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MICROSOFT PROJECT DELAY ANALYSIS TECHNIQUES

1 Abstract

Many construction contracts specify that a delay must be calculated on the critical path of the contract program.

Often project programs are completed in Microsoft Project and therefore to demonstrate a delay the scheduler needs to add delays to the program to demonstrate and calculate the delay.

This paper outlines the various techniques for demonstrating delays using Microsoft Project.

2 Introduction

Many construction contracts specify that a delay must be calculated on the critical path of the contract program.

Often project programs are completed in Microsoft Project and therefore to demonstrate a delay the scheduler needs to add delays to the program to demonstrate and calculate the delay.

Delays are often assigned categories such as:

- Inexcusable, an extension of time is NOT granted.
- Excusable, an extension of time would be granted.
- Compensable is an Excusable delay and costs would be paid.
- Non Compensable is an Excusable delay and costs would NOT be paid.

Before a delay may be assigned a category it must have a value calculated and delays may occur in different ways for example:

- They may occur at the start of the activity,
- They may occur during the activity and therefore splitting the work and the activity is no longer contiguous, and the crew are not gainfully engaged in work,
- There may be a reason for low productivity and resulting in the work taking longer,
- The delay may affect one activity or it may affect multiple activities, for example:
    - A delay affecting one activity could be a delay in delivering some equipment,
    - A delay affecting multiple activities might be a delay where there is adverse weather affecting the whole site.
- It may be on the critical path or it may be off the critical path,
- Some delays may initially not be on the critical path and have float but then may result in the activity being moving on to the critical path. In this case the full delay of the activity is not equal to the critical path delay.
- Finally, how you demonstrate acceleration in a program? I'll cover this issue as well.

This process of adding delays to a program is often not obvious and there are several techniques that I will document in this paper that show you methods that you can use to demonstrate delays and calculate delay values.

One issue with Microsoft Project, unlike P6, although it allows the splitting of activities into multiple splits like many other software packages, but it is not possible to access the Finish Date and Time of the first split and the Start Date and Time of the next split through the user interface. This option is useful in the evaluation of delays.

Another issue with Microsoft Project is that the Line numbers change all the time as Tasks are added and removed, but this issue may be overcome using the Unique ID field.

Also the Baseline functions of Microsoft Project are weak.

3 Aim

The aim of this paper is to demonstrate various techniques of assigning delays to activities in an Microsoft Project program, which will in turn allow you to select the method that is appropriate to your project and activities. I will also outline the advantages and disadvantages of each technique.

4 Prerequisites

4.1 Prereading

It is suggested that before you read this paper you should have a good understanding of delay analysis by reading some of the following types of papers:

- AACE International Recommended Practice 29R-03 Forensic Analysis and
- Society of Construction Delay and Disruption Protocol,

4.2 Planning your project

Many contracts are silent on how delay claim values should be calculated and this is the first step in the process is working out how delays are evaluated.

I recommend that the client and contractor agree the method that they are going to use to evaluate delays when the contract is signed and ensure the process is written into the contract; some of the issues you need to agree upon:

- What program will be used to evaluate delays, a couple of options are:
    - The contract program, or
    - The last updated program.
- It is delays only to the critical path, or all delay, or delays to activities that have high costs that are considered?
- If you are a contractor then will you record and calculate both the Client and Contractor delays or just Client delay?
- Contractors should ensure that they have planned the process of collecting delay information is such a way that it is simple to update the program.
    - Ensure site progress reports have Task Unique IDs against all items in the report.
    - Ensure they delay claim numbers are used in the daily reports and the updated schedule.
    - Ensure there is a written procedure for the project team to follow.

5 Methodology

I will use a very simple program with a few activities, a finish milestone and a baseline to represent the Contract Program demonstrate the various methods of assigning delays against a single activity.

In all the pictures the Baselined Contract Program is the lower bar in the pictures.

5.1 Unique Numbers for Tasks

Unique Task Numbers are very useful in the documentation of delays and the Microsoft Task ID is a line number which changes when tasks are added or deleted which in turn makes it hard to use this as a reference in documentation.

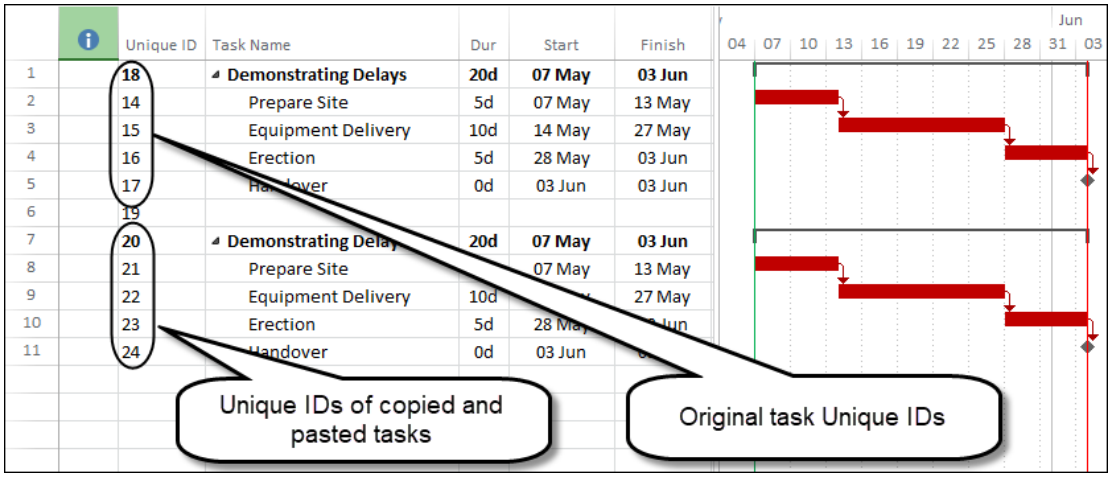
Each task is assigned a Unique ID when it is created and this number is not used again in the schedule, even if the task is deleted. The Unique ID is assigned to all new tasks and when tasks are created by copy and pasting existing tasks they are assigned a new Unique ID.

There are two other columns that may be used to edit and display relationships using the Unique ID:

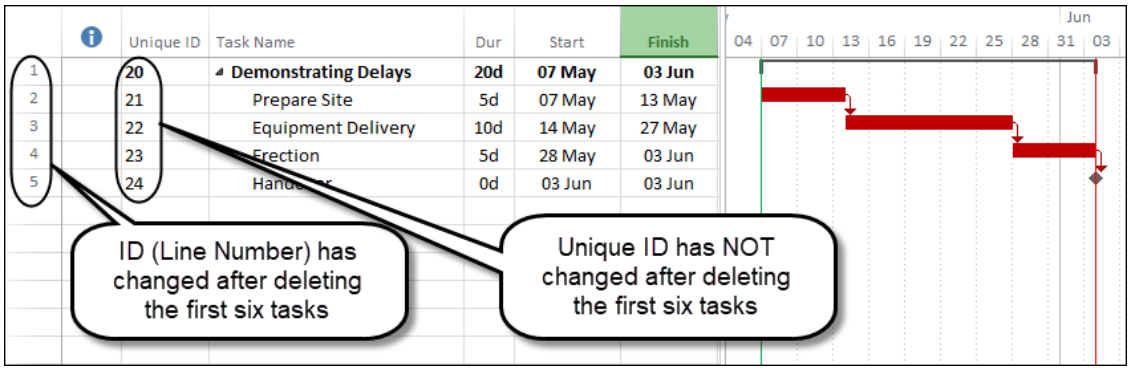
- The **Unique ID Predecessor**, and
- The **Unique ID Successor**.

The Task **Unique ID** will allow users to identify easily which tasks have been added or deleted when a revised schedule has been submitted.

The picture below displays the **Unique ID** column. The first five tasks were copied and pasted below to demonstrate how the Unique ID operates:



Now the first six tasks have been deleted and you see that the **Unique ID** has not changed:



On the other hand if one wants to either:

- Reset the Unique ID, or
- Hide the addition or deletion of tasks then a new schedule must be created.

Then the following process should be followed:

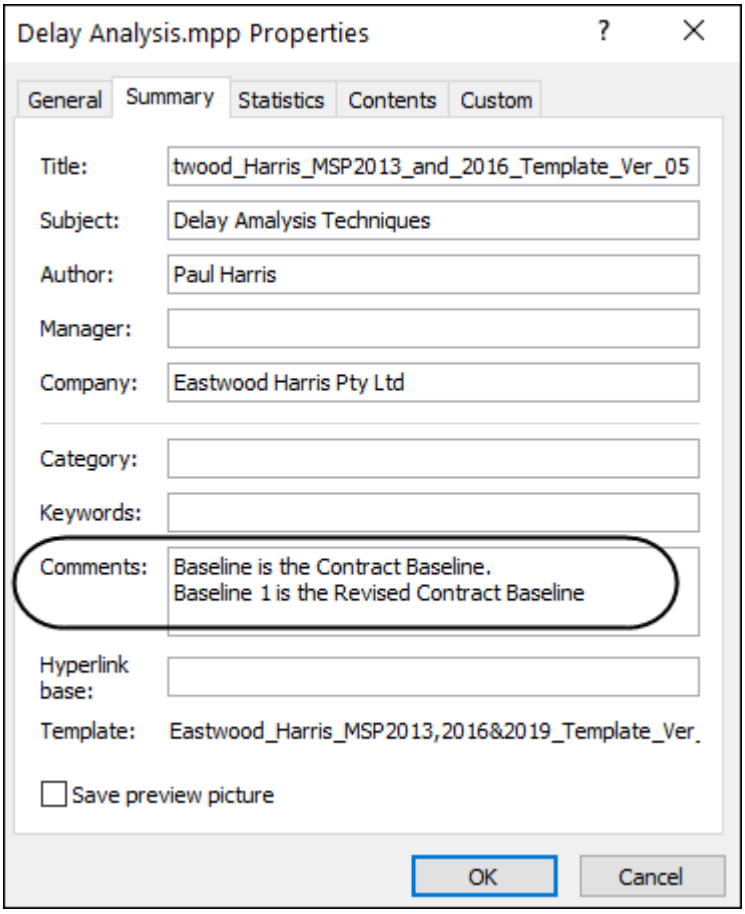
- A new Microsoft Project file created,
- The calendars transferred with **Organizer** and
- The all the tasks copied and pasted into the new schedule.

NOTE: There is also a unique **Resource ID** and a Resource Assignment **Unique ID**.

5.2 Microsoft Project Baseline Issues

There are a number of issues with the Microsoft Project Baseline function and the ones that affect delay analysis are:

- There is a limit of 11 baselines and if you wish to save a baseline after each update then you are limited in the number of baselines you may save to 11.
- You may use Start and Finish dates 1 to 10 which Microsoft Project terms **Interim Baselines**. But then you only have 21 baseline dates available.
- The Baselines may not have a description assigned to them, thus when you use multiple baselines then you may wish to identify what each baseline represents in the **Project Information** form:



- The Microsoft Project **Finish Variance** column only works on the **Baseline** fields and not **Baseline 1 to 10** fields. You may create a **Calculated Field** to show the Variance values from other Baselines.
- Delay Variances in Microsoft Project are shown as a positive where it is more common to show these as a negative and may lead to confusion.

5.3 Adding delays to represent a delay before the activity starts

5.3.1 Extending the Duration of the Delayed Activity

The simplest method of adding a delay to an activity is just extending the duration.

The pictures below show the before and after increasing the duration of the **Equipment Delivery** activity to demonstrate a delay to the delivery of the equipment:

	Task Name	Dur	Start	Finish	Finish Variance
1	**Demonstrating Delays**	**20d**	**07 May**	**03 Jun**	**0d**
2	Prepare Site	5d	07 May	13 May	0d
3	Equipment Delivery	10d	14 May	27 May	0d
4	Erection	5d	28 May	03 Jun	0d
5	Handover	0d	03 Jun	03 Jun	0d

	Task Name	Dur	Start	Finish	Finish Variance
1	**Demonstrating Delays**	**25d**	**07 May**	**10 Jun**	**5d**
2	Prepare Site	5d	07 May	13 May	0d
3	Equipment Delivery	15d	14 May	03 Jun	5d
4	Erection	5d	04 Jun	10 Jun	5d
5	Handover	0d	10 Jun	10 Jun	5d

Advantages

- It is very simple and easy to increase the duration of activity and demonstrate the delay to the project end date.

Disadvantages

- It does not show if the delay is at the beginning of the task or in the middle of the task,
- It does not show you the value of the delay.
- If the activity is a resourced activity, then the cost will be increased which is undesirable if the resource is were not working during the delay period.
- It is not possible to simply zero out the duration of the task in order to bring the project schedule back to its original status.
- Not simple to identify client or contractor delays.

Recommendations

- I suggest you do not use this method.

5.4 Adding a delay activity before the start of the delayed activity

This method inserts an activity to represent the delay before the task starts.

	Task Name	Dur	Start	Finish	Finis Variar
1	**Demonstrating Delays**	**25d**	**07 May**	**10 Jun**	**5d**
2	Prepare Site	5d	07 May	13 May	0d
3	Delay to Equipment Delivery	5d	14 May	20 May	0d
4	Equipment Delivery	10d	21 May	03 Jun	5d
5	Erection	5d	04 Jun	10 Jun	5d
6	Handover	0d	10 Jun	10 Jun	5d

Advantages

- This is a good method to demonstrate a delay to the start of an activity.
- It could be used to demonstrate a delay in the middle of an activity, as long as there is sufficient evidence in the activity description.
- The cost of the delay could be modeled by assigning resources to the delay activity.
- It is also simple to change the duration to zero to remove the delay and create a collapsed schedule.
- Multiple delay activities may be used to identify customer and contractor delays.
- It is also possible to code up activities and then be able to filter them out by client or contractor delays and zero out either the contractor or the client delays to calculate the impact of either the customer or the contractors delays.

Disadvantages

- I cannot identify any real disadvantages with this method.

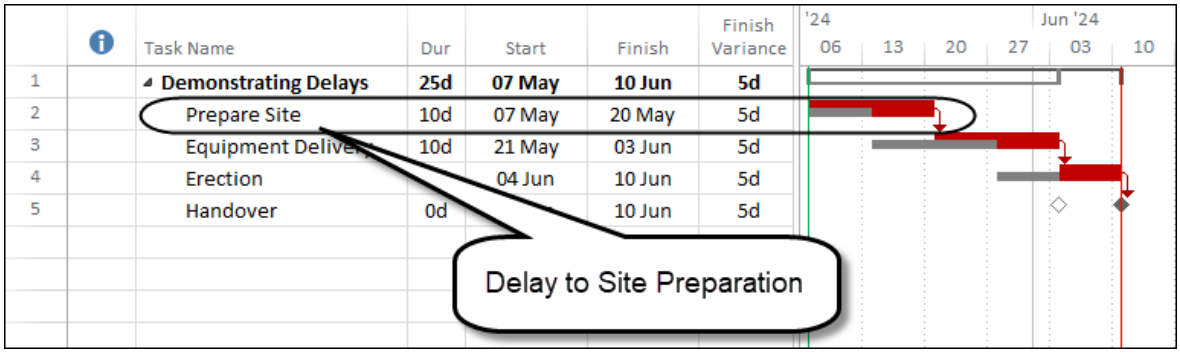
Recommendations

This is the method I recommend for all activities when there are delays before the work starts.

5.5 Modelling a delay after an activity starts

5.5.1 Extending the Duration of the Delayed Activity

This is exactly the same method as demonstrated in para 4.3. 1 and I do not recommend you use this method.



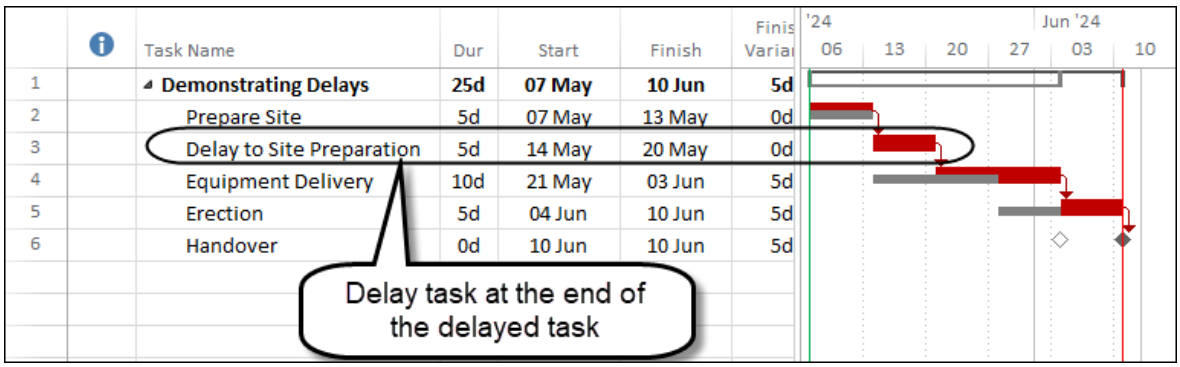
	Task Name	Dur	Start	Finish	Finish Variance
1	**Demonstrating Delays**	**25d**	**07 May**	**10 Jun**	**5d**
2	Prepare Site	10d	07 May	20 May	5d
3	Equipment Deliver	10d	21 May	03 Jun	5d
4	Erection		04 Jun	10 Jun	5d
5	Handover	0d		10 Jun	5d

5.5.2 Adding a delay activity before the start of the delayed activity

If the delay occurs before after the task starts then it is best not to put the delay at the start as one would want to set the actual start of the original task when the task started.

5.5.3 Adding a delay activity after the delayed activity

The picture below shows a delay activity **A1002 Prepare Site Delay** has been added after the original activity duration.



Disadvantages

- The delay activity does not clearly demonstrate when the delay happened.
- The delay does not impact the end date of the delayed activity.

Advantages

- This is quick and simple.
- This allows the assignment of the delay activities to the contractor or client and filtering against client or contractor delays.
- May provide a collapsed program by zeroing of activity durations

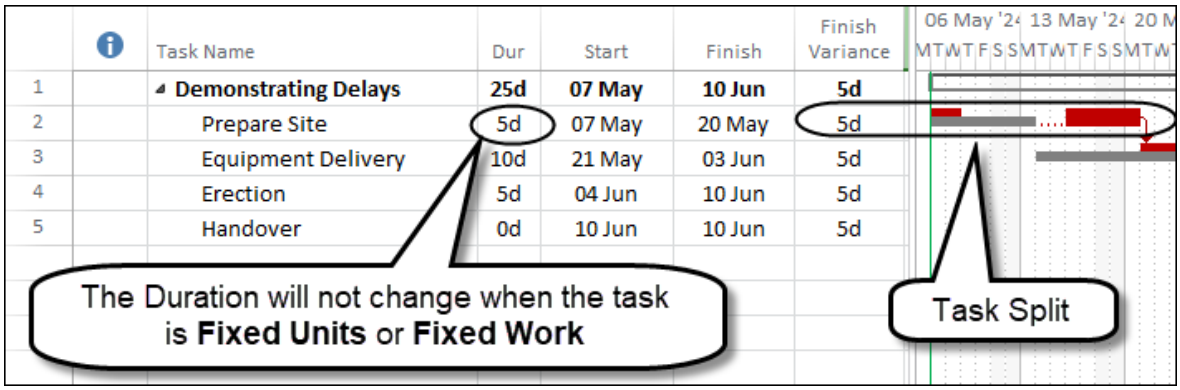
Recommendations

- This method is suitable when the customer is in agreement to allowing delays during an activity execution to be added at the end of a delayed activity.

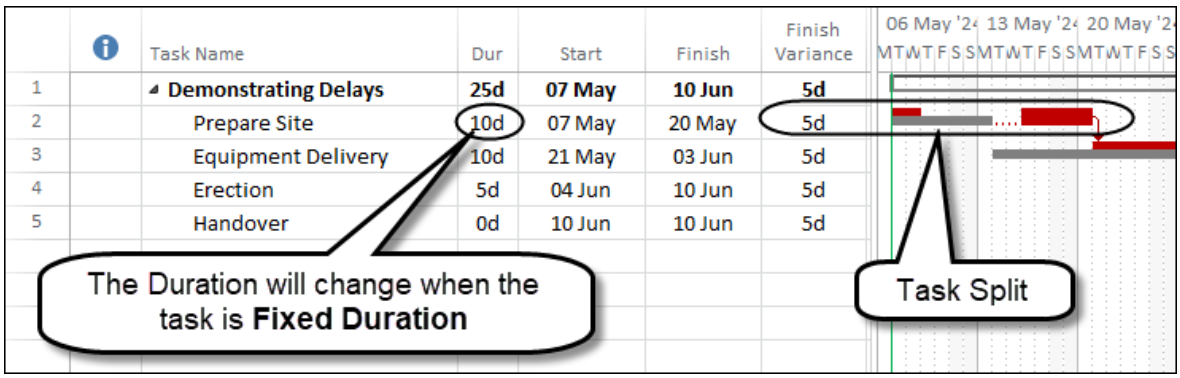
5.5.4 Using Microsoft Project Task Splitting

Microsoft Project allows task splitting:

- When the task is **Fixed Units** or **Fixed Work** then the task duration will not usually change and remain the “Worked Duration”:

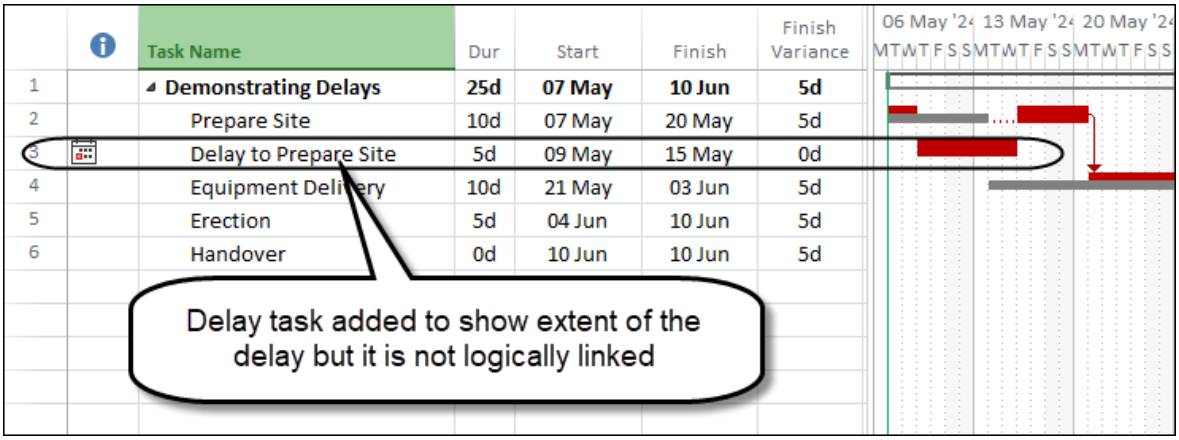


- When the task is **Fixed Duration** then the task duration will change to the elapsed duration and not the worked duration:



Advantages

- It keeps the activity at completion duration equal to the working time of the activity when **Fixed Units** or **Fixed Work** is used.
- It is simple to demonstrate the delay value by the addition of a second activity below as indicated in the picture below by the addition of the **Erection Delay** activity that has been added with a **Start On** constraint and thus makes the Float Values zero.



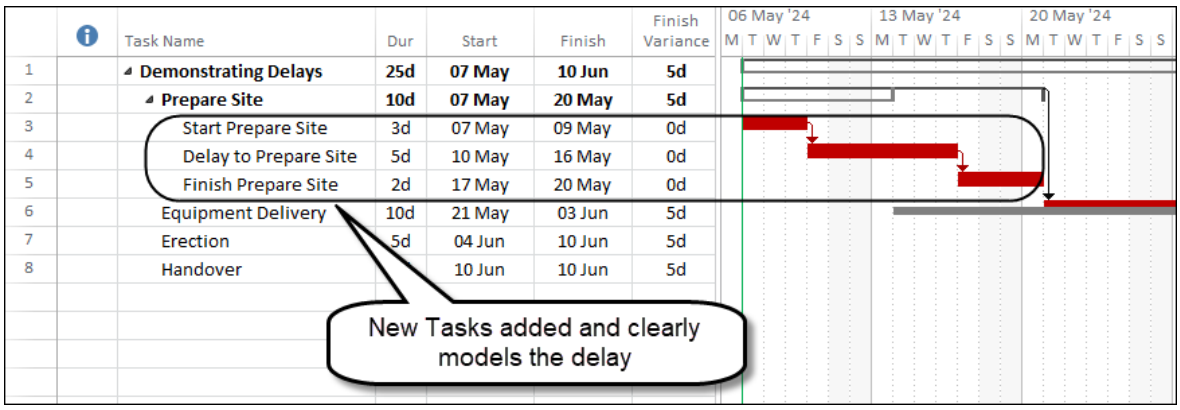
- The cost of the delay could be modeled by assigning resources to the delay activity.

Disadvantages

- Because the delay task was added to show extent of the delay but it is not logically linked into the program this method could be criticized as not being a Critical Path schedule.

5.5.5 *Breaking the original activity into multiple activities*

The method adds new tasks to represent what actually happened and when and then make the original task a Summary Task, which preserves the baseline.



Advantages

- It may be used for a collapse as built by changing the delay activity durations to zero.
- It is possible to assign codes and filter out delays and then zero out either the client or the contractor delays to evaluate the total delay by the contractor and/or the client on a project schedule that has not been updated with actuals.
- This method allows multiple delays.
- The cost of the delay could be modeled by assigning resources to the delay activity.
- It clearly identifies when the work started and finished and when the delay happened.

Disadvantages

- The original task bar changes shape when made as Summary Task and is not as easily identified.

Recommendations

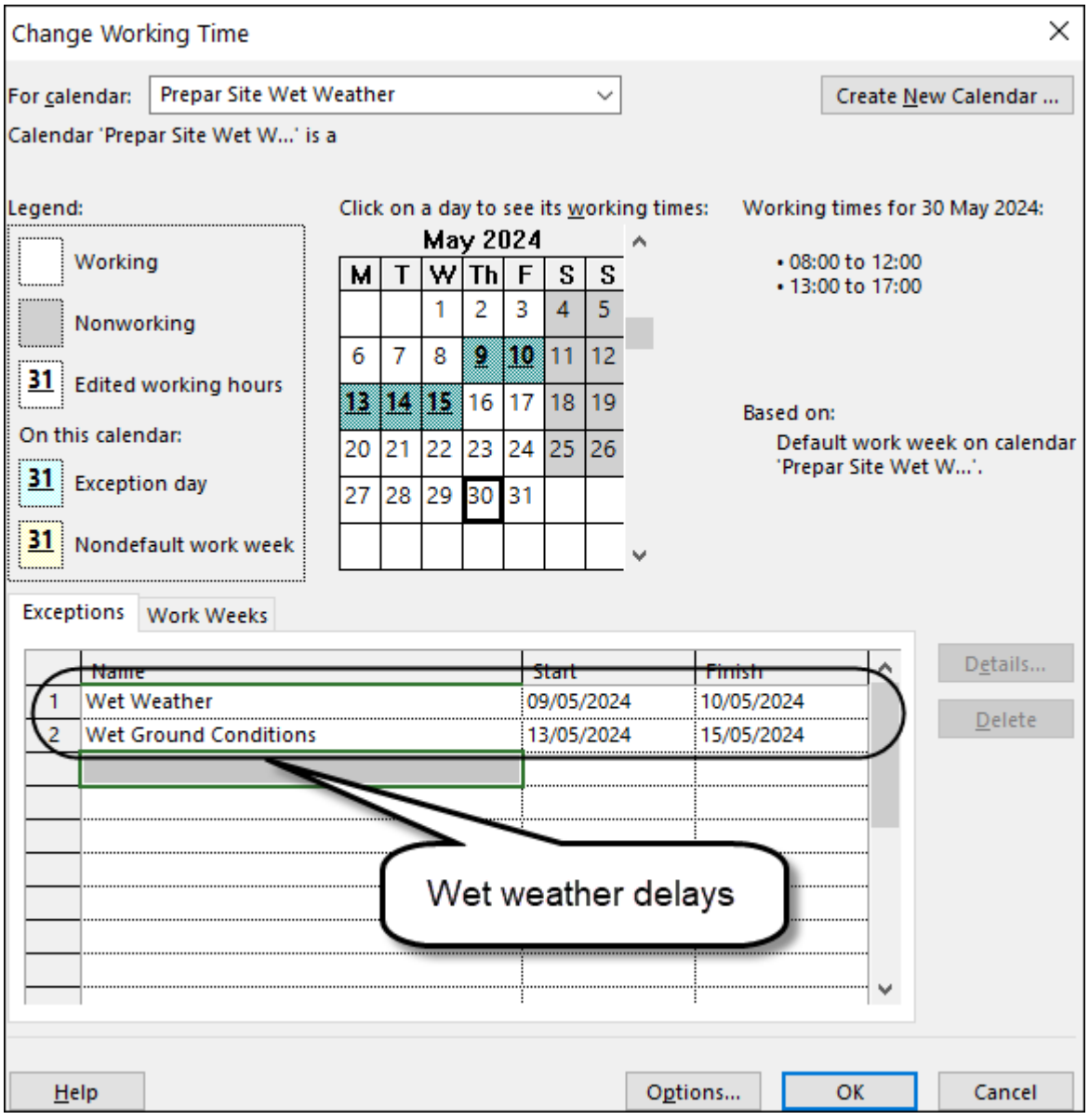
- This is the recommended method in Microsoft Project if you have the time to do it.

5.6 Modeling delays using a calendar

5.6.1 Modeling a delay against a single activity

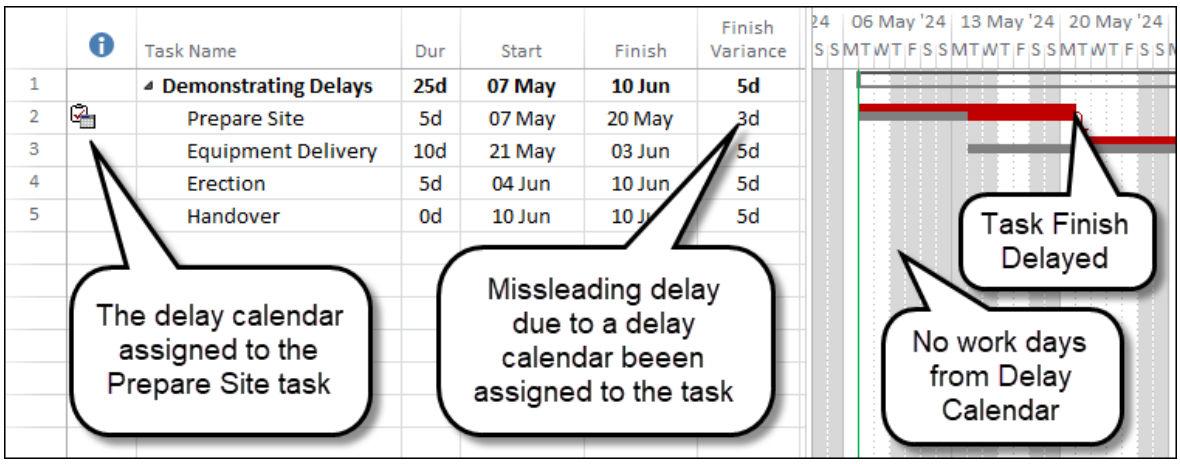
If you wish to model a delay against a single activity using a calendar, then you will need to create a new calendar just for that task and assign that calendar to the single activity.

In this example I have created a new calendar called **Prepare Site Wet Weather**, assigned five non-work days to it and assigned the calendar to the activity.



You can see the impact of the delay on the **Prepare Site** activity in the picture below.

In the picture below you are also able to see which days are not working when you change the View Calendar.



Another option in Microsoft Project would be to change the **View Calendar** to show the calendar with non-work periods as in the picture above but this can get misleading.

Advantages

- The duration of the task that has been delayed remains the correct worked duration.
- The delay may be removed to create a collapsed as built by changing the calendar.

Disadvantages

- The delay value may not be calculated as an activity and only available by inspection over calendar.
- Bar necking is NOT available with Microsoft Project to see the days that the activity is not working.
- This does not show the value of the delay as an activity.

5.6.2 Modeling a delay against multiple activities using a calendar

This method is exactly the same as modeling a delay on a single activity with the calendar but you assign a calendar to multiple activities.

This method is ideal when a whole site is being shut down due to bad weather or large number of activities can be assigned a calendar to represent inclement weather.

For example, all crane activities could be assigned a windy weather calendar and when the crane may not be used non work periods are assigned to the windy weather calendar.

6 Acceleration

There are several methods of demonstrating acceleration:

6.1 Reducing the activity duration

The first one is to reduce the duration of the activity,

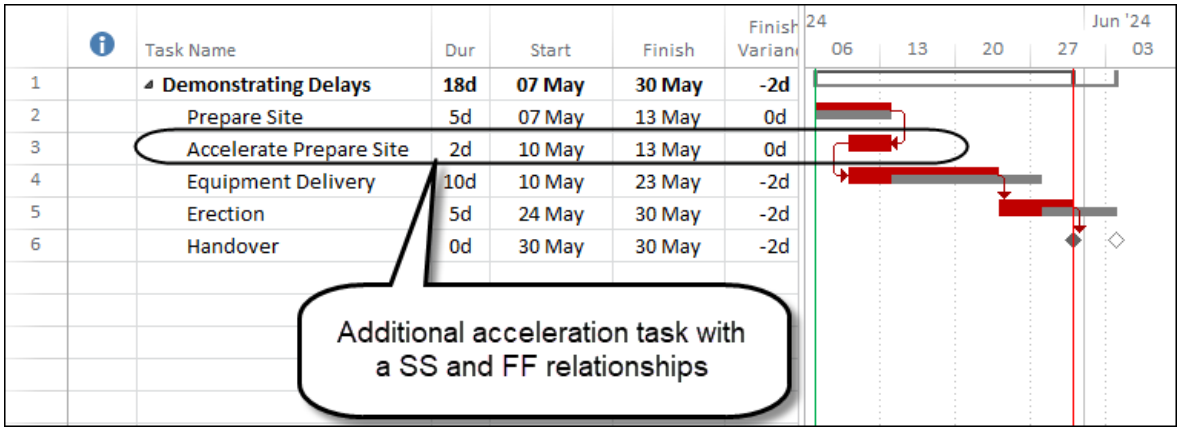
The task **Prepare Site** has been reduced by 2 days,

I do not recommend this method as the acceleration value is not visible in the program.

	Task Name	Dur	Start	Finish	Finish Variance
1	**Demonstrating Delays**	**18d**	**07 May**	**30 May**	**-2d**
2	Prepare Site	3d	07 May	09 May	-2d
3	Equipment Delivery	10d	10 May	23 May	-2d
4	Erection	5d	24 May	30 May	-2d
5	Handover	0d	30 May	30 May	-2d

6.2 Adding an acceleration activity

The second one is to add an acceleration activity with SS and FF relationships and as you increase the acceleration it reduces the end date of the project as per the picture below.



	Task Name	Dur	Start	Finish	Finish Variance
1	**Demonstrating Delays**	**18d**	**07 May**	**30 May**	**-2d**
2	Prepare Site	5d	07 May	13 May	0d
3	Accelerate Prepare Site	2d	10 May	13 May	0d
4	Equipment Delivery	10d	10 May	23 May	-2d
5	Erection	5d	24 May	30 May	-2d
6	Handover	0d	30 May	30 May	-2d

Advantages

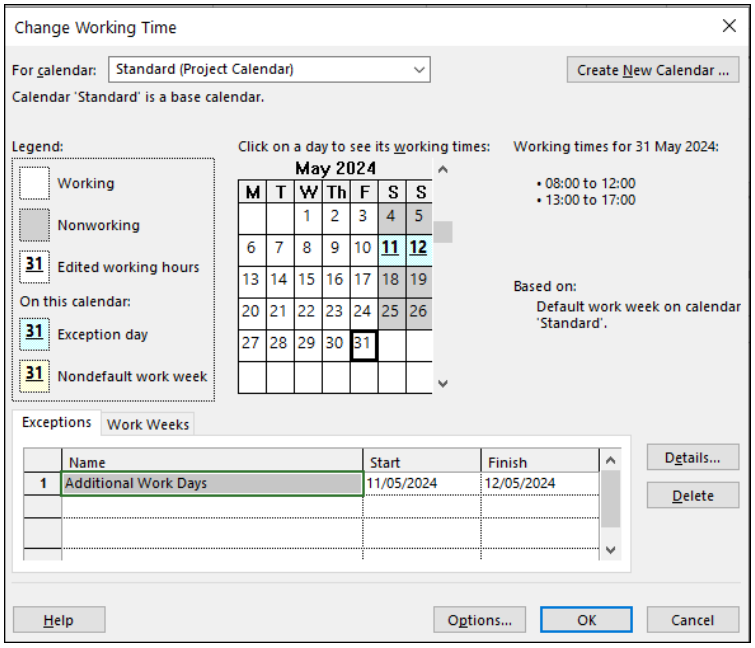
- The delay activity may be zeroed out to remove the acceleration.
- The delay activity may have codes and be filtered to isolate acceleration activities.

Disadvantages

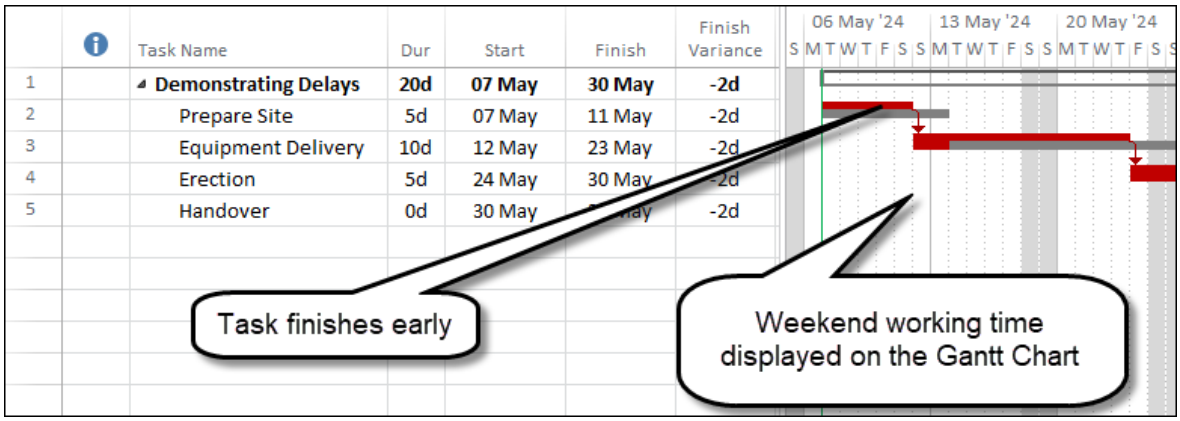
- The disadvantage of this method is that if you accelerate the last activity in a project then the last activity will be scheduled beyond the end of the project.
- Some people would object to the use of an activity in this unusual manner.
- This method also does not reduce the costs against the activity if it is a resource activity.
- You may put a negative cost against the acceleration activity to reduce costs.

6.3 Making changes to the calendar

If the acceleration has been achieved by working on non-work days such as Saturdays or Sundays or by increasing them the number of hours per day worked against activities then it may be appropriate to make changes to the calendar:



The picture below shows the calendar against all the activities has now allowed for Saturday and Sunday workdays.

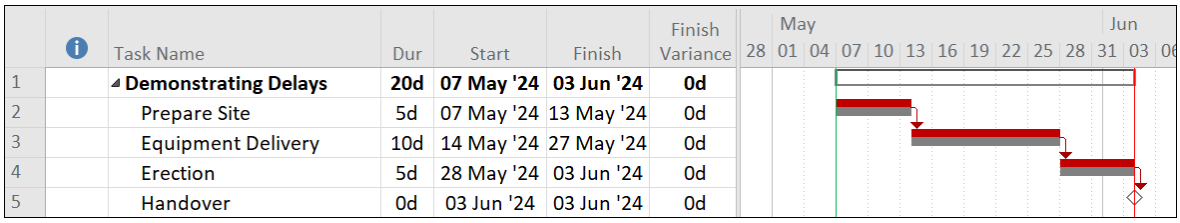


7 Removing Scope

If you wish to remove scope is best to maintain a history and as opposed to deleting the task you should reduce the duration to zero and make a comment in the **Task Name** or **Notes**. The other option in Microsoft project is to make the task inactive which is a nice function and you'll see the pictures below showing you the different techniques.

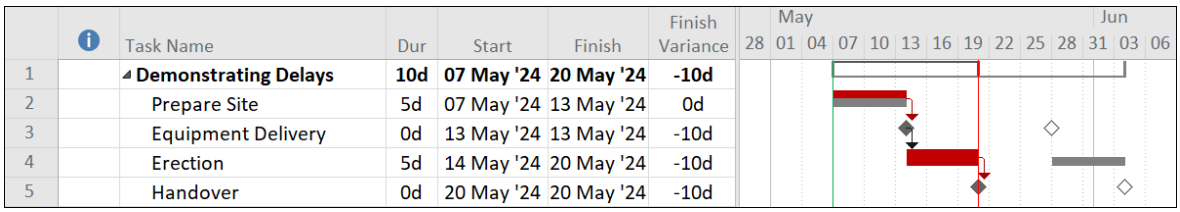
In the example below we're assuming that there is no equipment to be delivered or it is being delivered by the customer and we need to show acceleration due to the equipment delivery activity being removed.

- Before removing the equipment delivery activity by zeroing out the duration.



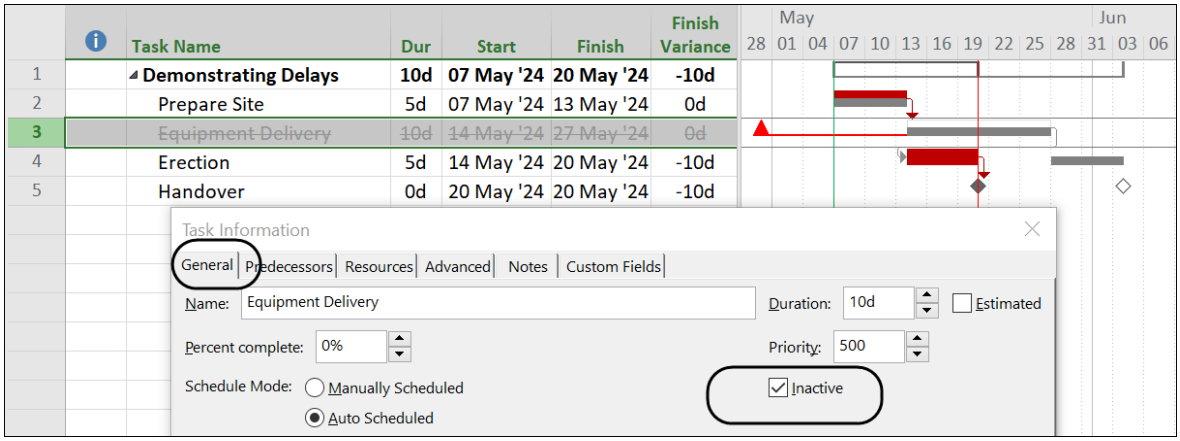
	Task Name	Dur	Start	Finish	Finish Variance
1	**Demonstrating Delays**	**20d**	**07 May '24**	**03 Jun '24**	**0d**
2	Prepare Site	5d	07 May '24	13 May '24	0d
3	Equipment Delivery	10d	14 May '24	27 May '24	0d
4	Erection	5d	28 May '24	03 Jun '24	0d
5	Handover	0d	03 Jun '24	03 Jun '24	0d

- After zeroing out the duration of equipment delivery and you'll see the finish variance has come in by 10 days.



	Task Name	Dur	Start	Finish	Finish Variance
1	**Demonstrating Delays**	**10d**	**07 May '24**	**20 May '24**	**-10d**
2	Prepare Site	5d	07 May '24	13 May '24	0d
3	Equipment Delivery	0d	13 May '24	13 May '24	-10d
4	Erection	5d	14 May '24	20 May '24	-10d
5	Handover	0d	20 May '24	20 May '24	-10d

- After making equipment delivery inactive you will see that the same result the finished ages come in by 10 days but unfortunately Microsoft Project display some strange negative float values against the task in the Gantt chart.



	Task Name	Dur	Start	Finish	Finish Variance
1	**Demonstrating Delays**	**10d**	**07 May '24**	**20 May '24**	**-10d**
2	Prepare Site	5d	07 May '24	13 May '24	0d
3	~~Equipment Delivery~~	~~10d~~	~~14 May '24~~	~~27 May '24~~	~~0d~~
4	Erection	5d	14 May '24	20 May '24	-10d
5	Handover	0d	20 May '24	20 May '24	-10d

8 Updating the program after delays have been assigned

Delays are normally added to activities at each update and it is normal to actualize the program by applying actual starts and actual finishes to the activities that are all complete and actual start and remaining durations to those that are in progress, and then the program rescheduled to calculate a new project end date.

Normally at this point in time client and contractor delays are transfer to a spreadsheet to calculate the sum of the delays for each party at the end of the project.

Another option that some companies adopt is not to actualize their schedule and keep what I term a **Live As Built** program but this is quite difficult and this process is very rare. Then all the delays may be zeroed and a **Collapsed As Built** program is available. I have written a paper on the three methods of updating a program and you may wish to read this next. You will find the paper here: http://eastwoodharris.com/DL/TP/PS-2768_Rev2018-04-16.pdf

9 Conclusion

Microsoft Project is perfectly adequate for demonstrating a delay in a construction project.

The major weaknesses with Microsoft Project baseline functions which make it difficult to evaluate delays are:

- It does not save a complete project as a baseline,
- Limit of 11 baselines,
- Not being able to name or add notes to baselines and
- Lack of inbuilt Baseline variance fields.

Furthermore, Microsoft Project is not a strong scheduling tool and the following issues make it difficult to manage large complex schedules:

- The inability to add more than one relationship between two tasks making it difficult to create a Closed Network,
- The difficulty in updating a project properly with all the incomplete work in the past and complete work in the future.

10 Bibliography

The following are documents that you may consider reading in association with this paper:

- AACE International Recommended Practice 29R-03 Forensic Analysis
- Society of Construction Delay and Disruption Protocol
- Planning and Control Using Microsoft Project 2013, 2016 & 2019 - ISBN 978-1-925185-62-1 (1-925185-62-1)

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