Chapter 3

**Effort Driven – Task Type**

By now, you will be getting sick of my repetition of the effort driven formula:

\[ \text{Resource Units} \times \text{Duration} = \text{Work} \]

I make no apologies, as it needs to be engraved in the brain so that whatever you do with resources you will automatically take the formula into account. Remember, the values in the formula are set up for each task when a resource is first assigned; subsequent changes will be governed by the formula.

**Moving Example for effort driven scheduling**

The first step in effort-driven scheduling is determining whether a given task is, in fact, effort-driven. After all, there are tasks within projects that are not effort-driven. For example, while packing is effort-driven, driving the moving truck is not. No matter how many people are working on the move, the moving truck can only go so fast.

A good way to determine whether a task is effort-driven is to ask yourself “If one person can complete this task in x amount of days, can two people complete it in 1/2x amount of days, and three people complete it in 1/3x amount of days?”

So if one person can paint a room in 12 hours, two people could paint a room in 6 hours, and three people could paint a room in 4 hours; this is an example of an effort-driven task.

Once it has been determined that the assigned task is, in fact, effort-driven, then the project manager must add a resource (person assigned the task) to the task. Perhaps the task will take one month to complete with one person working on it, but only ½ a month to complete with two people working on it. Once a second resource has been
added to the task, using Project, it will automatically calculate the schedule each time a new resource is added.

The important thing to remember is that when you schedule this way, you do not take into account the fact that you might have individuals who are less efficient or more efficient than other resources working on the task. Because of this, you may need to adjust – does Tony work at half the rate as Amy – if so, you need to consider this when assigning and scheduling the task.

The second point is do you need additional equipment to support the additional person and the cost.

Question -
Explain why effort-driven scheduling may not always be the best approach to take when planning a project.

Effort-driven scheduling may not be the best approach. For example, if one resource take 10 hours to complete a task, 10 resources may not be able to accomplish the task in one hour in real life based on limited space, equipment, etc. If effort-driven scheduling is turned on, this would be the result in this case.

It is best for the project manager to analyze the nature of the work required for the task, and then use best judgment as to whether or not to apply effort-driven

Plan, Monitor and Control
Plan: Proper planning is crucial to a successful project. You wouldn’t build a house without a complete detailed plan, but many companies try to build software with little if any plan
Monitor: Unless you know the status of the project at any point in time, you will be unable to respond to problems and changes in a timely manner.

Control: To keep a project on schedule and on budget, you must act quickly and decisively to all problems, changes and issues that arise. Central to this aspect is decisive and timely problem management. Experience and study will help you look at many of the common problems that arise in a project and how to deal with them.

Chapter 4

Project: Working with Effort-Driven Scheduling

A step-by-step guide to working with effort-driven scheduling in Project.

Effort-driven scheduling means that the total work for a task drives the calculations of duration, units, and work for individual assignments. If you add or subtract resources, the total work remains the same, while Project adjusts the task duration or units at which resources are assigned.

On the other hand, if you disable effort-driven scheduling, the total amount of work will change if you add or remove resources, just as the number of person-hours increases as you ask more people to attend a two-hour meeting. Essentially, effort-driven scheduling works hand-in-hand with the task type.

Learning About Effort-Driven Scheduling

Effort-driven scheduling can be a frustrating part of your work with Project, but it is a worth the extra time you need to devote to fully understand how this feature works. This way
you can begin to predict what Project is going to do with your work unit and duration calculations.

Remember, Project does not change anything the first time you assign a resource. Effort-driven scheduling and task types come into play only when you begin modifying original resource assignments. The first time you open the Assign Resources dialog box and assign resources to a task, your duration stays the same, your max units stay at their default setting from the Resource Sheet, and the work is automatically calculated. That is the easy part.

Fixed Units, Fixed Duration and Fixed Work
The challenging part in understanding effort-driven scheduling arises when you try to predict what is going to happen if you add another resource, if you remove a resource, or if you change the project duration. There are so many variables. But really, you just need to break it down to three. Those three variables are essentially the task types.

The task types are:
Fixed Duration
Fixed Units
Fixed Work

You know that the duration is the length between the start and finish dates for the task. Units are essentially the amount of capacity that any one resource can devote to a task. Work is the amount of time assigned to a task.

Effort-Driven Scheduling Scenarios

Consider a task with a duration of 5 days that has work of 10 hours. That is to say, your resource will be working 2 hours a day for 5 days to arrive at the 10 hours of work.
Now let's apply what we know about effort-driven scheduling. As you know, effort-driven scheduling is enabled by default on all tasks. Additionally, the default task type is Fixed Units. Initially, when you assign a resource to a task, Project applies the maximum units from the Resource Sheet and pulls that entry over to the Entry table (and ultimately to the Task Form). When you understand the three variables of fixed units, fixed duration, and fixed work, you can then begin to break this down by units, work, and duration. Making one of those variables “fixed” simply means that Project does not have the ability (or the permission) to modify that one “fixed” variable when a resource assignment changes. However, you always have the ability to modify that variable on a task. For example, on a Fixed Units task you can change the units from 100 percent to 50 percent (or any percentage you choose), but Project will not touch a “fixed” variable during an automatic calculation.

Now you know what “fixed” means in terms of this program. In most cases all effort-driven means is “more people equals less duration.” Essentially, the more people you assign to a task, the less duration that task should take to complete. Makes sense, in most cases.

Understanding when to use effort-driven scheduling or when to turn it off is critical to getting Project to modify your tasks the way you want when you make changes. However, consider the following scenario.

As a project manager, you have assigned three resources to attend a 2 hour project meeting. If you assign three more resources to attend the same meeting, the meeting will still take two hours. In this case, assigning additional resources to a task for a meeting will not necessarily decrease the time associated with completing the task. That is a determination
only you as the project manager can make. Project cannot make that determination for you. In this example you would disable effort-driven scheduling because adding additional resources will not make the meeting wrap up any sooner.

Now I will try and explain the differences between task types (Fixed Work, Fixed Duration, and Fixed Units) and which types should be used when.

A fixed duration task is one on which the duration cannot vary. Consequently, if you change either the amount of work that a resource does then the level-of-effort of that resource necessarily changes.

An example of a fixed duration task would be one where you monitored a new system for a fixed period after commissioning it for example. I also use it to represent monthly administrative overhead where the work is not specifically attributable to a deliverable but must nevertheless be accounted for.

A fixed work task is the most common task type. It represents a task type where there is a specific amount of work required to complete it. So, if you change the level-of-effort, the duration must necessarily change in order to complete that amount of work. Typically, if you add more resources to such a task, it will decrease in duration.

Examples of this include most common pieces of work such as writing a piece of well defined software, laying a given quantity of bricks, producing a document etc.

A fixed unit task is one where the level-of-effort is fixed. Consequently, for a given duration, the units determine the amount of work in the task. Similarly, if you change the
amount of work on a task, then the duration must change in order to keep the units constant.

This task type could for example be used to represent supervisory overheads. If somebody spends 10% of their time supervising an activity irrespective of its length, then this is the task type to use. Consequently, if the task gains in length, the work goes up.

About constraints

Constraints (constraint: A restriction set on the start or finish date of a task. You can specify that a task must start on or finish no later than a particular date. Constraints can be flexible [not tied to a specific date] or inflexible [tied to a specific date].) impose restrictions on the way Microsoft Project 2003 calculates the start (start date: The date when a task is scheduled to begin. This date is based on the duration, calendars, and constraints of predecessor and successor tasks. A task's start date is also based on its own calendars and constraints.) and finish dates (finish date: The date that a task is scheduled to be completed. This date is based on the task's start date, duration, calendars, predecessor dates, task dependencies, and constraints.) of tasks. By default, Project applies flexible constraints (flexible constraint: A constraint that is flexible and does not tie a task to a single date. Flexible constraints are As Soon As Possible, As Late As Possible, Finish No Earlier Than, Finish No Later Than, Start No Earlier Than, and Start No Later Than.), such as As Soon As Possible (ASAP), to tasks.

For optimal scheduling flexibility, it's recommended that you allow Project to use flexible constraints to calculate the start and finish dates for tasks based on the durations (duration: The total span of active working time that is required to
complete a task. This is generally the amount of working time from the start to finish of a task, as defined by the project and resource calendar.) and task dependencies (task dependencies: A relationship between two linked tasks; linked by a dependency between their finish and start dates. There are four kinds of task dependencies: Finish-to-start [FS], Start-to-start [SS], Finish-to-finish [FF], and Start-to-finish [SF].) you enter. Only if you have unavoidable constraints, such as an event date that cannot be moved, should you consider setting a constraint for a task manually.

Flexible constraints

Flexible constraints (flexible constraint: A constraint that is flexible and does not tie a task to a single date. Flexible constraints are As Soon As Possible, As Late As Possible, Finish No Earlier Than, Finish No Later Than, Start No Earlier Than, and Start No Later Than.) such as As Soon As Possible (ASAP) and As Late As Possible (ALAP) do not have specific dates associated with them. Setting these constraints allows you to start tasks as early as possible or as late as possible with the task ending before the project finish, given other constraints and task dependencies in the schedule.

Inflexible constraints

Inflexible constraints (inflexible constraint: A constraint that is inflexible because it ties a task to a date. The inflexible constraints are Must Finish On and Must Start On.) such as Must Start On (MSO) and Must Finish On (MFO) require an associated date, which controls the start or finish date of the task. These constraints are useful when you need to make your schedule take into account external factors, such as the availability of equipment or resources, deadlines, contract milestones, and start and finish dates.
Setting of constraints

When you enter a new task in the Task Name field, Project assigns the As Soon As Possible (ASAP) constraint when you schedule your project from the start date. When scheduling from the finish date, Project assigns the As Late As Possible (ALAP) constraint.

If you drag the mouse in the chart portion of the Gantt Chart to create a new task, however, Project automatically assigns the Start No Earlier Than (SNET) constraint when you schedule your project from the start date. When scheduling from the finish date, Project automatically assigns the Start No Later Than (SNLT) constraint.

When you manually enter a start or finish date for task, you automatically apply a constraint to it.

When you schedule your project from the start date and you type a start or finish date for a task, Project constrains the task to begin or complete no earlier than that date. If you schedule your project from the finish date, however, Project constrains the task to begin or complete no later than the date you type.

Constraints and task dependencies

Constraining a task that is dependent on another task can produce unwanted results, as illustrated in the following example:

The task "Pour foundation" is linked so that it starts as soon as "Dig hole" finishes; "Dig hole" is supposed to happen on the 10th. If you enter an inflexible constraint that forces
"Pour foundation" to start on the 10th and then "Dig hole" finishes early, Project will not be able to take advantage of the early finish and move "Pour foundation" to start earlier.

Rather than setting specific dates for a task, consider assigning an As Soon As Possible (ASAP) constraint and enter a deadline (deadline: A target date indicating when you want a task to be completed. If the deadline date passes and the task is not completed, Project displays an indicator.) for the task. Entering a deadline causes Project to display a deadline marker on the Gantt Chart, and an indicator (indicators: Small icons representing information for a task or resource that are displayed in the Indicators field. The Indicators field is located to the right of the ID field and appears in a number of tables.) will alert you when the task’s finish date moves past the deadline.

Available constraints

Microsoft Project 2003 provides the following constraints (constraint: A restriction set on the start or finish date of a task. You can specify that a task must start on or finish no later than a particular date. Constraints can be flexible [not tied to a specific date] or inflexible [tied to a specific date].).

As Late As Possible (ALAP)

This flexible constraint (flexible constraint: A constraint that is flexible and does not tie a task to a single date. Flexible constraints are As Soon As Possible, As Late As Possible, Finish No Earlier Than, Finish No Later Than, Start No Earlier Than, and Start No Later Than.) schedules the task as late as possible with the task ending before the project finish and without delaying subsequent tasks. This is the default
constraint for tasks when scheduling from the project finish date. Do not enter a task or finish date with this constraint.

As Soon As Possible (ASAP)

This flexible constraint (flexible constraint: A constraint that is flexible and does not tie a task to a single date. Flexible constraints are As Soon As Possible, As Late As Possible, Finish No Earlier Than, Finish No Later Than, Start No Earlier Than, and Start No Later Than.) schedules the task to begin as early as possible. This is the default constraint for tasks when scheduling from the project start date. Do not enter a start or finish date with this constraint.

Finish No Earlier Than (FNET)

Schedules the task to finish on or after a specified date. Use this constraint to ensure that a task does not finish before a certain date.

Finish No Later Than (FNLT)

Schedules the task to finish on or before a specified date. Use this constraint to ensure that a task does not finish after a certain date.

Must Finish On (MFO)

This inflexible constraint (inflexible constraint: A constraint that is inflexible because it ties a task to a date. The inflexible constraints are Must Finish On, Must Start On, Finish No Earlier Than, Finish No Later Than, Start No Earlier Than, and Start No Later Than.) schedules the task to finish on a specified date. Sets the early, scheduled, and late finish
dates to the date you type and anchors the task in the schedule.

Must Start On (MSO)

This inflexible constraint (inflexible constraint: A constraint that is inflexible because it ties a task to a date. The inflexible constraints are Must Finish On, Must Start On, Finish No Earlier Than, Finish No Later Than, Start No Earlier Than, and Start No Later Than.) schedules the task to start on a specified date. Sets the early, scheduled, and late start dates to the date you type and anchors the task in the schedule.

Start No Earlier Than (SNET)

Schedules the task to start on or after a specified date. Use this constraint to ensure that a task does not start before a specified date.

Start No Later Than (SNLT)

Schedules the task to start on or before a specified date. Use this constraint to ensure that a task does not start after a specified date.

Critical path method

The critical path method (CPM) or critical path analysis, is a mathematically based algorithm for scheduling a set of project activities. It is an important tool for effective project management.

History
It was developed in the 1950s by the DuPont Corporation at about the same time that General Dynamics and the US Navy
were developing the Program Evaluation and Review Technique [1] Today, it is commonly used with all forms of projects, including construction, software development, research projects, product development, engineering, and plant maintenance, among others. Any project with interdependent activities can apply this method of scheduling.

END OF Chapter 4

General additional information -

Basic technique

The essential technique for using CPM is to construct a model of the project that includes the following:
A list of all activities required to complete the project (also known as work breakdown structure),
The time (duration) that each activity will take to completion, and

The dependencies between the activities.
Using these values, CPM calculates the longest path of planned activities to the end of the project, and the earliest and latest that each activity can start and finish without making the project longer. This process determines which activities are "critical" (i.e., on the longest path) and which have "total float" (i.e., can be delayed without making the project longer). In project management, a critical path is the sequence of project network activities which add up to the longest overall duration. This determines the shortest time possible to complete the project. Any delay of an activity on the critical path directly impacts the planned project completion date (i.e. there is no float on the critical path). A project can have several, parallel, near critical paths. An
additional parallel path through the network with the total durations shorter than the critical path is called a sub-critical or non-critical path.

These results allow managers to prioritize activities for the effective management of project completion, and to shorten the planned critical path of a project by pruning critical path activities, by "fast tracking" (i.e., performing more activities in parallel), and/or by "crashing the critical path" (i.e., shortening the durations of critical path activities by adding resources).

Expansion
Originally, the critical path method considered only logical dependencies between terminal elements. Since then, it has been expanded to allow for the inclusion of resources related to each activity, through processes called activity-based resource assignments and resource leveling. A resource-leveled schedule may include delays due to resource bottlenecks (i.e., unavailability of a resource at the required time), and may cause a previously shorter path to become the longest or most "resource critical" path. A related concept is called the critical chain, which attempts to protect activity and project durations from unforeseen delays due to resource constraints.

Since project schedules change on a regular basis, CPM allows continuous monitoring of the schedule, allows the project manager to track the critical activities, and alerts the project manager to the possibility that non-critical activities may be delayed beyond their total float, thus creating a new critical path and delaying project completion. In addition, the method can easily incorporate the concepts of stochastic predictions, using the Program Evaluation and Review Technique (PERT) and event chain methodology.
Currently, there are several software solutions available in industry that use the CPM method of scheduling, see list of project management software. However, the method was developed and used without the aid of computers.

Flexibility
A schedule generated using critical path techniques often is not realised precisely, as estimations are used to calculate times: if one mistake is made, the results of the analysis may change. This could cause an upset in the implementation of a project if the estimates are blindly believed, and if changes are not addressed promptly.

However, the structure of critical path analysis is such that the variance from the original schedule caused by any change can be measured, and its impact either ameliorated or adjusted for. Indeed, an important element of project postmortem analysis is the As Built Critical Path (ABCP), which analyzes the specific causes and impacts of changes between the planned schedule and eventual schedule as actually implemented.

Running time
Given a graph G=G(N,E) of N nodes and E edges, if we use the Big O notation, the CPM algorithm takes O(E) to complete, since topological ordering of a graph takes O(E) and every edge is considered only twice, which means linear time in number of edges.

Program Evaluation and Review Technique
The Program (or Project) Evaluation and Review Technique, commonly abbreviated PERT, is a model for project
management designed to analyze and represent the tasks involved in completing a given project. PERT is a method to analyze the involved tasks in completing a given project, especially the time needed to complete each task, and identifying the minimum time needed to complete the total project.

PERT was developed primarily to simplify the planning and scheduling of large and complex projects. It was able to incorporate uncertainty by making it possible to schedule a project while not knowing precisely the details and durations of all the activities.

It is more of an event-oriented technique rather than start-and completion-oriented, and is used more in projects where time, rather than cost, is the major factor. It is applied to very large-scale, one-time, complex, non-routine infrastructure and Research and Development projects.

This project model was the first of its kind, a revival for scientific management, founded by Frederick Taylor "Taylorism" and later refined by Henry Ford "Fordism". DuPont corporation's critical path method was invented at roughly the same time as PERT.

The Project Management Triangle is a model of the constraints of project management. It is often used to illustrate that project management success is measured by the project team's ability to manage the project, so that the expected results are produced while managing time and cost.

Overview
Like any human undertaking, projects need to be performed and delivered under certain constraints. Traditionally, these
constraints have been listed as "scope," "time," and "cost". These are also referred to as the "Project Management Triangle," where each side represents a constraint. One side of the triangle cannot be changed without affecting the others. A further refinement of the constraints separates product "quality" or "performance" from scope, and turns quality into a fourth constraint.

The time constraint refers to the amount of time available to complete a project. The cost constraint refers to the budgeted amount available for the project. The scope constraint refers to what must be done to produce the project's end result. These three constraints are often competing constraints: increased scope typically means increased time and increased cost, a tight time constraint could mean increased costs and reduced scope, and a tight budget could mean increased time and reduced scope.

The discipline of Project Management is about providing the tools and techniques that enable the project team (not just the project manager) to organize their work to meet these constraints.

Another approach to Project Management is to consider the three constraints as finance, time and human resources. If you need to finish a job in a shorter time, you can throw more people at the problem, which in turn will raise the cost of the project, unless by doing this task quicker we will reduce costs elsewhere in the project by an equal amount.

Project management triangle topics

Time
For analytical purposes, the time required to produce a deliverable is estimated using several techniques. One
method is to identify tasks needed to produce the deliverables documented in a work breakdown structure or WBS. The work effort for each task is estimated and those estimates are rolled up into the final deliverable estimate.

The tasks are also prioritized, dependencies between tasks are identified, and this information is documented in a project schedule. The dependencies between the tasks can affect the length of the overall project (dependency constrained), as can the availability of resources (resource constrained). Time is different from all other resources and cost categories.

**Cost**

To develop an approximation of a project cost depends on several variables including: resources, work packages such as labor rates and mitigating or controlling influencing factors that create cost variances tools used in cost are, risk management, cost contingency), cost escalation, and indirect costs. But beyond this basic accounting approach to fixed and variable costs, the economic cost that must be considered includes worker skill and productivity which is calculated using various project cost estimate tools. This is important when companies hire temporary or contract employees or outsource work.

**Cost Process Areas**

Cost Estimating is an approximation of the cost of all resources needed to complete activities. Cost budgeting aggregating the estimated costs of resources, work packages and activities to establish a cost baseline.
Cost Control - factors that create cost fluctuation and variance can be influenced and controlled using various cost management tools.


Analogous Estimating
Using the cost of similar project to determine the cost of the current project

Determining Resource Cost rates
The cost of goods and labor by unit gathered through estimates or estimation.

Bottom Up estimating
Using the lowest level of work package detail and summarizing the cost associated with it. Then rolling it up to a higher level aimed and calculating the entire cost of the project.

Parametric Estimating
Measuring the statistical relationship between historical data and other variable or flow.

Vendor Bid Analysis
taking the average of several bids given by vendors for the project.

Reserve Analysis
Aggregate the cost of each activity on the network path then add a contingency or reserve to the end result of the analysis by a factor determined by the project manager.

Cost of Quality Analysis
Estimating the cost at the highest quality for each activity.

Project managers often use project management software to calculate the cost variances for a project.
Scope
Requirements specified to achieve the end result. The overall definition of what the project is supposed to accomplish, and a specific description of what the end result should be or accomplish. A major component of scope is the quality of the final product. The amount of time put into individual tasks determines the overall quality of the project. Some tasks may require a given amount of time to complete adequately, but given more time could be completed exceptionally. Over the course of a large project, quality can have a significant impact on time and cost (or vice versa).

Together, these three constraints have given rise to the phrase "On Time, On Spec, On Budget." In this case, the term "scope" is substituted with "spec(ification)."

According to PMBOK the Project Time Management processes include:

1. Activity Definition
2. Activity Sequencing
3. Activity Resource Estimating
4. Activity Duration Estimating
5. Schedule Development
6. Schedule Control
Activity Definition (detail)

1a. Activity Definition Inputs
Enterprise environmental factors, Organizational process assets, Project Scope statement, Work Breakdown Structure, WBS Dictionary, Project Management Plan

1b. Activity Definition Tools
Decomposition, Activity Templates, Rolling Wave Planning, Expert Judgment Collection, Planning Components
1c. Activity Definition Outputs
Activity list, Activity scope attributes, Milestones list, Change Requests

Activity Sequencing

2a. Activity Sequencing Inputs
Project Scope Statement, Activity List, Activity Attributes, Milestones List, Approved change requests
2b. Activity Sequencing Tools
Procedure Diagram Method (PDM), Arrow Diagramming Method (ADM), Schedule Network templates, Dependency degeneration, Applying leads and lags
2c. Activity Sequencing Outputs
Project Schedule Network diagrams, Activity List Updates, Activity Attributes Updates, Request Changes

Activity Resource Estimating (detail):

3a. Activity Resource Estimating Inputs
Enterprise Environmental factoring, Organizational process assets, Activity list, Activity attributes, Resources Availability, Project Management Plan
3b. Activity Resource Estimating Tools
Expert Judgment Collections, Alternative Analysis, Publishing estimating data, Project management software implementation, Bottom up estimating
3c. Activity Resource Estimating Outputs
Activity resource requirements, Activity attributes, Resource breakdown structure, Resource calendars Request change updates.

Activity Duration Estimating (detail):

4a. Activity Duration Estimating Inputs
Enterprise environmental factors, organization process assets, Project scope statement, activity list, activity attributes, activity resource requirements, resource calendars, project management plan, risk register, activity cost estimates

4b. Activity Duration Estimating Tools
Expert judgment collection, analogous estimating, parametric estimating, three point estimating, reserve analysis

4c. Activity Duration Estimating Outputs
Activity duration estimates, activity attribute updates and estimates

Schedule Development (detail):

5a. Schedule Development Inputs
Organizational process assets, Project scope Statement, Activity list, Activity attributes, project Schedule Network diagrams, Activity resource requirements, Resource calendars, Activity duration estimates, project management plan, risk register

5b. Schedule Development Tools
Schedule Network Analysis, Critical path method, schedule compression, what if scenario analysis, resources leveling, critical chain method, project management software, applying calendars, adjusting leads and lags, schedule model

5c. Schedule Development Outputs
Project schedule, Schedule model data, schedule baseline, resource requirements update, activity attributes, project calendar updates, request changes, project management plan updates, schedule management plan updates

Schedule Control (detail):
6a. Schedule Control Inputs
Schedule management plan, schedule baseline, performance reports, approved change requests

6b. Schedule Control Tools
Progressive elaboration reporting, schedule change control system, performance measurement, project management software, variance, analysis, schedule comparison bar charts

6c. Schedule Control Outputs
Schedule model data updates, schedule baseline, performance measurement, requested changes, recommended corrective actions, organizational process assets, activity list updates, activity attribute updates, project management plan updates

Due to the complex nature of the Process Group called 'Time' the unique project management credential PMI-SP (PMI Scheduling Professional) was created.