Duration Estimating

Probably the most common action undertaken by project planners everywhere is assigning a duration to a task; most of us do this almost automatically. Generally it is only when a dispute arises that the complex interaction of the factors discussed involved in setting the duration come into play. There is no universal answer to the question of what is the 'correct' way to assess durations but this White Paper will provide an overview of the multiple factors that should be considered by competent planners and managers.

Estimating the duration of a future activity is a balance between setting an objective to motivate team performance and allowing adequate time for the scope of work in the activity to be achieved. The process of duration estimating requires:

- Dealing with each activity in turn
- Considering the work involved, the ideal crew size and the team's experience
- Estimating optimum duration for activity[1]

As a starting point, each activity needs to be concisely and precisely defined. This implies the activity is a discrete element of work, its description is unique and unambiguous and the work is capable of proceeding to completion without interruption. Ideally a single person should be responsible for managing the performance of the work so you can involve people who will be responsible actually for 'doing' the work in the estimating process.

When estimating durations you need to be realistic! For 90% of projects use days; for most of the rest use weeks. Estimating in hours for projects longer than a few days is dangerous – you have no idea when the work will actually occur (you will be lucky if it's done on the planned day!), but will have created false expectations as to the accuracy of the estimating and scheduling process.

The recommended options for determining the duration[2] of each activity (in order of preference) are:

- Option 1 – Ask the person who knows and preferably will be doing the work. This creates a commitment to achieve the estimate but will be affected by the person's innate biases[3].
- Option 2 – Use recorded information from previous similar projects[4]. This aligns with people's expectations (particularly management) but needs expertise to make appropriate adjustments to the data.

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1 For a more detailed consideration see: ***The Cost of Time (Durations)*** https://mosaicprojects.com.au/PDF_Papers/P009_The_Cost_of_Time.pdf

2 Options 1 and 2 are forms of analogous estimating; option 3 is a form of parametric estimating.
- Analogous: comparing the current activity with a similar completed activity and making appropriate adjustments.
- Parametric: using adjusted historical data to estimate the duration based on the quantity of work.

3 For more on the ***effect of cognitive biases*** see: https://www.mosaicprojects.com.au/WhitePapers/WP1069_Bias.pdf

4 Recorded information can be sourced from internal and external sources. Internal sources include lessons learned and the organisations knowledge management / historical records system (Organisational Process Assets). External sources include commercial published databases and free peer reviewed sources such as Planning Planet (Enterprise Environment Factors). For more on ***OPAs and EEFs*** see: https://www.mosaicprojects.com.au/WhitePapers/WP1026_EEF_OPA.pdf

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- Option 3 – Calculate the duration from production rate data (but beware… see 'rate based estimating below)

The estimating framework

The initial planning decisions concern the project framework used to define the task should be established first, this includes:

- Sizing the time units: As mentioned above, 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: 24 x 7, 5 x 8, etc.
- Determining how frequently the schedule will be updated.
- Determining the tasks. Ideally the tasks will be sized so that they take around 1 update cycle to be accomplished.

Once the task is determined, and the overall project framework set; the issues concerning the estimation of the optimum task duration come into play. Some of the factors that may influence the final answer include:

- The expectations of the person doing the work.
- Prior expectations: previous experience sets management's expectations.
- Volume of work and production rates (but these are highly variable). Some activities are time-constrained, the duration is unaffected by the resources applied to the work (eg, a 24 hour immersion test will always require 24 hours); others tasks can have their duration changed depending on the resources used for the work (see 'effort driven durations' below).
- Optimum crew sizes and the production 'J' curve.
- Capacity and capability of resources.
- Work methods and physical constraints—efficiency of working.
- Understanding variability (PERT[5], Monte Carlo).
- Setting new expectations: the 'Critical Chain' effect of using stretch targets as motivators.
- Achieving quality (adequate time for testing, etc).

Once the optimum duration of each task has been determined, the next factor to consider is the overall scheduling process, balancing schedule logic, working times, task durations and resources to achieve the overall project objectives, while 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. But this is only the beginning…

As the project progresses the need to accelerate frequently occurs, generally caused by a delaying factor earlier in the project. Reducing the overall duration of the remaining part of the schedule is relatively simple on paper; however achieving acceleration in the workplace is altogether more difficult. Some of the factors to be considered are:

- The degree of change required to production levels.
- The increased risks, resource and management issues associated with fast tracking.
- The inefficiencies, increased resource and management issues associated with 'crashing' durations.

[5] For more on ***PERT*** see: https://www.mosaicprojects.com.au/WhitePapers/WP1087_PERT.pdf

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When confronted with the need to accelerate, it is probably wise to think vary carefully about what fundamental changes will be made before simply cutting a few durations. And the critical thing about fundamental change is that it is usually expensive[6]!

Problems with rate based estimating

Resource production rates are based on the ideas inherent in 'Scientific Management' theories (C19th) supported by work study from the 1940s and 50s[7]. Their use in stable manufacturing environments has been consistently successful, but every project unique (variable) and therefore production rates vary with the consequential need for subjective assessments; as the following example demonstrates:

Production rates for block laying[8]

Slow =	7.0m2/per day
Average =	12.0m2/per day
Fast =	17.5m2/per day

This range of rates requires subjective assessments. Some of the questions to be answered include:

- How do you decide which rate to use? Or is an intermediate rate more appropriate; 'a bit quicker than average' (say 13m2/per day)?
- Based on this decision a duration can be calculated. For 100m2 of block work
  Slow = 14.285 days of effort
  Fast = 5.714 days of effort Note the overall variability (nearly a factor of 3)
- If you decide the 'slow' production rate is appropriate, should you round the duration up or down? (15 or 14 days of effort)
- Based on this decision, if the optimum 'crew' for this work is 4 people does the actual duration become 4 days or 3 (a 25% variation)?

Whilst rate based calculations appear to be objective calculations, based on data and arithmetic; they are in fact subjective assessments based on opinions and personal preferences!

However, the quantum of work cannot be ignored! Whilst we recommend involving the people doing the work in determining the estimated duration, it is important they understand the volume of work involved in the activity. Understanding the quantum of work:

- Is essential for cost estimating (although this is usually done on a more aggregate basis[9] than individual activities[10]).
- Helps size work crews and estimate durations based on understanding production rates from previous projects[11].
- Helps define initial expectations of what is achievable and reasonable.

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6 For more on ***acceleration issues*** see: https://www.mosaicprojects.com.au/WhitePapers/WP1059_Schedule_Compression.pdf

7 See The ***Origins of Modern Project Management***: https://mosaicprojects.com.au/PDF_Papers/P050_Origins_of_Modern_PM.pdf

8 Source Planning Planet – www.planningplanet.com

9 For more on ***WBS*** see: https://www.mosaicprojects.com.au/WhitePapers/WP1011_WBS.pdf

10 For more on ***cost estimating*** see: https://www.mosaicprojects.com.au/WhitePapers/WP1051_Cost_Estimating.pdf

11 Very few software tools use ***resource optimisation*** to balance durations, available resources and overall efficiency. The technology is available, but not used in project scheduling. For more on this see: https://mosaicprojects.com.au/PDF_Papers/P152_Resource_Optimisation_2.pdf

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The danger of effort driven durations

The duration needed to accomplish the work inherent in an activity is directly influenced by the effort applied to the work. However, the relationship between the number of people involved and the duration is a complex curve. The concept of effort driven resource durations used in many popular software tools is completely false.

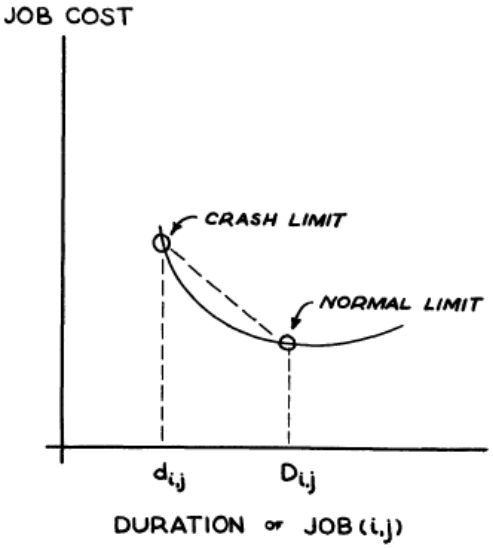

Fig. 2—Typical job cost curve.

Part time effort (multi tasking) has been proven to cause significant inefficiencies. Increasing the size of the work crew beyond the optimum also generates inefficient working and higher costs. The diagram below is taken from the 1959 paper by Kelly and Walker that defined 'Critical Path Scheduling' for the world[12].

This is a similar concept to the ideas described in **The Mythical Man Month**[13], summarized in Brooks' Law: Adding people to a bad project makes it worse! When agreeing durations the resource effort and work quantity are critically important considerations but they do not have a simple relationship. Understanding the work involved and the people involved is critical.

Productivity Factors (PF)

The net time needed to accomplish a set quantity of work and the actual time is based on how much time resources can actually apply to the work and how much is consumed in other activities that may be essential for the work but do not directly contribute to its accomplishment. These non-productive but essential activities include safety meetings, waiting for inspections or permits, refreshment breaks that are not defined in the calendar, on-site travel time between work locations etc.

For example, if you have an activity that you estimate will take forty hours for the assigned team to complete; it is unlikely that it can be completed in five eight-hour calendar days. No one is 100% productive! Without taking the productivity factor into account, you may achieve your estimate for the hours of work required, but you will exceed your duration estimates.

The productivity factor for any given work situation needs to be assessed and applied to the work to base the scheduling process against the net available productive hours rather than the 'paid hours'. The factor is not

[12] For more on ***'crashing' durations and schedule compression*** see: https://www.mosaicprojects.com.au/WhitePapers/WP1059_Schedule_Compression.pdf

[13] Frederick P. Brooks Jr. ***The Mythical Man Month*** - Addison-Wesley, Reading USA. 1975

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fixed, it can vary depending on geographic region, climate, the accessibility of the work place (working at height or in confined spaces), the skill of the contractor, etc. And in every workplace time is needed for things like social interaction during the day, going to the bathroom and travelling to meetings. It also takes into account people that need a little time to get going in the morning, as well as people that start to fade in the late afternoon. It is impossible to assess the number of productive hours per day for each person on the team, so a general factor should be assessed. A generally accepted rule-of-thumb for average productive hours per day is 6.5, based on an eight-hour day. This is an 80% productivity factor and extending the day by 'working' longer does not seem to make much difference to the productive work component of 6.5 hours – a 10 hour day is likely to has a PF of around 65%.

The PF needs to be factual and not used to hide administrative inefficiencies:

- Waiting for an inspection to be completed is a legitimate PF inclusion – the work cannot be completed or continued without the sign-off.
- Waiting for the inspector to turn up is an administrative inefficiency – a better organised process would ensure the inspector is available when needed.
- The down-time for a scheduled tea break included in an award is a legitimate inclusion, plus reasonable travel time from the work place to the tea room.
- If lax behaviour routinely extends a 15 minute break to 25 minutes, the additional 10 minutes is an inefficiency, not a PF inclusion.

The PF adjustment can be made as a global adjustment via calendars (eg, reducing a standard 8 hour day to 6.5 hours) or as a more specific task and resource level adjustment. Care needs to be taken to ensure these schedule adjustments are time related rather than cost related:

- If there is a fixed price quoted for a section of work, the contractor is paid the fixed price; the schedule adjustment is focused on ensuring the project time management is realistic.
- If workers are paid for a standard 8 hour day, the payment and cost remains unaltered by the PF requiring the schedule to be based on a 6.5 Hr effective day.

Developing durations

Developing the overall project duration and its underlying activity durations is an iterative process. There is no point in assuming knowledge that does not exist. The concept of ***Schedule Density***[14] is designed to allow a definitive 'Low Density' baseline schedule to be created based on heuristics and analogous estimating techniques. This baseline is preserved with more detailed activities being incorporated at 'Medium Density' and 'High Density' as more information becomes available and importantly, the people who will undertake the work become available. This is a similar concept to 'rolling wave' planning[15], however, schedule density offers a more sophisticated approach to developing a useful schedule.

Two key aspects of creating a duration are firstly the effect of the duration as a motivator[16]; secondly understanding the degree of risk associated with the estimate and creating appropriate contingencies.

There is also a direct relationship between the design of the schedule, the design of appropriate 'high density' activities and the calculation of activity durations. The schedule should be designed so that most activities at the final level of detail are less than one or two times the schedule update cycle:

- PMI Practice Standard for Scheduling recommends: ***'less than 2 times the schedule update cycle'***.

[14] For more on ***schedule density*** see: https://www.mosaicprojects.com.au/WhitePapers/WP1016_Schedule_Density.pdf

[15] For more on ***Rolling Wave Planning*** see: https://www.mosaicprojects.com.au/WhitePapers/WP1060_Rolling_Wave.pdf

[16] For more ***durations as performance motivators*** see: https://www.mosaicprojects.com.au/WhitePapers/WP1050_Critical_Chain.pdf

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- CIOB Guide to Good Practice in the Management of Time in Major Projects recommends: ***'not more than the update cycle'***.

For more on the design of the schedule and selecting an appropriate update cycle see: ***A Guide to Scheduling Good Practice***[17]***.***

Planning -v- Execution Estimates

Planning estimates are created during the overall project planning process. Typically starting as general estimates for phases or sections in the business case and then more detailed task estimates in the schedule baseline. Where allowed[18], it is a good idea to revisit these estimates prior to undertaking the work.

Execution estimates are developed immediately prior to starting work on a group of activities. Initially tasks retain their original planning task estimates, then at an appropriate time these are reviewed and adjusted by the people assigned to the task (working with the project planner or manager). The best estimate comes from the resource working the task. In cases where they have done similar tasks before, the estimate will be reliable. If the resource is new to a task, the estimate tends to be high, but this serves as built in risk mitigation offsetting the resource's inexperience. As the resource revises the estimate, it becomes more accurate and reliable. As work progresses, the routine updating processes will automatically update the task estimate provided the key information captured is the resource's estimate of the time remaining to complete the work.

Including the step of reviewing and revising each task estimate with the people who will be responsible for undertaking the task before starting work, ensures they understand the requirements and have 'bought into' the time needed to complete the work. Where this step creates changes in the plan, everyone knows in advance what is most likely to occur and other actions can be taken to lock in gains and mitigate the effet of longer durations.

Guideline for Creating a Good Estimate

Schedulers forecast the future, attempting to predict the time required to produce a product or service. Predicting the future is never an easy task, and becomes increasingly difficult the more unique the project. However, knowing and applying these golden rules of estimating will provide greater opportunity for a successful forecast:

Find the Right Scheduler. Schedulers familiar with the work and duration estimating methods are key. There are many duration estimating techniques including: phased, top-down, analogous, parametric, and bottom-up. Regardless of the estimating method, the person making the estimate should have an understanding of the work to be done, and have a proper understanding of the techniques and goals of estimating. He or she needs to understand that the goal is to predict the most likely outcome.

Estimate Based on Experience. All projects are unique, but they often have similarities with other historical projects. Data from past projects can be helpful in estimating future ones - past performance data improves the accuracy of any of the discussed estimating techniques. Formal data is best, if this is unavailable people's personal experiences and recollections are valid, but need confirmation.

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[17] See: https://mosaicprojects.com.au/PDF-Gen/Good_Scheduling_Practice.pdf

[18] Agile projects expect change and are amenable to adaptation prior to the start of each iteration or sprint. In other situations, the form of contract and the degree of flexibility in managing the work may impose limitations on what can be changed.

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Avoid Negotiating Estimates. The tendency of management is to request estimate changes to reduce schedule this should be resisted by demonstrating that the estimate was created from project specifications and represents a realistic balance of cost, schedule, and risk. Also, demonstrate that the estimate is linked to product specifications and the work breakdown structure. Further, highlight that the only way to reduce an accurate estimate is by changing the product scope or worker productivity.

Dealing with objections

It is not uncommon in internal projects and negotiations, that your carefully prepared project estimates have to be justified or defended if the client or sponsor thinks the numbers are too high. If you have done the estimating properly, reducing the durations (or costs) in the face of an objection simply creates a bigger problem later when the project overruns its (reduced) time!

Information is the key to validating your work. You should be able to defend the estimate by demonstrating:

- Your understanding of the work
- The estimating technique(s) you used
- Your estimate of the effort hours, duration and cost
- The detailed estimating information in case the sponsor would like to review
- Your estimating assumptions
- The level of uncertainty as reflected in the estimating range

This level of information gives you the facts to respond to the challenge, and it will stop many challenges because people will have difficulty disputing your facts. The keys to this part of discussion are your credibility[19] and the quality of the information you have presented.

Once the credibility of your estimate is accepted based on your estimating rigor, the discussion can then proceed to alternatives if the sponsor still thinks the overall duration of the project is too long, a few alternative options include:

- Determine if the client has any additional information that would allow you to revise your assumptions and perhaps revise the way the overall plan is structured. Working shifts increases costs but reduces time.
- Determine whether high-level requirements and functionality can be scaled back. In many cases, the original set of features and functions is more of a wish list. After seeing the times associated with the full list, it is very possible that the client can live without certain features or simplify requirements, particularly those with a long lead time.
- If you included a high contingency to reflect a high estimating risk, ask the client for more time to gather more detail for the estimate. This may result in there being less uncertainty and risk, and allow you to reflect this as a smaller contingency.

No estimate is perfect, what sensible sponsors and clients are seeking is reassurance you have done the best job possible in the circumstances and the costs are realistic. This requires them to believe you are skilled and credible and our estimating processes were rigours and effective. .

Linking the Schedule with Cost Estimates

Apart from very small short-term projects (3 to 6 months and under $200,000) attempting to directly integrate the cost estimating process with the scheduling process in fraught with difficulty. Even on these smaller projects, direct linking is not really feasible unless the primary source of all costs is staff directly employed on the work.

[19] For more on ***credibility*** see: https://mosaicprojects.wordpress.com/2013/04/27/credibility/

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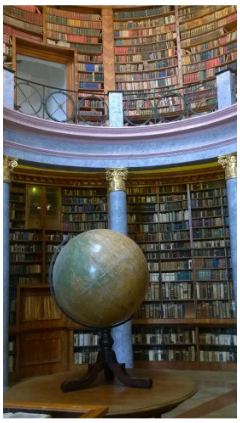
Most normal projects require a degree of integration between cost and schedule. This is usually achieved by developing a WBS and integrating time, cost, scope, risk and quality at either the Work Package level or the Control Account level[20].



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For more information on scheduling and planning, visit Mosaic's scheduling home page at: https://mosaicprojects.com.au/PMKI-SCH.php

[20] For more on the ***WBS*** see: https://www.mosaicprojects.com.au/WhitePapers/WP1011_WBS.pdf

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