Pooled Risk Scheduling in PSNext 3.0

01/02/09 – Revision 1.0

Sciforma

Sciforma Europe: 10 rue Vercingétorix 75014 Paris – France
Tel : +33 (0) 1 56 54 83 00 – www.sciforma.fr – info@sciforma.fr

Sommaire

A - Introduction

Project managers know that there is uncertainty in the estimates of task duration and, therefore, in the estimate of a project's duration. Often, task estimates include a safety margin in an attempt to plan for the variances.

In 1997, Dr. Eliyahu Goldratt introduced the Critical Chain methodology for removing the margins in individual tasks and managing a pooled margin in special tasks known as buffers. Importantly, Dr. Goldratt also described the human factors that contribute to poor project performance and introduced a methodology for improved project performance.

After looking carefully at the best parts of Critical Chain, PSNext 3.0 derives a new approach that keeps the best concepts whilst providing a simpler solution.

Pooled Risk Scheduling borrows the concept of buffers from Critical Chain Theory and extends the concept further by adding Monte Carlo simulation to calculate the size of the buffers. Resource Leveling is optionally performed during each simulation iteration to incorporate resource constraints in the determination of the critical path and the buffer sizes.

B - Buffers

During project scheduling it is very difficult to estimate the exact duration of each task. Numerous risks are undertaken when defining these durations since multiple delays might occur even when everything seems to be going smoothly. For these reasons, committing to a project's end date is difficult to achieve. However, difficult or not, project managers are obliged to commit on a final delivery date.

When using the critical path methodology the project's finish date is recalculated on every update impacting the critical path.

The main idea on including buffers in the schedule is to size them according to the project manager's convenience in order to fix the project's finish date whilst taking into consideration the possible slippages that the Project Manager can identify.

The delivery date is no longer a fluctuating finish date as with the critical path but the finish date of the project's buffer.

PSNext 3.0 allows project Managers to insert buffer tasks in the parts of the schedule that they would like to protect, generally the end of the project. The size of these buffers can either be determined manually by the Project Manager or by using Monte Carlo simulation and probability functions. The following sections of this paper will explain both approaches in detail.

C - Size Buffers Manually

This first approach is for project managers who would like to estimate an overall buffer size for the project they are scheduling. It is a simplistic approach intended to understand the main features that PSNext 3.0 provides to support pooled risk scheduling. It considers then that the project manager will manually estimate the size of the required buffer to protect the project's finish date.

1 - Level Resources

Resource leveling is a starting point when determining the project's finish date. Before getting into the buffer insertion and sizing, the project manager would firstly like to know what the project's finish date is once resource conflicts are solved. This action already decreases some of the risk.

PSNext's built-in leveling tools can be used by the project manager to solve resource conflicts for both named and generic resource assignments. The leveling tool is available under Tools/Resources/Level Resources... or using the toolbar icon :

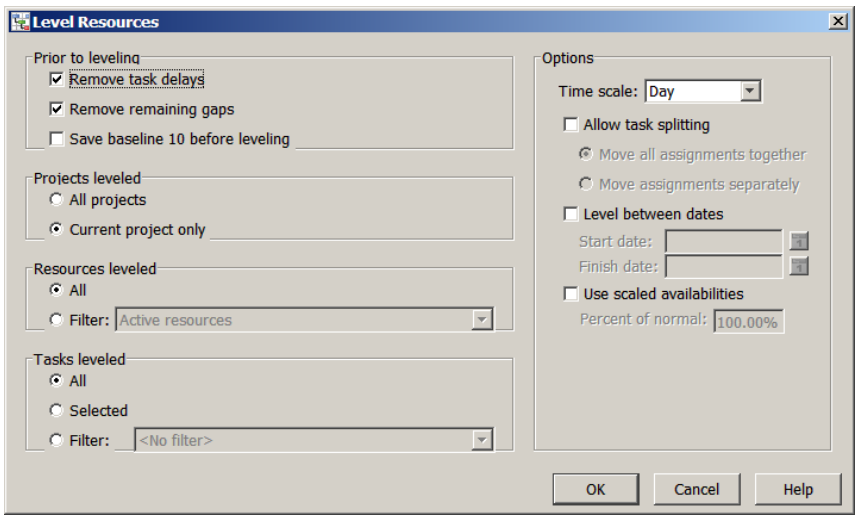

Fig 1. PSNext Resource leveling tool

2 - Insert a Buffer

As the finish date of the project has been updated after leveling, the project manager may like to include an additional overall duration in case the tasks of the project might shift. This is carried out by inserting a buffer at the end of the project.

PSNext 3.0 enhances a new schedule type for tasks called “Buffer”. Inserting a buffer is then simply done by inserting a new task and setting its Schedule Type to “Buffer”.

As any task, a buffer can be linked to any predecessor or successor. In general, a buffer task protects its successor task(s) by padding the schedule with extra duration.

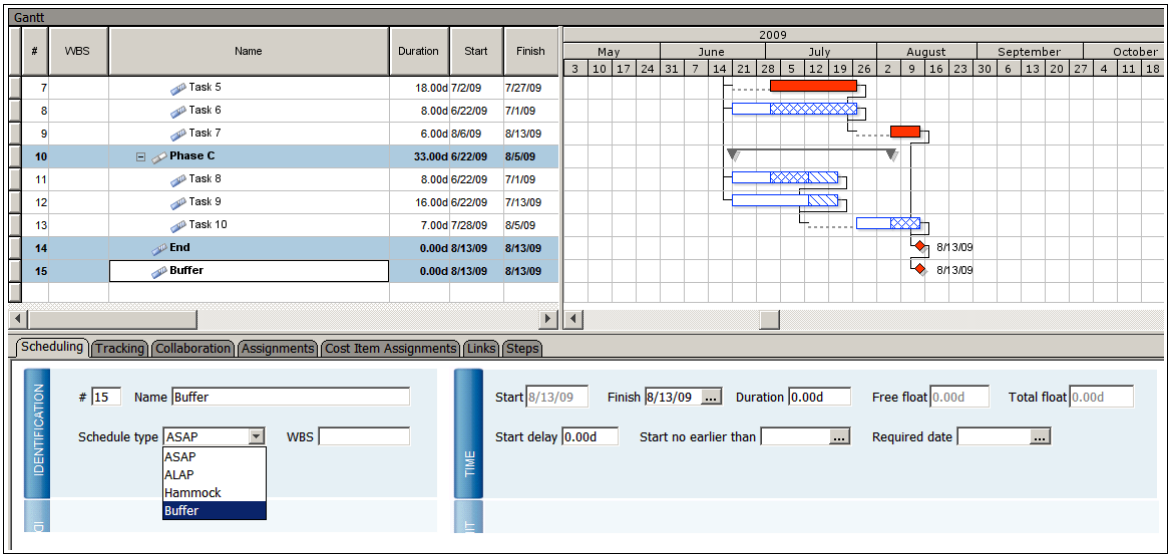

Fig 2. The "Buffer" Schedule type

3 - Size the Buffer

The size of the buffer corresponds to the duration of the buffer task. In this first part of the paper we will consider that the project manager is manually sizing the buffer.

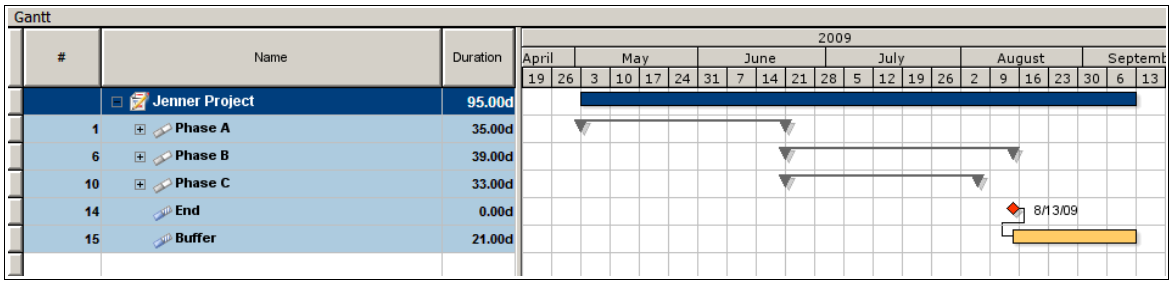

Fig 3. Manually setting the buffer size

In the example above, the project manager estimated an overall possible delay of 21 days. As a consequence, the project's finish date is updated and includes the duration of the buffer. The Project Manager can confidently commit to the project's finish date.

4 - Lock the Buffer

Locking the buffer will fix the buffer in the schedule, its start or finish dates can no longer be changed. Even if predecessors slip, the locked buffer task does not slip accordingly.

The Task field “Buffer Lock” is used to lock or unlock a buffer.

Note that the Duration and Finish fields are locked such as the mouse pointers used to delay or resize the task's bar.

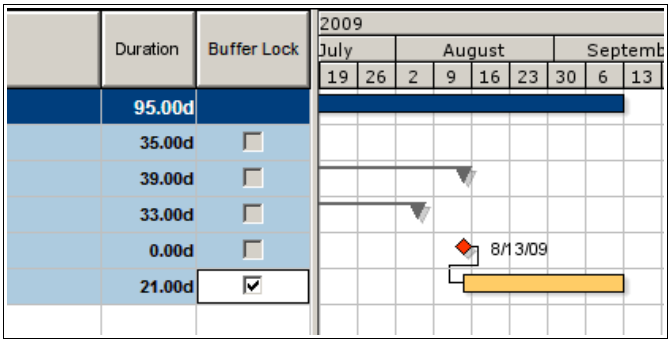

Fig 4. Locking a buffer

5 - Buffer Incursion

Buffer incursion refers to the buffer's utilization. As soon as the predecessor is delayed, the buffer task will suffer an incursion. Instead of being delayed the buffer is absorbing the delay that the tasks are undergoing. The successor of the buffer task (the task that is being protected from schedule slippage) will not slip until the buffer incursion exceeds the duration of the buffer itself.

In the following example, predecessors are being delayed but the buffer task is not being “pushed forward”. Instead the predecessors are overlapping the buffer task and consuming the security cushion that has been previewed. Note that the finish date of the project does not change.

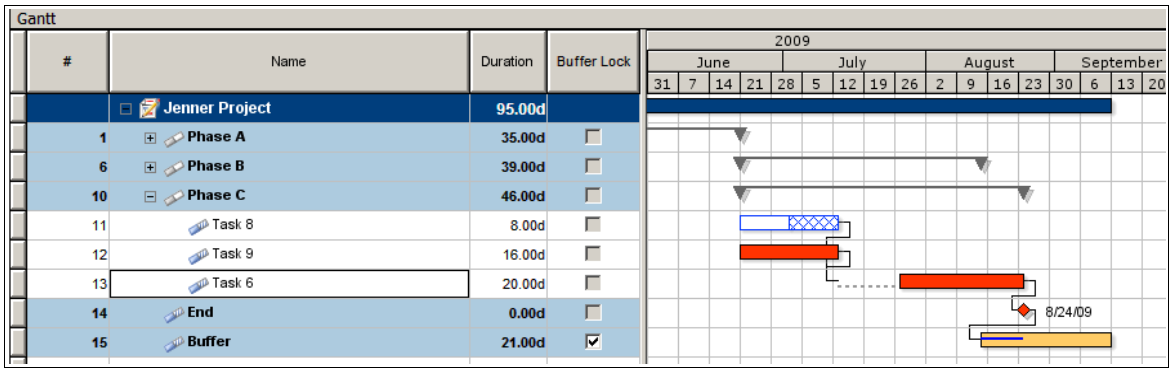

Fig 5. An incursion on a locked buffer

6 - Color Settings

It is possible to define color settings to improve the visibility of buffer tasks and their incursions. To do so the Gantt preference can use a filter to identify and customize buffer tasks. A new item in the “region list” enables buffer incursion display and settings.

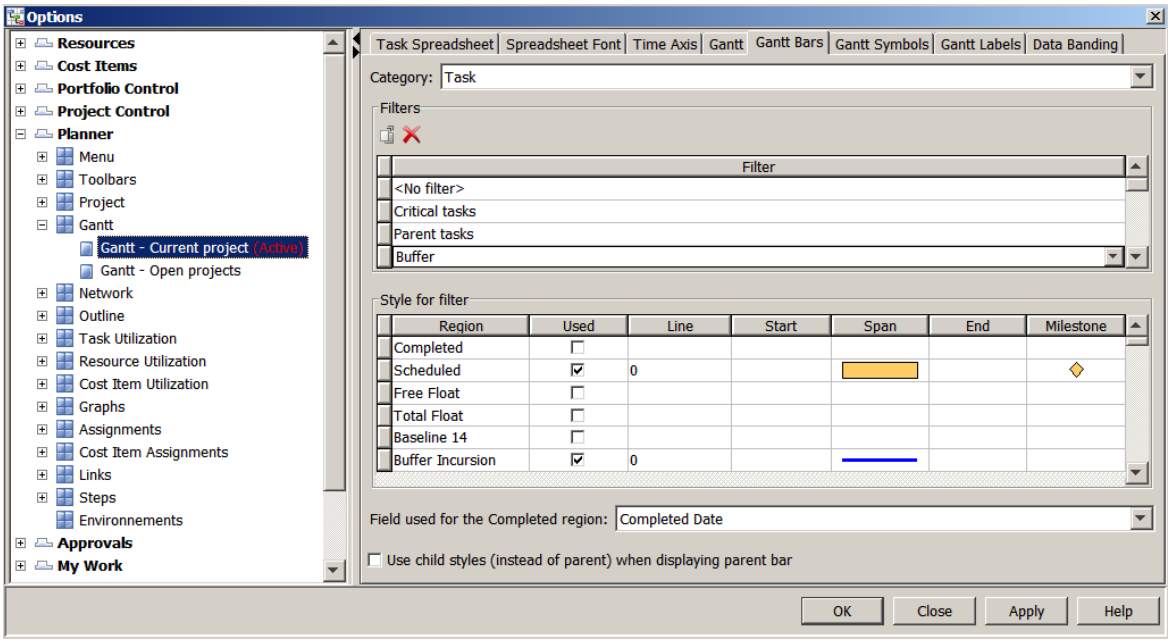

Fig 6. Color settings for buffer bars and incursions

7 - Project Tracking When Using Buffers

When there is no buffer in a project, the update process requires you to constantly reschedule the project's tasks whenever a slippage impacts the project's end date.

Using a buffer on a project ensures that safety time is allocated globally. Its duration is estimated to include potential delays. If estimates are sufficient, re scheduling should not be performed as frequently.

When a project contains a buffer, its progress update is carried out as usual. Actual efforts and dates can be updated using any tracking method that has been chosen (none, timesheets, task sheets, etc.)

However, when the project has a buffer, tracking and analysis is much simpler. By comparing the buffer's utilization against the project progress the project manager gets a quick overview on what the situation of the project is. Some buffer time is being used (there is an incursion), but the project is progressing conveniently so there is nothing to worry about.

Project Managers can create any kind of indicators and alerts to help them evaluate how critical the buffer's incursion is.

For instance a Green, Amber or Red indicator for the buffer could be determined as follows:

- **Green:** % buffer utilization < 1/3 of project's % completed
- **Amber:** % buffer utilization < 2/3 of project's % completed
- **Red:** % buffer utilization > 2/3 of project's % completed

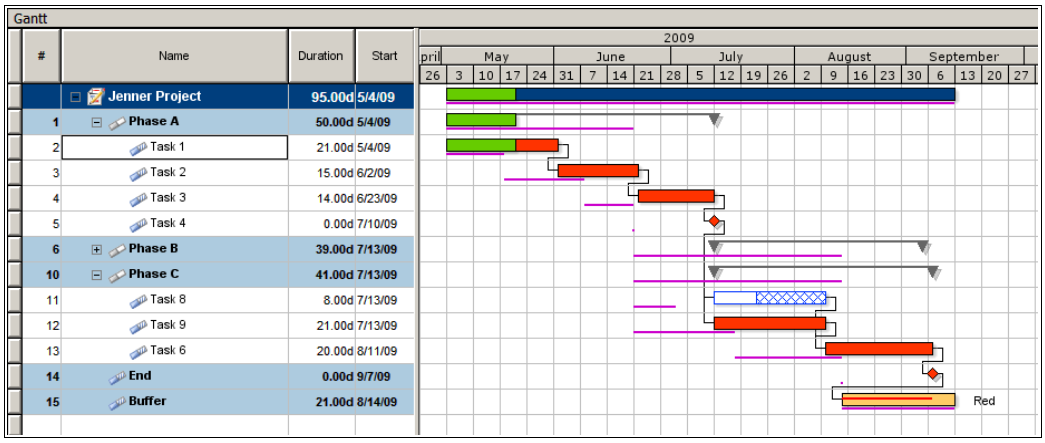

Fig 7. Buffer incursion is considerable and the project has just started, the indicator is Red

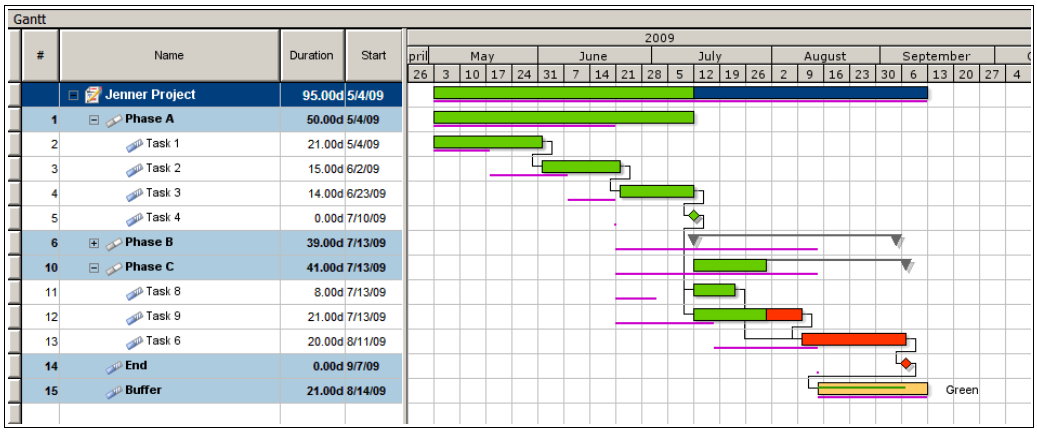

Fig 8. Buffer incursion is considerable however the project is almost finished, the indicator is Green.

D - Size Buffer Using Probability Calculations

The previous section explained the main concepts of buffers and project tracking when using them. The project manager globally estimated what the size of the project buffer should be.

This section presents a new tool provided by PSNext 3.0 that based on probability distributions and Monte Carlo simulations will calculate the size of the buffers.

Project Managers can fully customize the parameters that are used by the probability distributions and simulations, by using built-in fields or user defined fields.

Additionally resource leveling can be run during each simulation to solve resource conflicts for each simulated schedule.

1 - Probability Distributions

The purpose of running simulations is to randomly give a duration to each task of the project and calculate what the project's end date would be.

The random durations given to each task are controlled by a probability distribution. By running numerous iterations, a set of possible project end dates will be obtained. PSNext will finally calculate the buffer's size based on these results and the level of confidence of such results entered by the project manager.

PSNext 3.0 provides three new probability distribution functions that can be used when running simulations to estimate the random duration of a task. These distributions are:

1.1 - The Uniform Distribution

The UniformDistr() function takes two parameters (minimum and maximum). The returned durations will be distributed evenly between these two values.

This formula can use the task's duration field as the minimum and a user defined field for the maximum duration: i.e. UniformDistr(Duration, Pessimistic Duration)

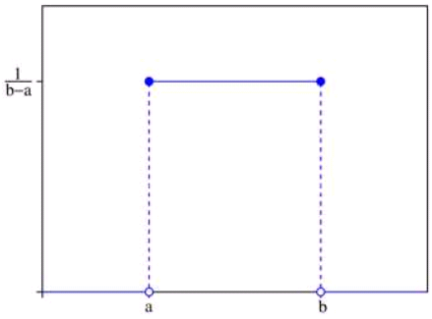

Fig 9. Uniform distribution

1.2 - Normal Distribution

The NormalDistr() function takes two parameters: the mean and the standard deviation. The results will be normally distributed. This distribution is also known as the bell curve or Gaussian distribution.

This formula can use the task's duration field as the mean and a percentage of that duration as the standard deviation: i.e. NormalDistr(Duration, Duration*0.2)

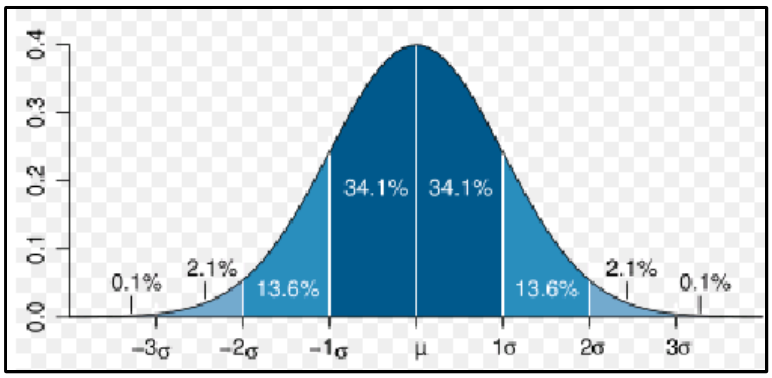

Fig 10. Normal distribution

1.3 - The Triangular Distribution

The TriangDistr function takes three parameters: minimum, center, and maximum. The results will be distributed in a triangular fashion.

This formula can use the task's duration field and two additional user defined fields: i.e. TriangDistr(Duration, Most Likely Duration, Pessimistic Duration)

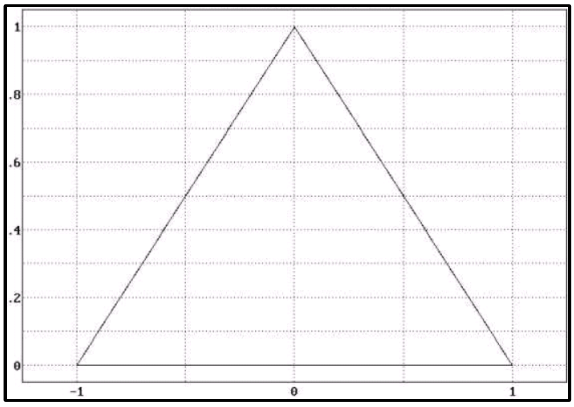

Fig 11. Triangular distribution

2 - Size Buffers Based on Simulations

Once the buffer's have been inserted in the project, the Pooled Risk tool is used to calculate their sizes by using Monte Carlo simulations. The Pooled Risk tool is available in the Portfolio Control and Planner components under the Tools menu or by using the toolbar icon .

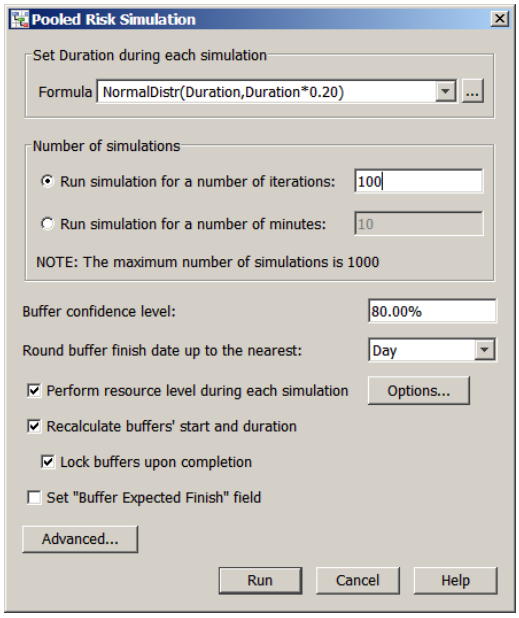

Fig 12. Pooled Risk simulation dialog

Set duration formula	The formula used during the simulation for each non-buffer task to obtain its simulated duration. Probability distribution functions are generally used alone in this field (see Probability Distributions)
Number of simulations	Users can determine either the number of iterations to run or a number of minutes to run simulations.
Buffer confidence level	A confidence level is considered by the statistical analysis. A 60% confidence means that the buffer durations will provide enough padding such that in 60% of all the simulated schedules the protected tasks would not incur any slippage.
Round buffer finish date	Time scale to round the buffer's obtained duration. If a buffer's duration is 17.8d it can be rounded to the nearest “day”.
Perform Resource leveling	During each iteration, resource leveling can be run to solve any overallocation that might occur with the estimated task durations by the iteration.
Recalculate Buffers	Indicates whether or not buffer sizes should be recalculated after the simulations are carried out (see Pertinence and Risk of Buffers)
Set buffer expected finish	The value of the “Buffer expected finish date” can be overwritten to save the finish date of the buffer after the simulation is carried out.
Advanced	Advanced features for tracking data while simulating.

The size of all the buffer tasks are then calculated and will be locked if the related options were checked in the Pooled Risk Simulations dialog.

3 - Project Tracking Using Pooled Risk

The tracking of the buffer, its incursions and the analysis that can be carried out to evaluate project progress is carried out in the same way as presented in previous sections. The only difference is that this time PSNext was in charge of calculating the size of the buffers.

Once calculated, buffer tasks are locked and their end dates should not be recalculated. They define the expected end date of the project.

3.1 - Pertinence and Risk of Buffers

The main principle when carrying out project buffer scheduling and tracking is to initially calculate a buffer with a duration that includes all possible slippages. The buffer is never recalculated during the project's execution, its incursion observation is enough to control the project and make decisions.

While the project progresses, the information that was known when the buffer's duration was initially calculated might have changed. Some tasks might already be completed, and this with an actual duration that might be outside of the initial estimations. Additionally, the information available on remaining tasks could lead to a different risk estimation than the one initially considered.

Buffer planning and tracking principles do not intend to recalculate a buffer's duration while the project progresses. However, it is important to keep track of how pertinent or valid the initial buffer size is at the current time.

Pooled Risk simulations can be used to recalculate the “Buffer Expected Finish Date” and this without recalculating the buffer duration itself.

Such options are provided as check boxes in the Pooled Risk dialog.

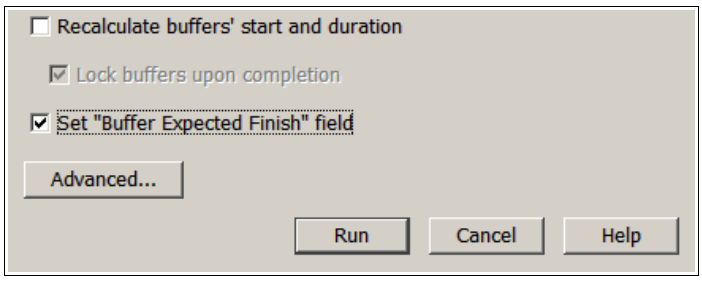

Fig 13. Simulations can be run to update “Buffer Expected Finish” dates without recalculating the buffer's size

3.2 - The "Buffer Expected finish"

A new task field called "Buffer Expected Finish" is related to the option set in the Pooled Risk dialog.

Project Managers can easily display this date in the Gantt chart by using symbols.

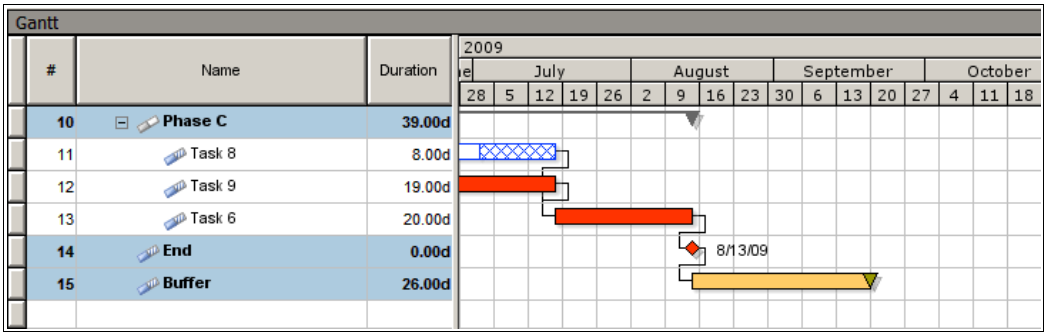

Fig 14. "Buffer Expected Finish" = "Finish" on the first calculation

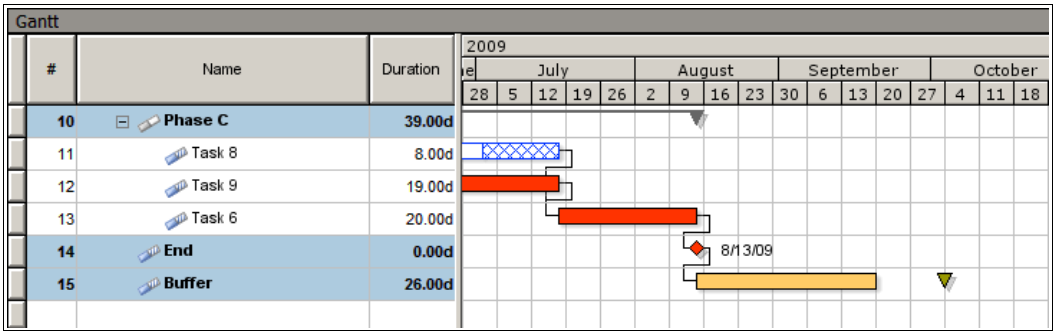

Fig 15. If the buffer "Finish" was to be recalculated at this time it would finish at a later date. Danger.

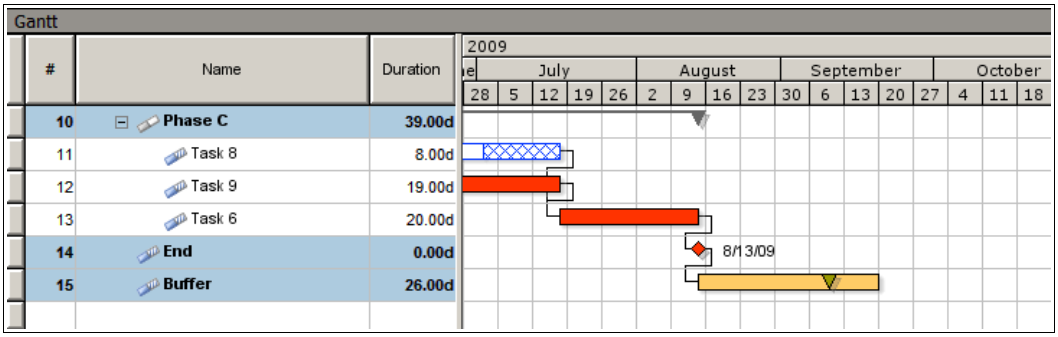

Fig 16. If the buffer "Finish" was to be recalculated at this time it would finish at an earlier date. Good news.

When a project update is carried out, it would be useful to re estimate the "Buffer Expected Finish" values and to log them either by using "log capture" feature or "view definition" audit trails.

The following graph plots the calculated % deviation between the initial buffer “Finish” and the “Expected Buffer Finish” that has been updated by the latest simulation.

Values above zero are potential indications of problems. Values below zero are a good thing. This sample shows a problem that occurred in week 5 being corrected by week 8.

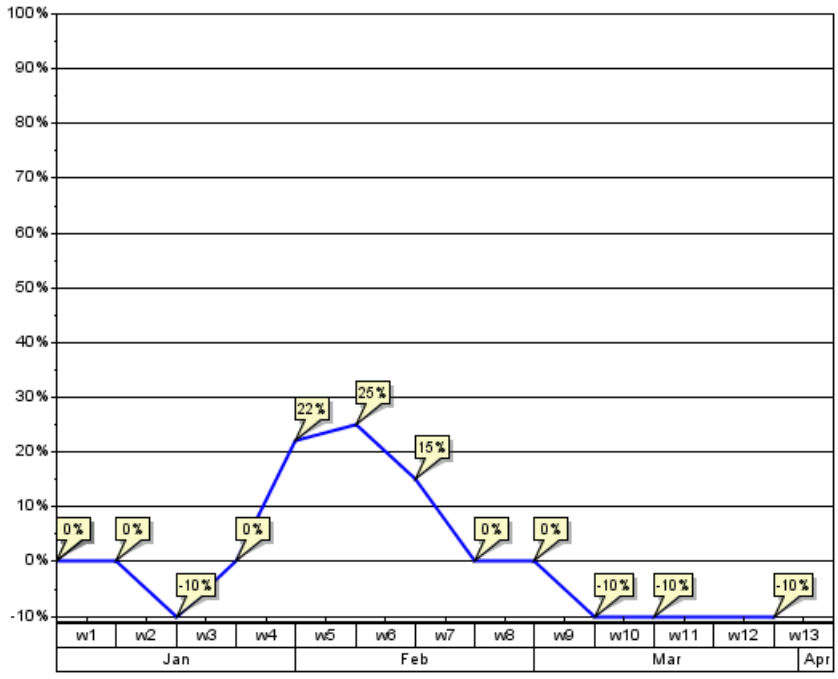

Fig 17. History of the “Buffer Expected Finish” deviation

E - Conclusion

This new schedule type for tasks enhances the insertion of time buffers to protect a project's schedule. This security cushion will absorb any slippages of its predecessors to protect the project's end date (or successors start date).

The size of the buffer can be directly determined by the project manager or by using the Pooled risk tool provided by PSNext 3.0.

Monte Carlo simulations will calculate different probable project schedules based on random durations that its tasks might receive following a probability distribution. Resource leveling can be run for each probable schedule so that overallocation conflicts are also considered in the simulation process.

Additionally, it is possible to study the buffer's pertinence during the project's execution to help project managers consider risks that were not identified at the starting point.

These two new concepts, Buffers and Pooled risk simulations, simplify project tracking and updating. The project manager can track the buffer indicators to identify when the project really needs to be rescheduled.