SHAFT SINKING SCHEDULING/PLANNING

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Introduction

Mining companies are challenged with increased difficulty in delivering capital projects on schedule and within budget. In 2005, PricewaterhouseCoopers global review of major capital projects in the mining industry only 2.5% of projects could be defined as successful when assessed across the four critical dimensions of scope, cost, schedule and business benefits. Thus 97.5% of major mining capital projects were not successful according to the criteria PricewaterhouseCoopers used. Normally if a project fails on all these criteria it indicates scope creep. Scope creep refers to the change in a project's scope after the project work has started. As a result, the projects drift away from their original design, timeline, and budget, and as a consequence destroy business benefits. The major reasons for scope creep are poor change control and the lack of proper front end loading.

Change control and front end loading are based on project processes in the planning and monitoring & control process group of the Project Management Body of Knowledge[1] (PMBOK). This paper will focus on key factors to consider during project scheduling/planning with special reference to cost and schedule (using Microsoft Project as a tool although the principal is universal)

Project Management Body of Knowledge

In total there are 44 project processes in 5 project process groups and 9 project knowledge areas. The planning process group consist of the most processes namely 21 (48%). The monitoring and control process group is second and consist of 12 processes (27%).

What gets planned gets measured and what gets measured gets done.

The focus of this paper is therefore on planning. The 21 project process in the planning process group falls in all the project knowledge areas. Table 1 shows the planning processes and there relationships.

[1] A Guide to the Project Management Body of Knowledge (PMBOK) is a project management guide, and an internationally recognized standard, that provides the fundamentals of project management as they apply to a wide range of projects, including construction, software, engineering, automotive, etc. It is published by the Project Management Institute (PMI)

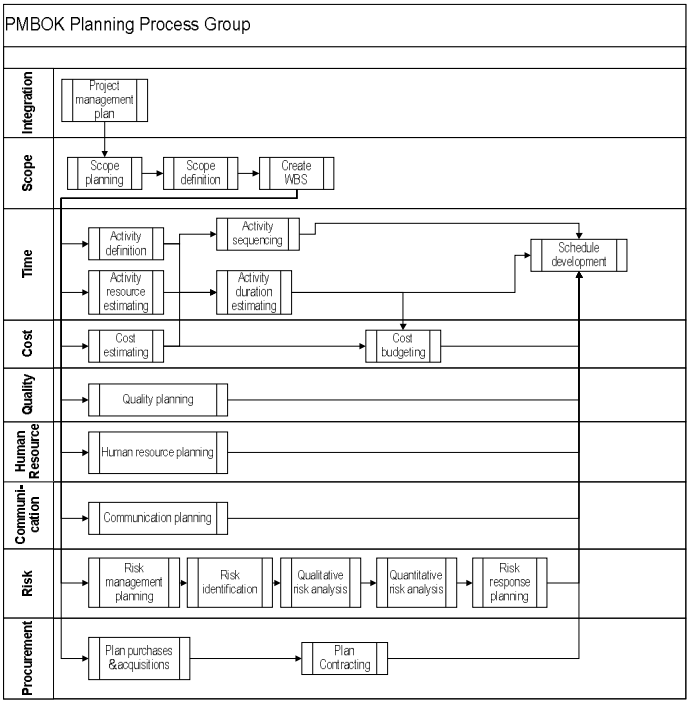

Figure 1

What to plan?

As an architect walks through the building he wants to design in his mind, the project planner needs to walk through what needs to be delivered in his mind. The project planner therefore needs to walk with each discipline design engineer the steps to build and deliver their part of the project.

The scope of the project is the story of the project. This story consists of a list of deliverables with their descriptions and subdivided deliverables that needs to be completed to ensure project delivery. For example the mine requires a 10 level as a deliverable. To deliver 10 level it can be divided into sub deliverables namely development (all excavations need to be completed), rail and pipe installations, battery bay, workshop, refuge bay, waste tip, reef tip construction.

The output of the scope management in the planning process group is a work breakdown structure (WBS). The principal purpose of a WBS is to facilitate the decomposition of the total project scope of work into definitive components that are separable and measurable, and that can be resourced, priced, scheduled, executed, monitored, managed and reported.

Due to the integration ability of all Microsoft Office Packages, Microsoft Project can export data to Microsoft Visio[2] to automatically generate a hierarchical WBS structure (based on levels). Figure 1 shows an example of such an export.

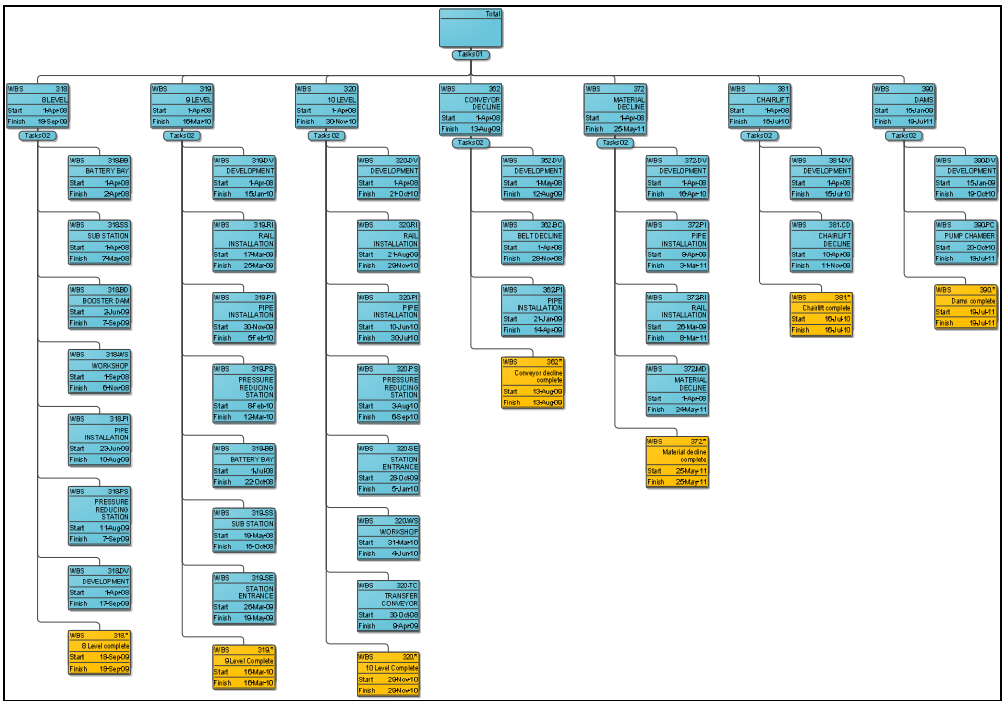

Figure 2

In this example the start and finish dates are shown. During execution this data could also be replaced with the cost and schedule performance indices[3], to assist management in drilling down to the root causes of a project's poor performance.

How to plan?

This paper will only discuss time and cost management in the planning process. When the WBS is created the next knowledge areas in the planning process group are time and cost management. The output of time management is an integrated project schedule (all the knowledge areas) as shown in figure 1. When the schedule is resource loaded[4] and resource unit costs are estimated, the schedule will dictate the project cash flow. This cash flow forms the main artery of the project life and will be used to determine project status (earned value[5] and project indices).

[2] Microsoft Visio is a Microsoft Office package to create, edit and share diagram
[3] Cost performance index is a ratio of earned value to actual cost and schedule performance index is a ratio of earned value to planned value - ≥ 1 good performance & < 1 poor performance
[4] Resource loading is the process of assigning resources (people, facilities, and equipment) to a project, usually activity by activity
[5] Earned value is the budgeted cost of work performed

To ensure accurate time estimates for the project schedule the PMBOK steps needs to be followed. These steps should be followed by involving all relevant stakeholders in the project team (critical team members – construction managers, project managers, master sinkers, contractors, discipline engineers, procurement, cost engineers, and contract managers)

- Step 1 – is activity definition which involves identifying and documenting the specific activities that must be performed to produce the deliverables or sub deliverables identified in the work breakdown structure. It is important to note that all quality related activities should also be included during this step (integrated schedule). First load all the deliverables and sub deliverables with WBS coding into Microsoft Project (use WBS field to ensure uniqueness). If the activities are then inserted and indented an automatic unique WBS code will be generated.
- Step 2 – is to sequence these activities. To make certain accurate activity relationships (start-to-start, start-to-finish, finish-to-finish, and finish-to-start, leads & lags) are allocated a network diagram must be used. Start with activity sequencing for each deliverable or sub deliverable and then build the relationships between sub deliverables and deliverables. The activity information block in the detailed network diagram view of Microsoft Project can be populated with any data required to assist with the sequencing.
- Step 3 – is to determine the resources required to deliver each activity (resource loading). Resources can be loaded into the resources data sheet in Microsoft Project and allocated from a drop-down menu or resources can be defined on allocation. This is also important for stakeholders to start understanding the magnitude of the activities for activity duration estimation.
- Step 4 – is the cost estimating. A unit cost is determined for all allocated resources. Procurement strategy can be applied to determine the best unit price based on economies of scale (bill of material is available from step 3). The selected unit price is then loaded into the resource data sheet. Escalation per resource can also be loaded. The reason for this is for accurate forecasting during execution if activities are happening earlier or later than planned.
- Step 5 – is to determine activity duration. Activity calendars and resource working calendars need to be defined and setup to ensure duration allocation to activities is scheduled accurately. The technique to assist with determining a calculated duration is PERT (Program Evaluation and Review Technique). There are two methodologies to follow, either based on experience of the stakeholders or based on a data base. For the first the three durations are required namely pessimistic (p), optimistic (o), and most likely (m). The three time durations are imposed on a normal distribution to calculate the expected activity duration.

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

The other methodology is if an activity duration database is available statistical duration distributions (negatively/positively skewed, normal, binomial, constant minimum & maximum distributions) can be allocated to the activities to determine expected activity duration.

To run a Monte Carlo Simulation on the schedule PERT is required. The reason for a Monte Carlo Simulation is to determine whether a resource loaded project schedule could be delivered on time and budget (within a 90 percent confidence level). Monte Carlo Simulation also identifies the at risk activities regarding time and cost, which is used to develop risk response plans.

- Step 6 – is the cost budgeting process (cash flow). After the activity duration is determined the allocated supply resources can either be scheduled on a Just-in-Time (JIT) basis or at risk supply resources scheduled to be delivered with slack. The erection resources are allocated on a prorate basis according to workload (back loaded, front loaded, flat, binomial, or according to usage). The resource unit rates are already loaded into the resource database and therefore the scheduling of the resource requirements will reflect an accurate cash flow.
- Step 7 – is the procurement operating plan (POP).

> *The old saying in mining is that if a stope/development face is cleaned, environmentally friendly, and the required human-, support-, compressed air-, water-, explosive & accessory resources are available the face will be blasted. The same saying goes for project execution.*

The resource usage in the schedule is used to populate the POP. All the allocated resources have start dates. These start dates are seen as delivery dates on site. An export map is created in Microsoft Project to populate an Excel spread sheet with resource requirements per activity and delivery dates. These dates will be linked to the POP which is back driven to determine all the planned dates in the procurement process. The procurement officer will therefore always have a life plan which is linked to the project schedule. If the procurement officer updates his actual dates in the POP it will forecast delivery dates of the required resources. It will highlight immediately whether resources will be delivered late on which he can act or give an early warning back to the project manager or planner.

- The project schedule development is an iterative process until all the knowledge areas in the planning process group is completed.

Conclusion

From literature review project success can be achieved by doing quality front end loading while the cost of change is low and impact of change high. During the latter part of front end loading the vitals of the project is finalised namely cost and time, which are used as the baseline to measure project status. By applying the steps (PMBOK) highlighted above during the latter part of project front end loading more accurate baselines can be produced, which could only result in better project performance.

Reference

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