A Risk Perspective: Rolling Wave Planning is a Bet

By John C. Goodpasture, PMP
info@sqpegconsulting.com

Introduction to the Rolling Wave

Planning a project is not an easy thing to do. It's pretty much impossible to plan the whole project at one time to the same level of detail because, as a practical matter, there are simply too many unknowns. Anyone who has done the planning for anything other than a few dozen tasks over a time line of a few weeks knows this to be common sense. Typically, a planner works in time sequence, planning near term activity with more certainty and knowledge of likely outcomes, addressing much finer detail than that of later tasks. Even when there is a pretty good model of what the tasks should be at various points in the lifecycle of a project, planners are cognizant of uncertainties that can, and many likely will, develop over the course of the project. When some uncertainties become realities, the project may then take an alternate course, tasks may have to be re-sequenced, resources may be replaced, replenished, or retrained, or the project plan may have to be rebaselined. In short, things happen!

Most projects have a lifecycle that more or less fits this template: Phase 1 is to charter the project and develop the business case accurately enough to get project approval and resources committed. Subsequent phases define requirements, perform design and execution, conduct test and validation of deliverables against the requirements deck, and then rollout deliverables to operations. Many project plans carry on through benefits capture during operations, and even retirement.

Wave planning, some would call it phased planning, aligns with the lifecycle. By example, let's consider the first wave, Wave 1. The Wave 1 plan is built on the template of all wave plans, really three subordinate plans sequenced together but defined at different levels of detail for each plan, as shown in Table 1 Planning Wave Properties.

The first subordinate plan in Wave 1 is often a plan for the project initiating tasks to an actionable level of detail; the second is a plan for the requirements gathering at a level of detail corresponding to a model plan, and the third plan in Wave 1 blocks out resource allocations for the design and subsequent phases.

Table 1 Planning Wave Properties	
Wave N, Plan 1 Actionable activities	Nearest activities in time, planned to a level of detail that project participants can execute specific tasks

Table 1 Planning Wave Properties	
Wave N, Plan 2 Model activities	Next nearest activities, but planned only to a level of detail represented by a model of the activity. To act on this model, planning to the level of detail in Plan 1 is required
Wave N, Plan 3 Allocation Blocks	Fartherest activities in time. Perhaps no model of what is to be done is available, but a top-down allocation can be made of resources.

Wave 2 rolls in about the time Wave 1 is approved. Wave 2 is timed to produce a just-in-time actionable plan for what was the model-based plan in Wave 1, provide a model for the next block of activities, taking into account the outcomes of Wave 1, and perhaps reallocate resources for the other phases. So it then goes with each wave rolling in to provide actionable detail just in time.

Place your bets!

Everything that is known is a certainty, and everything that is not known is an uncertainty, in a word: a risk. Wave planning brings unknowns, at least undefined or unspecified tasks, into the project plan. Wave planning brings risk into the project plan. Of course there are many other sources of risk in the project environment, and wave planning may not contribute the greatest risk.

Risk is either an opportunity or a threat. Realistically, in the project business, the focus is on the threat component of risk. Consider this statement as a mission statement for project managers:

"The project manager's mission is to manage resource capability and capacity to deliver expected scope, taking measured risks to do so"[1]

The fact is, managing risk is what project managers do! Managing risk is managing unpredictability. Is it so hard? Gamblers do it all the time. The difference is that the project environment is much messier than the casino. The dice only have six faces on each; there are only 52 values in a deck of cards, there are rules, and there are referees. Nevertheless, introducing risk to a project is tantamount to placing a bet that the outcome will be favorable.

[1] Quotation from author's book "Managing Projects for Value", p46, published by Management Concepts, 2002

Mitigating Unpredictability

For a long time mathematics has been a project's best friend. Most of us could make a long list of tasks we do with mathematics in the course of project management. But predicting the future is not often one of those tasks.

In fact predicting the future mathematically only came along since the 16th century even though games of chance go back to the very earliest civilizations in ancient Egypt. In 1525, an Italian physician named Girolamo Cardano first wrote down the numerical values of chance with a set of dice, but it took another hundred years until two French mathematicians, Pascal and Fermat, discovered probability theory. The famous bell curve came along nearly 200 years after Cardano when another French researcher, Abraham de Moivre recognized the bell pattern of many observable phenomena in every day life. 80 more years would pass before Karl Friedrich Gauss showed how to use probability distributions, like the bell curve, to predict future values. His work is honored by naming the bell curve the Gaussian distribution, but also known as the Normal distribution.[2]

This general area of mathematics is called statistics; a statistic is a calculated or estimated data value.

Our history brings us to the present: wave planning is a bet on the future, a probabilistic bet on the future; mathematics can mitigate the uncertainty of the bet. We use one very important idea: a chance event taken in isolation is not predictable, but many such events, happening independently, reveal patterns of behavior that can be described mathematically and simulated with computer assistance. Such patterns are so repeatable that they are reliable predictors of future behavior. Even though projects are one-time endeavors, simulation allows us to execute the project many times mathematically and thereby discover the likely project outcomes before the actual execution occurs.

Day to Day heuristics for Wave Planning Predictions

Few projects keep a statistician on staff, and few project managers or analysts are steeped in statistics well enough to apply statistics with mathematical rigor. Fortunately such is not necessary to make use of the key concepts for mitigating risk in the wave plans.

The important statistical ideas are given in Table 2 Statistics for Project Managers

Table 2 Statistics for Project Managers

[2] History paraphrased from the book "The Language of Mathematics", chapter 7, by Keith Devlin, 1998 W.H. Freeman publisher

Table 2 Statistics for Project Managers	
Distribution of possible planned durations	Each plan within a wave and each task within a plan are risk-adjusted with a 3-point estimate of outcomes: a **most likely** duration, a **most optimistic** shortest duration, and a **most pessimistic** longest duration. Each **duration** has a **probability of occurrence**. Project impact is the product of duration x probability. Pessimistic or optimistic durations may be possible, but their likely impact is small because in most instances they are not going to happen. A graph or pattern of the duration values vs. the probability of a specific duration value is called a **distribution**. A common distribution for modeling projects is the **triangular distribution**. The peak of the triangle is at the most likely duration value, and the other two corners are at the optimistic and pessimistic values.
Statistics [calculated data values] that are day-to-day important	For a large number of mathematical trials of a project plan, there is an **average** outcome, an **expected value** of outcome, a **most likely** outcome, a **confidence** that the outcome will be within a range of values, and measures of dispersion or spread around these statistics. The common measures of dispersion are **variance, standard deviation,** and **standard error.**
Simulation of many project trials by Monte Carlo simulation	A **Monte Carlo simulation** is created by 'executing' the project many times by mathematical means, assisted by a computer, and then calculating the statistics from the trial set.

Table 3 provides the definitions of statistics most used by project managers and most applicable to wave planning risk analysis.

Table 3 Definition of Statistics for Projects	
Measurements of Duration	**Average** is the sum of all duration outcomes divided by the number of trials **Expected value** [EV] is sum of all outcomes, each outcome weighted [multiplied] by its probability of occurrence. EV is a **risk adjusted average** and a more accurate estimate of the expected outcome when the project is executed for real. EV and average are mathematically equal when every outcome has the same probability, 1/N **Most likely** outcome is the outcome value that occurs most often in the trial set, but it may not be the expected value

Table 3 Definition of Statistics for Projects	
Measurements of Risk and Predictability Lower numbers infer lower risk and improved predictability of outcomes	**Variance**, and its square root **Standard Deviation**, are measures of dispersion around the average. Each can be calculated from the trial values of the simulation. Variances can be added together among independent task durations. **Standard error** is a measure of how well the calculated standard deviation is really the standard deviation. It measures the deviation of the standard deviation value
Measurement of confidence that an outcome will be within a given interval. A confidence of 40-80 over a certain outcome interval means that 40% of the time the outcome will be greater than the lower limit of the outcome interval and 80% of the time the outcome will be less than the upper limit of the interval	**Confidence** is a measure over an interval that the outcome will be within the interval. Confidence is usually expressed as a number between 0 and 1, or 0% to 100%

What Happens in a Wave Plan

What happens in a wave plan happens as a consequence of deferred planning: during the each planning wave, many tasks are left undefined in any detail in the model plan and the allocation plan. Subsequently, as each wave rolls in, these plans are decomposed into finer tasks and ultimately they are planned for each work-package to an actionable level of precision.

Along the way the risks change. Intuitively, plans built on less information are naturally less predictable. More information improves predictability. Risk follows predictability. Using the heuristics in Table 2, we can put some numbers to the risk and provide estimates of the future.

By example, let’s assume we have an allocation plan in one of the waves which is allocated 60days duration as a most likely value. In subsequent waves we break this duration down into three tandem tasks.[3] In doing so, we assume that nothing requires that the task sequencing or general project approach needs to be changed. Here are some other parameters of the plans:

[3] By tandem task, we mean that when task one ends, task 2 begins, and then task three begins when task 2 ends.

- Each task is described by a triangular distribution of possible outcomes. The **optimistic value is 20% shorter** than the most likely value, and the most **pessimistic value is 50% longer** than the most likely value. For the example you will see, these ratios don't change as the 60day task is decomposed into three shorter tasks, but they could.
- The three shorter tasks are of equal length, and their **most likely values sum to 60days**. The specification of three equal lengths is again an arbitrary choice that does not impact the overall conclusions.
- A Monte Carlo simulation of 50 trials is run for the 60day task and the three shorter tasks in tandem. Generally speaking 50 trials is a small number, but it is sufficient to demonstrate the main conclusions.

In the example that follows, look for the following as representative of what really will happen as you invoke rolling wave planning:

- The expected value of each task, whether short task or long task, is more pessimistic than the average value because of the asymmetry of triangular distribution which is weighted toward pessimism.
- Both the **average and the expected values are more pessimistic than the planning value**, the most likely value, because of the risk adjustment provided by the pattern of the distribution.
- The variance and expected values of the three shorter tasks are additive because the tasks are independent of each other. The expected values are very close, but the variance sum is less than the variance of the originally allocated task by the ratio of the of the number of tasks, or in this case, 3. The practical consequence is that as the longer task is decomposed, the **predictability of the outcome improves by the square root of the number of decompositions**. Such an improvement is because predictability is synonymous with the standard deviation and the standard error of the deviation: smaller deviations mean greater predictability. Both statistics improve, and the standard deviation improves by the square root of the number of decompositions.
- The confidence interval of the outcome milestone is narrower for the three tasks in tandem, giving another view of the improved predictability.

Simulation Results

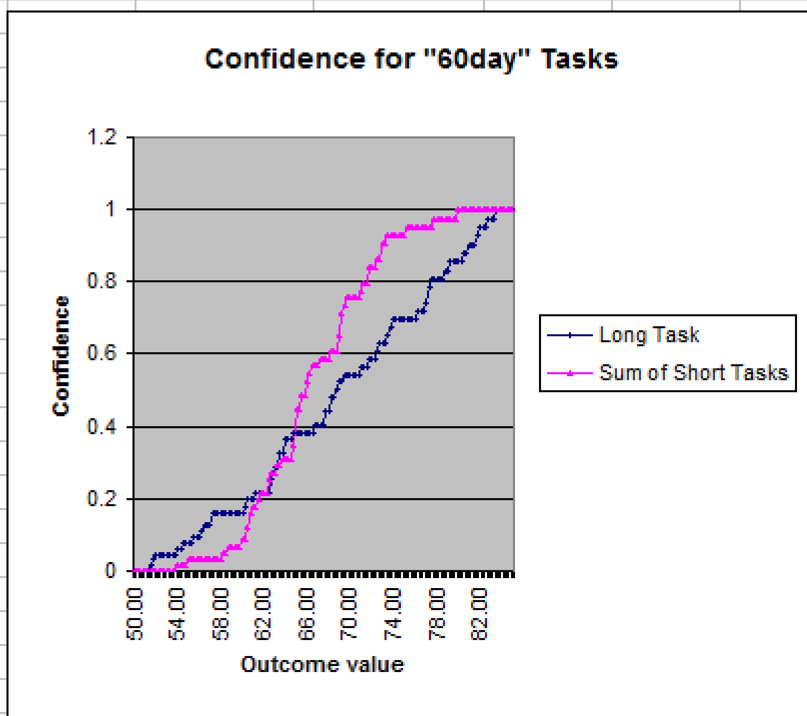
In Table 4 Simulation Statistics with Triangular Distribution are given the simulation results for the example we have been discussing.

Table 4 Simulation Statistics with Triangular Distribution
Planning Parameters: 3 short tasks of 20 days each vs. 1 long task of 60 days

Statistic	Measures	Short Task 1 20d plan	Short Task 2 20 day plan	Short Task 3 20 day plan	Long Task 60 day plan	Sum of 3 Short Tasks 60 day plan	Unit
EV	Duration	22.10	21.99	22.36	66.18	67.80	days
Average	Duration	21.96	21.88	22.22	66.06	67.68	days
Variance	Risk	8.45	9.10	10.48	85.03	30.32	days-squared
Std Dev	Risk	2.91	3.02	3.24	9.22	5.51	days
Std Dev Error	Estimate quality	0.41	0.43	0.46	1.30	0.78	days
Max*	Confidence	28.07	28.77	28.24	83.46	79.99	days
Min*	Confidence	17.01	17.60	16.32	51.40	53.81	days
		*Max or Min value observed in 50 trials of the project					

Figure 1 Confidence of Long Task and Sum of Short Tasks shows the improvement in the outcome forecast. The curve representing the sum of the short tasks is steeper and the confidence interval for a 40-80 interval is 40% narrower than the long task.

Figure 1 Confidence of Long Task and Sum of Short Tasks



40-80 Long Task	67 - 77 days	=10 days
40-80 Sum Short Tasks	65 - 71 days	=6 days

Summary and Conclusions

Every project planner engages in wave planning to some degree or another. Everything can not be known at the outset, and there are too many imponderables to waste time on premature detail planning. However introducing wave planning to a project introduces risk. We have shown that the risks are quantifiable and can be estimated with reasonably simple arithmetic operations available to every project.

The most important take away is that as a long and unplanned task or phase is decomposed, its overall risk to the project is mitigated by a ratio of the square root of the number of decompositions. Taken to an extreme, the risk in an unplanned event can be driven to a negligible figure by simply decomposing the task enumerable times.

We conclude by saying that even though many project planners recognize at the beginning the built in hazard of long unplanned events, it being a very intuitive conclusion to reach, fewer take the next step to put numbers to their intuition, a risk they need not take.