

07. PROJECT MANAGEMENT

This Module illustrates the methodologies and techniques of Project Management. Obviously, it has no claims of being exhaustive, but wants to provide a complete view of the principle on which the development and managing of the projects is based.

The matter is fundamental as the project approach to reality is a consolidated practice in all organisational contexts characterised by constant transformations and in which to the transformations correspond the identifying of new objectives to which we must respond effectively and efficiently, reducing the risks of failure and maximising results.

Obviously, we talk about organisational contexts when we refer to a very high multiplicity of systems without limitations to goals and processes: in this sense, an educational system, an enterprise, a public administration, etc., are all organisational contexts where the concept of "project approach to reality" and, therefore, Project Management, can be applied.

***Project Management** is born in America in the 50s, in the field of managing the Military Project development of a nuclear warhead missile, but since then the methodologies and techniques set up have evolved, but a few base elements, those that we can say represent **the Project Management Paradigm**, have remained unchanged. Among these we must remember: the concept of project, the complexity of the project concept and objectives, risk concept, constraint concept, management roles of the projects*

*Project Management offers itself as the tool for whomever has the responsibility of a project, called **Project Manager**, to manage human resources, but also to keep under control project development. Therefore, on one hand it is made up by a set of planning techniques and controls of the operating development of the project activities.*

In this module we refer basically to the second, even though we will illustrate the general elements of the paradigm.

At the end we will describe even the general characteristics of the software tools that have been achieved to provide specialistic informatic environments in support to the application of the planning techniques and control of the Projects. These tools have become during the years more and more sophisticated and represent an excellent, and in many cases, unreplaceable tool for making Project Management applicable to complex projects.

07.1. General aspects of Project Management

In this Chapter we will provide a general overview of Project Management, starting from its origins and from the birth of the "Culture of objectives". We will deal with, then, the study of the so called concept of "Lifecycle of a Company Process" so as to place the Approach for Projects in a specific context where this approach becomes "organisational system of production" for any type of organisation. From here we will move on to give a precise definition of "Project" and of "Lifecycle of a Project" and we will deal with, lastly, the problem of organisational elements that affect a Project, such as : Time, Costs and Risks.

07.1.1. The origins of Project Management

The following definition can be given of *Project Management*:

"Project Management is a set of techniques to **Plan, Control** and **Manage** a set of human, time and material resources operating in temporary synergy for the reaching of a common goal "

Project Management was born in the field of the great military projects of the USA during the 50s and has confirmed itself, only in recent years, in civilian applications, as an *indispensable tool for the optimization of resources*, whether they be economic, human or structural.

The achievement reached by these techniques and their consequent widespreading are linked, on one hand, by an ever growing complexity of objectives of an organisation in terms of “products” to achieve and of the “contexts” where they are to be realised, while on the other, to the mindboggling increase of *productivity* and of *efficiency* necessary to keep any initiative *competitive*.

07.1.2. *Turbulent environments and the culture of objectives*

Among the causes of this renewed competitiveness there stands, without a shade of doubt, *technological innovation*. In this strongly dynamic scenario, the productive environments have changed into *extremely turbulent environments*, that is, interested by *rapid and constant change*.

All this has forced organisations to change into *multistable players*, that is, capable of establishing their own conditions of balance even in the presence of:

constant redefinitions of the reference goals.

ample interactions among the various parts of the Organisational System.

high impact of external factors.

reconfiguration of the organisational mechanisms and roles.

Real-Time governing of the FeedBacks of the on-going processes.

Because such a transformation was possible, adequate *tools* had to become necessary that could favor *integration* and the possibility of *working in a synergic manner* for reaching an *objective*.

The results of the transformations occurred in these years have been the passage from a typically *bureaucratic* culture oriented to the production processes and defined as **Process-Oriented**, to *adhocratic* culture of a project type and defined as **Result-Oriented**. The term *adhocratic* derives from the latin *ad hoc*, which means “*linked to the contingent situation, the circumstances*”

07.1.3. *The Lifecycle of the Company Process*

As a consequence of this new culture, new forms of Organisations have been born and we have started to talk about Life Cycles conceived as processes that have an origin, an evolution and an end.

Therefore, the Logical Flow of the Organisational Processes becomes a “closed cycle” made up by the following “processes” (or “phases”):

- *Project design*
- *Realisation*
- *Performance Control*

connected among themselves by a specific process of

- *Control*

The *project design* phase must provide the **operational plan** of the realisation phase for reaching the Objective.

The *realisation* Phase is that in which, in order to reach the objective, the **plan developed in the project design phase is applied**.

The *performance control* phase must instead assess the **deviations occurring between project and realisation to provide** the internal know-how necessary for the upcoming project designs.

07.1.4. *“Control” in the Life Cycle of the Company Process*

The *Control* Phase involves the analysis made by the organisation on the projects to assess elements such as:

- good outcome of the project approaches in terms of forecasted and realised
- effectiveness of the control processes
- correct organisation of the productive system.

Therefore, the “Control” in the Life Cycle of the Organisational Process involves the organisation and not the individual project.

As we can see from the figure, the central Phase of *Control* is structured in three components distributed on the entire Life Cycle of the Organisational process:

- *Project Control*
- *Process Control*
- *Result Control*

It is the case here to emphasise, to avoid confusion with the other Life Cycle that we will introduce shortly, the “Life Cycle of the Project”, of the Control Phase that we observe here

The first component allows us to constantly verify that the *Realisation* Phase of Project is always in line with the forecasted version, developed during the *Planning* phase. This control is capable of measuring the effectiveness and correctness of the applied techniques just in the *Project design* phase.

The second component of the *Control* is capable of analysing the results provided from the phase of *Realisation* for the purpose of measuring the correctness of the productive processes.

The third and last component, perhaps the most important, represents the Phase of *Performance Assessment*, that is, final results offered by the *Realisation* Phase in relation to “as foreseen by the original Project” and of the “expectations of the organisation”. This control, seen from the perspective of the organisation, indicates the verification, by the same, of the level of capacity of the company planning process to respond to the needs of the organisation in terms of “company results”.

Overall, the *Control* Phase assesses any possible deviations occurring among the “company objectives” and “design processes” to provide the internal *know-how* necessary for the subsequent project designs.

07.1.5. *Design and the Project*

The **Life cycle of an organisational Process** represents the results of a dynamic activity which, generally, is also called **Designing of the production process**. It represents a logical plan where the entire production process of new products is divided into a series of fundamental phases which, once carried out, allow realising them.

Of the three phases of this Life Cycle, the first is that which allows to realise company results based on a specific Objective.

The **DESIGN** is the process that allows to analyse an idea and build the track to follow in order to reach the Objective that said idea represents.

Project Design makes up the most delicate phase of the Company Process, that which *provides a hard shape to the idea and defines the realisation activities* of it.

The result of the Design Phase is called **PROJECT**.

07.1.6. *The origin of a Project*

Design comes from an **Idea** that represents the new objective to realise, and that can be, in turn:

- a new product
 - a new service
 - a new system
 - a new process
 - a new company
- etc.

07.1.7. *Project Design and the Life Cycle of the Project*

Starting from the Idea, the process that governs the design is also a cyclical process called **Project Life Cycle** and made up by various Phases. The various Models of Project Management divide the cycle into a varying number of Phases (in some cases, you get to at least 11 phases).

Among these we will consider the Model most greatly consolidated that identifies a Life cycle into **three phases**:

- **Analysis,**
- **Planning,**
- **Execution**

to which a transversal phase is added, defined as:

- **Control**

07.1.8. *The Phases of the Life Cycle of the project: the Analysis*

As said previously, Design is born from an **Idea** that represents the new objective to realise.

But any type of idea that presupposes the *activation of a productive process* once expressed must be analysed to be then reformulated in terms of:

- constraints and resources
- **objective** to reach

This phase is defined, as we have seen, as **ANALYSIS**.

The **constraints** and the **resources** represent the *design context*, that is the set of:

- *risks,*
- *costs,*
- *times*
- human resources,
- logistic/structural resources,
- economic resources,

that determine the boundaries within which the project may be realised.

the **objective to reach** is the *result that we want to have* from the project. This result must be verifiable, that's to say that it must be possible to establish, *unequivocally*, that the expected objective has been reached. This means that an objective of a Project can not be a generic result or for which the verification of its attainment depends on the subject performing the verification itself.

For example, it is not possible that the objective of a Project in the automotive sector is simply that of realising a new automobile without contextualising and specifying the technical and market features.

It is exactly the *verifiability of the objective* that entails its redefinition in terms of measurable features of the product to obtain.

Summing up, the **ANALYSIS** Phase consists in the following actions:

- reformulation of the idea in *productive context* and *objective*
- specification of the *constraints* and of the *resources* that characterise the productive context
- definition of the *specific features of the product* so as to determine the productive process.

Therefore, this phase allows to *give a shape to the product* and to *insert it into a specific productive context*. At the end of this phase we will not accurately know yet the activities and times that will articulate the production of the product, but we will know for sure what we will produce and the "reasonable" guarantee of producing it.

The result of this track is the **Project!**

From this, going through the phase of the **realisation of the Prototype** we will arrive to the **Planning of the Activities** of production.

07.1.9. *The Phases of the Project's Life Cycle: Planning*

After the Analysis phase and the correct definition of Resources and Constraints on one hand, and Objective on the other, we will move on to the second Phase of the Life cycle of the Project: **PLANNING** (also called **SCHEDULING**).

PLANNING consists in identifying the activities which, carried out according to defined priorities, allow the human resources involved, using the logistic, structural, and economic resources, to realise the product expected in the defined times.

At the end of the Project phase it becomes, from the operational standpoint, a set of activities, temporally related among themselves according to precise functional dependencies.

The **PLANNING** phase is the actual building phase of the Project. It is in this phase that we start to apply what are defined as the **Project Management Techniques** which we will widely study in the next chapter.

From a procedural point of view, we can say that Planning is a process consisting in subsequent polishings where the project path takes shape on a more clear-cut manner before it becomes the **Forecasted Project**

07.1.10. *The Phases of the Project Life Cycle: Execution*

The **EXECUTION** phase represents the last phase of a Project. In this phase the **Forecasted Project** is applied to realise the expected Objective. It is exactly its *forecasted* nature that assumes that *changes in progress* may occur to correct any possible inaccuracies determined in the PLANNING phase or from the rising of obstacles and difficulties which were not foreseeable.

Even in this phase the Techniques of Project Management help the Project Manager in managing the changes that transform the Forecasted Project. The gradual revisions of the Forecasted Project represent different forms of the **Forecasted Project**.

07.1.11. *The Resources*

A Project is realised using certain **RESOURCES**. There are distinguished in:

- **Human Resources**
- **Logistical Structures**

Human Resources are all those people that are dedicated to reaching the Project objective. They are divided through the assigning of **specific Organisational Roles** that represent the different functions of development and realisation of the Project. These Organisational roles are basically three; **Project Leader**, **Project Management Group**, **Development Human Resources**..

The **Project Leader** (or **Project Manager**) is the player that has the overall responsibility of the project and performs the following tasks:

- writes and plans the Forecasted Budget
- controls the times and developments of production
- develops the budget
- carries out the changes to the Forecasted Budget

The **Project Management Group** is the group of players that go alongside the Project Leader and monitor the operational phases. According to the complexity of the Project it can be more or less broad.

The **Development Human Resources** are displayed by the set of all players that are employed in the actual realisation of the Project. They are, practically, the operational resources, that is, those that are tasked with materially realising the project products.

The **Logistical Structures** are the places where the Project is realised. These places are divided into basically two large groups:

- **Management Places**
- **Development Places**

The **Management Places** represent the outfitted sites where the Project Leader and the Project Group work.

The **Development Places** are made up by all the sites where all the players involved in the actual realisation Project work.

07.1.12. *The Constraints*

The **CONSTRAINTS** determine the borders within which the Project can be developed. They are displayed by three main sets:

- **Times**
- **Economic Resources**
- **Risks**

Times

Time is the main constraint of a Project, but it is also the main parameter of design. The final forecasted shape of the Project derives from the duration of the same. Not adhering to the time schedule of a project may seriously jeopardise its success. In some cases these constraints are set by regulations; for example:

- a school year must necessarily end on a certain day and the teacher who has not completed the curricula, because he/she has not correctly developed the Didactic Project, cannot change the end of the school year in order to complete it
- a project financed within the scope of a national or EU initiative must have the duration forecasted by the Project and cannot go over the date of the forecasted end

In other cases the duration is determined by the constraints set by the market; for example

- if I am coming up with a new type of cellular phone with colour videoscreen, I cannot have a Project for its manufacturing that lasts too long to allow my competitors to invade the market with their own cellulars with colour video, I would be creating an "old" product

the main time constraints are:

- the **Project start date**
- **overall duration of the Project**
- **general calendar of the Project**

This last constraint consists in defining:

- which are the work days of a typical week (for example: in certain countries or for certain professions, Saturday and Sunday can be work days, while in other countries or for other professions they are holidays)
- what is the duration of a typical work day (for example, shift workers have work days with different duration with non shift workers and even among these teachers have working hours different from bank workers, etc.)
- what are the holidays in the period of the Project (Christmas is an almost universal holiday, but the Saint's name day of a city is considered a local holiday)

Economic Resources

These are made up by the quantity of money that the Project has at its disposal to reach the objective. This resource is articulated in the defined costs in the **Project Budget** and represents another constraint for all the projects that call for economic costs. Obviously, the Budget can also be null if all the project resources (human,

logistic, instrumental) do not have a cost; but usually, projects always have an economic cost to them.

Risks

These represent an element present in any project. Their existence *is intrinsic in the idea itself of PROJECT* it is seen as a “new” objective to reach

A correct, forecasted Project may only decrease the probability that the project does not reach its objectives, but cannot eliminate it. During the Life Cycle of the Organisational process the analysis of Project **success** takes into account even the risk level that it had for failure. The higher this risk the more of a success a good project is.

Risks depend on many factors that may be “*internal to the objective*” (for example research and the realisation of a very innovative or unknown Product) or “*internal to the realisation of the Project*” (for example the Project of an electric power plant to realise in an area of strong social turbulence is riskier than a similar project that can be realised in a socially peaceful area).

07.2. Technical tools of Project Management

Operational wise, the Planning process starts from identifying the “Activities” (what are they, how long does each one last, etc.) that we must realise to reach the project objective. How much these activities must be placed in a well defined path or set of project paths, where activities are identified which chronologically precede other activities, in this manner it is displayed with a table named “Work Breakdown Table”.

Therefore, Planning goes through involving certain “Resources” (such as, how much do they cost, what work times do they have, etc.) that the project has at its disposal; therefore the Resources assigned to the activities and this relation is displayed by a table called “Activities-Resources Table”.

At this point Planning consists in polishing the first result obtained, analysing all the elements planned and going to research any possible errors. The entire process of checks and polishing of the Forecasted Project is developed using specific tools and techniques made available by the Project Management; this goes from the graphic display tools, such as Gantt and PERT, to the Reticular Techniques, to the Critical Path Method for the control of the so called “critical paths” of the Project. But even the analysis techniques and correction of Conflicts of Resources (use of a quantity of resources greater than those available).

In this Chapter we will analyse all these aspects.

07.2.1. The Elementary Activities of a Project

Operational wise, the Planning of a Project is developed according to a procedure of:

- identification of the elementary activities
- their arranging according to precise propedeuticity criteria

An **activity** is a *work unit* that cannot be divided further and which, once started, must be completed without solution of continuity.

Therefore an activity (the **elementary** can be eliminated so it does not cause confusion) is a part of the project path which, from a time standpoint cannot have interruptions. If an activity is interrupted it intrinsically must be separated in its homogenous components .

For example:

If in a Didactic Project we introduce the “Control Tests in Progress” Activity that represents the execution of a *prova di verifica* at the end of each Didactic Unit of the didactic path, we are making a mistake. In fact, the duration of this activity – which objectively is equal to the sum of the necessary times to realise and correct each *prova di verifica* – which would correspond to the duration of the entire Project, or almost. This is a case where an activity must be divided into more elementary activities, of the kind: “Control Tests Unit 1”, “Control Tests Unit 2”, etc.

07.2.2. *The characteristics of an elementary Activity*

Each activity is characterised by the following parameters:

- **name**

it is a word or a phrase capable of making it clear of what an activity is; it is used to identify the activity within each representation tool used by the Project Management;

- **start date**

represents the date in which the activity must start; it can be either a *specific date* (for example 25/3/2004) or a code that indicates a *type of start*. Among these the most common are:

- **ASAP (As Soon As Possible)**
- **ALAP (As Late As Possible)**

The indication of a code as the start date indicates the date of actual start is determined by the start date of an activity that precedes it. For example, ASAP will mean that the start date of our activity will be the day after the end of the activity that it precedes.

Further down we will describe specifically the use of these codes.

- **duration**

it is a number expressed in any unit of time (from the hour to the year) that indicates the entire duration of the activity; for activities belonging to the same Project the same measure of unit for time is used.

- **propedeutic activities**

that is all the activities that precede it chronologically and must end before it starts; in the event in which the activity is a start activity, it will not have propedeutic activities. The propedeutic activities are also called **predecessors**;

- **resources**

resources are (human, material, logistic, technical, etc.) which will operate within the activity;

- **expected results**

these are the specific results that the activity must provide

07.2.3. *The*

07.2.4.07.2.3. *Work Breakdown Table*

The scheduling of activities has its own natural display in a special table called **WBT (Work Breakdown Table)**; for each activity the following only are indicated in it:

- the **name**,
- the **duration**,
- the **propedeutic activities**
- the **start date**

It provides an immediate idea of the articulating of the project! It is practically the "draft" of the Project that the Project Manager realises in order to have an initial general idea of the Project and its progress.

On the side, a WBT is shown. In this example, for ease of display:

- the **activities** are named with letters of the alphabet
- the **durations** are displayed in a non determined unit of measure (but always the same for each activity)
- the **start date** is always As Soon As Possible.

07.2.5.07.2.4. *Graphic Displays of the WBT*

If the Work Breakdown Table is capable of providing us with an immediate and clear view of the activities that make up the project, it is not as much efficient to illustrate the *functional dependence* among the activities and the *temporal structuring* of the Project.

For example, the WBT does not allow us to immediately “see” if an activity comes before another or if two activities are simultaneous, or still yet, what is the temporal unfolding of the Project.

For this reason, two different scheduling *graphic display techniques* have been introduced: **PERT** and **Gantt**.

07.2.6.07.2.5. *PERT*

A first graphic display of the WBT is shown by **PERT**. This term is the acronym of **Program Evaluation Review Technique**. PERT is used for *defining* the *operational layout* of the activities involved in the Project. This means highlighting especially *functional dependencies existing* among the various activities, that is visualise the propedeuticity and course.

This operation is achieved through a graph oriented display (that is a diagram made up by points, called *nodes* and by oriented lines that connect them, called *arches*) where every activity is displayed by a circle (or a rectangle) and the priority binds are visualised by arches that connect two nodes. The display obtained, therefore, highlights exactly the flow of the project activities and in particular all the sequences of activities that make up the paths that go from the start to the end of the project itself, that is the sequences of activities that are linked one to the other by a bind of propedeuticity and that take from an initial activity to a final one. We will be able to give a broader explanation of the concept of path in a next paragraph.

In the example on the side you can see the PERT of the WBT introduced previously and that we report for ease of comparison. The particular typology of PERT displayed in the example is called **AsN (Activity on the Nodes)**.

07.2.7.07.2.6. *The Gantt Diagram*

The **Gantt Diagram** (or, more simply, **Gantt**) is a *bar diagram* capable of highlighting the **temporal evolution of the project**. In it, for each activity a bar is drawn whose length is proportional to the time duration of the activity and whose start is placed after the end of all the possible activities propedeutiche.

The Gantt diagram makes up an effective help tool to planning and allows to arrange in an integrated and visual form, the overall temporal evolution of the project and the interrelation among the activities in which the project itself has been broken down.

Even though on the side we have provided a very simplified version that represents our sample WBT, usually in a Gantt diagram other information is also specified, for each activity (that are placed before the actual diagram, such as the start date, the end date and duration).

In some cases, the following are also indicated: the allocated resources, the activities from which they depend and those subordinate to them.

07.2.8.07.2.7. *Characteristic aspects of a Gantt diagram*

As we can see from the Gantt sample introduced in the previous paragraph and as it is indicated by the notes on the side, the indication of the code **asap** for the activities is translated, into Gantt, in a display in which two activities, one propedeutic to the other, are directly linked by means of a continuation point of the first and one for the start of the second.

Obviously, this entails that for an initial activity of the Project its start coincides with the start date of the Project itself and in the display there will be no point at the start of the temporal segment that stands for the duration of the activity.

Furthermore, it is interesting to note the case in which two parallel activities are present (that is simultaneous) – that is two activities that are both predecessors of a same successive activity - of which one lasts less than the other and both. In this case the activity that lasts less has a “free” time that represents the waiting of the end of the longer activity for the purpose of allowing the start of the common subsequent activity.

This time has an important role in Project Management, as we will see soon.

07.2.9.07.2.8. *The Reticular Techniques*

Due to the importance the Project takes on and its management in the entire process of realisation of the Product, Project Management has introduced technical specifications that help in the *planning* and in *control* of the Project.

These techniques are called **Reticular Techniques** and they are based on the synergic use of the WBT, of PERT and Gantt, flanking them with a specific method of planning and monitoring called **CPM (Critical Path Method)**.

At the basis of this method there is the postulation that “*the most important constraint of an entire Project is its duration*”, conceived as time that goes from the start to the end of a Project. The reason for this postulation is clear: a delay in the closing times of the Project may determine new costs, risks of acceptance of the Product, risks for the ending of the Project, etc.

07.2.10.07.2.9. *Paths in a PERT*

It is easy to realise how the activities that make up a project form one or more constant sequences that join the start of the project to its end; each of these sequences is called **Path**

We can observe on the side that in PERT that we have developed previously four paths can be seen that are coloured:

The first of these paths, as can be easily verified, has a greater duration of the other and this duration coincides with the overall duration of the Project

Obviously, these paths have no importance in respects to the overall realisation of the Project. In fact, it is clear, that each activity of the Project, regardless of the path or paths it belongs to, must be carried out.

The importance of these paths is linked instead to identifying, among all the activities of the Project, those that have a somewhat own specificity and that are also called **critical activities** as we will see soon.

07.2.11.07.2.10. *Critical paths and the Critical Path Method*

The **Critical Path Method (CPM)** is based on identifying that, or those, paths whose sequence of activities is so that a delay even of one single of these entails the delay to the Project.

A path of this type is called **Critical Path** and the activities that make it up **Critical Activities**

From a formal standpoint, we may also say that a **Critical Activity** is an activity that has no “free” time before or after an activity, therefore, its minimum duration coincides, exactly with its actual duration.

We will investigate this further in the next paragraph: the role of what we have defined as “**free**” time.

A **critical path** is quite evident in Gantt that we are using as an example as displayed by the figure on the side in which we have colored the critical activities in red. As we can see, a Critical path is also a path whose duration coincides exactly with the duration of the Project.

where the activities of the critical path have been colored in red: and as we can see it is exactly the longest (time wise) of the four paths that make up the PERT, as seen previously.

07.2.12.07.2.11. *Slack Times and their role in the CPM*

The CPM allows also to manage another significant element of the temporal evolution of the Project: the **Slack Times** (or **Release**), those which, previously, we have defined as “free times”.

A **Slack Time** is the time, not null, that separates the end of an activity from the start of the following.

In the sample Gantt, of which on the side we show a detail, we have two Slack times: at the end of activity **f** and at the end of activity **i**.

We have said that the Slack Times have a considerable importance in managing the Project within the Critical Path Method. This occurs especially when the Project is in execution. In fact, through the action of the activities that have the Slack times we can face any possible delays that may occur in the critical activities.

Let's make an example following the graphic display on the side.

If in our reference Project a delay risk were to appear on the critical activity **h**, one can transfer resources from the non-critical activity **i** and therefore block the delay risk. This, of course would delay the activity **i**, but since it is equipped with a slack time its contained delay would not constitute a risk for the end of the Project.

Further on, we will see another use of the Slack times for the resolution of another typical problem that surfaces when the Resources are planned.

07.2.13.07.2.12. *The operational Resources of a Project*

We have already spoken about Resources in the previous Chapter. Let's give here a definition which is more in line with the Project Management and refers only to the only resources that carry out some sort of role in the realisation of the Project:

“a **RESOURCE** of a Project is any entity capable of contributing to the execution of one or more activities of the Project itself.

As we have seen, a Resource can be of any type:

- human,
- logistical,
- technological
- instrumental,
- etc.

as long as it carries out a job.

In an activity, obviously, more resources of the same type can be used (more computers, more workers, more graphic operators, etc.).

07.2.14.07.2.13. *Planning of the Resources*

Planning of Resources of a Project is an activity of the Project Manager who for complexities and importance has the same value of the Planning of Activities. Often the success or insuccess of a Project depends on the correctness with which the Resources were planned. For this reason Project Management has developed a range of tools that support exactly this objective. These tools allow on one hand, to organise the entire set of Resources available within the unitary layout (the **Table of Resources**) and, on the other, to assign to the individual Activities of the WBT the Resources necessary to it (**Activities-Resources Table**). The integration of these two layouts allow both to monitor the planning of the Resources as well as be in line with what is available and with the Project and, on the other, to perform those assessments of the project Costs that we have illustrated in a previous paragraph.

07.2.15.07.2.14. *The Table of Resources*

The **TABLE OF RESOURCES** is the tool for their planning. It allows to list, homogeneously, all the resources that are available for the Project that we are scheduling. For each Resource the following parameters are defined:

- **Resource Code**

Is the code that simplifies the indication of the Resources in the other table where it appears.

- **Resource type name**

Is the name of the resource conceived as “typology”; usually the choice made is that of inserting in this table not the specific name of the resource, but its typology (for example not Bob ROSS but “Director”, even if the Director is Bob ROSS).

- **Unit Cost**

Is the Resource cost per Time Unit (for example: the monthly salary of an employee, hourly cost for a consultant, the overall cost of a technological apparatus, the daily cost for leasing a conference room, etc.).

- **Type of Cost**

Specifies what kind is the cost indicated by the previous parameter (daily, hourly, monthly, forfeit, etc.).

- **Quantity (Capacity)**

This is an important parameter that indicates the number of units of that resource available to the Project (for example: 2 programmers, 1 director, 3 Personal Computers, 2 Production rooms, etc.)

In the example on the side a possible Table of Resources for the generic Project that we are using as an example is shown and of which we have already provided, WBT, PERT and Gantt.

07.2.16.07.2.15. *The Activities-Resources Table*

The **ACTIVITIES-RESOURCES TABLE** is the second tool for planning. This table shows, for each activity, the type of resources employed in the activity, with the number of unit for each one - called **Amount** (or **Level**) – assigned to the activity. This number can be also decimal and this means that the resource is committed for a fraction of its work day.

In our example on the side, an Activities-Resources Table for the Project for which in the previous paragraph we have introduced the Table of Resources is presented.

As we can notice in the example, in certain cases the **Dir** resource is used for half its time. For it, therefore the cost will cut into these cases for half of the value of the resource. Where, for example, for the **h** activity that lasts 10 days, the cost of the Dir resource, which is of 2.324,06 €/month (that is 20 conventional working days), will be of 1.161,03 € .

07.2.17.07.2.16. *The Resource Diagram*

The use of a Resource can be graphically displayed using a specific time diagram named **RESOURCE DIAGRAM**.

In this graph a rectangle that has the height equal to the Amount of the resource for that activity and the width equal to the number of the Activity Time Unit of duration is represented.

Obviously, if two activities are parallel and the Resource is used in both, the two rectangles will overlap.

In the example on the side the Resource Dir Diagram of our Project is displayed. As we can note in the diagram, for the parallel activities **c** and **d** there are, for the entire duration in which the two activities are simultaneous (equal to the duration of the shorter activities, that's to say **c** that lasts **10 time units**) the two rectangles that represent the use of the Director by half of the time, overlap and reach the value of the Capacity of the Resource (which in the case under study is **1**)

07.2.18.07.2.17. *The Costs of the Project*

The two tables previously illustrated allow to calculate the **COST OF A PROJECT**. This valorisation starts from the cost of the Resource, goes to assessing the cost of each Activity and therefore of the entire Project.

In fact from the Cost of a Resource per Time Unit you can obtain the **cost of the Resources for each activity** (multiplying *unit number* of each resource assigned to that activity for the *duration of the activity*). The result of this calculation is therefore the **Cost of each Activity**.

Project Cost will result therefore by the sum of the costs of all resources for all the activities.

In the table on the side, an example of this calculation made for our Project is shown. The table shown is an integration between the WBT, the Table of the Resources and the Table Activities –Resources. You can recognise the origin of each data by the colour of its denomination in the table heading. The orange color heading data refers to the values calculated of the Project Costs.

07.2.19.07.2.18. *Resource conflict*

A **RESOURCE CONFLICT** occurs when for that Resource its Capacity in a certain moment is overcome by the value of the Amount of that resource assigned to an Activity (or by their sum if the resource is utilised in more parallel activities in that moment)"

Basically, a Resource Conflict occurs when in a certain moment of the Project, a Resource has been planned in a number of employed units greater than those available overall for the Project itself.

Obviously, this discussion is true only if the resource Capacity is not ideally infinite.

07.2.20.07.2.19. *How is Resource Conflict displayed: an example*

To understand how Resource Conflict is manifested, we can use an example.

Let's suppose to have a WBT like that displayed in the upper left figure on the side. Therefore we have a Project made up by four activities. a1, a2, a3 and a4. The relative Gantt and PERT illustrate how of the four activities the first three are parallel among themselves while the fourth is subsequent.

Let's suppose, still, that the Project has a R Resource displayed in the **Table of Resources** as illustrated in the figure on the side – that shows us that this Resource has a Capacity equal to **1** – and that the Table Activities-Resources sees the **R** Resource assigned, with Amount **1**, to the activities **a2**, **a3** and **a4**.

It turns out, then, quite evident that in the time interval that goes from the start of the project up to the end of the 'activities **a3**, the resource **R** is in conflict since in that period two R resources should be employed (**Amount = 2**) while we have an only R resource for the Project (**Capacity = 1**).

The Resource Diagram, placed below right in the side figure, shows that situation in very clearly.

Therefore the Resource Conflict is displayed through the Diagram of the Resources, with rectangles that are higher than the line that represents the Capacity of the Resource. A point where the height is greater to the Capacity is called **Peak**.

In the diagram on the side we can notice, therefore, that the Amount of Resource **R** overcomes its Capacity in the first 10 days of the Project, when they evolve together both activity **a2** and activity **a3**.

07.2.21.07.2.20. *The solution of the Conflicts of Resources: Leveling*

The solution of Resource Conflicts can be carried out, usually, replanning a part of the Project. In certain more complex cases, instead, this solution cannot come from but an increase of the *capacity* of the resource, but obviously this is a drastic solution. In many cases, however, the first approach is very effective.

The solution of a conflict is called **RESOURCE LEVELING** (or **LEVELING**), expression that refers to the effect of that operation that consists in "*levelling*" a **peak** to the *capacity* of the same.

The leveling operation is performed, in the most part of the cases of replanning, utilising the slack times, practically postponing one or more of the activities that involve the resource. Obviously this must be possible. In the next paragraph we will analyse an example.

07.2.22.07.2.21. *An example of Levelling Operation*

Let's see how, applying the technique described in the previous paragraph, the Resource Conflict illustrated in the example introduced before can be resolved.

In the figure we may note by the sample Gantt, that the activities: **a2** and **a3** have both a slack time and easily verifies that the shifting of the start date of the **a3** activity after the end of the **a2** activity resolves the resource conflict without changing the project end date and levels the resource **R**.

07.3. First Elements about the Informatic Tools for Project Management

The complexity of the tool made available by Project management for the planning and managing of projects, makes it immediately clear to all that a manual approach to their use is absolutely inefficient. In the years prior to the driven diffusion of the information technologies and communication, these techniques were applied by hand: these techniques were drafted by hand with a typewriter, PETs and GANTTs were drawn by hand, etc..

The ICT have allowed the development of software environments capable of finely applying the techniques of Project Management. During the last fifteen years, numerous software packages have been produced for Personal Computers, Networks or Main Frames, dedicated to this type of application.

The Softwares for Project Management are capable of providing to the user multiple tools that allow not only to plan a Project, its Resources and Costs, but also to apply the Critical Path Method, manage the forecasted and current versions of a Project in execution phase, to simulate corrective actions and allow the Project Manager to verify the effects of a change to the Project, provide an enormous number of Project reports, etc.

In this chapter we will describe the characteristic elements of these softwares, while we will suggest to return to another Module for the description of the utilisation techniques of one of these environments: "Project" by Microsoft.

07.3.1. What are the informatic environments for Project Management

The **informatic environments for the P.M.** (called also **Planning environments**) are individual productivity software finalised to the "planning and monitoring of projects". They provide a very important support to the Project Management to realise the **forecasted planning** of a Project, but also to monitor and possibly quickly and easily change, during the development phase, that planning, through the realisation of **intermediate planning**.

During the phase of forecasted planning these software applications set themselves as outstanding development contexts because they represent excellent real-time simulation environments. By using them, the project designer can obtain the immediate vision of his project decision, by simply evaluating the effects. In particular:

- In defining the times
- In planning the activities
- In assigning the resources
- In evaluating costs
- In the analysis of the critical elements

Furthermore they are a valid help in the domain of complex projects, since they make available to apply methodologies of "reduction of complexities", through the dividing of a Project into **Sub-Projects**.

In the action of **control in execution phase** they allow the Project Management to analyse in real-time the solution of every problem of planning that may occur, in particular:

- Delay in critical times
- Variation in costs
- Crisis in resources

Lastly\ many of these environments are excellent tools of project documentation, because they are capable of providing automatically:

- layouts,
- graphs,
- tables,

07.3.2. Certain Environments of Project Planning

There are many Planning environments for the Project Management, with levels of applicational sophistication very different one from the other. Some allow to manage

even other functions and operations of Project Management, such as: distance cooperative work, organisation of work groups, the managing of company budgets, etc.

In the following list (and in the following paragraph) the main Planning software on the market today.

- **Microsoft Project** by Microsoft
- **SureTrak Project Manager** by Primavera Systems
- **Project KickStart** by Experience in Software
- **PlanWrite Business** by Nova Sun Publishing
- **Home Productivity** Kit by Elibrium
- **MindManager** by MindJet
- **FastTrack Schedule** by AEC Software
- **Maximizer** by Ingram Microz
- **Org Plus** by IMSI
- **Onestep Connect** by One For All
- **Suretrak Project Manager** by Princess Jade
- **ECBuilder Pro** by Multi Toys

07.3.3. *Other Environments of Project Planning*

Here is a further listing of Project Management Software:

- **Turboproject Professional** by IMSI
- **Anytime Deluxe** by Individual Software
- **AAA Map N' Go 7.0** by DeLorme
- **onProject e-Service** by At Your e-Service
- **Planmaker** by Power Publishing
- **Organizer** by Lotus Development
- **Ultimate Employer 4.0** by Knowledge Point
- **Mindmanager Standard Edition** by Victory Technology

Of the previous environments, most are specialised software in the *planning and control of Projects* and operate with more or less varying levels of sophistication. Besides the level of complexity and the facilities that each one offers, all of them are based on a series of common functionalities, that we will describe in the next paragraph.

07.3.4. *Base Functionalities of the Project Planning Environments*

All the environments of Planning of a certain level have a series of common functional features:

- managing the Project Calendar
- managing of Calendars for Resource
- planning of the activities (WBT)
- planning of the resources and their costs
- assigning of the resources and the activities
- analysis of the resource conflicts
- managing of the forecast and operational versions of a Project
- macro and micro assessments of the Project Costs
- cash-flow by Project, by Activity, by Resource
- Graphic displays of Activities and Resources

Furthermore, forecasts can be performed for costs and draft estimates. One can also purchase the actuals: costs, resources, and times with costs forecasts, resources and times.

The most part of these environments is very flexible and can be for this used in multiple project contexts, to manage projects of varying sizes and complexity.

We will illustrate these features from the next paragraph on using, as an exemplary environment, **Microsoft Project**.

07.3.5. *The work environment*

Usually the planning softwares supply a work environment that allows to directly input the WBT. On the side you can see how the environment of Microsoft Project is presented:

In the area of initial work, the project designer can insert the Work Breakdown Table, using the **WBT Area** and, in real time, Project will design, in the **Gantt Area**, the corresponding Gantt.

By using the **Menus** one can perform all the operations forecasted by the environment, while the icons on the left allow access to other work environments, such as: **PERT**, the **Table of Resources**, etc.

07.3.6. *The display of WBT*

Let's see, in the image on the side, how the Project work area is shown after having inserted the WBT of the exemplary project up til now used.

As we can note, Project associates to each activity a progressive number, named **ID**, that is utilised to indicate, for the Activities that have them, the relative **Predecessori**.

The **Project start date** is indicated in a specific mask that represents the Project Summary Information. By default the date of the day memorised in the Computer is used.

07.3.7. *The display of a Gantt*

After having introduced the WBT, inserting for each activity, the name, duration (in unit of time) and the time constraints (a *specific start date* or codes such as *asap* or *alap*), the environment provides in real time, as we have seen, the Gantt.

Project offers the opportunity to represent the Gantt using a time scale that goes from an hour, to a year.

In the figure on the side, the same Gantt is displayed in a daily scale and in one weekly one.

07.3.8. *The display of a PERT*

Using one of the buttons of the section "Work Areas Area" that we have indicated in a previous paragraph, the PERT of the Project is obtained automatically. Even in the case of PERT, Project allows to obtain various versions, that are distinguished by type and number of information that we require to be displayed on the nodes.

In the figure on the side we can note tow of these typologies:

- The first visualises, on each node, only the ID of the activity
- The second visualises, on each node,: name of the activity, ID, duration, start date and end date

In both cases the red nodes represent the Critical path.

07.3.9. *The calendars*

Before performing the loading operation of the WBT it is indispensable to personalise the **Project Calendar**. Usually the environment presents a standard calendar and a standard work day. In the standard week the working days are all the days of the week except Saturday and Sunday, while the standard work day is characterised by 8 working hours, from 8am to 12am and from 1pm to 5pm. Furthermore, the Standard Calendar shows no other holiday in addition to Saturdays and Sundays.

Obviously the Project Calendar can be totally customised and there is even the possibility of defining by particular type of resources (for example: the "shift workers", the persons in "part-time", "season workers", "consultants") Personalised Calendars, that will then be asociated to each resource of that type.

Here on the side is how Project presents the Project Calendar. The boxes in gray represent the non working Days.

Each day can go from working to non working or viceversa with an easy click of the mouse and, for each day, you can specify the work day.

07.3.10. The display of the Table of Resources

The Resources are planned above all using the work area relative to the “Table of Resources”. Even for the Resources, as for the Activities, Project allows the use of identification codes. In the case of the Resources, furthermore, Project allows to aggregate the resources in homogenous Groups that allow specific analyses by Group.

The sample Table of Resources is presented on the side.

07.3.11. The display of a Resource Diagram

In the moment in which the resources are assigned to the activities, with the indication, for each of them, of the Amount, the environment is capable to indicate if certain **resource conflicts** exist. It is the case of Project that will indicate in red the resources in this situation; for example, as we can note from the figure on the side, the resource Operator PC is in conflict (and therefore we have discovered that our Example developed in the previous chapters, shows a conflict of which we could not realise if not representing the trend of the resources use).

07.3.12. Other useful displays

Many other displays are offered by these environments. On the side, the visualisation given by Project of a detail of the hourly use of the resources of our example Project is shown:

07.3.13. Conclusions

We have seen how the Planning Environments allow to automatically and efficiently apply all the techniques introduced by Project Management. The main feature of these environments is that of operating in real-time. This feature makes them excellent support environments to the reasoning that a Project Manager activates when he must deal with a design problem. In this sense the use of these environments is suggested from the very start of the project design and, then, in the execution part of the Project, when the obstacles and difficulties undermine the original planning and require immediate interventions on behalf of the Project Manager who can utilise the planning environment to identify possible and sustainable changes in progress.

Therefore, these softwares are an optimal decisional support.