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Primavera's Float Path Calculation: Review and Analysis of Applications

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Abstract—Oracle's Primavera P6 Professional Project Management scheduling software remains the dominant package in construction scheduling, and features introduced by this software often become lingua franca between schedulers and schedule analysts. Such has been the case with the "float path" calculation that Oracle includes in its P6 software. Oracle's documentation states that the Multiple Float Path module of P6 calculates a "most critical path" and "sub-critical" paths, ranked in order of "criticality" by the Float Path Value. Schedulers and analysts who use P6 have sometimes adopted this feature and used it to determine "near-critical" paths, or even "concurrently critical" paths. This paper will present multiple case studies to illuminate the operation of the float path calculation so that analysts can properly employ the module through an understanding of its uses and limitations.

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Table of Contents

Abstract 1
Introduction 3
First Principles: Critical Path Definitions 4
Critical Path Defined by Total Float 4
Critical Path Defined as Longest Path 5
Sub-Critical vs. Near-Critical 6
Issues Affecting Critical Path Calculations 6
Multiple Calendars 6
Projects Linked Within a Portfolio 7
Resources & Resource Levelling 7
Finish Constraints and Negative Float 7
Multiple Float Path Calculations 8
Calculating Float Paths Method 1: Total Float Option 11
Calculating Float Paths Method 2: Free Float Option 15
Conclusion 20
References 20

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Introduction

For schedules developed using Critical Path Method ("CPM"), a day of delay to an activity on the critical path of a schedule causes a corresponding day of delay to the predicted completion date of that schedule. This is the commonly understood definition of the term "critical path" and the one that is most consistent with the "forward and backward pass" of CPM scheduling. AACE International's definition of critical path is also consistent with this basic concept:

> *CRITICAL PATH – The longest continuous chain of activities (may be more than one path) which establishes the minimum overall project duration. A slippage or delay in completion of any activity by one time period will extend final completion correspondingly. (1 p. 34)*

Although axiomatic and seemingly uncontroversial, this definition is not the only one used to describe the term "critical path." As laid out further below, there are alternate definitions of criticality that have come into common usage that do not adhere to the basic concept that a critical activity must be one that causes day-for-day delay to the predicted completion date of the schedule. And a number of those alternate definitions stem from the scheduling software packages that schedulers[1] and analysts[2] rely upon to perform the increasingly complex calculations that underlie modern schedules.

Among the most common schedule software packages in the construction industry is Oracle Corporation's Primavera P6 ("P6"), and due to its ubiquity, the features of P6 often help define how schedulers and analysts perform their work. One such feature in P6 is the calculation of "Multiple Float Paths." According to support documentation provided by Oracle for P6, the Multiple Float Path feature "*identifies the **most critical float path** in the schedule… [D]epending on the number of paths you choose to calculate, the module identifies other float paths (**sub-critical float paths**) that affect the most critical float path and numbers the paths in ascending order based on the criticality of the path"* [emphasis added] (2). There are many practical uses for this feature, which notably include the tracing of the various logical paths through a CPM network to completion. This is very useful for schedulers, since it allows them a better understanding of the network that is modeling the work.

Analysts, however, have taken to using the P6 Multiple Float Path functionality not only to analyze the logic of a CPM network, but also to determine "near critical" paths, or concurrent critical paths. Indeed, based on Oracle's definition alone, an analyst could reasonably conclude

[1] The term "scheduler" refers to the project scheduler: the individual who is assigned to a specific project during construction and who is essential to the creation and updating of the project schedules contemporaneously. A scheduler relies on judgment and expertise to estimate and predict activity durations and relationships.

[2] The term "analyst" refers to the forensic schedule analyst: the individual who applies scientific and mathematical principles, within a context of practical knowledge about engineering, contracting, and construction means and methods, in the study and investigation of events that occurred during the design and construction of various structures, using CPM or other recognized schedule calculation methods. The analyst is typically introduced to a project much later than the scheduler, often after project completion.

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that the chain of activities assigned a float path value of one are "more critical" than activities with a float path value of two. Considering this expanding use of the feature, the definition provided by Oracle, and the actual calculations that P6 is performing, warrants further investigation.

First Principles: Critical Path Definitions

While different work activities can be delayed on a project, for there to be a case for an extension of time or extended project performance, an analyst typically must show that potential delays in fact influenced the overall completion of the project. A delay is "critical" if it extends the overall project completion date (3 pp. 1-16). Furthermore the critical path through a CPM network is defined as the longest chain or chains of connected activities through the project in terms of time (4 p. 315) and the critical path of a project determines the period in which the project may be completed (3 pp. 11-16). This is consistent with the definition of critical path activities provided by Oracle:

> *Critical Path activities are the project tasks that must start and finish on time to ensure that the project ends on schedule. A delay in any critical path activity will delay completion of the project, unless the project plan can be adjusted so that successor tasks can finish more quickly than planned. (5)*

This definition is consistent with what schedulers and analysts understand from their introductory work manually performing forward and backward passes on simple networks, where the last activity's Early Finish ("EF") date becomes the Late Finish ("LF") date for the overall network. In simple networks, unburdened by multiple calendars or finish constraints (and the resultant negative float) it is simple to determine the critical path: it is that chain of activities where the Total Float is equal to zero.

However, the CPM networks of today's construction schedules are rarely simple, and a variety of issues and features tend to complicate definitions of criticality. P6 provides two ways to define criticality within a schedule. In one method, the software allows users to "Define Critical Activities" as either "Total Float less than or equal to" a value of Total Float that the user can select. The default Total Float value that defines criticality is zero. The second method that Primavera P6 provides to define criticality is the "Longest Path."

Critical Path Defined by Total Float

In CPM scheduling, the activities on the critical path are generally determined in one of two ways: by examining the activity Total Float values or by evaluating the longest path. Wickwire et al cite caselaw (*Utley-James Inc. vs. United States*, 1985) in describing how activity float relates to critical path: "*An activity with no float is said to be on the critical path… a job activity on the critical path, for which there is no float, will have the same early start date and late start date... one day's delay*

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to that job activity will cost one day in completion of the job unless it is somehow made up" (4 p. 313).

Within P6, defining the critical path activities by the Total Float methodology dictates that the software evaluates criticality as such: The Early Start ("ES"), Late Start ("LS"), EF, and LF are determined via a forward pass and backward pass through the network; then, if the ES and LS dates for an activity are equal, the activity is identified as having zero float. These zero float activities are then flagged in the software as being critical path activities (5).

However, within P6, the Total Float values of activities calculated relative to more than just the early and late dates of each activity. As discussed further below, Total Float values are often altered for other reasons, most notably due to the use of multiple calendars or because of the presence of finish constraints (at the project or activity level). This often results in Total Float values less than zero, which is a phenomenon not possible in a pure CPM network.

Within this framework, a scheduler or analyst can set the Total Float threshold value that defines criticality for the network in question. Schedulers may, for example, decide to define anything with less than -45 days of Total Float as "critical," and that scheduler may have a project-specific reason for doing so, even if the lowest value of Total Float in that schedule is -60. For a forensic analysist, these definitions of criticality may have relevance given the facts of a particular case; regardless, it remains true that a critical activity is only one which causes a day of delay to the predicted completion date when itself has a day of delay. In the presence of negative float, the Total Float value is of decreasing usefulness in determining whether an activity meets that criteria.

Critical Path Defined as Longest Path

Within P6, defining critical path activities by the longest path will dictate that the software will define the sequence of driving activities that determine the end date of the project (5). The software first calculates the ES and EF of every activity in the network (the forward pass). Then, instead of using the backward pass to identify activities with zero float (per the Total Float methodology described previously), P6 identifies the controlling logic path using Free Float. By identifying predecessors on a backward pass that have zero Free Float, P6 identifies the string of activities that defines the overall project duration.

There is a broad consensus among industry treatises that the definition of "critical path" includes the notion of the "longest path". Per Bruner & O'Connor, "*CPM identifies the "critical path" of the project which is 'the longest path through the network [of identified and logically sequenced construction activities] that establishes the minimum overall duration ("Construction Planning & Scheduling," 78)* (6 p. 19). And in *Construction Delay Claims*, the authors state "*Critical Activities are not necessarily the most difficult or those that may seem to be the most important; they merely form the longest path."* (3)

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As noted previously, for an activity to be "critical" it is necessary that extending its duration in turn delays the overall project completion duration. The longest path is preferable to the Total Float definition of criticality because, in the realm of modern scheduling software and the features offered by those packages, the latter identifies "critical" activities that don't necessarily adhere to the overarching definition. As articulated by R. Winter, "*The longest path is a superior method for identifying the schedule's critical path over using Total Float as the indicator. The Total Float method sometimes misses activities and can become discontinuous due to activity calendar changes or start float being different from finish float*" (7 p. 30).

Sub-Critical vs. Near-Critical

The Multiple Float Path calculation "*identifies other float paths (sub-critical float paths) that affect the most critical float path."* (2) No specific definition of "sub-critical" is provided; however, it can be inferred from the context that a sub-critical path is logically tied to the "most-critical" path and is within a reasonable proximity to that most-critical path in a way that there is potential for transmission of delay from one to the other. In this way, the sub-critical path appears similar to the near-critical path:

> *NEAR-CRITICAL PATH – An activity or set of activities that are almost critical or are at risk of becoming critical if delayed past their expected completion times. Inclusion in this list may be made by using total float, longest path value, or multiple critical paths. The value associated with these near-critical path activities typically are approximately one half of the reporting period's duration or less. (1 p. 77)*

Notwithstanding the potential usefulness of additional clarification and reconciliation, it seems that the practical definitions are substantively similar. For the purposes of this paper, the terms are considered synonymous.

Issues Affecting Critical Path Calculations

Advanced scheduling applications provide a number of new features that, while useful, sometimes have implications for how schedulers create and understand their schedules. The following features have the ability to alter the Total Float calculations of activities within a CPM network. This list is not exhaustive, and neither is it meant to imply that these features represent a deficiency in the software.

Multiple Calendars

P6 includes the functionality to establish multiple calendars (with different working hours/days/periods) and assign them to respective activities. As a result, the apparent durations of activities can vary from what is expected and the critical path can appear incongruous. Further, because float values are calculated relative to calendars, it is very possible that two on the longest path could have different float values.

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Projects Linked Within a Portfolio

In P6 when single projects are linked externally to other projects within a portfolio of projects, the critical path of an individual project can be altered from what it would be absent those intra-project links. Furthermore, the critical path reflected in each individual schedule might not accurately reflect the overall portfolio critical path. P6 allows the user to decide whether or not it considers relationships to and from other projects.

Resources & Resource Levelling

If the "Level Resources During Scheduling" option is selected in P6, resource availability will influence and/or dictate the schedule logic and durations. A schedule scheduler/analyst needs to be wary if this option is selected as the underlying CPM will no longer be functioning as expected, thus influencing the critical path.

Finish Constraints and Negative Float

The issue most likely to influence the critical path calculations is that of the use of finish constraints on activities and the subsequent creation of "negative float." In unconstrained networks, the EF for the last activity in the network becomes the LF for that activity. Furthermore, The LF for the last activity in the network becomes the LF for the overall network and all measurements of float values are relative to this last LF date. As the project gains or loses time due to progress or network revisions, the LF of the last activity responds in kind, which then keeps the lowest value of Total Float equal to zero.

When finish constraints are added to a network, the P6 functionality changes and the float is measured from the LF of the network (or a specific activity) to a fixed date, rather than to the LF of the last activity in the network. If one assumes that a finish constraint is assigned to the last activity in the network, that activity's LF date becomes fixed on that date. This results in the EF and LF of the last activity in the network as no longer equal, and therefore a lowest value of Total Float that is not equal to zero. And, when the predicted EF of that activity is later than the LF date – fixed by finish constraint – the Total Float value becomes negative. Negative float values can be "created" which are in no way reflective of how a delay in a particular activity might affect the overall project completion (predicted EF date). M. Nagata[3] notes that:

> *There is a misconception that the existence of activities showing negative float in a construction schedule imparts added significance to those activities, requiring special consideration when measuring delays. This is unfounded and ignores the basic principles of CPM scheduling and schedule analysis, such as the principle*

[3] This paper is not intended to provide an exhaustive discussion of negative float. Please see CDR.2292 "When Measuring Delays, Negative Float Does Not Matter!" by Mark F. Nagata, PSP and Bryan Van Lenten, PE, for a detailed discussion.

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> *stating that only delays to the critical path, which is the longest path in the schedule network, will result in project delay (8).*

As with the other innovations provided by schedule software, valid uses of finish constraints by an analyst are conceivable. However, it should also be noted that that the use of constraints overrides the basic CPM algorithm and complicates the meaning of Total Float measurements. Thus the identification of the critical path by means of measuring Total Float (or most negative Total Float) will produce a list of "critical" activities which do not impact the predicted completion date of the schedule. Notably, finish constraints have no impact on the Free Float measurements of activities and thus the introduction of constraints will have no impact on P6 identifying the longest path.

Multiple Float Path Calculations

For analysts, calculating Multiple Float Paths is driven by the desire for the determination of near-critical activities or strings of activities that might not be strictly on the longest path of a network but which are close to delaying the project completion and/or interim milestones. Review of AACE literature shows that a similar concept of grouping and ranking strings of critical or near-critical activities was introduced in 2004 via a discussion of "Enhanced PDM" by Scott C. Herold (9). Using Primavera P3, the author developed a method for illustrating "subcritical" strings of activities while accounting for multiple calendars, non-zero lags on relationships, out-of-sequence progress, and date constraints. Shortly thereafter, the "Multiple Float Path" functionality of Oracle Primavera Project Management was first introduced in version 5.0 of the software (2). Oracle describes the Multiple Float Path calculation as follows:

> *When you schedule a project, you can choose to calculate multiple critical float paths (sequences of activities) that affect the project schedule. By calculating multiple critical float paths, you can determine the most critical path in the project schedule, along with sub-critical paths that affect the completion of the most-critical path. (10)*

Regarding the limitations of the critical path calculations and purpose of the multiple float calculation, the relevant P6 help documentation states the following:

- **When defining critical path by Total Float value**: "[I]f you choose to identify critical activities based on a maximum Total Float threshold, the module will identify all activities beyond the threshold as critical even if the activities **have no relationships or do not affect the project end date**." [emphasis added] (2)
- **When defining critical path as longest path**: "[I]f you choose to identify critical activities based on longest path, the module will identify the critical path of activities but **will not identify sub-critical paths** that affect the critical path." [emphasis added] (2)

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These statements provide insight into the specific problem that this feature was meant to solve, which can be restated as follows:

In a schedule with multiple calendars and multiple finish constraints that create negative float relative to a variety of fixed dates, the Total Float value becomes less meaningful as a tool to determine (1) which activities, if delayed, will cause a corresponding delay to the predicted completion date of the schedule, and (2) the proximity of an activity to that longest path.

The intent of the Multiple Float Path calculation is to assist the scheduler/analyst with identifying the critical paths as well as near-critical paths because the Total Float "threshold value" can be overly inclusive of activities that do not have impact on the predicted completion date of the schedule.

Schedulers and analysts can select to which activity float paths are traced; in other words, the Multiple Float Path calculation need not only be performed to the last activity in the network. Therefore, the entire network does not necessarily have to be considered and the analysis can be more narrowly focused. An example of this would be to set the float path analysis to end on the substantial completion date or other intermediate milestones that might be contractually significant (e.g. be tied to liquidated damages). To the scheduler, this is a very useful aspect of the calculation, which simplifies the process of determining a path to a specific interim activity. However, because of the descriptions of Multiple Float Path calculations that tie its functionality to determining the "most critical path" of an entire network, the examples in this paper trace the Multiple Float Paths to the last activity in each of the networks. Furthermore, in each of the examples included herein, critical path is defined as longest path and therefore all activities shown in red are longest path activities.

Figure 1, below, shows a schedule with Multiple Float Paths (1 through 20) calculated. The schedule is an actual construction schedule, used as the baseline on a large multi-million-dollar highway improvement program. The schedule contained roughly 3100 activities, and the schedule was calculated to define up to 200 float paths using the Free Float method (which is discussed further below).

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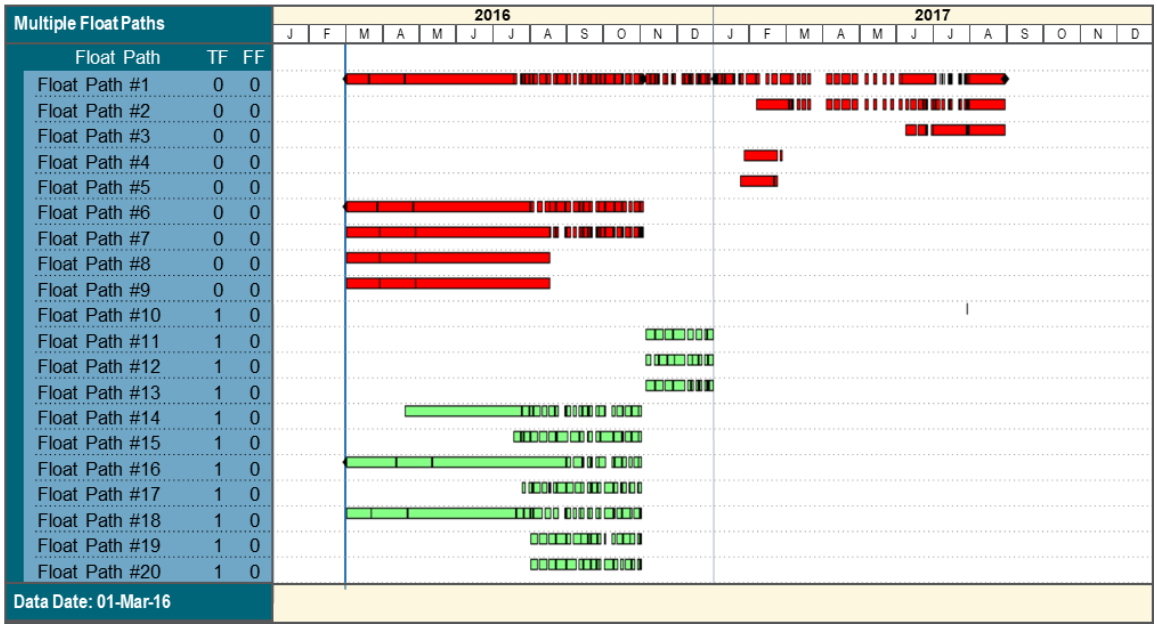


Figure 1–Schedule Float Paths #1 through #20

As illustrated in the graphic above, calculating Multiple Float Paths yields not only the longest path (shown in red) but a series of ranked secondary paths through the network. These secondary paths allow the scheduler/analyst to better understand the network, and according to P6, identify the sub-critical paths. Note, however, that Oracle's help documentation suggests that the float path number represents a ranked degree of criticality:

> *When you schedule the project, the module identifies the most critical float path in the schedule and assigns those activities a Float Path value of 1. Then, depending on the number of paths you choose to calculate, the module identifies other float paths (sub-critical float paths) that affect the most critical float path and numbers the paths in ascending order (beginning with 2) based on the criticality of the path. (2)*

Schedulers and analysts have interpreted this to mean that Float Path #1 is more critical that Float Path #2, and #2 more critical that #3, and so on. However, it is unclear that the module actually does this. Note that, in Figure 1, Float Paths #1 through #9 are all on the longest path, and all have zero days of Total Float. A day of delay to any activity on the longest path would cause a corresponding day of delay to the predicted completion date of the project; therefore, in what way are the longest path activities assigned to Float Path #6 "more critical" than the longest path activities assigned to Float Path #7?

Furthermore, there are occasions where the Float Path values assigned to activities, and the ranking of criticality that is implied, contradicts the Total Float value calculated by the forward and backward pass. For instance, Figure 2 shows the activities assigned Float Paths #28 through #30 in the same schedule. Note that these three activities are all on the same calendar.

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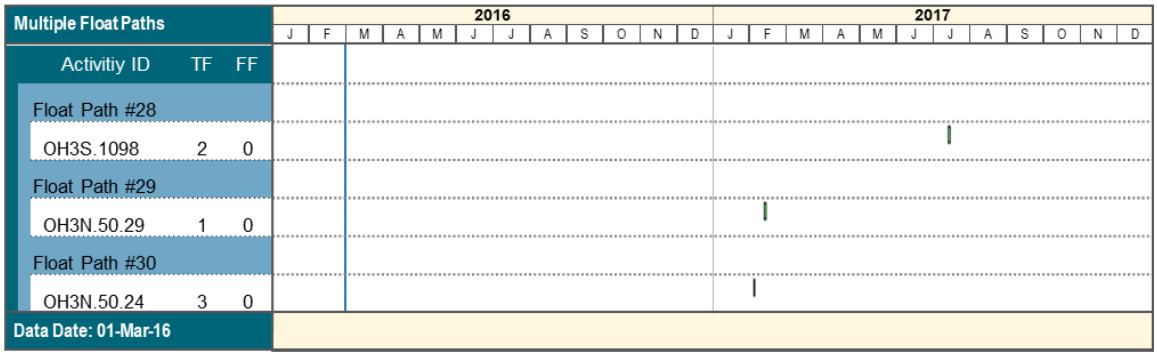


Figure 2–Schedule Float Paths #28 through #30

Taking the plain language of the description of the module, the activity on Float Path #28 is more critical than the activity on Float Path #29. Yet, the Total Float value of Activity #OH3S.1098 is two, whereas the Total Float value of Activity #OH3N.50.29 is one. Again, this raises the question: how is it that an activity with lower float is less critical than an activity with higher float? The key to understanding the answers to these questions lies in the details of how the float paths are calculated.

Calculating Float Paths Method 1: Total Float Option

P6's process for calculating Multiple Float Paths using the Total Float option is described as follows:

> *If you choose to calculate multiple paths using Total Float, based on the activity you want the paths to end on, P6…determines which predecessor activity has the most critical **Relationship Total Float** on the backward pass. This process repeats until an activity is reached that has no relationship. The forward pass begins from this activity and the successor activity that has the most critical Relationship Successor Total Float is determined. This process repeats until an activity is reached that has no relationship. This process repeats…until the specified number of paths are calculated. [emphasis added] (11)*

There are two key points in this description. First, the process of float path calculation occurs on the backward pass, which means that activities toward the end of the network are evaluated and assigned a Float Path value before activities at the start of the network. This is true regardless of whether the Float Paths are calculated using the Total Float or the Free Float option.

The second key point is the concept of "Relationship Total Float" ("TF_{Rel}"), which is a value of Total Float assigned to a relationship. It is calculated by subtracting the Relationship ES[4] ("ES_{Rel}") from the Relationship LS[5] ("LS_{Rel}"). These fields are calculated by P6 and are viewable as columns in the Predecessor or Successor tabs of the Activity Details pane.

[4] The first work period, using the relationship calendar, after the predecessor's EF date.
[5] The first work period, using the relationship calendar, after the predecessor's LF date.

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Consider the simple network in Figure 3. This schedule, consisting of 13 activities (two milestones, eleven tasks, and no constraints). This schedule was calculated for Multiple Float Paths using the Total Float option, but critical activities are defined as longest path.

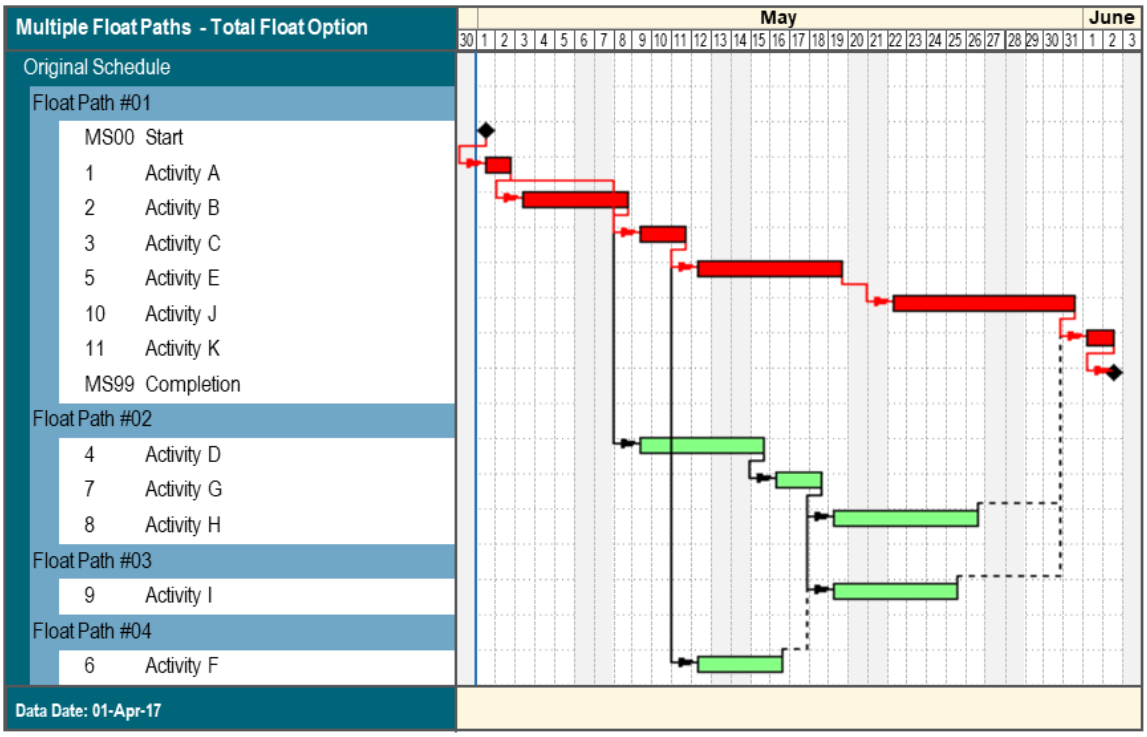


Figure 3–Total Float Option, No Constraints

Float Path #01 is comprised solely of longest path activities, and unlike the more complex schedule in Figure 1, all the longest path activities are on Float Path #01. Activity K is the last task activity in the network and therefore the first activity to be evaluated as part of the backward pass for Float Path calculations. Figure 2 shows the predecessors to Activity K, sorted by TF_{Rel} in ascending order.

#11 "Activity K"

Activity ID	Activity Name	OD	RD	Rel Type	Lag	ES_{Act}	EF_{Act}	TF_{Act}	ES_{Rel}	EF_{Rel}	TF_{Rel}
10	Activity J	8	8	FS	0	22-May-17	31-May-17	0	31-May-17	31-May-17	0
8	Activity H	6	6	FS	0	19-May-17	26-May-17	3	26-May-17	26-May-17	3
9	Activity I	5	5	FS	0	19-May-17	25-May-17	4	25-May-17	25-May-17	4

Figure 4–Float Path Calculation from Activity K, Total Float Option and No Constraints

Activity J has a TF_{rel} equal to zero. It is the lowest value of TF_{Rel} of the three predecessors, so it is assigned to Float Path #01. Of the remaining two predecessors, Activity H has the lower TF_{Rel} so that is assigned to Float Path #02, and Activity I is assigned to Float Path #03. Table 1 shows the Total Float and Free Float values for each activity in the network.

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Activity ID	Activity Name	LP	TF	FF
Float Path #01				
MS00	Start	Yes	0	0
1	Activity A	Yes	0	0
2	Activity B	Yes	0	0
3	Activity C	Yes	0	0
5	Activity E	Yes	0	0
10	Activity J	Yes	0	0
11	Activity K	Yes	0	0
MS99	Completion	Yes	0	0
Float Path #02				
4	Activity D	No	3	0
7	Activity G	No	3	0
8	Activity H	No	3	3
Float Path #03				
9	Activity I	No	4	2
Float Path #04				
6	Activity F	No	5	4

Table 1–Total Float Values by Float Path, No Constraints

The Total Float values seem consistent with the assigned Float Paths, in that the activities with the lowest values of Total Float – traditionally a mark of what is “most critical” – are also designated as the lower Float Paths. However, the introduction of finish constraints into the network adds complications to the calculations. In Figure 5, a “Finish On or Before” constraint is added to Activity F for a date four calendar days earlier than the calculated EF date. This created a negative Total Float on Activity F of -2. The Float Path calculation, using the Total Float option, is altered as a result of this constraint.

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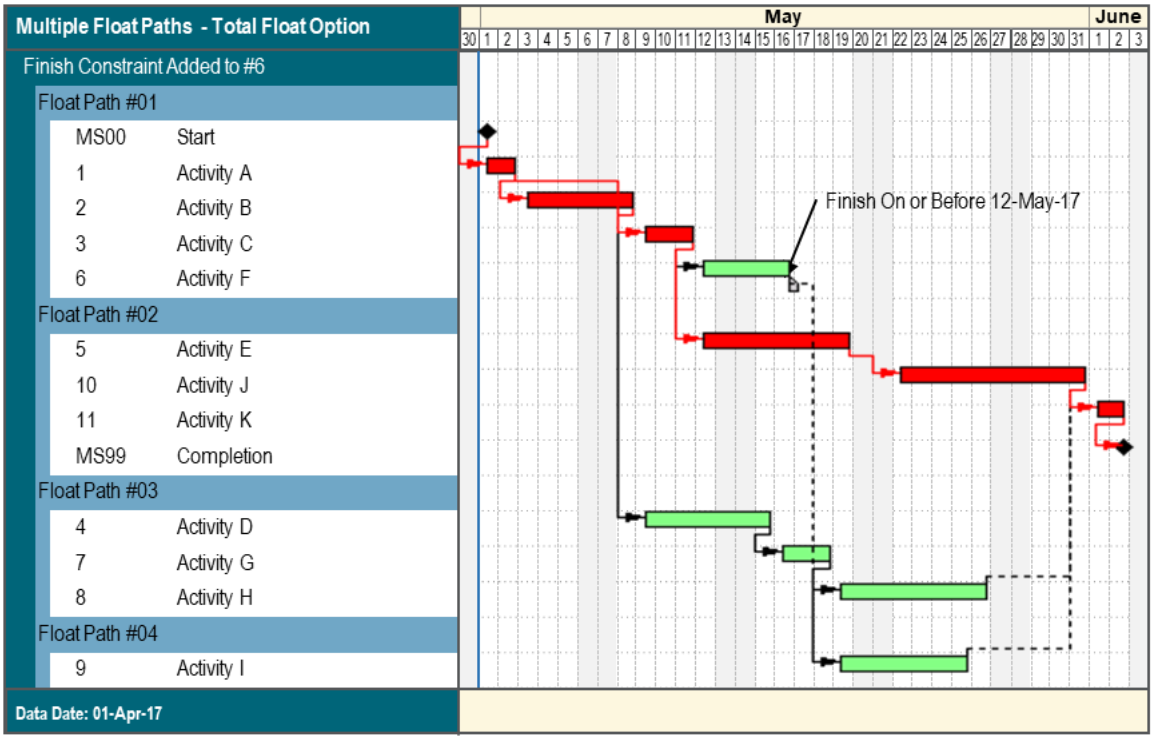


Figure 5–Total Float Option, with Finish Constraint & Negative Float

Float Path #01 now begins with Activity F, since it now has a lower value of Total Float than Activity E, Activity J, and Activity K – activities which remain on the longest path. Table 2 shows the altered Float Path assignments and the activities float values.

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Activity ID	Activity Name	LP	TF	FF
Float Path #01				
MS00	Start	Yes	-2	0
1	Activity A	Yes	-2	0
2	Activity B	Yes	-2	0
3	Activity C	Yes	-2	0
6	Activity F	No	-2	2
Float Path #02				
5	Activity E	Yes	0	0
10	Activity J	Yes	0	0
11	Activity K	Yes	0	0
MS99	Completion	Yes	0	0
Float Path #03				
4	Activity D	No	3	0
7	Activity G	No	3	0
8	Activity H	No	3	3
Float Path #04				
9	Activity I	Yes	4	5

Table 2–Total Float Values by Float Path, with Finish Constraint & Negative Float

Because of the introduction of the "Finish On or Before" constraint on an activity that is not on the longest path, the first Float Path – the "most critical" – is defined by an activity that does not fit the traditional definition of criticality. A day of delay to Activity F will push that activity one day farther beyond the Finish Constraint date, but it will not impact the predicted completion date of the project. In this scenario, defining Float Path #01 as most critical is potentially confusing or misleading, given that the longest path resides elsewhere.

Calculating Float Paths Method 2: Free Float Option

The Free Float option for calculating Multiple Float Paths is the more commonly employed method, since it is more aligned with the software's method of calculating the longest path (12). Comparing the two options in P6, the "*total float setting will reflect relationship float while the free float setting will reflect longest path*" (7 pp. 34, 36). The process is described as follows:

> *If you choose to calculate multiple float paths using Free Float, the most critical path will be identical to the critical path that is derived when you choose to define critical activities as Longest Path in the General tab of the Schedule Options dialog box. In a multi-calendar project, the longest path is calculated by identifying the activities that have an early finish equal to the latest calculated early finish for the*

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project and tracing all driving relationships for those activities back to the project start date. (11)

With the Free Float option, "*the lowest free float equals the 'controlling relationship' with Float Path 1 being the same as P6 calculated longest path.*" Figure 6 shows the same simplified network as Figures 3 and 5, with no constraints and calculated using the Free Float option.

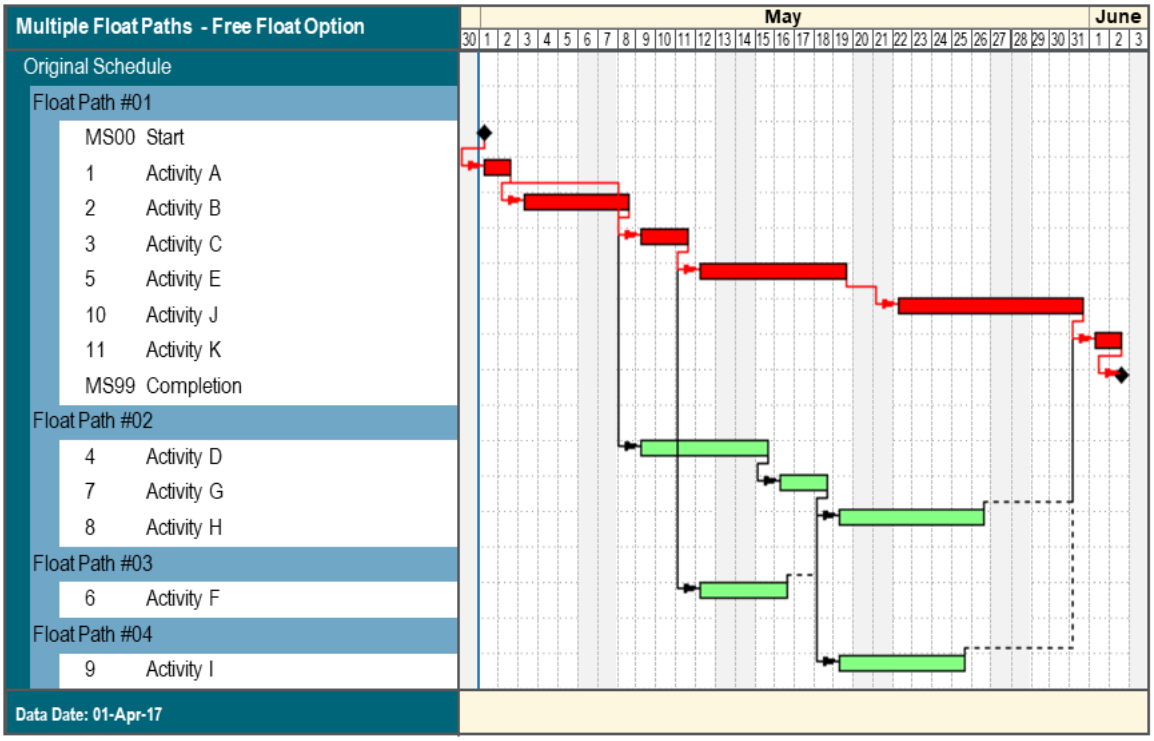


Figure 6–Free Float Option, No Constraints

As with Figure 3, Float Path #01 consists of the longest path activities, and there are no longest path activities outside of Float Path #01. Again, although this is the case in this simplified network, more complicated networks often have the longest path activities distributed across several float paths. Is the "most critical path" the longest path? Not exclusively, because the Free-Float Option sometimes calculates different float path values for activities on the Longest Path (see Figure 1). The "most critical path" defined in the Oracle P6 Help article (10), then, is typically the Longest Path – or at least part of it.

To determine the Float Path value for the activities, P6 compares the Free Float of a predecessor to the Relationship Successor Free Float ("$FF_{Rel\ Succ}$"). The value of $FF_{Rel\ Succ}$ is calculated by subtracting the Relationship EF[6] ("EF_{Rel}") from the Successor Activity's ES.

[6] The first work period, using the relationship calendar, after the ES_{Rel} plus any relationship lag.

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The steps for assigning Float Path values is as follows (2):

1. P6 calculates Free Float on an activity as part of the normal schedule recalculation.
2. P6 will then look at that activity's predecessor activities to see if the activity's Free Float and the $FF_{Rel\ Succ}$ match.
3. Once P6 finds a predecessor where the $FF_{Rel\ Succ}$ and Free Float are different, the first path ends there.
4. Once that path is determined it looks at the next activity with the least Free Float and starts again.

Figure 7 shows the relevant columns for the predecessors of Activity K. Note that Activity J has Free Float of zero, and $FF_{Rel\ Succ}$ of zero, so it is assigned to the first float path. Activity H has three days of Free Float and three days of $FF_{Rel\ Succ}$, compared to Activity I which has four days of Free Float and four days of $FF_{Rel\ Succ}$.

#11 "Activty K"

Activity ID	Activity Name	OD	RD	Rel Type	Lag	ES_{Act}	EF_{Act}	FF_{Act}	ES_{Rel}	EF_{Rel}	$FF_{Rel\ Succ}$
10	Activity J	8	8	FS	0	22-May-17	31-May-17	0	31-May-17	31-May-17	0
8	Activity H	6	6	FS	0	19-May-17	26-May-17	3	26-May-17	26-May-17	3
9	Activity I	5	5	FS	0	19-May-17	25-May-17	4	25-May-17	25-May-17	4

Figure 7–Float Path Calculation from Activity #11, Free Float Option and No Constraints

As a result, Activity H is on Float Path #03 and Activity I is on Float Path #04. The process continues through the network until the requested number of float paths have been calculated. Because Free Float is not affected by finish constraints, and thus Free Float cannot be negative, the problems of negative Total Float are avoided using this method. This is useful in overcoming complications in understanding the schedule in situations where there are multiple finish constraints creating negative float relative to different fixed points in time. However, certain constraints can impact the Free Float method of calculation. For instance, Figure 8 shows a version of the schedule with an "As Late As Possible" constraint added to Activity I, which under normal circumstances was on Float Path #04.

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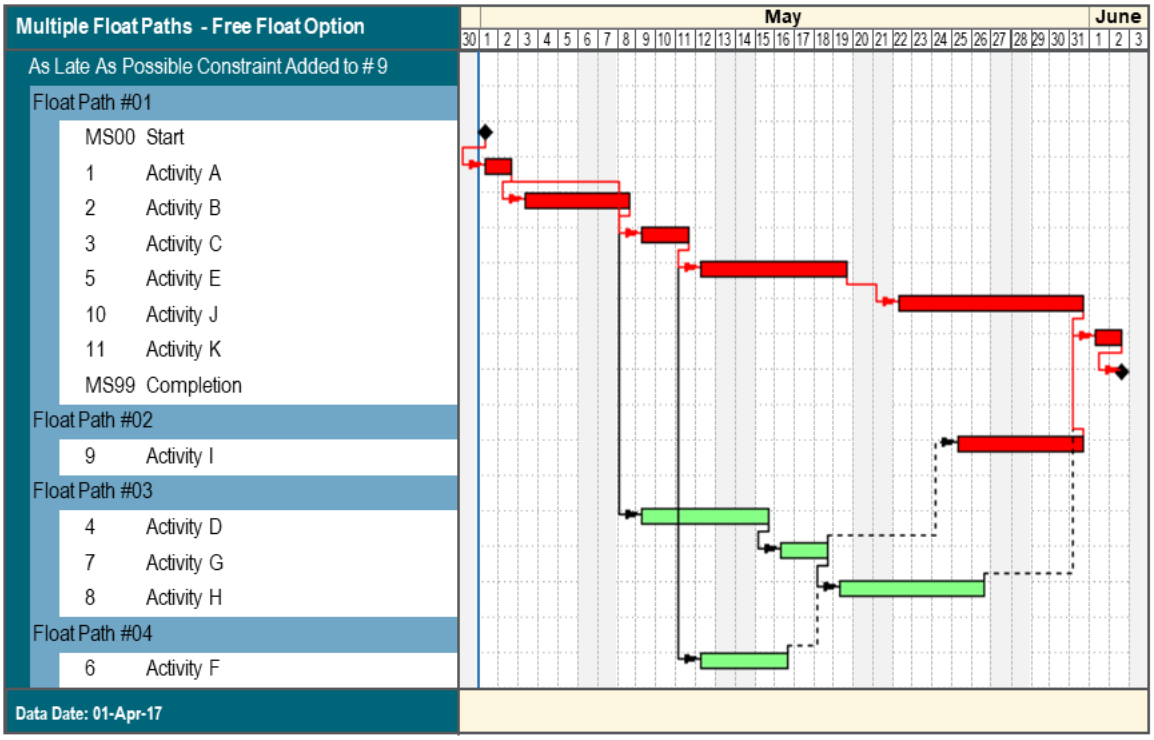


Figure 8–Free Float Option, "As Late as Possible" Constraint to Activity #9

"As Late as Possible" constraints, sometimes known as "zero float constraints," will reduce the Free Float in an activity to zero. As a result, the predecessors of Activity K have values as follows.

#11 "Activty K"

Activity ID	Activity Name	OD	RD	Rel Type	Lag	ES_{Act}	EF_{Act}	FF_{Act}	ES_{Rel}	EF_{Rel}	$FF_{Rel\ Succ}$
9	Activity I	5	5	FS	0	25-May-17	31-May-17	0	31-May-17	31-May-17	0
10	Activity J	8	8	FS	0	22-May-17	31-May-17	0	31-May-17	31-May-17	0
8	Activity H	6	6	FS	0	19-May-17	26-May-17	3	26-May-17	26-May-17	3

Figure 9–Float Path Calculation from Activity #11, "As Late as Possible" Constraint

With the "As Late As Possible" constraint in place, Activity I has Free Float of zero, which is the same as Activity J. As a result, Activity I is now on Float Path #02, and the previous occupant of that path, Activity H, has been demoted to Float Path #03.

On occasion, the Float Path calculation runs into multiple activities with the same $FF_{Rel\ Succ}$. In these situations, P6 is provided with a series of business rules that define the "tie breakers." If there are multiple activities with the same $FF_{Rel\ Succ}$, the tie breakers are as follows (2):

1. Activity Free Float
2. EF (Latest Date)
3. ES (Earliest Date)
4. Activity ID

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To examine how these tie breakers affect the assignment of Float Path values, consider the schedule[7] represented in Figure 10. The figure represents only about a month of the overall two-year duration of the schedule.

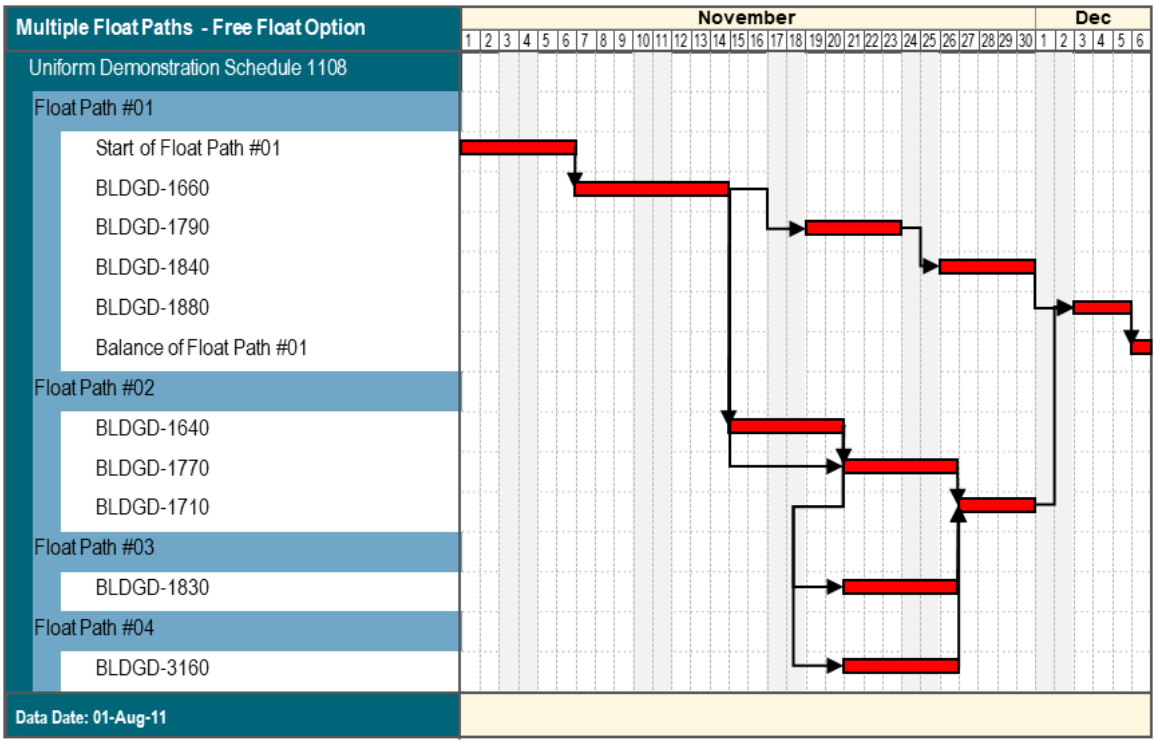


Figure 10–Free Float Option, No Constraints

Float Paths #01 through #04 are all part of the longest path, and therefore all activities have $FF_{Rel\ Succ}$ equal to zero. Focusing on Activity #BLDG-1880, assigned to Float Path #01, note that there are two predecessor activities, each of which have the same $FF_{Rel\ Succ}$. In this case, to determine which activity is assigned to Float Path #01 and which to Float Path #02, the tie breakers are applied in order.

Activity #BLDGD-1880

Activity ID	OD	RD	Rel Type	Lag	ES_{Act}	EF_{Act}	FF_{Act}	ES_{Rel}	EF_{Rel}	$FF_{Rel\ Succ}$
BLDGD-1710	4	4	FS	0	27-Nov-12	30-Nov-12	0	30-Nov-12	30-Nov-12	0
BLDGD-1840	5	5	FS	0	26-Nov-12	30-Nov-12	0	30-Nov-12	30-Nov-12	0

Figure 11–Float Path Calculation from Activity #BLDGD-1880

The first tie breaker is activity FF; however, the Free Float of the two predecessors is the same. The second tie breaker is which activity has the later EF, but again, the EF for these two activities is the same. The third tie breaker is the one that makes the determination: the ES of Activity BLDGD-1840 is the earliest, so it is assigned as Float Path #01 and BLDGD-1710 is relegated to

[7] This schedule is the Uniform Demonstration Construction Schedule baseline, as discussed in CDR-2542 "Uniform Demonstration Construction Schedule Series" by Michael S. Dennis, Kenji Hoshino, PSP, CFCC, GfFA, Patrick M. Kelly, PE, PSP, and Greta Martin, PE, PSP.

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Float Path #02. Again, the question arises: does this mean that BLDGD-1840 is "more critical" than BLDGD-1710? By the standard definition of critical path, the answer is no. Delay to either activity would translate to a day-for-day delay to the predicted completion date. However, understanding of P6's business rules makes it clear why one activity is assigned above another.

The figure below provides a similar picture, from the point of view of Activity #BLDGD-1710. This activity has three predecessors.

Activity #BLDGD-1710

Activity ID	OD	RD	Rel Type	Lag	ES_{Act}	EF_{Act}	FF_{Act}	ES_{Rel}	EF_{Rel}	$FF_{Rel\ Succ}$
BLDGD-1770	4	4	FS	0	21-Nov-17	26-Nov-17	0	26-Nov-17	26-Nov-17	0
BLDGD-1830	4	4	FS	0	21-Nov-17	26-Nov-17	0	26-Nov-17	26-Nov-17	0
BLDGD-3160	4	4	FS	0	21-Nov-17	26-Nov-17	0	26-Nov-17	26-Nov-17	0

Figure 12–Float Path Calculation from Activity #BLDGD-1710

All these activities have the same $FF_{Rel\ Succ}$ value of zero. They all have the same EF date, and the same ES date. So, in this case, it is the fourth tie breaker – Activity ID – that provides the rationale for assignment of Float Path value. The activities are assigned to Float Paths by sorting their activity IDs in alphanumeric order; thus, BLDGD-1770 is ranked above BLDGD-1830, which is ranked above BLDGD-3160. Although this is a rational basis for assignment of a Float Path value, it is difficult to support a conclusion that any one of these longest path activities is "more critical" than the other. Nevertheless, important information regarding the logic paths through the schedule has been uncovered and demonstrated to the scheduler.

Conclusion

P6's Multiple Float Path Calculation module is a useful tool for analyzing and understanding the logic of a schedule, and for graphically depicting the various parallel paths through the network in a bar chart form. However, Oracle describes the Multiple Float Path functionality as indicating other "sub-critical" paths in addition to the "most critical" path (2). Other authors have described that the purpose of this functionality "*… is to identify and rank secondary critical paths*" (7 p. 31). As has been shown, however, the longest path remains the correct definition of critical path and Total Float values in a network without finish constraints remains the best way to gauge an activity's proximity to the critical path. While the Float Path values do provide useful information about the CPM network to analysts and schedulers alike, those values do not represent a ranked order of criticality.

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