Project Services Pty Ltd

THE COST OF TIME,

OR WHOSE DURATION IS IT ANYWAY?

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Introduction

The purpose of this paper is to put into one document the multiple factors that should be considered by competent planners and managers when assigning a duration to a task. The paper is not intended to reach any conclusion on what is the 'correct' way to assess durations (we suggest there is no universally correct answer this question), rather to explore the options and possibilities involved in the process and recognise the inherent uncertainties associated with the 'simple' task of assessing a duration.

This paper is intended as a companion to an earlier paper '***Float – is it real?***[1]' which identifies some of the limitations and constraints inherent in the 'Critical Path' scheduling methodology. This paper will consider the four areas of decision making that impact the overall choice of an appropriate duration for a task, these are decisions pertaining to:

- The overall project framework.
- Estimating the optimum task duration.
- Balancing the requirements of individual tasks against the need to optimise the overall project
- Managing the consequences of actual progress and deviations from the schedule.

The underlying theme is the need for everyone involved in developing the schedule and managing the project to recognise that scheduling is not a precise science and that ignoring the variability and potential for errors inherent in every schedule is far more damaging than accepting them and managing the consequences.

Variability in the Overall Project Framework

Determining the overall project framework requires a number of critical decisions to be made (simply accepting system defaults should not be an option!). These initial planning decisions concern the project framework and constrain the definition of tasks later in the schedule development process. Some of the key framework decisions are:

- Deciding on the project update cycle – ideally a task's duration should not exceed two update cycles.
- Sizing the time units – just because your software can calculate in minutes this is not always appropriate: time units of days, weeks and in some cases even months may provide a clearer picture of the overall flow of work in a project.
- Setting appropriate work periods and calendars – 24Hrs x 7 days, 8Hrs x 5 days, etc.

[1] Weaver P: 2006. ***'Float is it real?'***: https://mosaicprojects.com.au/PDF_Papers/P043_Float-Is_it_Real.pdf

There tends to be correlation between the update cycle and time units. A short update cycle (eg, daily) supports the use of smaller time units (eg, hours); but it is pointless to use duration units of minutes if the project is only being updated every couple of weeks. The appropriate update cycle is determined by the volatility and management intensity of the project. It is pointless starting a new update cycle if the data from the previous one has not been issued to, and actioned by, the project team[2].

The normal range of task durations should be between one quarter, and twice the update cycle. These ratios impact the next range of decisions, determining the tasks themselves.

Scoping the Task

Determining appropriate tasks

After the project framework has been determined, designing tasks that fit within the framework is the next step. Some of the key factors involved in selecting the work to be included in a task include:

- Being the responsibility of a single person or management entity,
- Capable of being worked on continuously, and
- Unambiguous in its scope.

Within these parameters, as far as possible, the scope of work needs to be capable of being achieved within the maximum and minimum durations determined by the update cycle.

The discussion up to this point has not been directly related to the issue of cost and duration, the subject of this paper. However, it is important to recognise the element we will be focussing on, the task (and its duration) is itself subjective and variable, the 'right' answer being based on a series of decisions that are influenced by the nature of the project and the culture of the performing organisation.

After the tasks are determined and the overall project framework set, the issues concerning the estimation of the optimum duration for each task can be fully considered. Unfortunately, there are a complex series of issues that interact and can on occasions be mutually contradictory. Each issue is discussed separately below.

Managing and Using Expectations

Projects do not operate in isolation. Previous experience set expectations as to what is likely (or 'reasonable') and, conversely, the tasks, sequences and durations contained in the project schedule help shape expectations around the project's execution and outcome.

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2 For more on ***setting the planning framework*** see: https://mosaicprojects.com.au/WhitePapers/WP1039_Project_Planning.pdf

One of the best ways to obtain commitment to the achievement of tasks, on time and on budget is to ensure the people doing the work believe the information contained in the schedule is achievable and reasonable. The easiest way to achieve this is to ask the person responsible for undertaking the work (task) to provide the estimates used in the schedule (see: '***5-STEPS; Five Steps To Ensure Project Success***[3]').

The drawback to using this form of analogous estimating is that it limits innovation. Any move away from existing expectations founded on experience cannot be achieved without investing in project communications to change people's views as to what is realistic and achievable; this takes time and costs money. However, unless the new approach is seen to be realistic and achievable (ie, people's expectations have changed), there will be no commitment to achieving the task within the scheduled duration.

One of the valuable contributions made to the overall process of project scheduling by the Critical Chain methodology is to show that radical changes in expectations can be achieved, and very aggressive durations can be accepted as achievable, provided sufficient effort is made to explain the basis of the new estimates.

Within Australia, a similar shift in expectations was noted during the HERMES project (see: 'The VIPER Experience[4]'). The scheduled time to undertake similar maintenance tasks was reduced by some 50% over a number of years by a process that was seen by the project workers are fair and reasonable and the shorter durations were routinely achieved. The new, shorter durations became what were expected by both management and project team members.

The clear message from Critical Chain and HERMES is that the schedule sets expectations and as long as people are engaged with the process and believe the schedule is 'reasonable', will work to achieve their expectations. This makes the schedule a powerful tool to influence project outcomes.

Volume of work and production rates

A contrary view to the one discussed above is based on estimating time needed to complete a task based on the content of work included in a task and production rates. The initial answer from the calculation is either the number of 'hours' of work involved in a task (typical for ICT estimating processes) or the time needed for a normal 'crew' to complete the work (typical for construction activities). There are numerous sources of 'production rate' data available, with some web sites containing thousands of production rates[5].

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3 Doyle B & Weaver P: 1995. ***'5-STEPS - Five Steps To Ensure Project Success'***: https://mosaicprojects.com.au/PDF_Papers/P004_5-STEPS.pdf

4 Weaver P: 2003. ***'The VIPER Experience'*** (pages 8 – 11): https://mosaicprojects.com.au/PDF_Papers/P012_VIPER.pdf

5 For example, see: http://www.planningplanet.com/

This view of planning has its roots in the Scientific Management movement of the 1940s and 50s. The belief being that all work can be measured and an optimum production rate established. Work study techniques would time operations and set targets for workers to achieve. Whilst these ideas have some merit in production lines and repetitive work environments, they run into problems in a project environment simply because each project is unique. Some elements of a project may be repetitive and similar to other projects but there are always differences that generate variances.

The problem with applying 'production rates' to projects is they are always variable! One example from Planning Planet is: *Blockwork Laying in m^2/day* the options are: *Slow = 7.0, Average = 12.0* and *Fast = 17.5*. As a consequence, to lay 100m^2 of blockwork will take between 14.285 days and 5.714 days of effort.

- Problem #1, if days are being used as a planning unit should 14.285 be rounded up to 15 or down?
- Problem #2, the 'worst time (slow) is nearly three times greater than the best time (fast); someone has to decide what rate to use (or the adjustment factor to apply). As soon as someone has to address the question; "What actual duration should be used if the work is expected to be done a *bit quicker than average but not really fast*?"; the estimating process has become subjective.

When estimating systems simply produce bulk hours as is normal for ICT estimating processes (hours per function point, etc) the problem is worse. Fredrick Brooks first published his book ***'The Mythical Man Month*[6]'** in 1975 – that's 30 years ago. In his book, Brooks clearly demonstrates the folly of assuming any direct correlation between the effort involved in a project, the number of people available and its duration. There is a relationship but it is complex and variable; Brooks' key message is that people and time are not interchangeable. To quote 'Brooks' Law': *Adding manpower to a late software project makes it later*. Unfortunately, after 30 years this simple idea is still not well understood.

Understanding the volume of work is vital for cost estimating and helpful for sizing work crews and durations but estimating the actual duration of any task requires much more than simple arithmetic.

Optimum crew sizes and the 'J' curve

The relationship between crew size and the duration of a task is rarely a 'straight line'. The only time there is a straight-line relationship is when the work can be sub-divided into individual elements that only need one person to accomplish the work and there is no need for any external communication or assistance. And even then, there are finite limits on the number of people that can be effectively allocated to the work.

6 *The Mythical Man Month* (20th Anniversary Edition) Frederick P. Brooks Jr. pp322 Addison-Wesley, Reading USA. 1995

Many engineering and construction tasks require composite crews; eg, a crew of four brick layers supported by one labourer. The labourer's job is to keep the bricklayers supplied with bricks and mortar and clean up behind. Traditionally this crew keeps the bricklayers productively laying bricks without overloading the labourer. Adding an extra bricklayer or two means that for some of the time, some of the bricklayers will be either waiting for materials or doing labouring tasks instead of laying bricks. This is a sub-optimal outcome.

Where work is basically done by individuals, but the individuals need to cooperate and communicate; eg, software development, adding people increases the amount of effort that has to be spent interacting with others on the team. Every person added to the team reduces the overall efficiency of everyone else (this is the basic point of Brooks' Law).

The most usual relationship between the efficiency of the task (usually measured in Dollars per unit of production) and the crew size is a 'J' curve (see Fig. 1). There is a point below which the work is impossible. As the 'crew' increases in size, the efficiency increases until the optimum is reached, at this point, the work is being accomplished in the most efficient manner. If the crew size is increased above the optimum level, the efficiency starts to drop until a point is reached where adding more people to the crew is counter-productive and the work actually takes longer!

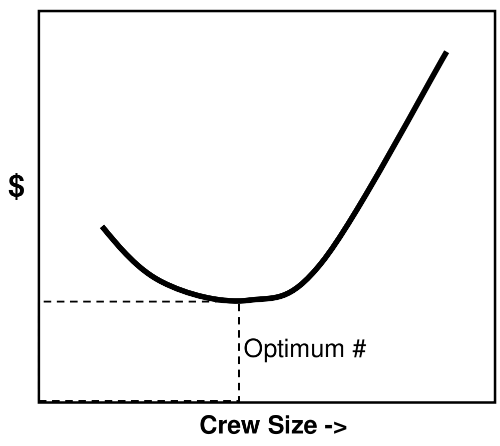


Fig. 1: Typical J-Curve

The relationship between the crew size and the elapsed duration for the task is more complex (see Fig. 2). Every increase in the crew size will reduce the task's duration until the point of ultimate inefficiency is reached. However, after the optimum crew size is reached, the payback is progressively reduced. The 'point of ultimate inefficiency' is where adding more people actually increases the duration of the task.

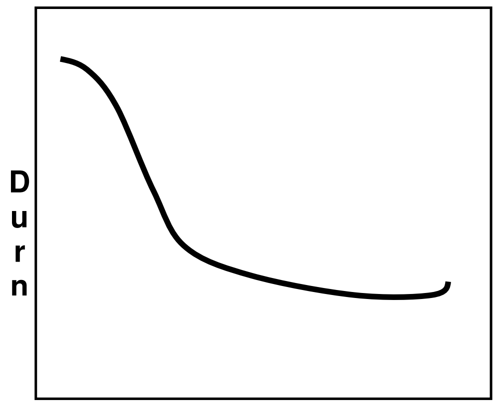


Fig. 2: Crew size -v- Duration

For many tasks in business and ICT projects, the optimum 'crew size' is one person; and these principles still apply. A one-person task is obviously not helped by adding a second person to the 'crew', nor is it helped by expecting that person to 'multi-task' (ie, reducing the crew size to, say 33% of a person's time). Multi-tasking introduces inefficiencies, primarily in the time needed to 'put away' one task and 'restart' another. It also unnecessarily delays the completion of most of the tasks. Figure 3 demonstrates a typical resource overload – one person has to complete three days-worth of work in one day.

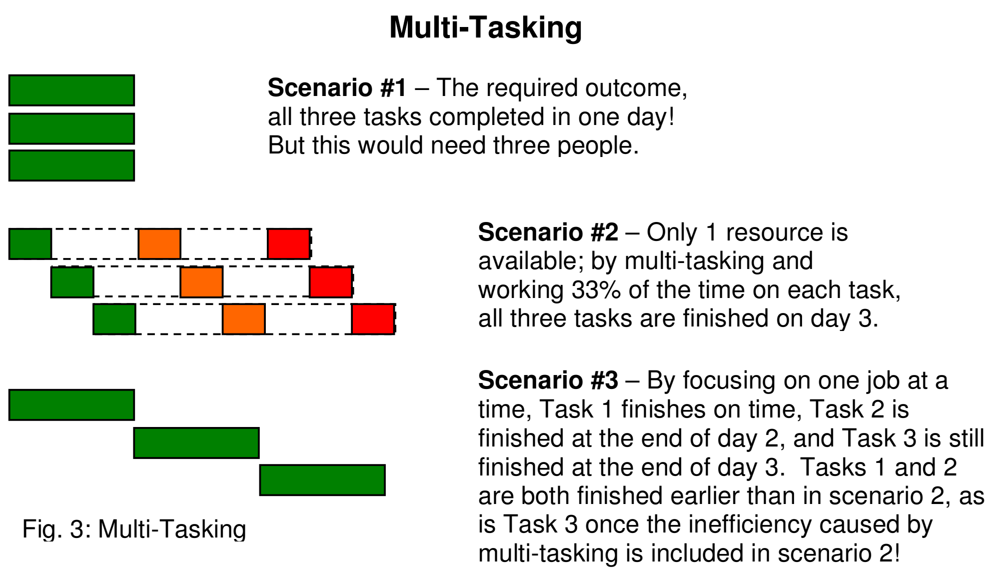


Fig. 3: Multi-Tasking

By multi-tasking none of the jobs are finished until well into day 3. By focusing on one job at a time, one is completed on schedule, the second is completed by the end of day 2 (a 1/3 of a day earlier than multi-tasking); and the last is completed in the same time as the multi-tasking option; and this example does not take into account the inefficiencies introduced by multi-tasking.

This section of the paper has demonstrated the relationship between a task's duration and the crew allocated to undertake the work is complex. Part of the planning process must be to determine and document the assumptions built into the duration estimates[7].

Work methods and physical constraints

The duration of a task can be significantly affected by the chosen method of working and / or any constraints placed on the work.

Some choices are totally within the control of the project team. Where there are no external constraints, the chosen method of working is generally based on other considerations such as cost. Choosing a quick but expensive method of working for a non-critical task adds little value to a project over a slower, less expensive option.

Sometimes, the method of working is genuinely a matter of preference (ie, there are minimal cost or other implications). When taking this type of decision, it is critical to involve the people who will be undertaking the work in the decision-making process so that the actual execution of the work is done in accord with the schedule. Whilst the decision itself may be 'open' during the planning process, once made the balance between resources (quantities, skills, etc) and the selected duration will be fixed and changing the work method is likely to change these requirements. There is no 'right answer' the objective is to achieve an optimum answer that is right for the project.

External constraints and limitations may also restrict, or dictate, the choice of work methods; examples include: mandated limitations on noise or work hours, the requirement to maintain safe access and nominated inspection or test points.

The other factor to be carefully considered when setting a task's duration is any physical limitations that may constrain or restrict access to the work, together with any safety requirements. Undertaking a task in a constricted work space is a much slower process than where easy access is available and can often require specific safety measures that add to the duration and resource requirements.

Capacity and capability of resources / efficiency of working

Closely aligned with decisions on work methods are decisions involving the selection of resources (or constraints imposed by existing resources). It is generally not practical to keep changing resources on a project to optimise each individual task. Rather, the durations of each task need to be adjusted to accommodate the resources allocated to the project. This applies equally to the skills of people and the capacity of

[7] For more on ***duration estimating*** see: https://mosaicprojects.com.au/WhitePapers/WP1052_Time_Estimating.pdf

plant and equipment. Where choice is available, the resources are selected to optimise the duration (and cost) of most tasks recognising some will be sub-optimal. Where there is no choice, the duration of the task has to be based on the resources actually available to undertake the work.

In some situations, the capacity or capability of the resources will be a significant constraint on the chosen method of working with a direct impact on the duration and cost of the effected tasks. Whilst these factors are fairly self evident, at the planning stage of many projects it can be very difficult to identify exactly what resources will be made available during the execution phase.

Variability and uncertainty.

The whole process of determining the scope of a task and then assessing an appropriate duration based on the selected method of working and the anticipated resources that will undertake the work is a subjective set of decisions based on assumptions. This means there is an element of risk associated with every task estimate. The nature of the risks will vary, depending on the decisions made during the scheduling process; a few of the possibilities include:

- Setting aggressive estimates to drive performance raises the risk of failing to achieve an adequate level of quality (requiring time for re-work),
- The actual resources may perform better or worse than the assumed resources incorporated in the planning process, and
- The actual method of working may differ from the planned.

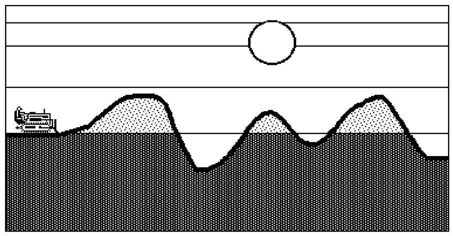
Whilst outside of the scope of this paper, it is critical that the project team recognise that whilst setting the duration of a task will help set expectations, the actual performance of the work is likely to vary from the plan. During planning phase, the impact of this variability can be assessed using three-point estimating, Monte Carlo simulation and other techniques. Once the work has started, variability is managed by regularly statusing and updating the schedule[8].

Overall Scheduling Constraints

Once the task durations have been determined, the next factor to consider is the overall scheduling process; balancing schedule logic, working times, tasks durations and resources to achieve the overall project objectives, whilst allowing appropriate contingency times for risks. This process frequently requires adjustments to the pre-determined optimum duration for a task to achieve contractual objectives, balance resources and/or meet imposed constraints.

[8] For more on ***managing schedule risk*** see: https://mosaicprojects.com.au/PMKI-SCH-015.php

From the perspective of setting task durations, the largest impact usually arises from the need to smooth resource demands. It is neither desirable nor practical to have a schedule that required 20 resources one day, 5 the next and 15 the day after. Some resource balancing can be achieved by moving tasks within their float periods. However, to optimise the resource balance it is frequently necessary to stretch some tasks (reducing their resource demand) and shorten others (to increase the demand). Whilst both of these options reduce the efficiency of the work on the individual task, the compensating improvement on overall resource usage on the project offsets the disadvantage.



At the end of the planning process the optimised schedule for the project should offer a realistic and achievable plan[9]. Then work starts!

Dealing With Reality

Project work rarely proceeds exactly as planned. Some changes are caused by factors within the project, others by external factors. Recognising and managing these variances are helped by the regular updating and statusing of the schedule[10].

As far as possible, small negative variances should be resolved within the day-to-day management of the project. However, as the project progresses the need to accelerate frequently arrises. Whilst reducing the overall duration of the remaining part of the schedule is relatively simple (on paper) – achieving real 'acceleration' in the work place is altogether more difficult. Some of the factors to be considered are:

- The degree of change required to production levels (see: '*The Mathematics of Losing*'[10]),
- Increased risks associated with fast tracking, and
- Inefficiencies associated with 'crashing' durations[11].

[9] For more on ***resource optimization*** see: https://mosaicprojects.com.au/PDF_Papers/P152_Resource_Optimisation_2.pdf

[10] See ***Managing for Success - The power of regular updates***: https://mosaicprojects.com.au/PDF_Papers/P002_MFS_Full.pdf

[11] For more on ***schedule compression*** see: https://mosaicprojects.com.au/WhitePapers/WP1059_Schedule_Compression.pdf

Starting a project 'right' is the best way to avoid problems, but this is not an easy feat to achieve[12]. Therefore, when confronted with the need to accelerate, it is probably wise to think very carefully about what fundamental changes will be made before simply cutting a few durations and hoping for an improvement. As this paper has demonstrated, there are a range of complex factors that interact to determine the best duration for a task and changing any of the factors, particularly the duration, requires corresponding changes in the others. Assuming the original task duration has been optimised during planning, these changes will cause inefficiencies and increase costs.

Conclusions

Recognising the inherent uncertainty (or variability) in estimating task durations and as a consequence the uncertainty of the overall schedule that results from the analysis of the tasks, logic and resources does not diminish the value of the schedule in any way. If anything, the contrary is true; assuming the schedule is an accurate representation of the future is far more likely to cause problems.

Mariners have always recognised the probability of error in the processes they use to navigate a course, they compensate for these expected errors by routinely 'checking their bearings' and making minor adjustments to stay on course. Similarly, everyone involved with managing a project needs to be aware of the variability of the project environment (resources, skills, etc), and the probability of errors in the estimating processes used to assess durations, and 'checking their bearings' by routinely statusing and updating the schedule to keep the project on track for a successful completion. Recognising the limitations of a schedule makes it a far more useful tool to help successfully navigate a project through to a successful conclusion than placing false hopes on its precision.

However, in the same way mariners have always sought the best possible charts and instruments to assist their navigation. Project managers should actively seek the best possible schedule to help achieve a successful project outcome. Whilst it is impossible to eliminate differences between the schedule and reality, good planning can minimise the variances.

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[12] Bourne L & Weaver P: 2001. ***'The Project Start-Up Conundrum'***: https://mosaicprojects.com.au/PDF_Papers/P003_Conundrum.pdf