## Beyond the Critical Path - the Need for Logic Analysis of Project Schedules

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This entry is intended to review the use of the Multiple Float-Path calculation option in Primavera Project Planner (P6) and to offer a brief example of its use compared to BPC Logic Filter.

Project schedules generated using the Critical Path Method (CPM) are commonly used to model – and to document – the project team's plan for executing the scope of work. Such a plan normally involves identifying necessary activities at an appropriate level of detail and specifying the necessary sequential relationships between them. The output from the CPM analysis is a list of activities with associated durations, dates, and float values – this constitutes "the schedule".

Unfortunately, the sequential relationships that ultimately drive the schedule (i.e. the logical "plan") can be difficult to communicate or analyze for all but the simplest projects. This is because Total Float – the telltale indicator of logical-path connectivity in simple projects – becomes unreliable (or unintelligible) for such purposes in the presence of variable activity calendars or late constraints. As a result, complex schedule models lose both usefulness and credibility among project stakeholders unless schedule managers go beyond the simple communication of dates, durations, and float.

P6 and its predecessors have for many years included an option to compute "Multiple Float Paths" when calculating the schedule, but many experienced planners seem unfamiliar with it. The option facilitates the identification of the "driving" and "near-driving" logical paths for a single selected activity. The selected activity can be a key project milestone that may or may not correspond to the end of the project, or it may be a simple intermediate activity of particular or urgent concern.

Figure 1 represents a simple project for construction and handover of a small utility installation – originally modelled in Microsoft Project and then converted to Primavera P6. (The model was developed primarily for illustrating the impact of calendars and constraints; the work techniques illustrated are neither typical nor ideal.)

- There are contractually-derived late-finish constraints on the Construction Project Complete milestone (24Apr'15) and the final Project Acceptance milestone (29Apr'15). These constraints affect the late dates (and consequently Total Float) for these activities and (parts of) their chains of predecessors.
- There is a late-finish constraint (25Feb'15) on the "Install Fence" activity (reason not known), with similar impacts on late dates and Total Float.
- Activities are scheduled using a 4d x 8h work week (M-Th), except for the two initial milestones which utilize a 24-hour calendar, and the final two Customer Checkout activies which utilize a 5d x 8h workweek.
- The "Notice to Proceed" milestone is constrained to start no earlier than 10:00 PM on 05Jan'15.
- P6's scheduling options are set to define critical path activities on the basis of "Longest Path" rather than Total Float, and the Gantt chart appears to properly display the Critical Path by this definition. Thus, the two initial milestones are marked as critical because they are driving the project's completion, even though their calendars allow a higher value for total float.

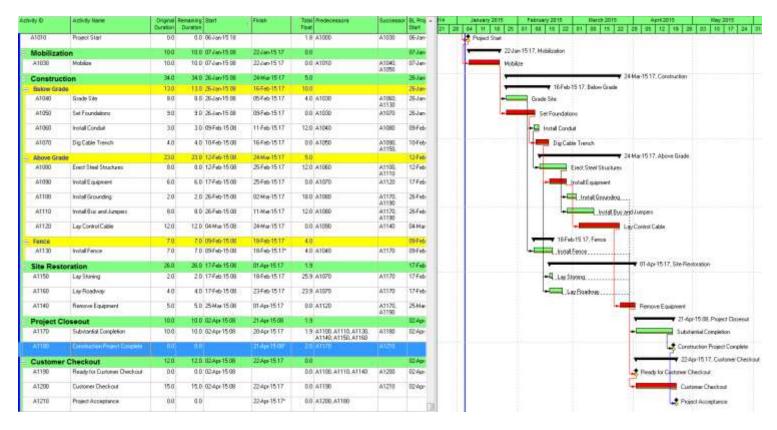


Figure 1: (P6) Simple Construction/Handover Project

Although "Longest Path" appears to correctly identify the driving path to the project completion (the Project Acceptance milestone), the contractor is equally interested in identifying the driving path to the "Construction Project Complete" intermediate milestone.

In P6's advanced schedule options, we select "calculate multiple float paths" ending with the "Construction Project Complete" milestone" (Figure 2). As a rule, we calculate the multiple paths using "free float" rather than "total float", since the former option best mimics "longest path" behavior. The default number of paths to calculate is ten.

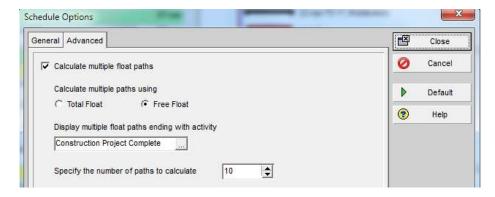


Figure 2: (P6) Schedule Option for Multiple Float Paths

Figure 3 illustrates the result of re-calculating the schedule then displaying a layout that arranges the activities by "Float Path" and sorting by "Float Path Order". In this figure, "Float Path 1" is the driving logical path leading to the Construction

Project Complete milestone. "Float Path 2" defines the first near-driving-path, "Float Path 3" defines the next near-driving path, etc. Each "float path" is essentially a discrete branch from the main, driving logical path. Obviously, Float Path 1 defines the activities that offer the most opportunity to accelerate the construction project (and maybe the most risk of extending it.) According to the figure, higher float paths tend to have higher values of total float, though the correlation is not universal.

Unfortunately, P6 does not rigidly distinguish between driving-paths and near-driving paths. That is, while float path 1 is always "the" driving path, float path 2 may designate another, parallel driving path or a path that is 2 days from the driving path. It is not obvious how far a certain numbered path may be from driving; that is, what is its "relative float" with respect to the end activity? You can try to estimate this manually by looking at start and finish dates of various related activities in the output. More rigorously, the relative float of each path can be computed by summing the "Relationship Free Float" of all the relationships between the given path and the end activity.

Ongoing management of projects often requires what-if analysis of prospective disruptions, and P6's MFP can be useful. For example, the subcontractor for the "Install Bus and Jumpers" activity may request early access to accommodate a staffing conflict. Running MFP ending with "Install Bus and Jumpers" will identify the driving path of predecessors for this work (Figure 4), assisting in the review and consideration of the request.

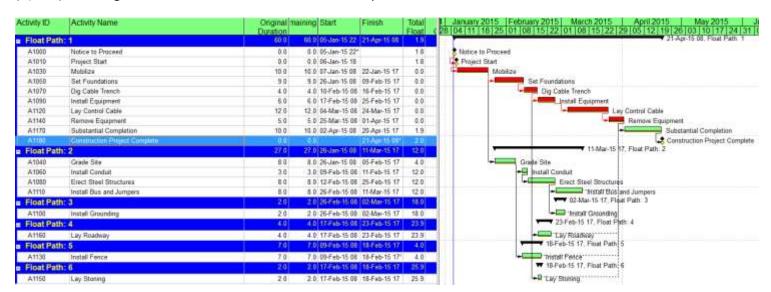


Figure 3: (P6) Multiple Float Paths to Interim Milestone

Figure 4 demonstrates the utter lack of correlation between Total Float and the driving logical path for any given activity in the schedule.

Activity ID	Activity Name	Original	Start	Finish	Total	Float	Float.	14		Qtr 1, 2015			Qtr 2, 201	
(2000)	(Committee of the Committee of the Commi	Duration	- TOTAL	1000000	Float	Path	Path	l u	Dec	Jan	Feb	Mar	Apr	May
<ul> <li>Float Path</li> </ul>	h: 1	38:0	05-Jan-15 22	11-Mar-15 17	12.0								Aar-15 17	7, Float Pati
A1008	Notice to Proceed	0.0	05-Jan-15 22"		1.8	- 1	- 1			* Notic	e to Proce	ed		
A1010	Project Start	0.0	06-Jan-15 18	Janes Roman	1.8	- 1	2		(	Proje	ct Start			
A1030	Mobilize	10.0	07-Jan-15 08	22-Jan-15 17	0.0	1	- 3		1	-	Mobilize			
A1040	Grade Site	8.0	26-Jan-15 08	05-Feb-15 17	4.0	1	4			las.	Grad	Site		
A1060	Install Conduit	3.0	09-Feb-15 08	11-Feb-15 17	12.0	.1	5				Inst	all Condu	it	
A1080	Erect Steel Structures	8.0	12-Feb-15 08	25-Feb-15 17	12.0	1	6				-	Erect St	eel Struc	tures
A1110	Vistall Bus and Jumpers	8.0	26-Feb-15-08	11-Mar-15 17	12.0	- 1	1				-	Inst	all Bus a	nd Jumpers

Figure 4: (P6) Multiple Float Path to Install Bus and Jumpers

(Microsoft Project provides neither Longest-Path nor Multiple-Float-Path analysis. BPC Logic Filter is an add-in that applies similar calculations to MSP schedules.) Figure 5, Figure 6, and Figure 7 illustrate the same steps as above, but this time executed on the Microsoft Project version of the schedule using BPC Logic Filter. In this type of analysis, the primary difference between P6 and BPC Logic Filter is that BPC Logic Filter explicitly computes and displays "Relative Float" (i.e. days away from driving) for each path. Thus two logical paths with the same relative float (i.e. parallel paths) are grouped together in BPC Logic Filter, while P6 assigns separate float paths. The MSP add-in also re-colors Gantt bars based on their path relative float with respect to the "selected" task.

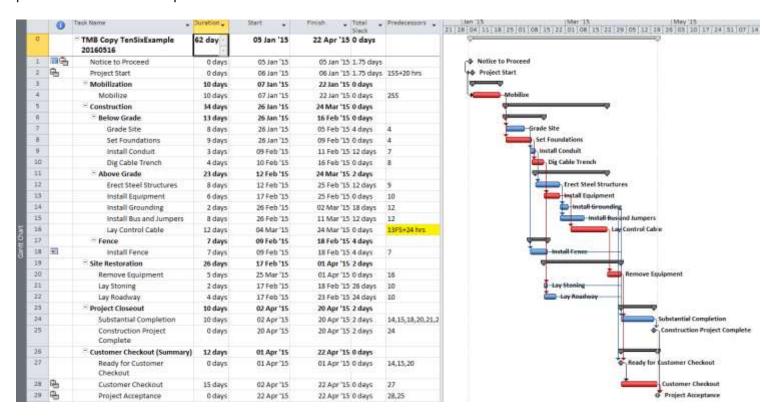


Figure 5: (MSP) Simple Construction/Handover Project

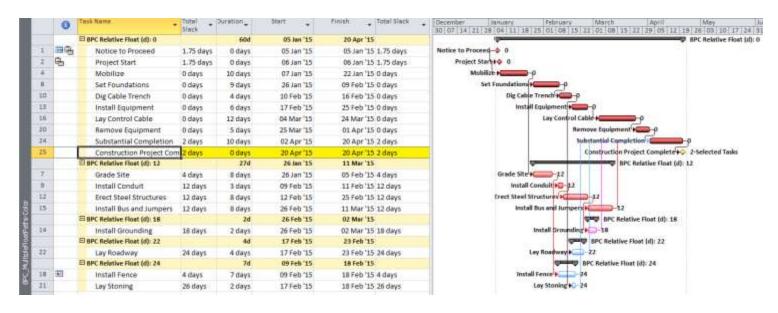


Figure 6: (MSP) BPC Logic Filter - Multiple Float Paths to Interim Milestone

	0	Task Name	Total -	Duration	Start	Finish Total Slack	*	December   January   February   March   April
		El BPC Relative Float (d): 0		38d	05 Jan '15	11 Mar 15		BPC Relative Float (d): 3
10	<b>B</b> 3	Notice to Proceed	1.75 days	0 days	05 Jan '15	05 Jan '15 1.75 days		Notice to Proceed - 0
2	G	Project Start	1.75 days	0 days	06 Jan '15	06 Jan '15 1.75 days		Project Start 0
+		Mobilize	0 days	10 days	07 Jan '15	22 Jan '15 0 days		Mobilize +0
7		Grade Site	4 days	8 days	26 Jan '15	05 Feb '15 4 days		Grade Site +
9		Install Conduit	12 days	3 days	09 Feb '15	11 Feb '15 12 days		Install Conduit 📲 O
12.		Erect Steel Structures	12 days	8 days	12 Feb '15	25 Feb '15 12 days		Erect Steel Structures + 0
15		Install Bus and Jumpers	12 days	8 days	26 Feb 15	11 Mar '15 12 days		install flus and Jumpers 2-Selected Tasks

Figure 7: (MSP) BPC Logic Filter - Driving Path to Install Bus and Jumpers

Finally, BPC Logic Filter allows a more substantial evaluation of the upstream and downstream logic affected by the potential change to "Install Bus and Jumpers". Figure 8 identifies the predecessor and successor paths for the selected task, all arranged according to their path relative float (shown at the end of each bar) with respect to the selected task.

	0	Task Name +	Total Slack	Duration.	Start .	Fleish .	Total Slack	December 30 07 14 11	28 04 11 18	74tiruary 25 01 08 15	22 01 08 1	April 15 33 29 05 13	May 19 10 03 10 1	7 34 31 07
		☐ 1-Predecessors of Selected Task		304	05 Am '15	25 Feb '15			(pa	The second	1-Predec	eisors of Selected Ta	sli)	
12		Erect Steel Structures	12 days	8 days	12 Feb '15	25 Feb '35	12 days		Great Steel	Structures +	<b>-</b> 9			
9		install Conduit	12 days	3 days	09 Feb '15	11 Feb '15	12 days	1	install	Conduit +0-0				
7		Grade Site	4 days	8 days	26.Ian "15	05 Feb '15	4 days	5	Grade Site	+				
4		Mobilize	0 days	10 days	07 Jan 125	22 Jan 15	0 days	Mol	dire H	-b				
2	8	Project Start	1.75 day	s 0 days	06 Jan "15	06 Jan '15	1.75 days	Project S	erité o					
1	100	Natice to Proceed	1.75 day	s 0 days	05 Jan *15	05 Jan *15	1.75 days	Notice to Proce	ed-> 0		41.1 TERRINA			
		El 2-Selected Tasks	Visita	Bd	26 Feb '15	11 Mer '15					V 2	Selected Tasks		
13)		Install Bus and Jumpers	12 days	8 days	26 Feb '15	11 Mar '15	12 days		Insta	di Bus and Jumper	+	Selected Tasks		
		El 3-Successors of Selected Task		12d	01 Apr '15	22 Apr '15						-	1) 3-Successors of	f Selected Task
17		Ready for Customer Check	0 days	0 days	01 Apr '15	01 Apr '15	0 days			Ready to	Customer Ch	eckout+0-12		
18	4	Customer Checkout	0 days	15 days	02 Apr '15	22 Apr '15	0 days				Customer C	heckout H	12	
19	0-	Project Acceptance	0 days	0 days	22 Apr '15	22 Apr '15	0 days				December 2	Project Acceptance	12	
24		Substantial Completion	2 days	10 days	02 Apr '15	20 Apr '15	2 days			19	obstantial Com	reletion +	12	
25		Construction Project Com	2 days	0 days	20 Apr '15	20 Apr '35	2 days				Construction	Project Complete	12	

Figure 8: (MSP) BPC Logic Filter – Driving and Driven Paths for Intermediate Activity (Install Bus and Jumpers)

As a long-time Primavera user accustomed to MFP analysis options, I was continually disappointed when faced with the need for logical path analysis in Microsoft Project. I wrote BPC Logic Filter in part to cover this gap; now I find myself facing disappointment in the opposite direction.