

In this article, as part of a continuing series of articles regarding critical path method (CPM) scheduling, Warner reviews various facets of the process of preparing, analyzing and utilizing schedules in project management. Warner has worked in all areas of the construction process with clients varying from suppliers to owners, and for all types of projects from residential to power plants. This series of articles is designed to pass along observations and insights, highlighting best practices found through the years of Warner's scheduling experience.

The author, Ralph Waagner, has over 25 years of construction scheduling experience. He has worked on many projects both commercial and public throughout that time. The projects he has scheduled involved working under a variety of contracting scenarios including General Contracting, Construction Management, and Scheduling Consulting. Mr. Waagner's responsibilities have largely involved preparation, analysis and review of Critical Path based (CPM) construction schedules. In his work as a scheduler he has used several scheduling software packages to assist in the development of logic and duration estimates developing Work Breakdown Structures (WBS), and cost / resource loaded CPM networks for Baseline Project Schedules. Mr. Waagner also currently works with contractors and developers providing scheduling management services across the country.

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HANDLING OUT-OF-SEQUENCE PROGRESS

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INTRODUCTION - OUT-OF-SEQUENCE PROGRESS

One of the primary goals of effective schedule management is to ensure that the planned schedule is periodically updated to reflect the actual progress of the work. Unless that updating procedure includes appropriately addressing out-of-sequence work, the schedule may become a poor reflection of reality and an unusable tool for planning. Out-of-sequence progress occurs when a series of activities are not performed as they were originally planned to be performed. This situation can cause detrimental consequences to the schedule if the scheduler does not carefully and appropriately respond to the changes presented by the actual conditions on the project.

DISCUSSION

Out-of-sequence work, as defined in scheduling language, is when work begins on an activity prior to the completion of its predecessor activities. This definition assumes the activities have a finish-to-start relationship without any lag or lead time. It is not uncommon for out-of-sequence work to occur on construction projects, as often one subcontractor may begin a portion of its work before the previous activity is 100% completed. A positive aspect of the typical construction earned value payment system is that subcontractors have a built-in incentive to perform work as early as possible and collect payment for same. While this is generally beneficial, it creates numerous instances of work proceeding earlier than its original sequencing. The greater the detail in a project schedule, the more likely an out-of-sequence chain of activities is to occur, since many activities may have been split without consideration of other external factors.

Reasons for Out-of-Sequence Progress

There are numerous reasons for of out-of-sequence work, most of which are legitimate. Work might be performed out-of-sequence to give crews and equipment a steady flow of work without stopping and waiting until the previous activity is complete. Crews could start an activity because they want to gain familiarity with the work before they have all areas available to them. Out-of-sequence logic also may result from an error in how the work was initially scheduled, necessitating a re-sequencing of particular activities. Regardless of the schedule logic, if work can proceed, it should proceed and the scheduler should handle the out-of-sequence notification and subsequent logic adjustments. Out of sequence work will often occur on a construction project, no matter how much effort has been used in developing a good schedule, one which is reflective of the planned sequencing.

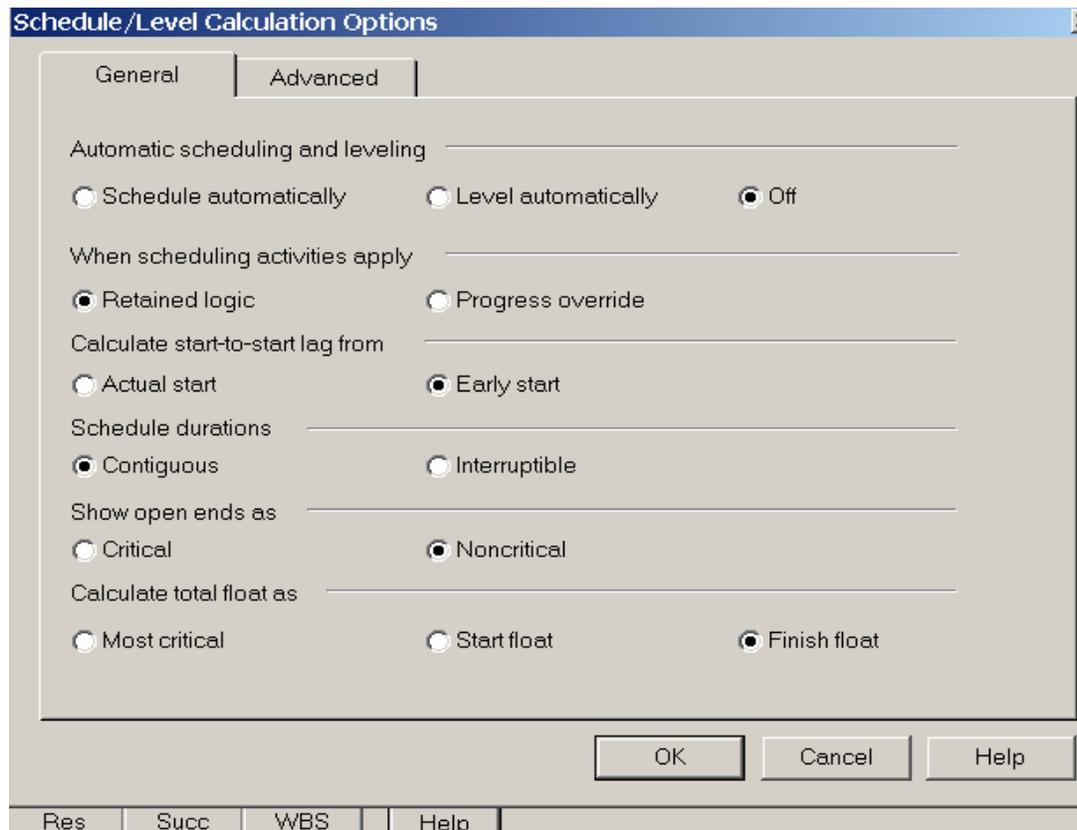
Methods of Reconciling Out-of-Sequence Progress

There are several ways of handling this problem and adjusting the schedule logic and relationships that allow for an accurate depiction of the project status and future activity sequences. Most of today's scheduling software allows the scheduling professional to choose when setting up a project to handle out-of-sequence progress. However, a contractual prohibition of out-of-sequence progress once the

Scheduling Best Practices

updating process starts is often found in current scheduling specifications. Many scheduling software packages are capable of producing an out-of-sequence report, so that the affected activities may be identified and isolated more easily.

Current scheduling practice recognizes two primary means of handling out-of-sequence progress as a part of the schedule's forward and backward pass calculations. These choices are commonly known as "Retained Logic" and "Progress Override." These two choices are just what they imply; either retaining the original sequencing logic, or allowing progress to override the old sequencing logic. The selection sample below illustrates how the Primavera software sets forth those options.



Progress Override

Selecting Progress Override will treat the activity with out-of-sequence progress as if it has no predecessors so it can continue without being affected by its incomplete

Scheduling Best Practices

predecessors. It's important to reiterate that this option essentially ignores the network logic affecting this activity since it treats it as if it has no predecessors. The report identifying out-of-sequence work will still indicate activities that are out of sequence, but will reflect the selection of Progress Override. In the typical logic example below, excavation of a concrete footing has begun and is progressing, and concrete placement for that footing has started earlier than planned. Using Progress Override the activities will show progress gained due to the start of concrete footings when the schedule is updated, despite excavation remaining incomplete. With this method the schedule calculation will allow this out-of-sequence start of the concrete placement activity. Again it should be noted that with this selection the out-of-sequence activity will continue ignoring its predecessor relationship.

Retained Logic

Selection of the Retained Logic option will allow the affected activity to start early, but schedule its completion in accordance with the network logic. The activity will not be allowed to complete until all its predecessors are completed, and the original duration is satisfied. An example of this would be one of the most typical in a construction schedule. With the example used below we have an 'Excavate Foundations' activity for 10 days with its successor as 'Pour Foundations' for 5 days. Half-way through the excavation the superintendent realizes he can start placing concrete prior to completion the excavation. He then begins to place the concrete before the excavation is completed, and indicates this on his update. But by using Retained Logic the scheduler will get an out-of-sequence notification and the concrete pour will not be considered in the schedule calculation. Thus, with the retained logic option chosen, the follow-on activities succeeding the 'Pour Foundations' activity will not be shown as starting early.

Typical Logic Example with Out-of-Sequence Report:

3265	<i>Excav. Foundation Ftg - North</i>	10	5	23 Dec 05A	05 Jan 05	
3270	<i>Pour Foundations - North</i>	5	4	30 Dec 05A	13 Jan 05	

<u>Activity</u>	<u>Predecessor</u>	<u>Rel.</u>	<u>Lag</u>	<u>Description</u>
3270	3265	FS	0	Activity started, predecessor has not finished.

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CONCLUSION

In my experience, I have found that the Progress Override selection is the preferred option for me to choose because in a sufficiently detailed schedule it will more accurately reflect actual work done. I typically do not adjust a schedule to remove out-of-sequence progress. When using this method, if the specification doesn't allow for it, I will make the adjustment to the logic. Most schedulers who manage large schedules understand that removing out-of-sequence progress can be a very time consuming process. It is also difficult to explain to a Project Manager what out-of-sequence logic is and why the schedule needs to be revised to accommodate it. But it is important to make these adjustments.

However, a scheduling specification might prohibit its use and require the scheduler to use Retained Logic selection instead. Thus, a thorough review of the contract documents governing the project should be done before selecting either option. If Retained Logic is being used, for example, and these activity relationships are not corrected, they may show the final completion date later than it could actually be completed if they affect the critical path of the project.

When removing out-of-sequence progress, the Project Manager should be involved in the changes made since it will require logic changes. In many cases the schedule can be adjusted to satisfy the out-of-sequence work through the use of a finish to finish (FF) relationship with a proper lag, to be determined by the Project Manager. Alternatively an additional schedule activity can be added that divides the activity into two parts. In the example above, 'Excavate Footings' could become two separate activities, one a predecessor to the start of concrete placement. This will remove the out-of-sequence progress and bring the schedule back into compliance with a specification that demands no out-of-sequence progress, and most importantly this will retain the actual schedule logic intent to better reflect reality. There are other ways to handle the out-of-sequence progress, but these methods seems to be the most preferred within the industry.

References on this subject can be found in:

CPM in Construction Management – 5th Edition – James O'Brien / Fred L. Plotnick P.E., Publisher, McGraw-Hill, Inc., 1999

AGC Construction Planning and Scheduling – 2nd Edition – Tom E. Glavinich, D.E., P.E., Associated General Contractors of America, 2004