



MODELLING EARTHWORKS OPERATIONS WITH ORACLE PRIMAVERA P6

1 Introduction

Many civil construction companies use P6 as their primary scheduling software and they run into a number of issues when trying to model earthmoving operations with P6.

This paper looks at the issues of using P6 resources for mobile equipment and/or earthworks cut and fill quantities and suggests some possible solutions.

2 Issues with P6 and Earthworks Modelling

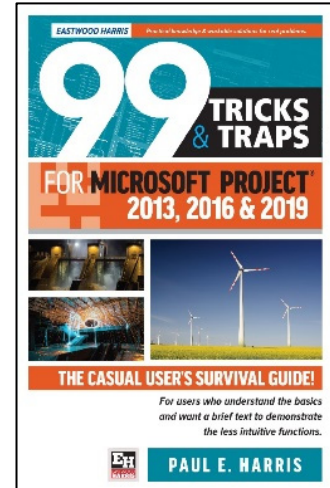
Firstly, I would like to set the scene and create a small P6 schedule that I'll use to demonstrate the issues with modelling earthworks operations with Primavera P6.

The schedule will have activities that I will assign an excavation quantity, an excavator and three trucks against it. I will then model the activities in the way one would expect to model it in P6 with Non Labour Resources for the mobile equipment and Material Resources for the Cut and Fill material and identified the issues.

The picture below shows two activities on an 8 hour per day calendar which:

- Are assigned a 10 day duration,
- Have been assigned an excavator and three trucks as Non Labour resources and
- 10,000 cubic metres of cut to fill assigned as a material resource.
- The **User Preferences, Resource Assignments** setting has been set to **Preserve the Units, Duration, and Units/Time for existing assignments** so as resources are assigned the existing assignment does not reduce.

I normally do not like using the options of **Fixed Units** or **Fixed Units/Time** because when you add and remove resources the duration changes. Thus, initially we have the option of making the resource is either **Fixed Duration & Units/Time** or **Fixed Duration & Units** and I have created two activities which have one of each option.



Activity ID	Activity Name	Duration Type	Original Duration	Remaining Nonlabor Units
Eastworks Modelling				
A1000	Cut to Fill Section 1	Fixed Duration & Units	10.0d	320.0h
A1010	Cut to Fill Section 2	Fixed Duration and Units/Time	10.0d	320.0h

General		Status	Resources	Summary	
Activity		A1000	Cut to Fill Section 1		
Resource ID Name	Remaining Duration	Remaining Units / Time	Actual Units	Remaining Units	At Completion Units
C2F.Cut to fill	10.0d	1000.0m3/d	0.0m3	10000.0m3	10000.0m3
EXV.Excavator	10.0d	8.0h/d	0.0h	80.0h	80.0h
TRC.Trucks	10.0d	24.0h/d	0.0h	240.0h	240.0h



What are the current issues:

- We can see the mobile equipment quantities as a total in the **Remaining Nonlabour Units** column
- We cannot see the Cut to Fill quantities (which is a Material Resource) in columns in the Activity workspace as this data column does not exist,
- We also cannot see the Material Resource quantities in the Activities Window Status or Summary tabs either.

2.1 Changing Durations

When the increase the duration of both activities by 2 we get the following results:

Fixed Duration and Units Activity

- The crew size is halved which is not desirable and
- The Cut to Fill quantity is unchanged and Unit / Time is halved which is desirable.

Activity ID	Activity Name	Duration Type	Original Duration	Remaining Nonlabor Units	Aug 01							Aug 08																																									
S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M																														
A1000	Cut to Fill Section 1	Fixed Duration & Units	20.0d	320.0h	[Gantt Chart]																																																
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Crew size halved

Quantity at Completion unchanged

Fixed Duration and Units/Time Activity

- The crew size is the same which is desirable and
- The Cut to Fill quantity has doubled which is undesirable.

Activity ID	Activity Name	Duration Type	Original Duration	Remaining Nonlabor Units	Aug 01							Aug 08																																									
S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M																														
A1010	Cut to Fill Section 2	Fixed Duration and Units/Time	20.0d	640.0h	[Gantt Chart]																																																
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Crew size unchanged

Quantity at Completion doubled

Fixed Units and Fixed Units / Time

You will find similar issues with both these Duration Types if you decide to use them



2.2 Changing Material Resource Quantities

When you change the Material Resource Quantities we end up with some interesting results:

Fixed Duration and Units Activity

Doubling the At Completion Units doubles the Remaining Units / Time and does not increase the activity Duration, which is not desirable:

Activity ID	Activity Name	Duration Type	Original Duration	Remaining Nonlabor Units	Aug 01							Aug 08																																																									
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Fixed Units and Fixed Units / Time

With both of these Duration Types increasing the At Completion Quantity increases the Remaining Duration of the Material resource but not the Non Labour Resources, which is not desirable:

Activity ID	Activity Name	Duration Type	Original Duration	Remaining Nonlabor Units	Aug 01							Aug 08																																																									
					S	S	M	T	W	T	F	S	S	S	S	M	T	W	T	F	S	S	M	T																																													
A1030	Cut to Fill Section 4	Fixed Units/Time	20.0d	320.0h	[Gantt Chart]																																																																
<table border="1"> <thead> <tr> <th colspan="2">Activity</th> <th colspan="21">Cut to Fill Section 4</th> </tr> <tr> <th>Resource ID Name</th> <th>Remaining Duration</th> <th>Remaining Units / Time</th> <th>Orig Rem Units / Time.</th> <th>Remaining Units</th> <th>At Completion Units</th> </tr> </thead> <tbody> <tr> <td>C2F.Cut to fill</td> <td>20.0d</td> <td>1000.0m3/d</td> <td></td> <td>20000.0m3</td> <td>20000.0m3</td> </tr> <tr> <td>EXV.Excavator</td> <td>10.0d</td> <td>8.0h/d</td> <td></td> <td>80.0h</td> <td>80.0h</td> </tr> <tr> <td>TRC.Trucks</td> <td>10.0d</td> <td>24.0h/d</td> <td></td> <td>240.0h</td> <td>240.0h</td> </tr> </tbody> </table>																							Activity		Cut to Fill Section 4																					Resource ID Name	Remaining Duration	Remaining Units / Time	Orig Rem Units / Time.	Remaining Units	At Completion Units	C2F.Cut to fill	20.0d	1000.0m3/d		20000.0m3	20000.0m3	EXV.Excavator	10.0d	8.0h/d		80.0h	80.0h	TRC.Trucks	10.0d	24.0h/d		240.0h	240.0h
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TRC.Trucks	10.0d	24.0h/d		240.0h	240.0h																																																																

Non Labor Resources have not increased in duration

Material resources has increased in duration

Thus the mobile equipment is no longer working the full duration of the activity.



2.3 Summary of Issues

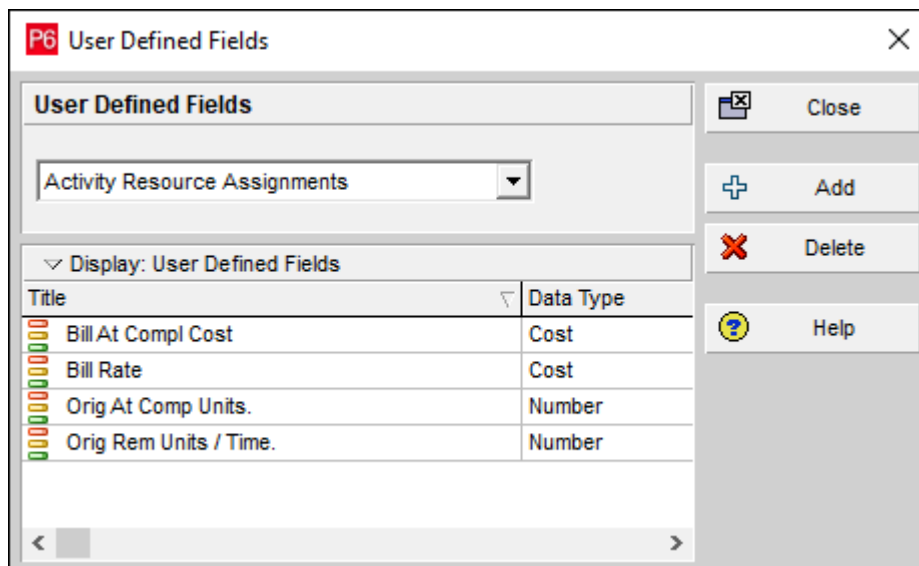
Thus, without being able to assign a duration type to the resource is as opposed to the activity it is difficult to manage activities with both mobile equipment and earthworks quantities assigned to one activity without continually readjusting either the earthworks quantity's or the crew size when the Activity Duration is adjusted or the Resource Remaining Durations when the Material Remaining Quantity is changed.

3 Possible Solutions

There are many solutions depending on what you are trying to achieve and will introduce some concepts but ultimately you need to select a solution that will meet your project requirements.

3.1 Activity Resource Assignments User Defined Fields to hold the Original Material Quantities and Unit/Time

You may create a couple of Activity Resource Assignments User Defined Fields to hold the Original Material Quantities and Original Remaining Unit/Time, thus you have a simple check to see the chnnages when you update a duration or other quantity:



Activity ID	Activity Name	Duration Type	Original Duration	Remaining Nonlabor Units	Aug 01				Aug 08													
					S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T
A1000	Cut to Fill Section 1	Fixed Duration & Units	10.0d	320.0h																		

Activity A1000 Cut to Fill Section 1						
Resource ID Name	Remaining Duration	Remaining Units / Time	Remaining Units	At Completion Units	Orig At Comp Units.	Orig Rem Units / Time.
C2F.Cut to fill	10.0d	800.0m3/d	8000.0m3	8000.0m3	10000.00	100.00
EXV.Excavator	10.0d	8.0h/d	80.0h	80.0h		
TRC.Trucks	10.0d	24.0h/d	240.0h	240.0h		

UDFs holding original Units and Units / Time



3.2 Using Labour Resources for Materials without Mobile Equipment as Non Labour Resources

When a single Labour Resource per activity is used for quantities of materials and mobile equipment is not entered as a resource, we now have a couple of advantages:

- Material Quantities may be seen in the Activity Workspace in columns,
- Material Quantities may be updated in the Activity Workspace columns and
- We get better calculation of Remaining Durations when the Duration Type of Fixed Units is used.

Initial Resources Assignment with a Labour Resource as a Material Quantity:

Layout: EWM					Filter: All Activities																															
Activity ID	Activity Name	Duration Type	Original Duration	Remaining Labor Units	Aug 01							Aug 08																								
A1060	Cut to Fill Section 7	Fixed Units	10.0d	10000.0h	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T																
<table border="1"> <tr> <th>General</th> <th>Status</th> <th>Resources</th> <th>Summary</th> </tr> <tr> <td colspan="2">Activity</td> <td>A1060</td> <td>Cut to Fill Section 7</td> </tr> <tr> <th>Resource ID Name</th> <th>Remaining Duration</th> <th>Remaining Units / Time</th> <th>Remaining Units</th> <th>At Completion Units</th> </tr> <tr> <td>C2FLR.Cut to Fill - Labour Resource</td> <td>10.0d</td> <td>1000.0h/d</td> <td>10000.0h</td> <td>10000.0h</td> </tr> </table>					General	Status	Resources	Summary	Activity		A1060	Cut to Fill Section 7	Resource ID Name	Remaining Duration	Remaining Units / Time	Remaining Units	At Completion Units	C2FLR.Cut to Fill - Labour Resource	10.0d	1000.0h/d	10000.0h	10000.0h														
General	Status	Resources	Summary																																	
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C2FLR.Cut to Fill - Labour Resource	10.0d	1000.0h/d	10000.0h	10000.0h																																

Increasing the At Completion Quantity increases the Remaining Duration which is desirable:

Layout: EWM					Filter: All Activities																															
Activity ID	Activity Name	Duration Type	Original Duration	Remaining Labor Units	Aug 01							Aug 08																								
A1060	Cut to Fill Section 7	Fixed Units	12.0d	12000.0h	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T																
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C2FLR.Cut to Fill - Labour Resource	12.0d	1000.0h/d	12000.0h	12000.0h																																

Changing the production rate by changing the Remaining Units / Time changes the Remaining Duration, which is desirable:

Layout: EWM					Filter: All Activities																															
Activity ID	Activity Name	Duration Type	Original Duration	Remaining Labor Units	Aug 01							Aug 08																								
A1060	Cut to Fill Section 7	Fixed Units	15.0d	12000.0h	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T																
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C2FLR.Cut to Fill - Labour Resource	15.0d	800.0h/d	12000.0h	12000.0h																																

In my experimentation the option of **Fixed Units** gives the best results for earthworks quantities.



3.3 Using Labour Resources for Materials without Mobile Equipment as Non Labour Resources – this does not work!

When a single Labour Resource per activity is used for quantities of materials and mobile equipment is entered as Non Labour Resources the problems begin again:

Before editing Cut to Fill Quantities:

Activity ID	Activity Name	Duration Type	Original Duration	Remaining Labor Units	Remaining Nonlabor Units
A1080	Cut to Fill Section 9	Fixed Units	10.0d	10000.0h	320.0h

Resource ID Name	Remaining Duration	Remaining Units / Time	Remaining Units	At Completion Units
C2FLR.Cut to Fill - Labour Resource	10.0d	1000.0h/d	10000.0h	10000.0h
EXV.Excavator	10.0d	8.0h/d	80.0h	80.0h
TRC.Trucks	10.0d	24.0h/d	240.0h	240.0h

After editing Cut to Fill Quantities the mobile equipment durations are too short:

Activity ID	Activity Name	Duration Type	Original Duration	Remaining Labor Units	Remaining Nonlabor Units
A1080	Cut to Fill Section 9	Fixed Units	15.0d	15000.0h	320.0h

Resource ID Name	Remaining Duration	Remaining Units / Time	Remaining Units	At Completion Units
C2FLR.Cut to Fill - Labour Resource	15.0d	1000.0h/d	15000.0h	15000.0h
EXV.Excavator	10.0d	8.0h/d	80.0h	80.0h
TRC.Trucks	10.0d	24.0h/d	240.0h	240.0h

Mobile Equipment Durations are now too short

Cut to Fill quantity increased

This method does not work.



3.4 Using LOE Activities to Model Mobile Equipment

So, in this situation I've created two activities:

- The first activity is a **Task Dependant** activity that has the Material Resource assigned as a Labour Resource and is **Fixed Units** and
- The second activity is a **Level of Effort** and linked to the first task and has the mobile equipment assigned as a **Fixed Units / Time**:

Activity ID	Activity Name	Duration Type	Activity Type	Original Duration	Remaining Labor Units	Remaining Nonlabor Unit	25									
A1090	Cut to Fill Section 10	Fixed Units	Task Dependent	10.0d	10000.0h	0.0h	F	S	S	M						
A1100	Cut to Fill Section 10	Fixed Units/Time	Level of Effort	10.0d	0.0h	320.0h										

General		Status	Resources	Summary
Activity		A1090	Cut to Fill Section 10	
Resource ID Name	Remaining Duration	Remaining Units / Time	Remaining Units	At Completion Units
C2FLR.Cut to Fill - Labour Resource	10.0d	1000.0h/d	10000.0h	10000.0h

Activity ID	Activity Name	Duration Type	Activity Type	25																																											
A1090	Cut to Fill Section 10	Fixed Units	Task Dependent	<table border="1"> <tr> <th colspan="7">Aug 01</th> <th colspan="7">Aug 08</th> </tr> <tr> <td>F</td><td>S</td><td>S</td><td>M</td><td>T</td><td>W</td><td>T</td> <td>F</td><td>S</td><td>S</td><td>M</td><td>T</td><td>W</td><td>T</td><td>F</td><td>S</td> </tr> </table>														Aug 01							Aug 08							F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
Aug 01							Aug 08																																								
F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S																																
A1100	Cut to Fill Section 10	Fixed Units/Time	Level of Effort																																												

General		Status	Resources	Summary
Activity		A1100	Cut to Fill Section 10	
Resource ID Name	Remaining Duration	Remaining Units / Time	Remaining Units	At Completion Units
EXV.Excavator	10.0d	8.0h/d	80.0h	80.0h
TRC.Trucks	10.0d	24.0h/d	240.0h	240.0h

With this combination:

- The quantities of material and mobile equipment may be seen in the columns and edited in the columns,
- Change the material Remaining Quantity or Unit / Time calculates in a desirable way and
- The duration of the LOE activity with the mobile equipment calculates correctly and the crew size does not change.

Obviously, the issue here is that you have twice the number of desirable activities for the earthworks activities.



4 Summary

These are my thoughts on the issue of managing earthworks operations with P6 but I would welcome any feedback and I will edit this paper in line with new information.

Paul E Harris

Director Eastwood Harris Pty Ltd

18 June 2021

EASTWOODHARRIS
EH
CREATE AND UPDATE AN UNRESOURCED PROJECT USING ELECSOFT (ASTA) POWERPROJECT VERSION 15.2

DESCRIPTION OF COURSE – The course objectives are to teach participants how to create projects without resources, formatting, printing, creating a baseline and updating an un-resourced project. Successful completion of all the course workshops will confirm that the objectives have been met.

<p>Day 1 – Create an Unresourced Project</p> <ul style="list-style-type: none"> → Introduction to Asta PowerProject → Navigation and Setting Up Users → Creating and Editing Calendar → Creating and Editing Tasks → Summary Views → Editing, Sorting and Create Critical Path Schedule → Resources → Constraints 	<p>Day 2 – Formatting, Reports and Updating an Unresourced Project</p> <ul style="list-style-type: none"> → Other – web Types → Formatting the Display → Code Libraries → Filters → Resourcing: Setting “links” → Printing and Reports → Escalation → Updating an Unresourced Project → Most Useful: Fields and WEG.
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 Email: harrispe@eh.com.au

PLANNING AND CONTROL USING MICROSOFT PROJECT 2013, 2016 & 2019

This book is designed for users of earlier versions to upgrade their skills and for new planners to learn the software. It starts with the basics required to create a schedule, through resource planning and on to the more advanced features. The workshops in this publication have been updated and improved.

Microsoft Project 2019 is an excellent addition to the book of Project 2016 and 2013. The book has been updated to cover the new features and functions of Project 2019. The book has been updated to cover the new features and functions of Project 2019.

PAUL E. HARRIS

EASTWOOD HARRIS *the knowledge of earthworks is independent.*

99 TRICKS & TRAPS FOR MICROSOFT PROJECT 2013, 2016 & 2019

THE CASUAL USER'S SURVIVAL GUIDE!

For users who understand the basics and want a brief text to demonstrate the less intuitive functions.

PAUL E. HARRIS

PLANNING AND CONTROL USING MICROSOFT PROJECT 365 Including Microsoft Project 2013, 2016 & 2019

This book is aimed at showing project management professionals how to use the software in a project environment. It is designed for users of earlier versions to upgrade their skills and for new planners to learn how to use the software. It starts with the basics required to create a schedule, then setting a baseline and updating a schedule. It then covers resource planning and some of the more advanced features.

Microsoft Project 365 is a subscription version of Microsoft Project 2019 Professional and therefore the book covers version 2013, 2016 and 2019. This book is similar to other books written by the author but has been tailored for Microsoft Project 365.

PAUL E. HARRIS

PLANNING & CONTROL USING ORACLE PRIMAVERA P6 VERSION 8 to 20 PPM PROFESSIONAL

A user guide and training manual written for Project Management Professionals who wish to learn how to plan and control projects in an established Primavera Enterprise environment with or without Resources and Roles.

This book is an update of the author's Primavera P6 version 8 to 20 book. It includes changes that were introduced with this update of the software. The book has been updated so it may be used with any software industry and other versions of the software.

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EASTWOOD HARRIS *providing cost-effective solutions to real world problems*

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