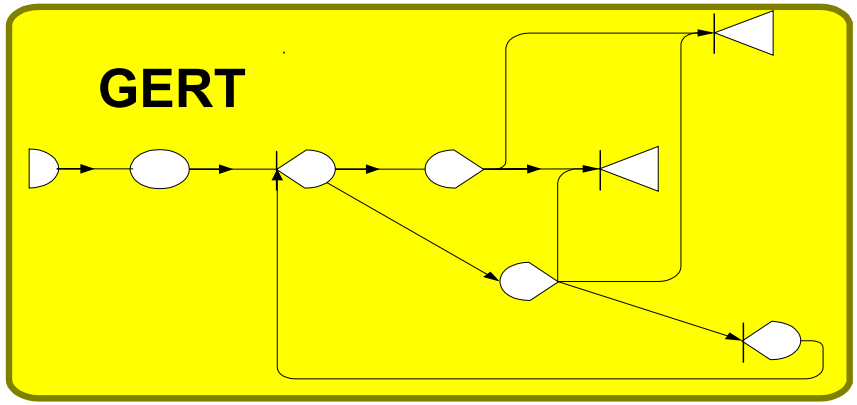
ID	Task Name	Start Date	End Date	Dur	Percent Complete
1	Task 1	24-Mai-99	31-Mai-99	1d	50,00%
2	Task 2	25-Mai-99	25-Mai-99	1d	0,00%
3	Task 3	26-Mai-99	04-Jun-99	7d 4h	20,00%
4	Task 4	28-Mai-99	02-Jun-99	3d 4h	0,00%
5	Task 5	02-Jun-99	07-Jun-99	3d	50,00%



Legend: Scheduled | Actual | Current

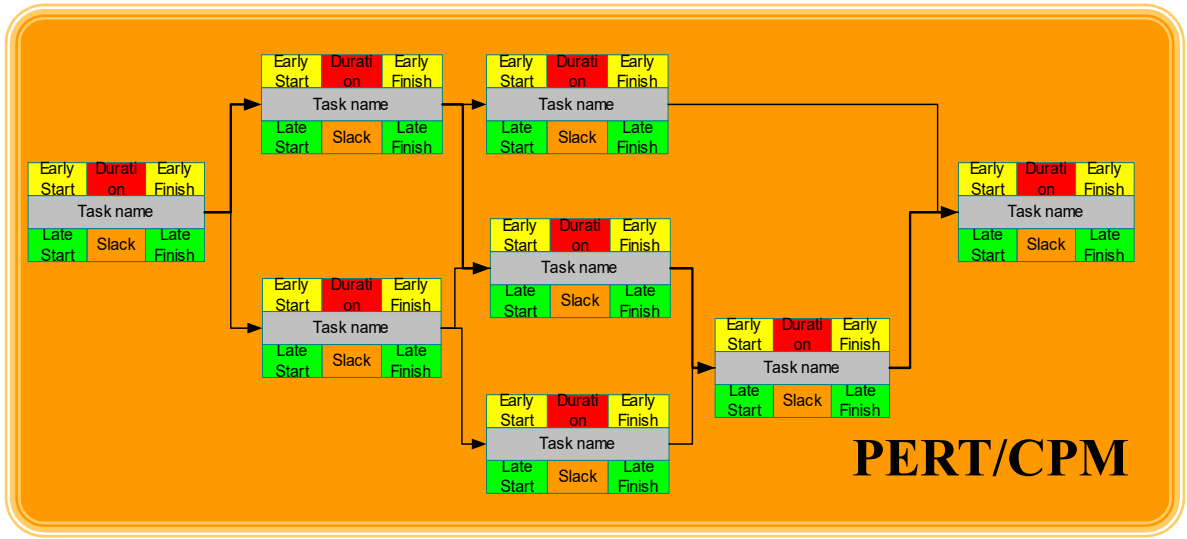
GERT *"GRAPHICAL EVALUATION AND REVIEW TECHNIQUE"*

IS A NETWORK ANALYSIS TECHNIQUE USED IN PROJECT MANAGEMENT, THAT ALLOWS PROBABILISTIC TREATMENT OF THE ESTIMATED DURATION OF THE ACTIVITIES BELONGING TO A SEQUENTIAL LOGIC NETWORK.
THE TECHNIQUE WAS FIRST DESCRIBED IN 1966 BY DR. ALAN B. PRITSKER, ARIZONA STATE UNIVERSITY PROFESSOR A RENOWNED ENGINEER.



CPM - *CRITICAL PATH METHOD*

PERT - *PROGRAM EVALUATION AND REVIEW TECHNIQUE*



❖ CPM *CRITICAL PATH METHOD*

IT WAS DEVELOPED BY DUPONT COMPANY, AT BEGINNING OF 50'S AND IS FOCUSED ON THE COST OF THE PROJECT ACTIVITIES AND THEIR DURATION. WAS USED IN 1958 FOLLOWING THE CONSTRUCTION OF ITS CHEMICAL PRODUCTION FACILITY

CALCULATION OF START, EARLIER AND LATER DATES OF TASKS BASED ON ESTIMATED DURATION (DETERMINISTIC) OF ACTIVITIES BELONGING TO A SEQUENTIAL LOGIC NETWORK

WHERE IT SHOULD BE USE - PRODUCTION

REPETITIVE TASKS, IN WHICH THE DURATION CAN BE ESTIMATED WITH A HIGH DEGREE OF CERTAINTY.

❖ PERT-PROGRAM EVALUATION AND REVIEW TECHNIQUE

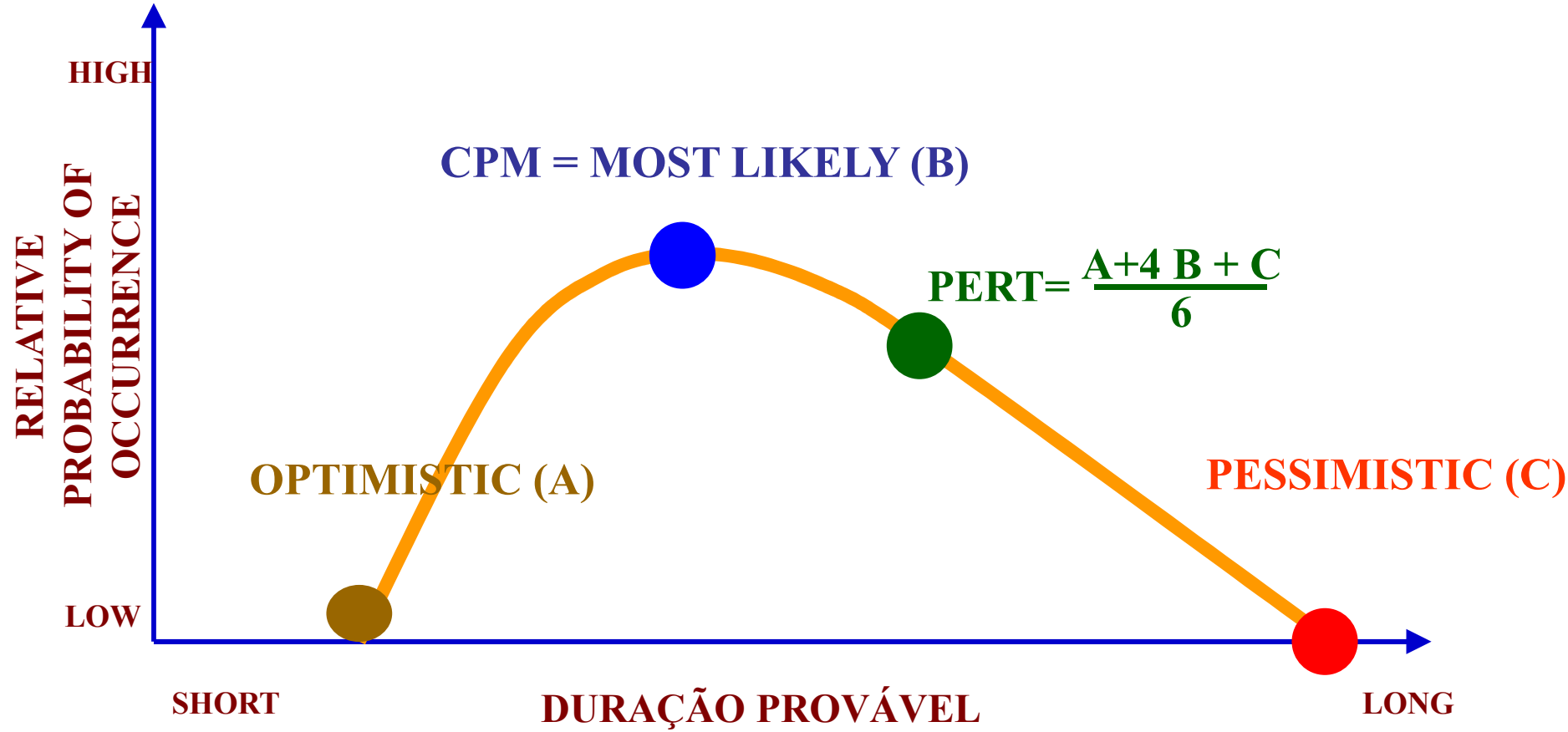
THIS MODEL WAS INVENTED BY "BOOZ ALLEN HAMILTON, INC." AND APPLIED IN 1957 BY THE NAVY OF THE UNITED STATES TO BE USED IN PLANNING AND CONTROL OF THE PROGRAM TO BUILD A NUCLEAR SUBMARINE "POLARIS PROJECT" AND WAS FOCUSED ON REDUCING THE TIME OF REALIZATION OF THE PROJECT.

IS A TECHNIQUE THAT ESTIMATES (MULTIPLE ESTIMATES) THE PROJECT DURATION, BASED ON A *PROBABILISTIC* DURATION OF THE WEIGHTED AVERAGE ACTIVITIES, BELONGING TO A SEQUENTIAL LOGIC NETWORK

WHERE IT SHOULD BE USE – PROJECT MANAGEMENT

NON-REPETITIVE TASKS IN WHICH THE DURATIONS CANNOT BE ESTIMATED WITH A HIGH DEGREE OF CERTAINTY.

DIFFERENCE BETWEEN CPM and PERT

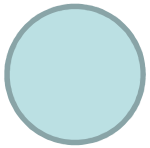


❖ NETWORKS

Graphical representation of a project that shows the chronological sequence and the interrelationships of all activities that constitute it.

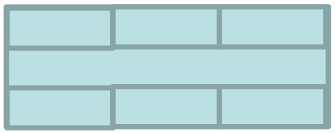
Normally used in this representation three conventional symbols:

THE CIRCLE



THE ARROW

THE RECTANGLE

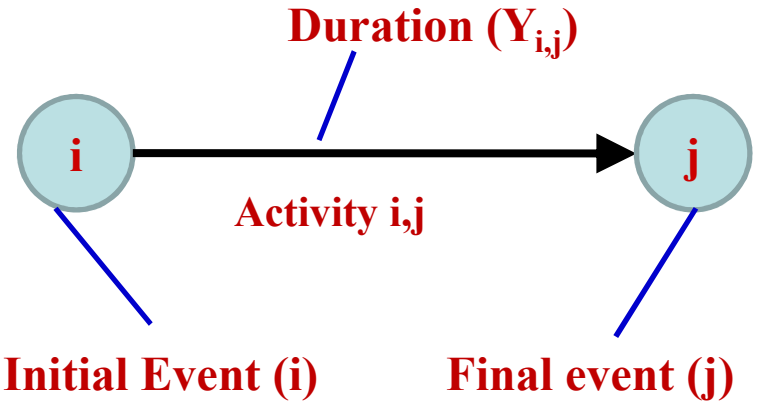


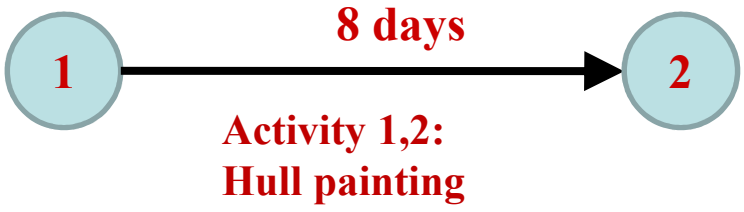
ADM - ARROW DIAGRAM METHOD or
AOA – ACTIVITY on ARROW DIAGRAM

Network type (i, j)

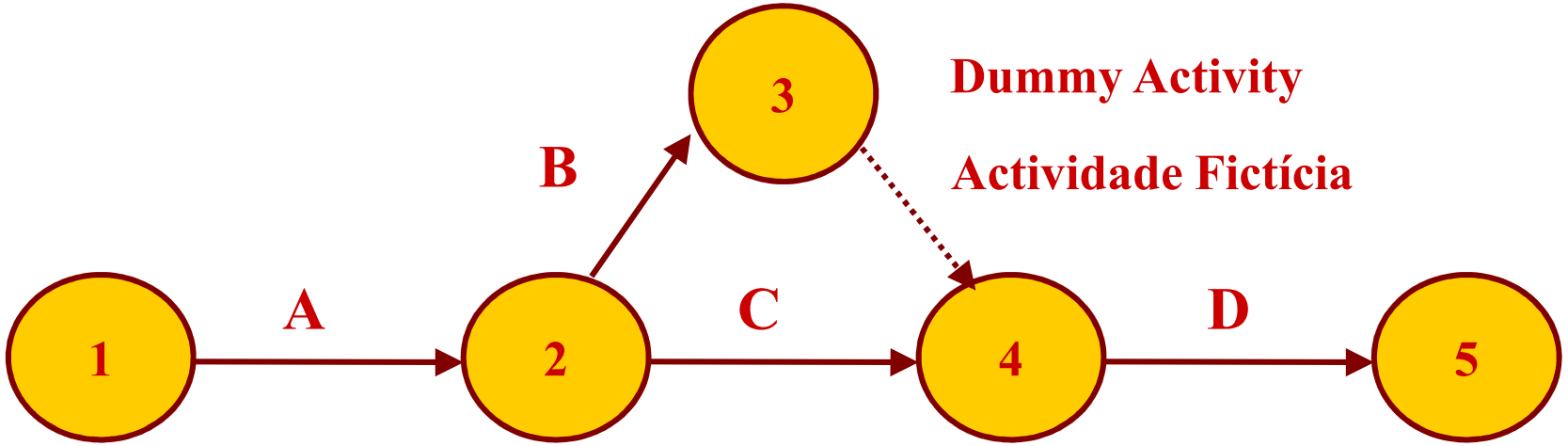
Each network activity (i, j) is represented by an "arrow" with its events, initial (i) and finished (j), well defined and linked to the nodes to indicate dependencies.

The duration of each activity ($Y_{i,j}$) is normally indicated on the arrow. This program uses fictitious activities, dummies, of null duration to indicate precedence, and to distinguish activities with the same Start and End.





ACTIVITY-ON-ARROW

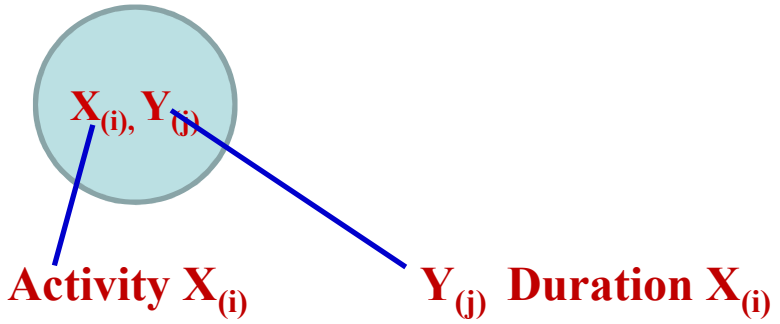


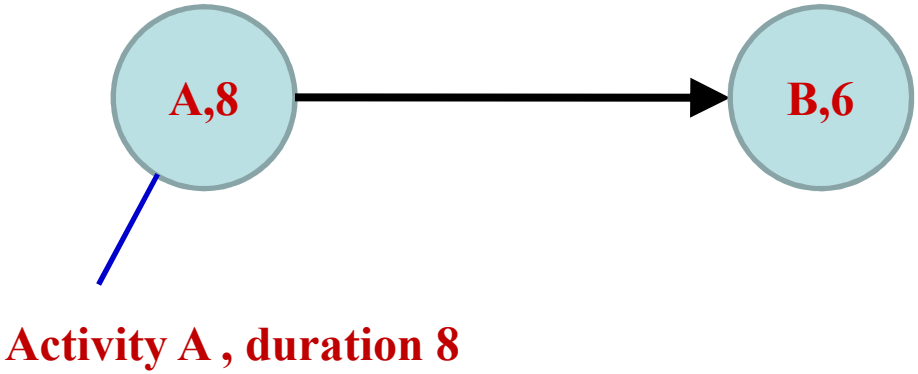
PDM - PRECEDENT DIAGRAM METHOD

AON - ACTIVITY on NODE NETWORK DIAGRAM

Network (X_i)

Each network activity or task is represented by a box or network node and the dependencies, or precedence links between the activities are represented by "arrows", being Start-End precedence the most usual. The duration of each activity is usually indicated within the circle right after the symbol that represents the activity



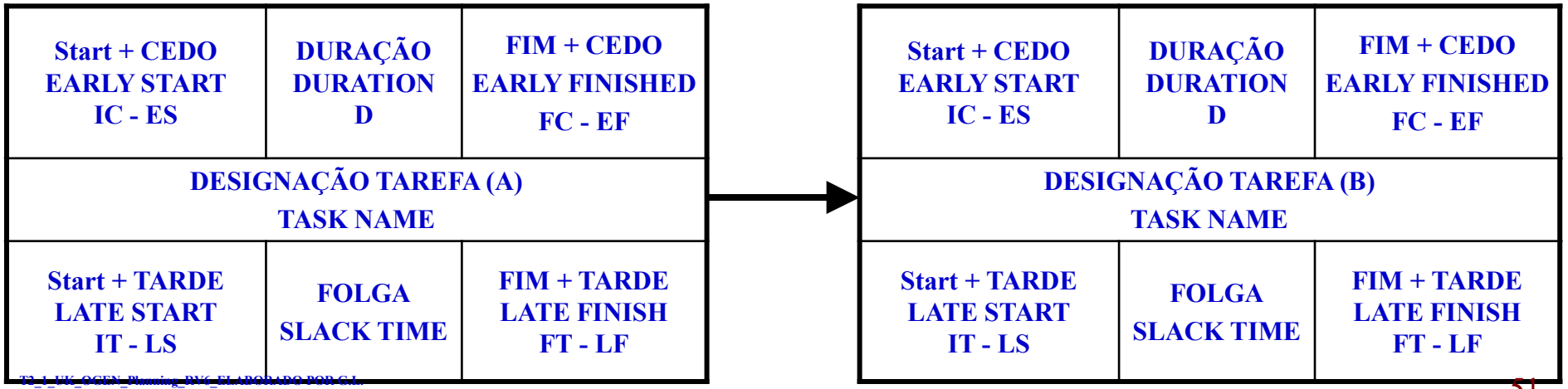


PDM - PRECEDENT DIAGRAM METHOD

AON - ACTIVITY on NODE NETWORK DIAGRAM

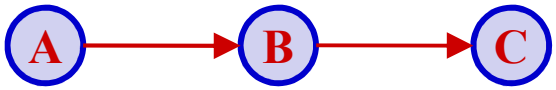
Network (X_i)

Each of the network activity is represented by a box node and the dependencies or precedence links between the activities or tasks are represented by "arrows", with the precedence of type, Start-End the most used. The rectangle of the box contains several information are represented.



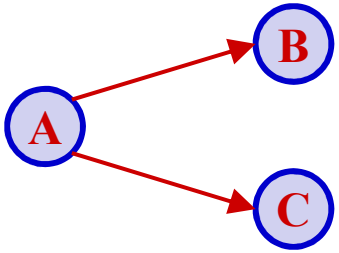
Networks AON e AOA

AON



A deve acabar antes de *B* e *B* antes de *C*

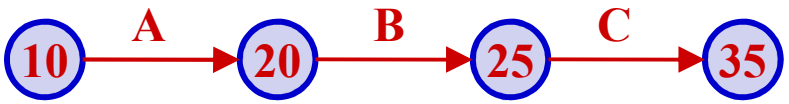
A must finish before *B and B* before *C*

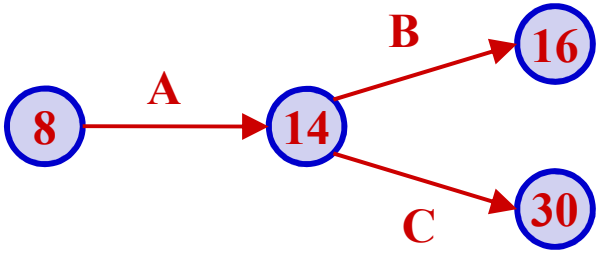


A deve acabar antes de *B* e *C* começarem

A must finish before *B and C start*

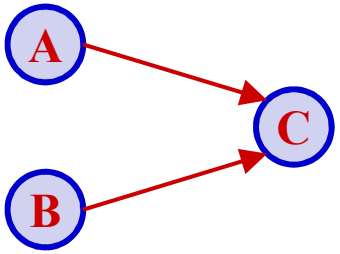
AOA



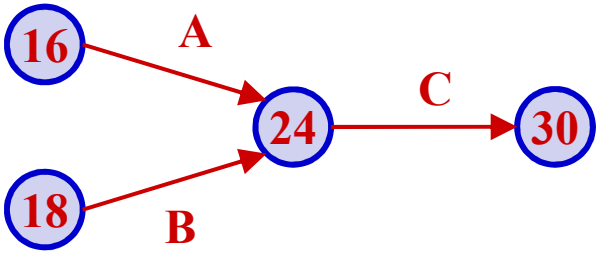


Networks AON e AOA

AON

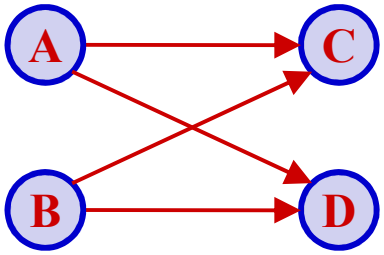


AOA



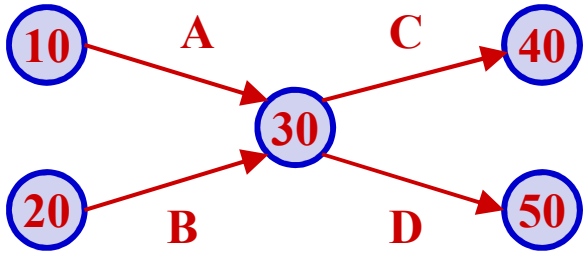
A e *B* devem acabar antes de *C* começar

A and *B* must finish before*C* start



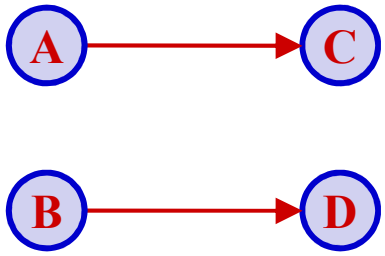
A e *B* antecede *C* e *D*

A and *B* precedes *C* and *D*

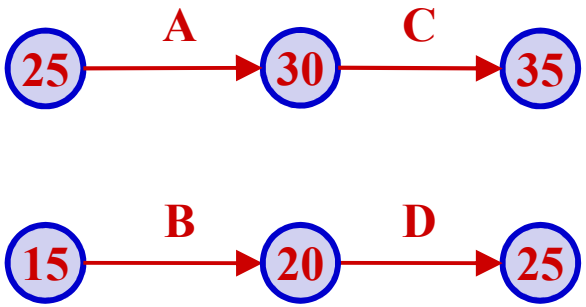


Networks AON e AOA

AON

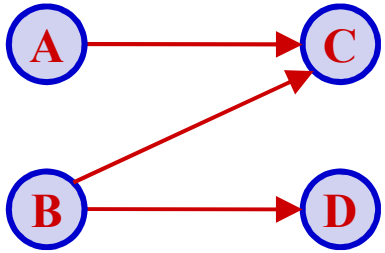


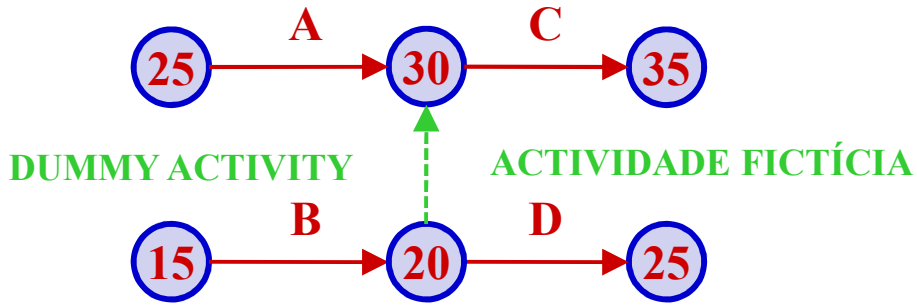
AOA



A antecede ***C*** e ***B*** antecede ***D***, mas o caminho ***A-C*** é independente de ***B-C***

A precedes ***C*** and ***B*** precedes ***D***, but the path ***A-C*** is independent of ***B-C***



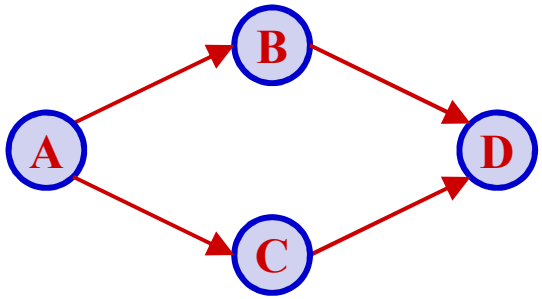


A e ***B*** precedes ***C***, ***B*** precedes ***D***, but ***A*** is independent of ***D***

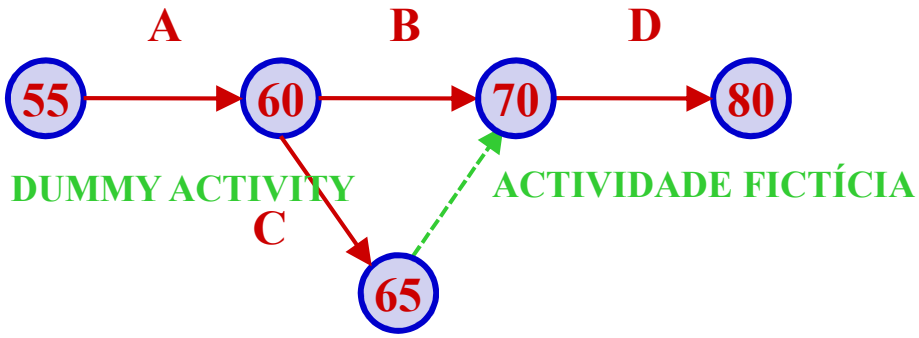
Networks AON e AOA

		ACTIVIDADE	PRECEDES	SUCCEEDS
55	60	A		B - C
60	70	B	A	D
60	65	C	A	D
70	80	D	B - C	

AON



AOA



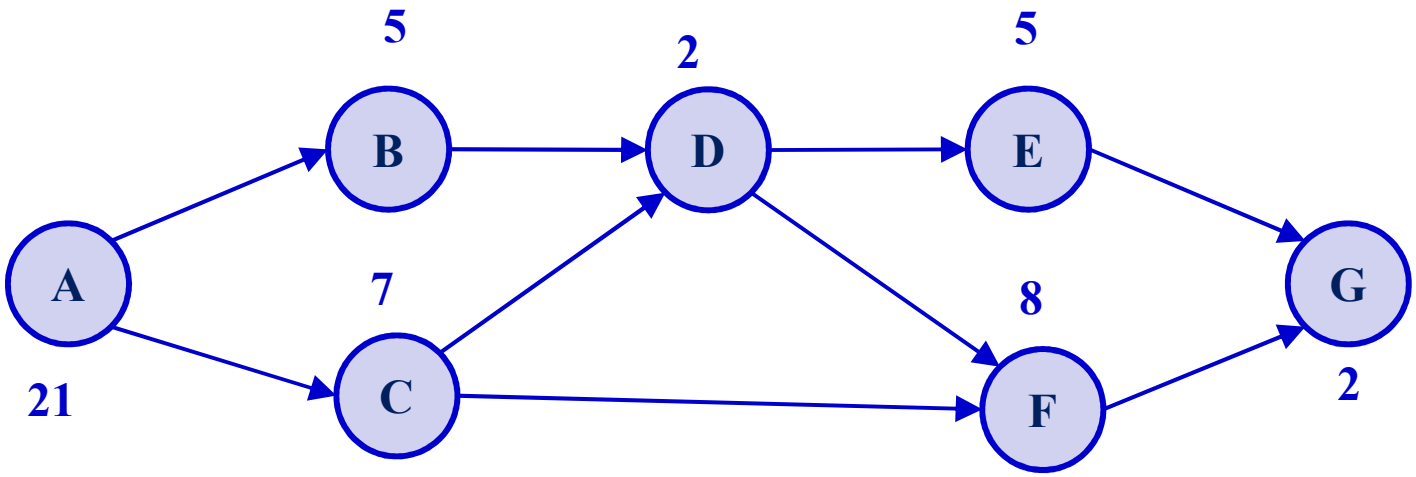
A precede *B* e *C*, *B* e *C* precede *D*

EXAMPLE - EXERCISE

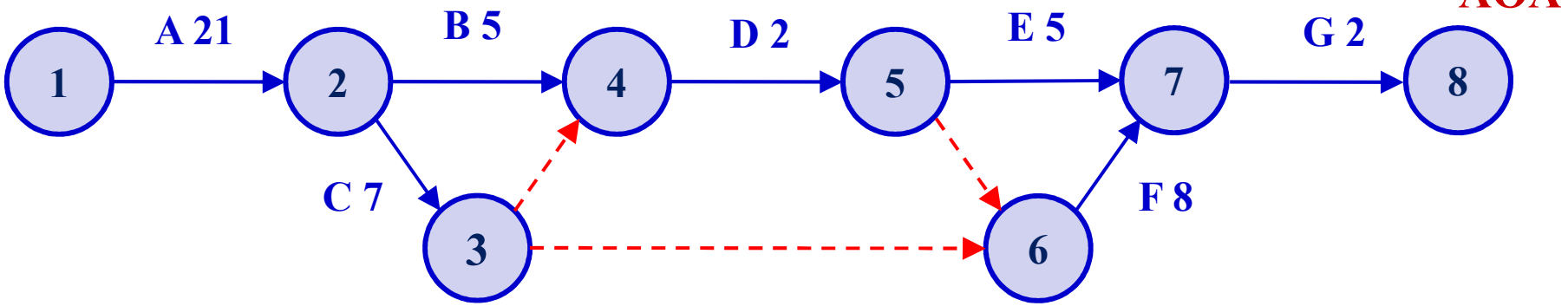
# ID	# Tarefa	Actividades	Dur.	PRECEDE	SUCEDE
1-2	A	Conceber o Protótipo Prototype conception	21		B,C
2-4	B	Construir Protótipo Prototype Building	5	A	D
2-3	C	Inspeccionar Protótipo Prototype Inspection	7	A	D,F
4-5	D	Testar o Protótipo Prototype Testing	2	B,C	E,F
5-7	E	Relatório preliminar Preliminar Report	5	D	G
6-7	F	Ajustes finais Final adjustments	8	C,D	G
7-8	G	Teste Final Final Test	2	E,F	

EXEMPLO DE REDES

AON



AOA



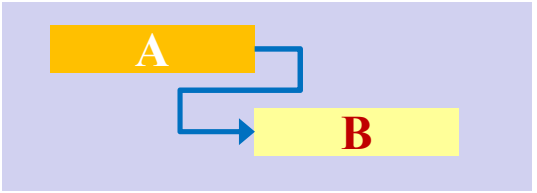
ACTIVIDADE FICTÍCIA - - - - - → DUMMY ACTIVITY

The tasks to be performed have a particular sequence

DEPENDENCIES

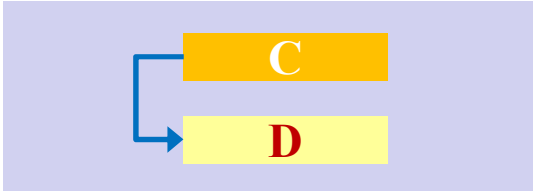
FIM – INÍCIO; FINISH - START

Finish-to-start dependency, in which one task can not start until another task has finished.



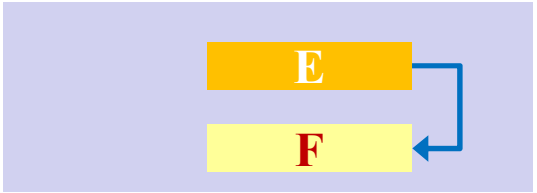
INÍCIO –INÍCIO; START - START

Start-to-start dependency, in which one task can not start until another task has started.



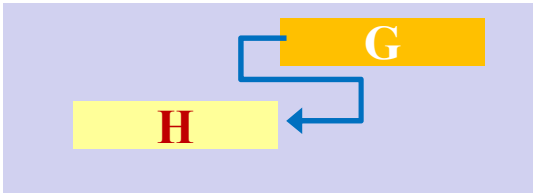
FIM – FIM; FINISH - FINISH

Finish-to-finish dependency, in which one task can not finish until another task has finished.



INÍCIO – FIM; START - FINISH

Start-to-finish dependency, in which one task can not finish until another task has started.



FLOAT

When it comes to each activity in the project, there are four parameters for each related to the timelines. Those are defined as:

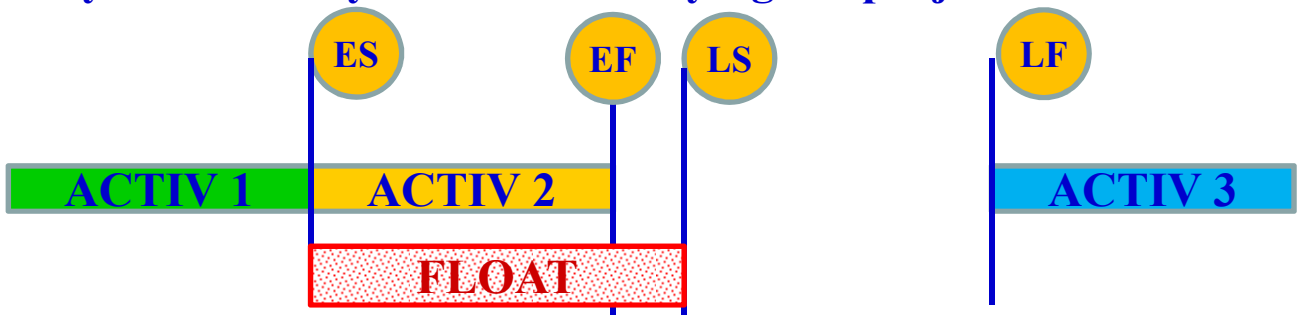
Earliest start time (ES) - The earliest time, an activity can start once the previous dependent activities are over.

Earliest finish time (EF) - This would be ES + activity duration.

Latest finish time (LF) - The latest time an activity can finish without delaying the project.

Latest start time (LS) - This would be LF - activity duration.

The float time for an activity is the time between the earliest (ES) and the latest (LS) start time or between the earliest (EF) and latest (LF) finish times. During the float time, an activity can be delayed without delaying the project finish date.



LEADS and LAGS

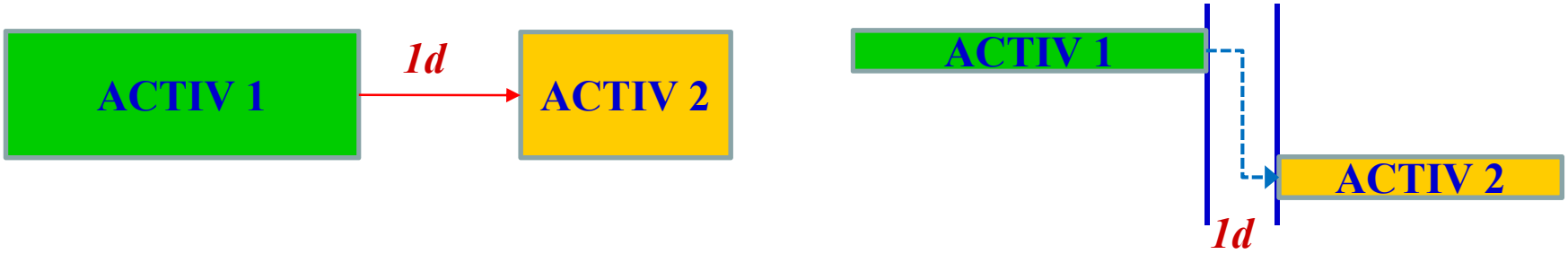
Are types of float

Lead

Is the amount of duration by which a Successor activity is advanced with respect to the Predecessor activity. A Lead provides acceleration to the Successor Activity.

Lag

Is the amount of duration by which a Successor activity is delayed with respect to the Predecessor activity. A Lag provides mandatory delay to the Successor Activity.



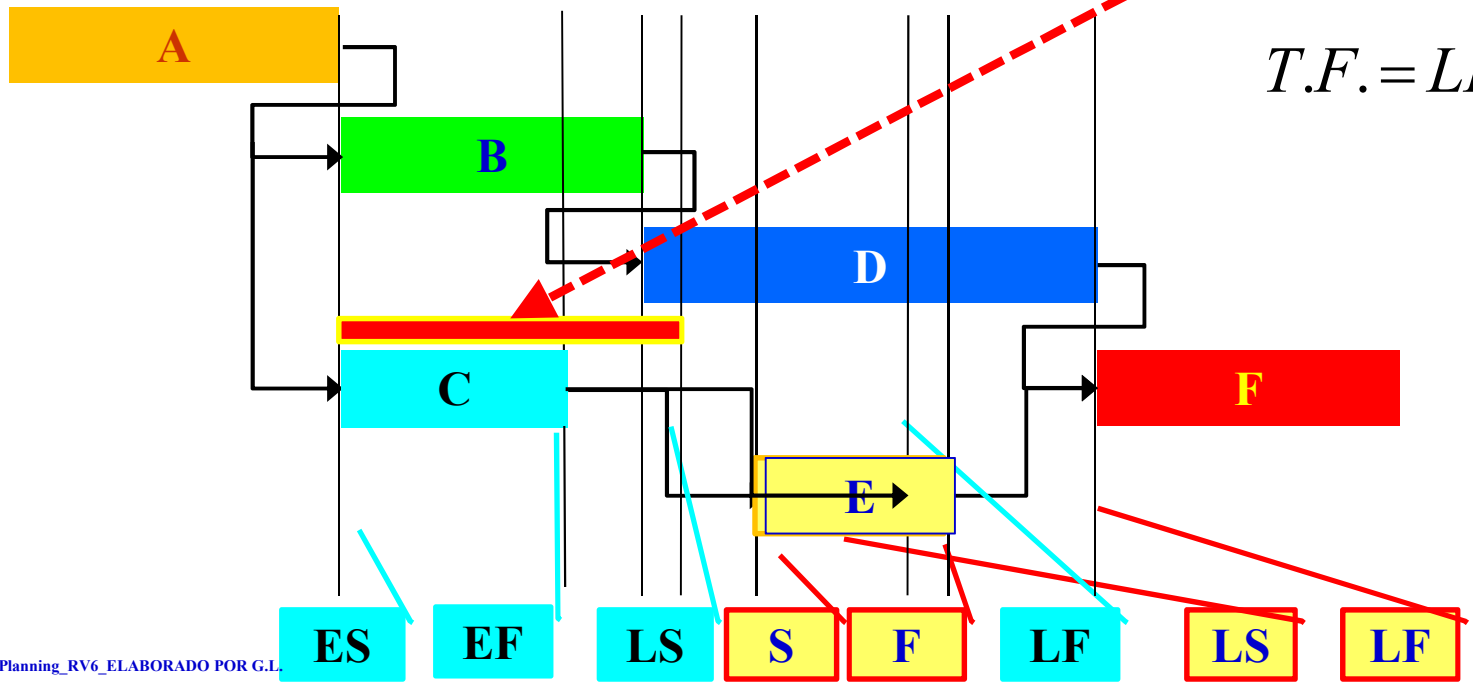
TOTAL FLOAT (T.F.)

- **Total float is the excess time available for an activity to be expanded or delayed without affecting the rest of the project -- assuming it begins at its earliest time.**

It is calculated using the following formula:
TOTAL FLOAT = LATEST FINISH - EARLIEST START - DURATION

$$T.F. = t_j^1 - t_i^0 - y_{ij}$$

$$T.F. = LF - ES - d$$

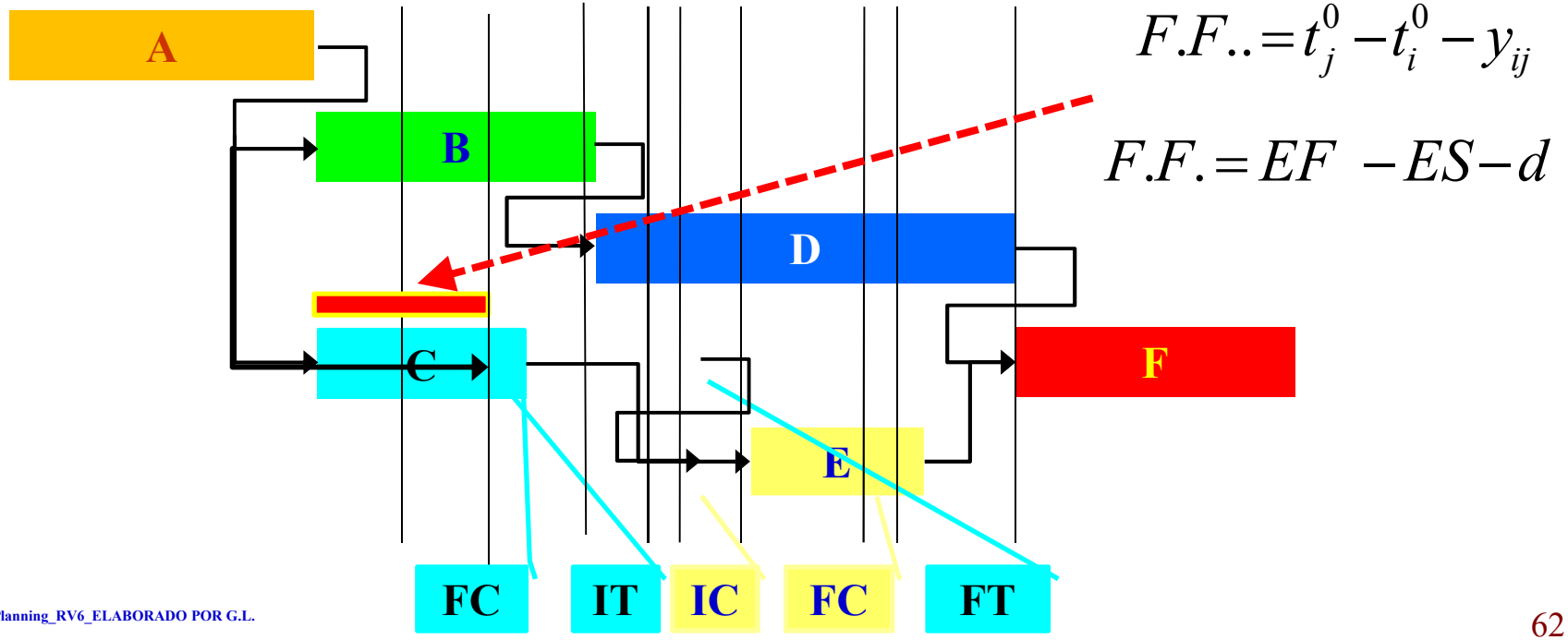


FREE FLOAT (F.F)

- **Free float is the excess time available before the start of the following activity, assuming that both activities start on their early start date.**

Is calculated in the following way:

FREE FLOAT = EARLIEST START OF FOLLOWING ACTIVITY - EARLIEST START OF PRESENT ACTIVITY - DURATION OF PRESENT ACTIVITY



DATE CONSTRAINTS

Use a date constraint if starting or finishing a task by a specific time is important to the completion of the task or the outcome of the project.

- As Soon As Possible
- As Late As Possible
- Finish No Earlier Then
- Finish No Later Than
- Must Finish On
- Must Start On
- Start No Earlier Then
- Start No Later Then

DESIGN AON AND AOA NETWORKS

If we know the tasks duration (Hours h; Days d; Weeks w; or Months m) and their related dependencies we are able to draw the scheduling Networks and obtain:

- The Early Start (ES) and Early Finish (EF) dates
- The Late Start (LS) and Late Finish (LF) dates
- The tasks Margins (M)

The networks allow us to simulate different variants of the project, using What-If analysis using:

- Different tasks durations related with Resources
- Different task Dependencies

CRITICAL PATH

A project has at least one critical path consisting of activities CALLED CRITICAL ACTIVITIES or activities with ZERO TOTAL FLOAT.

This activities cannot slip otherwise the project duration will increase compared with previous project objective.

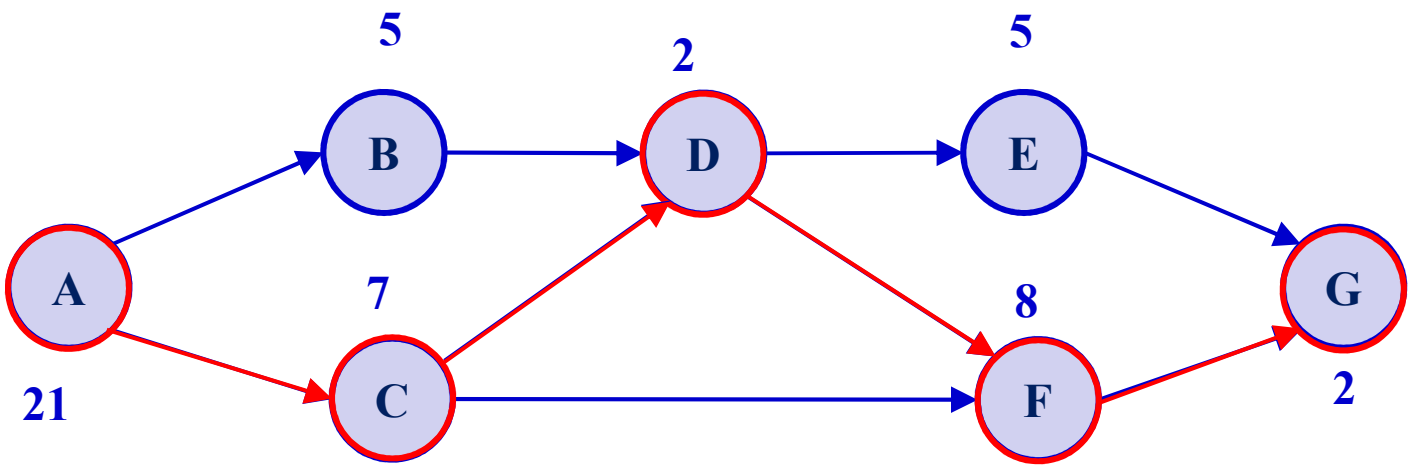
The critical path is the sequence of activities

- **With longer duration of the project network;**
- **corresponding to the minimum period of project implementation.**

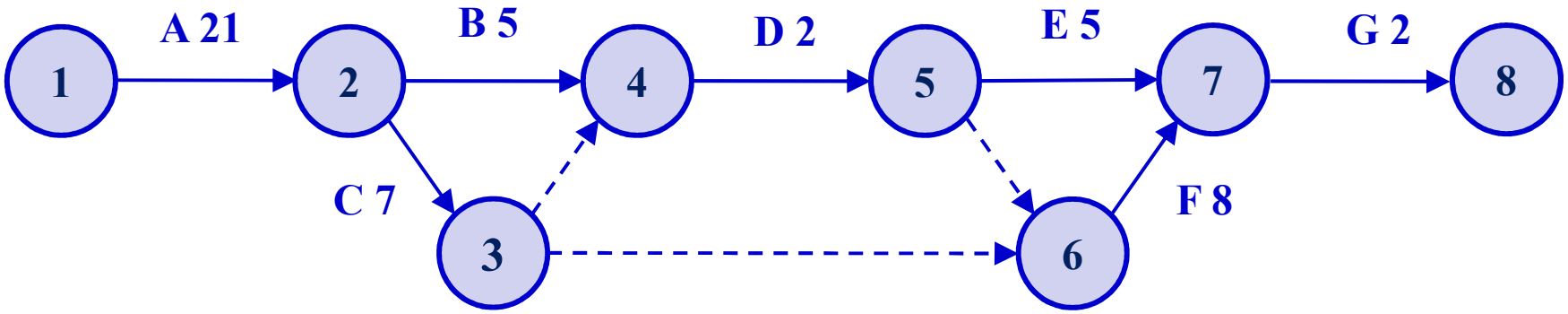
Note There are activities with small total floats called sub critical activities that should have be almost the same attention as the critical, that sub critical activities set up the sub-critical paths.

CRITICAL PATH

AON



AOA



RESOURCE ALLOCATION

Resource allocation describes the amount of resources (People, Materials and Services) that an existing project schedule requires ,during specific time periods.

The allocation (requirements) of each resource type are listed as a function of time period.

Resource location gives a general understanding of the demands a project or set of projects will make on a Shipyard's resources.

For allocate resources to the projects we need to know the project action plan, because it is the source of information of:

- ☺ Activities, Precedencies, Durations, Dates and Resources requirements,
- ☺ It is the primary input for both the project schedule and its budget
- ☺ The action plan links the schedule directly to specific demands for resources

RESOURCE LEVELING

Resource leveling is a procedure that can be used for almost all projects, whether or not resources are constrained

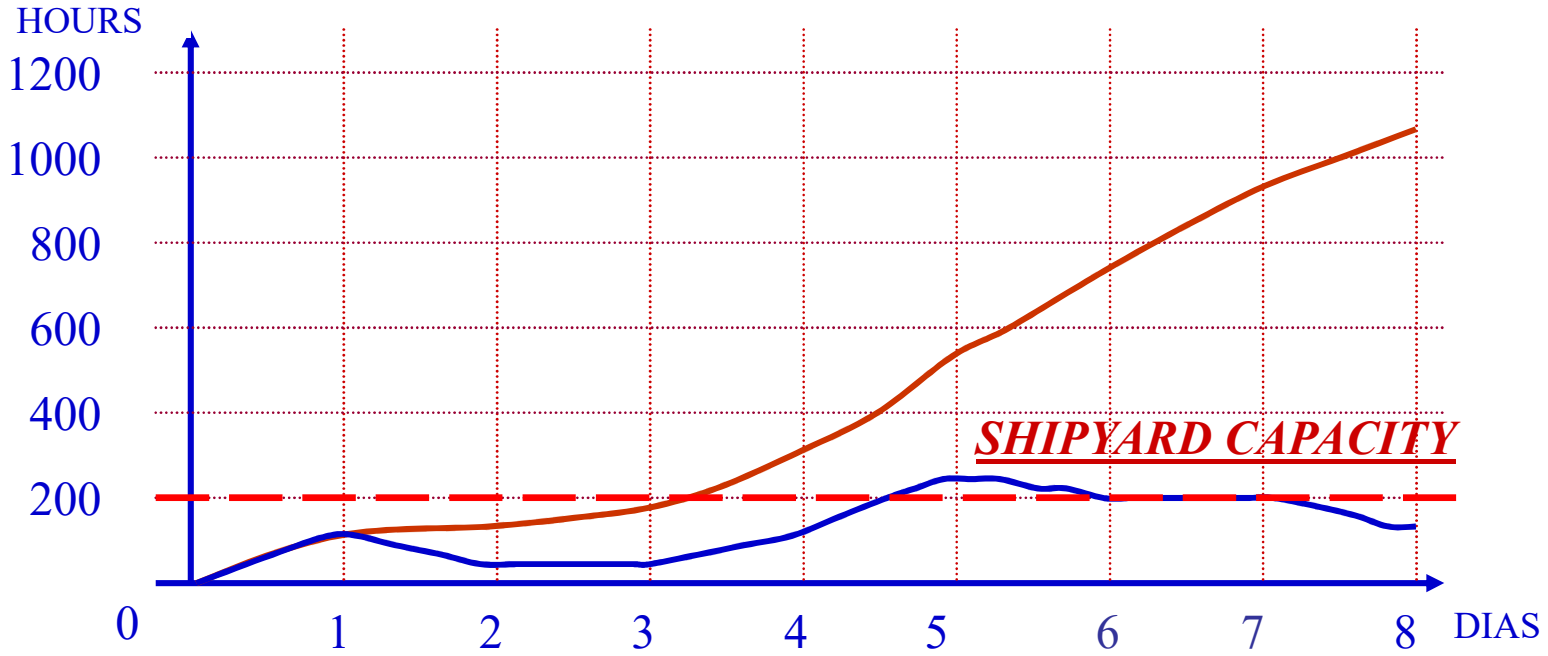
Resource leveling aims to minimize the overtime when the resource capacity is lower than the projects needs, by shifting tasks within their slack allowances

Several advantages include:

- **Less day-to-day resource manipulation needed**
- **Better morale, fewer HR problems/costs**
- **Leveling resources also levels costs, simplifies budgeting and funding**
- **When resources are leveled, the associated costs also tend to be leveled**

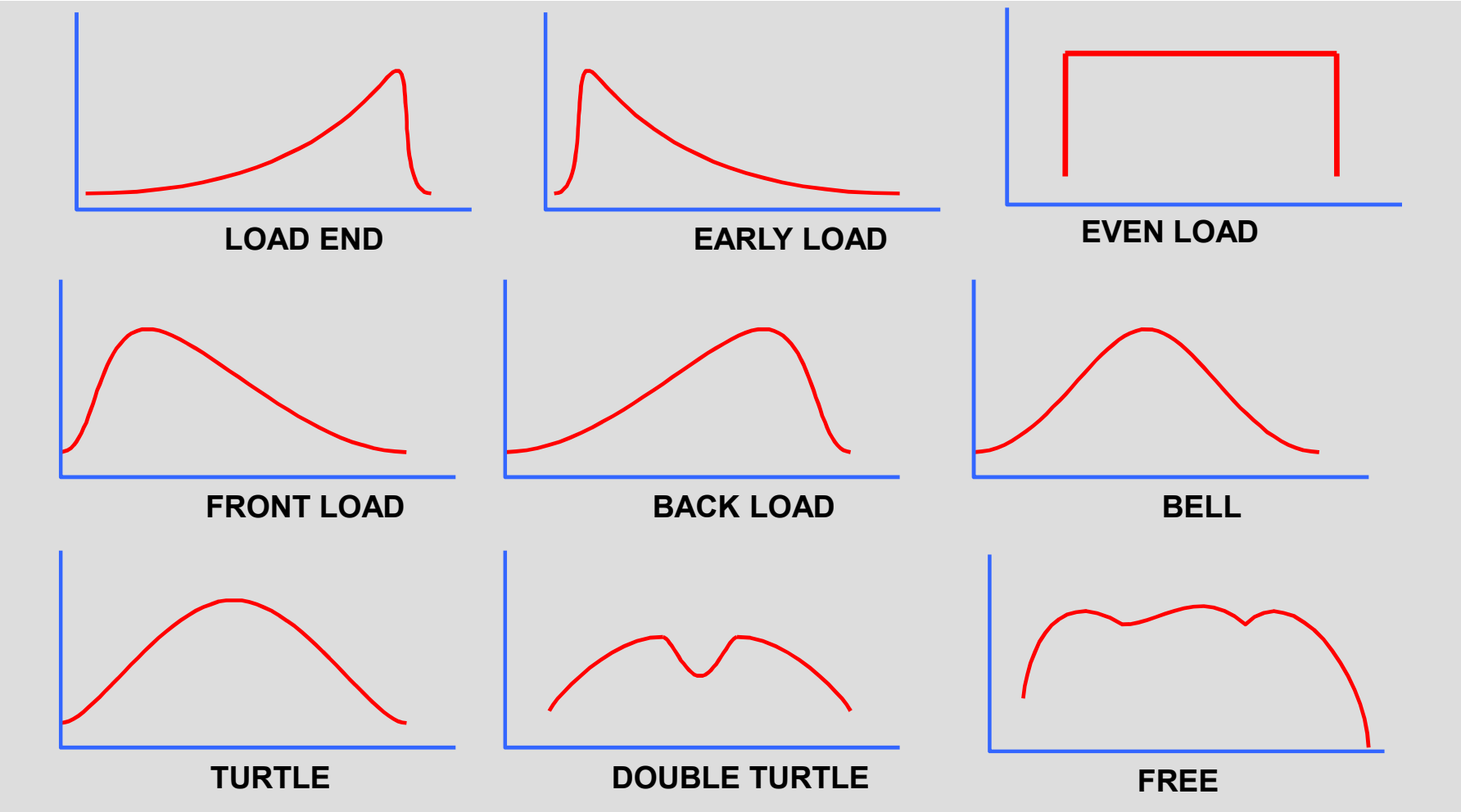
BASE LINE

Is a line of cumulative values which serves as a reference for future comparison



A	96							
B		40	40	40	40			
C				80	80	80	80	
D					120	120	120	120
DIÁRIO	96	40	40	120	240	200	200	120
ACUMULADO	96	136	176	290	536	700	936	1056

RESOURCE ALLOCATION CONTOURS



PERT METHODOLOGY

The Pert methodology assumes that each activity duration has a statistic development that follows a beta distribution.

Uses three time estimates for each activity: most likely, optimistic, pessimistic, and a weighted average value (expected duration) to represent activity durations.

(m) - Duração mais provável	**Most likely activity duration**
(a) - Duração optimista	**Optimistic duration**
(b) - Duração pessimista	**Pessimistic duration**

y_{ij} = te = duração expectável

$$t_e = \frac{1}{6}(a + 4m + b)$$

EXPECTED DURATION

The probabilistic values become deterministic values

MOST LIKELY DURATION Duração mais ProváveL (m)

This duration is expressed in time units required to perform an activity, assuming that no any unforeseen difficulty emerges;

OPTIMISTIC DURATION Duração Optimista (a)

Is the duration, expressed in units of time, required to perform a given activity when all goes more favorable. The probability of this value is not more than 1%;

PESSIMISTIC DURATION Duração Pessimista (b)

Is the maximum duration, expressed in units of time, required to perform a given activity, if any unexpected difficulties in the work show up. Also the probability of this value is not more than 1%.

THE VARIABILITY IN THE ACTIVITY TIME ESTIMATES IS GIVEN BY THE FOLLOWING EQUATIONS

VARIÂNCIA σ^2 (Variance) Probability distribution

Indicates the risk (uncertainty) of not hitting the expected average duration activity

$$\sigma_{ij}^2 = \left(\frac{b-a}{6}\right)^2$$

O Desvio Padrão (Standard Deviation) σ

Raiz quadrada da Variância σ^2

Square root of the Variance σ^2

$$\sigma_{ij} = \frac{b-a}{6}$$

LIKELIHOOD OF PROJECT DURATION D_t

The project duration is the sum of the duration of the activities that make up the critical path

$$D_{tc} = D_{tc1} + D_{tc2} + D_{tc3} + \ldots D_{tcn}$$

$$\sigma_t^2 = \sigma_1^2 + \sigma_2^2 + \sigma_3^2 + ..$$

Total variance is equal to the sum of the variances of the activities that constitute the critical path.

PROBABILIDADE DA DURAÇÃO DO PROJECTO
PROBABILITY OF PROJECT DURATION

$$Z = \frac{D - D_t}{\sigma_t}$$

The equation is used to compute the "*Z*" value found in statistical tables (*Z* = number of standard deviations from the mean), which in turn, tells the probability of completing the project in the time specified.

D_t - Duração do caminho crítico do Projecto - Project critical path duration

D - Duração do projecto a estimar - Project Duration to be estimated

PROBABILIDADE DA DURAÇÃO DO PROJECTO

EXEMPLO

A duração de um projecto Dt, é igual a 23 meses depois da data de arranque do projecto,

O desvio padrão é =3 σ_t

Qual a probabilidade Z do projecto concluir em D = 25 meses ?

$$Z = \frac{D - D_t}{\sigma_t}$$

Para Z=0,666 na tabela o valor correspondente de probabilidade é de 0,745

Probabilidade é de 74,5%.

The critical path duration of a project is Dt = 23 month after the starting date

The Standard deviation is =3 σ_t

What is the probability Z the project finish in D = 25 month ?

In the statistic table the value found for Z=0,666 is 0,745

The Probability is 74,5%.

$$0{,}666 = \frac{25 - 23}{3}$$

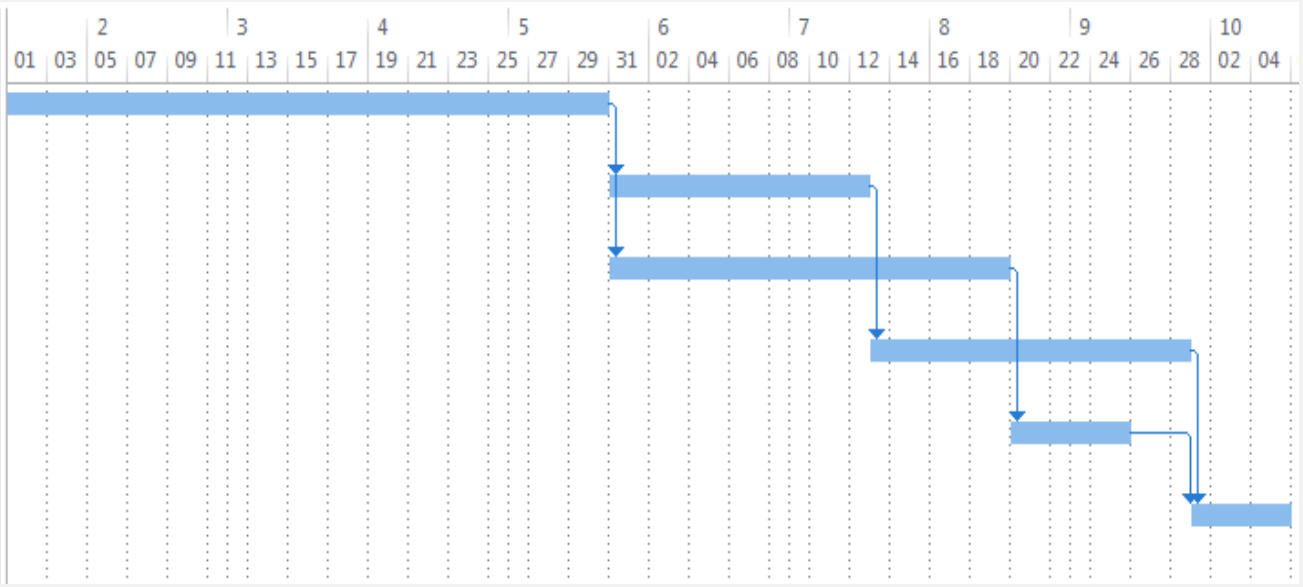
Activity		Dependency	a Optimistic Duration	m Most Likely Duration	b Pessimistic Duration
A	1-2		17	29	47
B	2-3	A	6	12	24
C	3-4	A	16	19	28
D	4-5	B	13	16	19
E	5-6	C	2	5	14
F	6-7	E-D	2	5	8

CALCULATE

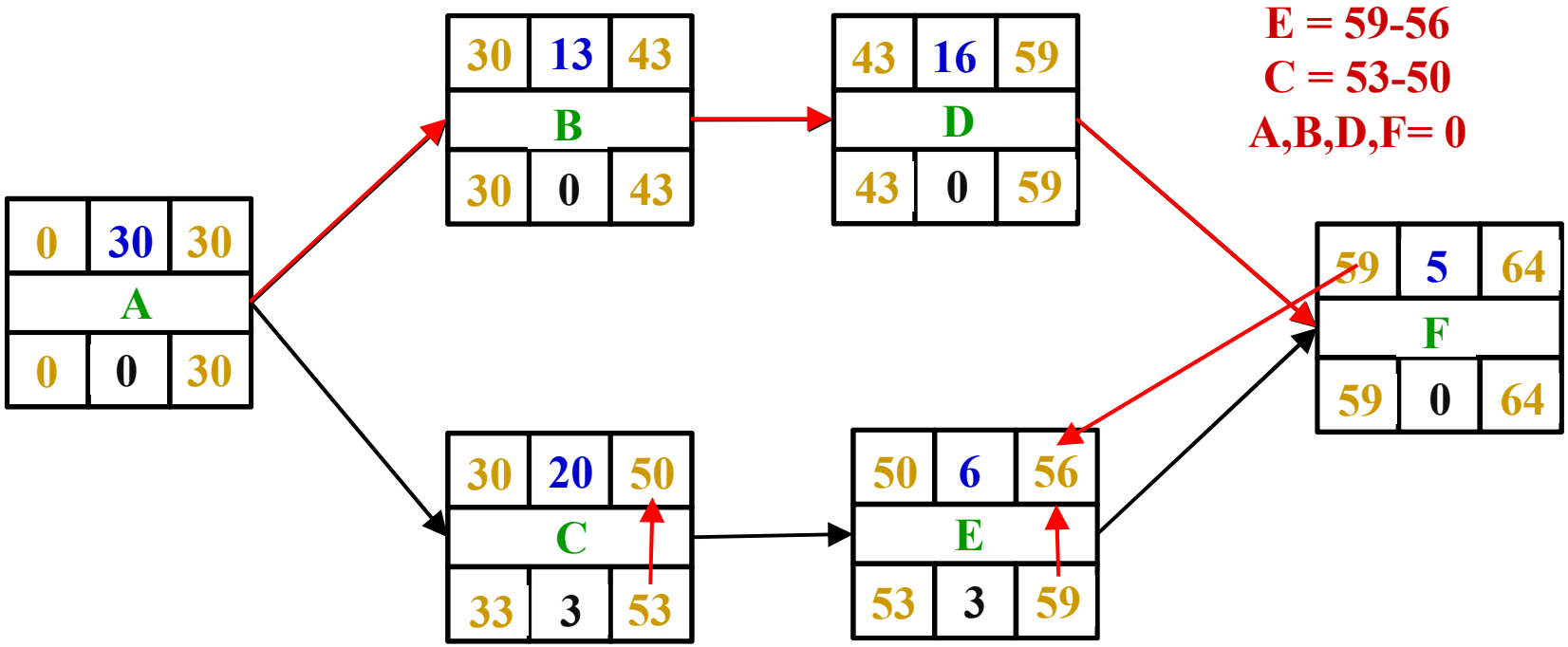
1 - Design the Bar chart;
2 - The Activity on the Node;
3 – Activity on the Arrow Diagram;
4 - Highlight the Critical path on both diagrams:
5 - Expected Duration;
6 - Standard deviation;
7 - What is the probability to finish if the project ends on 67 period of time?

BAR CHART

	ACTIVITY	ACTIVITY	DUR
1	A	1-2	30
2	B	2-3	13
3	C	3-4	20
4	D	4-5	16
5	E	5-6	6
6	F	6-7	5



ACTIVITY ON NODE



TOTAL SLACK

E = 59-56

C = 53-50

A,B,D,F= 0

Free Slack

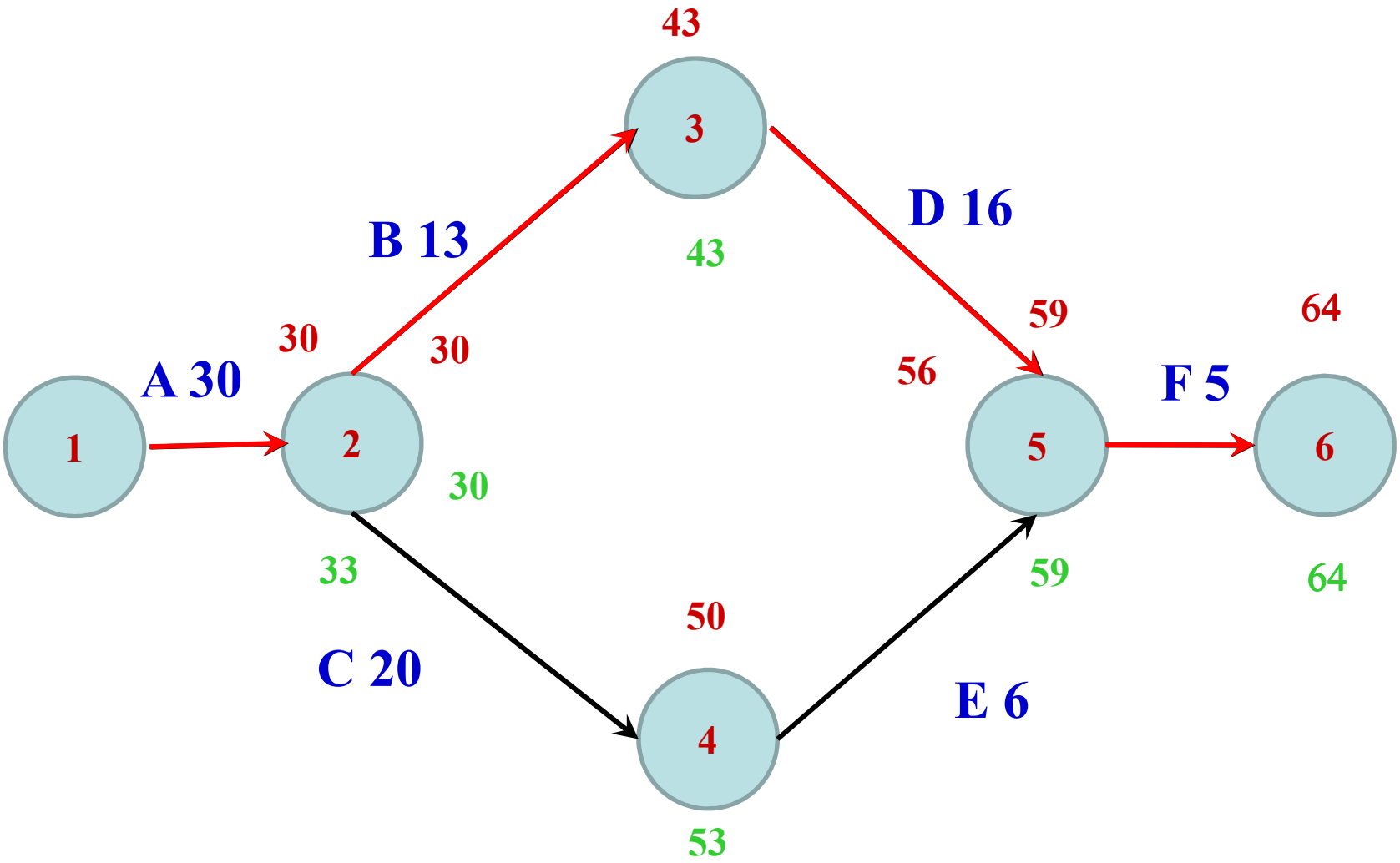
E = 59-56 = 3

A,B,C,D,F= 0

a) - Early Start
b) - Duration
c) - Early Finish
d) - ID
e) - Late Start
f) - Total Slack
g) - Late Finish

a	b	c
d		
e	f	g

ACTIVITY ON ARROW



Activity		Dependency	a Optimistic Duration	m Most Likely Duration	b Pessimistic Duration	t_e Expected Duration	σ^2 Variance	σ Standard Deviation
A	1-2		17	29	47	30	25	5
B	2-3	A	6	12	24	13	9	3
C	3-4	A	16	19	28	20	4	2
D	4-5	B	13	16	19	16	1	1
E	5-6	C	2	5	14	6	4	2
F	6-7	E -D	2	5	8	5	1	1
Critical Path A-B-D-F			38	62	98	64	36	6
Z			-4,33	-0,666	5,66	0		
PROBABILITY %			0,001	25,5	99,99	50		

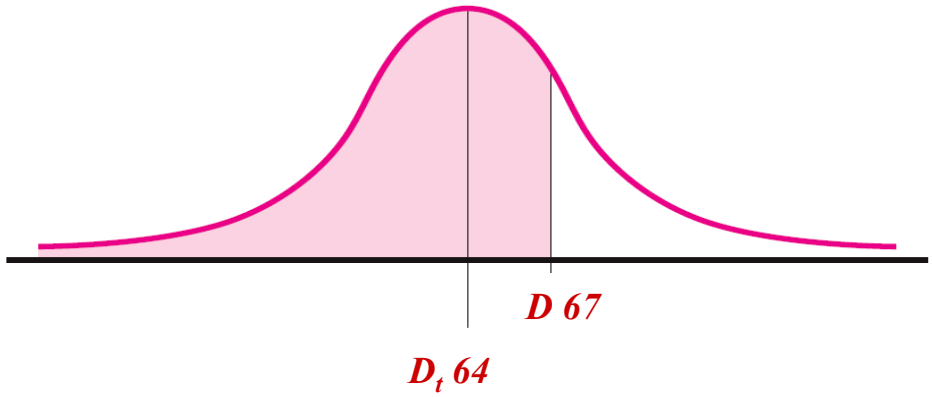
IF THE PROJECT FINISH ON 67th PERIOD OF TIME, WHAT IS THE PROBABILITY?

$$\sigma_t^2 = \sigma_1^2 + \sigma_2^2 + \sigma_3^2 + .. \qquad \sigma_t^2 = 25+9+1+1 = 36 \qquad \sigma_t = 6$$

$$Z = \frac{D - D_t}{\sigma_t} \qquad Z = \frac{67 - 64}{6} = 0{,}50$$

From the table Z = 0,50 is equivalente to 69

There is 69% of chance for the project to be finished in 67 periods of time



PROBABILISTIC ANALYSIS

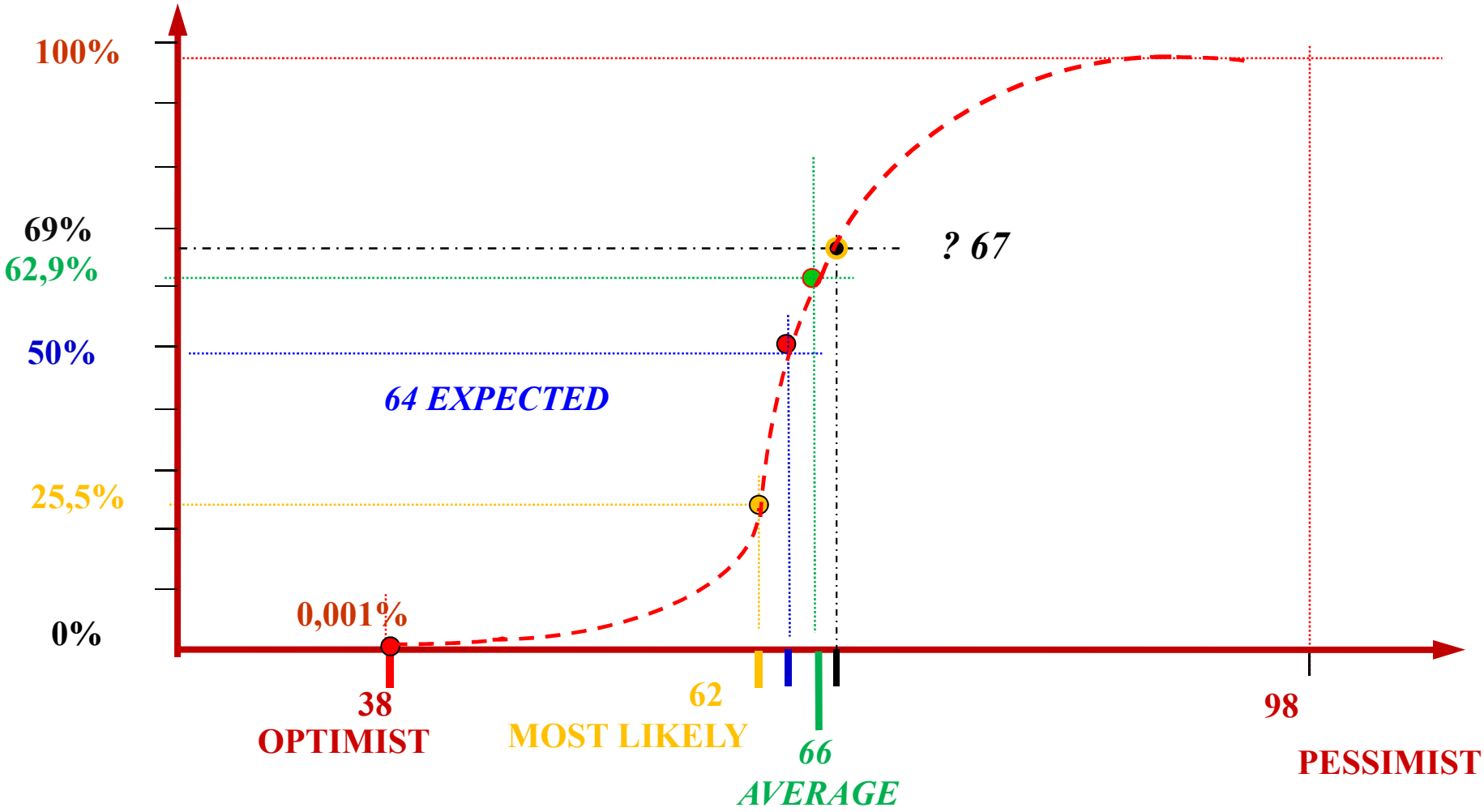


TABLE
Z AND PROBABILITIES VALUES

Z-Score	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767

END OF THE CLASS

FIM