Project management gantt and schedules construction essay

Engineering, Project Management

Project Management is a huge subject and without it, construction or engineering projects as we know them today simply could not be undertaken.

Project management has needed to adapt as the industry has grown and methods have developed particular in the last century, which has seen possibly the greatest transformation of all. Some aspects of Project management have had to be adapted with this whereas others have led the way to change, thanks to innovative thinking from the likes of Fayol and Maslow.

The successful management of a civil engineering project depends upon a number of factors. Planning, Organisation, Communication, Decisiveness are all subcategories that need managed. It is imperative that the right procedures are put in place at the start of the project.

Good project management will allow for excellent organisation and tracking; better control and use of resources; reduced complexity and early identification of problems leading to quicker correction.

A project manager should have a sound body of knowledge that will include the nine core areas of scope, time, cost, risk, integration, quality, procurement, communications and human resources. In addition to a project engineer’s professional judgement they will need to call upon the necessary tools in order to manage a project successfully, which could include past or similar tasks undertaken or specific management tools, such as charts and schedules.

History of Scheduling

Gantt charts were developed by mechanical engineer, Henry Laurence Gantt in the early 20th century as a visual tool to show scheduled and actual progress of projects. Although commonplace, today the Gantt chart was fundamental change in the way projects were managed at the time. Gantt charts were first used on high profile construction projects like the Hoover Dam (1931) and the interstate highway network (1956).

Complex network diagrams called PERT (Program Evaluation and Review Technique) charts were invented as part of the Polaris missile submarine program in 1955. Booz-Allen Hamilton worked with the U. S. Navy to create these charts and schedules.

The Critical Path Method (CPM) was developed by the DuPont corporation in 1957, to deal with a variety of tasks and numerous interactions at many points in time. Arguably, the evolution of modern project management is a direct consequence of the need to make effective use of the data generated by the schedulers in an attempt to manage and control the critical path.

The Work Breakdown Structure (WBS) was initially developed by the U. S. defence department, as an advancement of the PERT system noted above. In 1968, it was issued as a military standard, which required the use of work breakdown structures across the U. S. defence department. The standard has been revised and updated over the years and is still in use today.

Project

Installing new steel beams throughout an existing masonry building and adding a new floor.

The project will start on January the 14th and is to be completed by Friday the 29th of March.

List of Tasks

I have assumed the process of this project management starting from the design phase.

Existing masonry strength investigated/tested for ability to take loads

Building survey to set out the masonry piers and levels

Steelwork design required based on loads to be imposed /spans between piers

Timber floor joists and edge restraints designed (with timber plywood deck to act as structural diaphragm).

Fabrication drawings completed and issued for tender

Steel Tender period

Fabricator chosen and contract signed for steelwork

Fabrication commences

Method statement to complete (Health and Safety)

Method statement approved by CDM co-ordinator

Erection of scaffolding around piers

Existing general masonry repair to piers

Masonry removal for padstone and bearing end of beams

Padstone installation (Pouring of the in-situ concrete padstone)

Concrete padstone curing

Ordering of steel installation equipment (crane rig or cherry pickers)

Steel delivery to site

Steel erection and fixing

Timber cut on site

Timber floor joists fitted

Plywood cut to size

Timber edge restraints fixed

Plywood decking fitted.

Scaffolding around piers removed

Project handed over to client for fit out

As built drawings & records sent to Building Control

Project Completion.

The importance of getting this engineering aspect of the project completed on time (using affective and accurate scheduling) will allow the decking to be fitted and make the floor usable, enabling the ‘ fit out’ to commence on time and without the need for expensive temporary platforms.

Estimated resources and time periods for the tasks

Task resources for personnel- abbreviations for use in tables, charts etc.

PM – Project Manager

SU – Surveyor

SE – Structural Engineer

FB – Steel Fabricator

SW – Site Workers

HS – CDM co-ordinator (Health & Safety)

Estimated No. of days required to complete the task.

Personnel resource abbreviation

Breakdown of time and resources example

Detailed name of the task from task list on previous page

Shortened task name as it will appear in schedules

PM

0 Days

Existing masonry strength investigated/tested for ability to take loads

Existing Masonry Test

SU

7 Days

Building survey to set out the masonry piers and levels

Building Survey

SU

3 Days

Steelwork design required based on loads to be imposed /spans between piers

Steelwork Design

SE

4 Days

Timber floor joists and edge restraints designed

Timber Design

SE

3 Days

Fabrication drawings completed and issued for tender

Fabrication Drgs

SE

3 Days

Steel Tender period

Steel Tender Period

FB

7 Days

Fabricator chosen and contract signed for steelwork

Fabrication Contracts

PM

N/A

Steel fabrication commences

Steel Fabrication

FB

15 Days

Method statements to complete (Health and Safety)

Method Statements

PM

2 Days

Method statement approved by CDM co-ordinator

CDM Approval

HS

5 Days

Erection of scaffolding around piers

Scaffolding

SW

3 Days

Existing general masonry repair to piers

Masonry Repair

SW

2 Days

Masonry removal for padstone and bearing end of beams

Masonry Removal

SW

2 Days

Padstone installation (Pouring of the in-situ concrete padstone)

Padstone Installation

SW

2 Days

Concrete padstone curing

Concrete Curing

N/A

3 Days

Ordering of steel installation equipment (crane rig or cherry picker)

Plant Order

PM

N/A

Steel delivery to site

Steel Delivery

FB

1 Day

Steel erection and fixing

Steel Erection

SW

2 Days

Timber cut on site to fit

Cutting Timber

SW

1 Days

Timber floor joists fitted

Timber Joists

SW

4 Days

Timber edge restraints fixed

Timber Restraints

SW

3 Days

Plywood cut to size

Cutting Plywood

SW

1 Day

Plywood decking fitted

Plywood Deck Fixed

SW

1 Day

Scaffolding around piers removed

Scaffolding Removal

SW

1 Day

Project handed over to client for fit out

Project Hand Over

PM

N/A

As built drawings & records sent to Building Control

As Built Records

PM

1 Day

Project Completed

Project Completed

N/A

N/A

Work Breakdown Structure (WBS)

The WBS communicates a clear view of the total scope of the project, providing a logical and coherent statement of what the project comprises of. The WBS is neither over-simplified or overly complex. It is not a project plan or a project schedule, and it is not a chronological listing. A coding system is implemented to enable cost, schedule, technical and other data to be cross referenced across a project.

The project manager is to structure the project work into WBS elements that are:

Definable – can be described and easily understood by project participants.

Manageable – a unit of work where specific responsibility/authority can be assigned.

Estimate – duration and cost can be estimated in terms of resources.

Independent – minimum dependence on other on-going elements (i. e. assignable to a single task), and clearly distinguishable from other work packages.

Integrate – integrates with other project work elements and with higher level cost estimates and schedules to include the entire project.

Measurable – can be used to measure progress; has start and completion dates and measurable milestones.

Adaptable – sufficiently flexible so the addition/elimination of work scope can be accommodated in the WBS framework.

On the following pages are two different forms of the WBS. A standard tabular view used for quick reference / easy production, and the more familiar tree structure view; used to show more clearly the flow of tasks and their relationships.

Gantt Charts

A common technique for scheduling construction activities is the Gantt chart, named after the developer Henry Laurence Gantt, as mentioned in the introduction section.

The Gantt chart lists the construction tasks that need to be performed down a single column, generally in the order in which they are to be carried out, along with a second column indicating the length of time required to complete each task. At the top of the chart, dates for the construction project are noted in a horizontal row. To the right of each task a line/bar indicates the starting date to the completion date for that task. All tasks in the first column are charted in this manner across the rows of the chart, with the bar for each task beginning at the earliest possible starting date. Many tasks must be completed in sequence, requiring the completion of one activity before the next can be started, although some tasks may be completed independently of other work and can be charted when the work is most convenient.

The charting of activities allows the project manager to identify critical points in the construction schedule and provides the opportunity to adjust the tasks to meet schedule demands. Gantt charting is useful for small projects that must be completed in a linear manner, or one step after the other, and for contractors who have small crews and can only engage in one activity at a time.

Most Gantt charts these days are constructed using computer scheduling programs. Templates provide a listing of typical construction tasks so the project manager only has to insert the duration of the work; scheduling programs have advanced to the point where data about the activities, such as duration and sequence, can be provided and the entire chart generated. For my worked example I have used Microsoft Project.

On the following page is a Gantt chart, listing the project tasks and scheduling dates of completion; noting how each task is related and creating a program of works in real time, with dates and deadlines throughout the working week. It outlines which tasks are reliant on others and also which can run concurrently or have no specific scheduling requirements. For example the steel needs to be designed and ordered before it can be delivered to site and the padstones it sits on would need to be in place and the concrete cured before the steelwork could be erected. To maximise time efficiency these tasks will run concurrently (i. e. padstones can be installed while steel is fabricated and before it is delivered to site) these links between tasks can be seen on the Gantt chart.

Critical Path Analysis (CPA)

Similar to the Gantt chart the critical path analysis is a project-management technique that lays out all the activities needed to complete a task, the time it will take to complete each activity and the relationships between the activities. Also called the " critical path method", critical path analysis can help predict whether a project can be completed on time and can be used to predict problems within the program both before starting it and as it progresses, to keep the project's completion on track and ensure that deliverables are ready on time.

Advancing from the Gantt chart on the next page is the project critical path (highlighted in red on the subsequent page). Any fluctuations to these dates would have a knock on effect to the overall programming of the project meaning time would need to be made up elsewhere on the remaining tasks, or possible weekend overtime working would need to be implemented to ensure the project was completed by the March 29th deadline.

Project Evaluation and Review Technique (PERT)

As projects become even more complex and unpredictable, more complex scheduling methods become appropriate. Methods such as the ‘ program evaluation and review technique’ combines critical path analysis with probability to identify completion dates that are optimistic, pessimistic, and most likely. Such scheduling techniques are not applicable to every project, but may be used in large construction projects that are likely to be influenced by nature or human factors. Examples include projects that are to be completed during unseasonable weather conditions or grading in an area that may be delayed due to unknown underground conditions.

PERT planning involves the following steps that are described below.

Identify the specific activities and milestones. The activities are the tasks required to complete a project. The milestones are the events marking the beginning and the end of one or more activities. Using a work break down structure is helpful to list the tasks that in later steps can be expanded to include information on sequence and duration.

Determine the proper sequence of the activities. This step may be combined with the task identification step above since the activity sequence is evident for some tasks. Other tasks may require more analysis to determine the exact order in which they must be performed.

Construct a network diagram. Using the activity sequence information, a network diagram can be drawn showing the sequence of the serial and parallel activities. Each activity represents a node in the network, and the arrows represent the relation between activities. Software packages simplify this step by automatically converting tabular activity information into a network diagram.

Estimate the time required for each activity. Days are a commonly used unit of time for activity completion, but any consistent unit of time can be used. PERT has the ability to deal with uncertainty in task completion time. For each activity, the model usually includes three time estimates:

Optimistic time – generally the shortest time in which the activity can realistically be completed, also referred to as the ‘ best time’.

Most likely time – the completion time having the highest probability. Note that this time is different from the expected time, (as explained below).

Pessimistic time – the longest time that an activity might require, also referred to as the ‘ worst time’.

PERT can also assume a beta probability distribution for the time estimates.

Expected time – For a beta distribution, the expected time for each activity can be approximated using the following weighted average:

Expected time = (Optimistic + 4 x Most likely + Pessimistic) / 6

This expected time is not always used on the network diagram.

On the following page I have used Project Evaluation and Review Technique (PERT) scheduling to construct a network diagram that estimates; best, worst and most likely time periods for each task. While also determining the proper sequence of the activities with a critical path and milestones.