Broadleaf

Creating value from uncertainty

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Case study:
Lessons learned from a major plant shutdown

Broadleaf was commissioned to conduct a root cause analysis workshop to help a global mining group learn lessons after a major plant shutdown and refurbishment. This involved a one-day workshop with company employees and representatives from several contractors. Over 62 separate lessons were generated. The group developed actions to prevent failures and encourage successes in future similar projects.

Version 1, 2015

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Contents

Tables

Figures

1 Background

A global mining group conducted a shutdown and major overhaul of a large item of production plant to maintain its availability and operational utilisation.

The shutdown involved the inspection, replacement or repair of those components that were worn or damaged or where their expected remaining life was less than 35,000 hours of use. If these components were not replaced or repaired preventive maintenance analyses indicated there was a high likelihood of failure that would lead to significant downtime and production loss.

The principal objectives set for the shutdown and the actual performance are shown in Table 1.

Table 1: Comparison of actual performance against objectives

Objective	Actual performance
Return the machine to work on time, within 47 days	47 days, 5 hours
Conduct the work within a specified budget	100% over budget
Have all the required works completed (98-100% of scope completed)	Completed 98-100% of original scope
Achieve a good level of availability for the next 5 years (at 90% for each year)	Only be revealed in time
Do this all safely (zero accidents or incidents)	Two medical treatment injuries, no environmental incidents or community complaints

The testing and refurbishment program involved a large number of work items, all of which had to be coordinated and scheduled. These included:

- A full range of non-destructive testing (NDT) and inspections (visual, magnetic particle, vibration, ultrasonic, X-ray, gear inspections, oil sampling);
- Visual inspections by site maintenance crews;

- Capital improvements to the plant;
- Other upgrades and modifications;
- Replacement of components that had reached the ends of their lives.

While the budgeting exercise tried to predict the replacement costs for components that had reached the ends of their expected lives, it was less successful in predicting the cost to replace or repair components that were found by inspections to have failed or to be degraded. This was the major cause of the budget overrun.

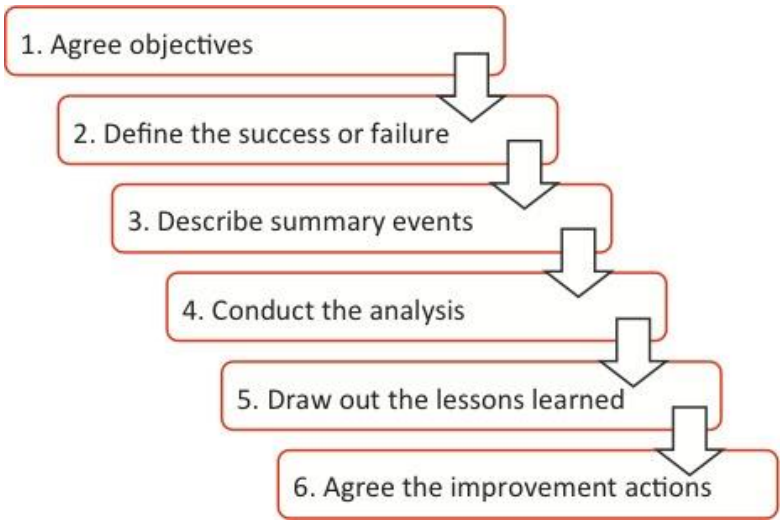
Broadleaf was commissioned to facilitate a workshop that reviewed and analysed both the successes and failures of the shutdown and refurbishment project. A systematic root cause analysis process was used to determine the causes for a range of events and the lessons that should be learned. The group then used these to define actions aimed at preventing such failures and repeating such successes at future, similar shutdowns.

There were 22 participants in the workshop, from the mining company and its principal contractor. All had first-hand involvement in the shutdown.

2 Approach

Broadleaf followed the general process shown in Figure 1. Our involvement stopped when step 5 was complete and the group went on to generate the action plan itself.

Figure 1: General approach



Preparation

Because the shutdown project was complex and involved a large number of sub-projects, and because most of the stakeholders were each only involved in one sub-project or element, it was important to ensure that all participants were properly briefed before the workshop.

We therefore established the context in a similar manner to the way we would prepare for a risk assessment. We issued a briefing note that contained:

- The project scope, description and objectives;
- The actual performance of the plant against objectives;
- A stakeholder analysis, including stakeholder objectives;
- The major external and internal factors that created uncertainty for the objectives;
- A workshop process outline;
- A structure for the workshop, including a set of key elements.

The key elements used to structure the workshop are given in Table 2.

Table 2: Key elements

Key element		Includes
1	Project planning	Scope of works, schedule development, budget development, project plan and Gantt chart, risk assessment and treatment actions
2	Project management	Overall, contractor project management
3	Reporting and communications	Daily meetings, briefings for owners, communications between contractors and principal
4	Contracting strategy	Strategies chosen, variations
5	Laydown area construction	Dimensions, gradients and falls, compaction and fill type, site layout
6	Mechanical works	Frame, motors, gearboxes and gears, large components
7	Electrical works	Transformers, motors and fans
8	Off-site repairs	Logistics, return dates
9	NDT and other testing	Preparation (cleaning), work plan
10	Parts procurement and compliance testing	Sourcing, stores

Key element		Includes
11	Handover	Commissioning, acceptance
12	Accommodation and rostering	Accommodation on site, transfer arrangements, rosters
13	Logistics, freight and transport	Equipment and materials
14	Health and safety	Reporting and investigation, accidents and incidents
15	Training and human resources	Induction, training, competency assessment

Workshop

A large off-site room was booked for the workshop. Tables and chairs to accommodate the 22 participants were arranged in a U-shape. The Broadleaf facilitator used a laptop computer with a video projector and large screen so that all participants could follow and contribute to the analysis. Flipcharts were also used extensively and completed sheets were posted around the walls.

Workshop participants were encouraged to stand up and add material to the flipchart sheets.

The Broadleaf facilitator created and projected the workshop output as the analysis progressed. The group provided a scribe who generated a complementary record of the discussions.

After initial introductions and an outline of the process, the key element structure was followed to brainstorm a list of successes and failures. Agreed nominees presented the background to each key element and the facilitator recorded the suggested successes and failures on flipcharts for each case. Table 3 and Table 4 are examples for the first key element, for project planning.

Table 3: Project planning successes

Achieved cleaning work front – but had to change work patterns
Were able to change and adapt when they discovered that delays were occurring for NDT and other testing
Contractor budget proved accurate
On time completion
Able to increase scope and still complete on time
Despite components from original equipment manufacturers (OEMs) not being compliant, detected these and modified them

Table 4: Project planning failures

Went considerably over budget
Did not spend enough time on planning. In particular, should have tested other scenarios
Lay down area cost more than expected
Did not realise that the peak time for cleaners and NDT was at the beginning of the job
If the project had not been postponed, late delivery of cabling would have caused problems
Major component was delivered late and not to design specifications
Accommodation was a significant issue that was not anticipated in planning; much time was wasted organising this
The roster had to be changed to fit in with travel and accommodation arrangements.
Training requirements were not properly understood; they were not flow charted
The use of software for training was problematic; some people were not IT-literate
Technology problems meant that some people were not trained and training took many hours for some
The majority of people were not properly authorised on time

Once the workshop had generated successes and failures for each key element, these were grouped for further analysis under a series of ten issues.

We used fish bone analysis, employing the '4 P' (People, Place, Process and Policy) methodology (see Figure 2), to help the participants to derive root causes. These analyses were recorded using MindManager™[1] software and projected to make them visible to participants. For each issue the completed fish bone was used to extract lessons and to suggest actions that should be considered by the group.

Figure 2 shows an example fish bone. Table 5 is a summary of all the issues analysed with some example lessons learned in each case.

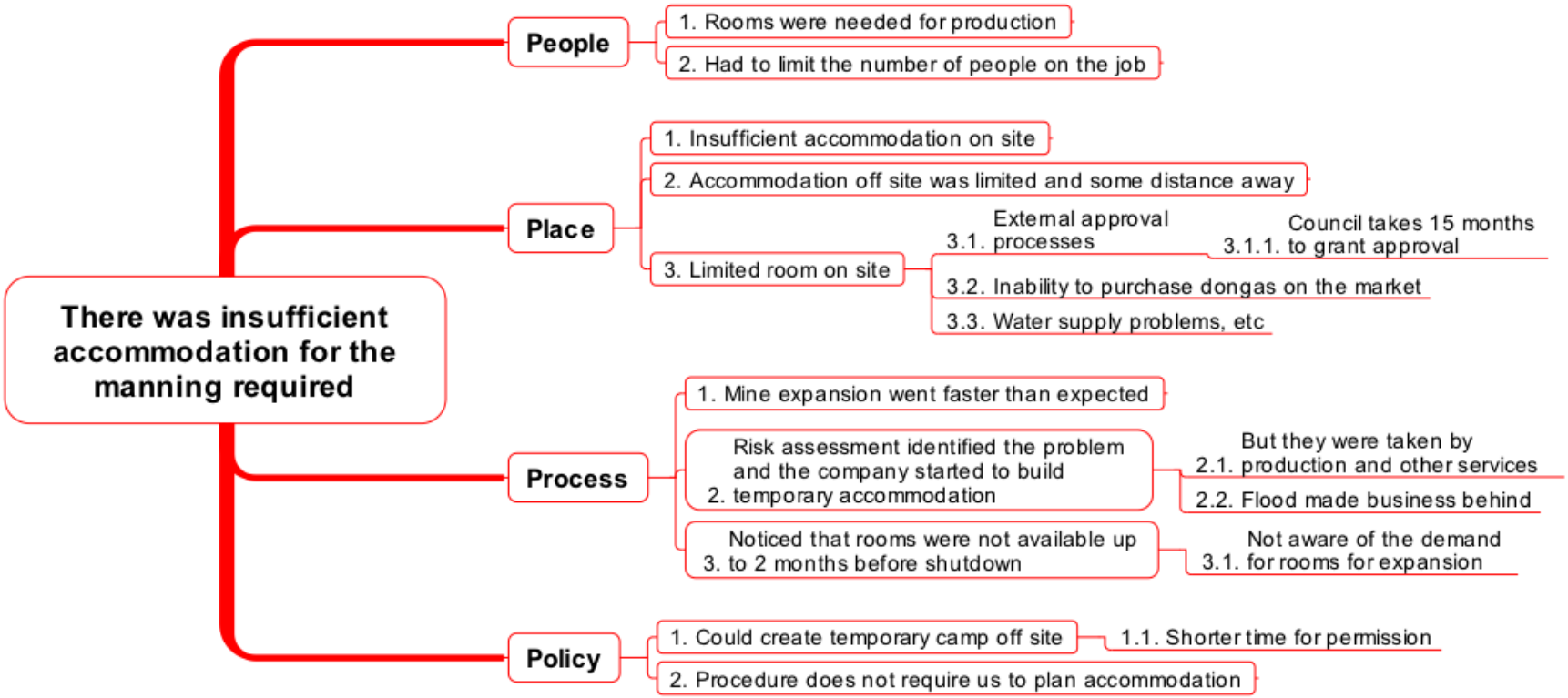
Table 5: Summary of issues and lessons

Issue	Examples of lessons learned
Insufficient accommodation	Accommodation usage should be monitored, on and off site, and do that early as part of project planning Everyone needs an en-suite room because of site labour agreements; take this into account when designing accommodation
Training was inefficient	Get people to a central area for pre-training well before the project starts Planning meeting to consider all training needs, including site people, is needed Involve contractors in improving training system
Safety system requirements and productivity were imbalanced	Job safety analyses (JSAs) could be simpler and more effective The rigour of the JSA should change according to the level of risk and complexity of the activity Lead hands could facilitate JSA discussions to free up supervisors
Offsite work not tracked	Need someone on the project dedicated to managing this Paperwork for offsite work should all be in one area Approval process for capital purchases during major projects should be faster

[1] www.Mindjet.com

Issue	Examples of lessons learned
The 'one team' approach worked well	Need to dedicate resources for planning these projects well in advance Plan jointly with contractors at an early stage Need faster issue resolution and sign off process
Inefficient supervision	Supervisors could delegate some workload to administrative staff The competancy of supervisors should be tested when they are hired
Inefficient shift handover	Supervisors should understand what is required for handover Longer handover periods are needed; for example 1/2 day handovers at the beginning of a new roster
Lay down area was well designed and constructed	A civil engineer should design the area Access to the laydown area must be possible at all times
Inefficient scheduling support	A one-day schedule review should be held before a similar project begins A dedicated scheduler should be employed
Non-compliant OEM components	Risk assessments should take place that lead to the QA of OEM parts Early site access is required

Figure 2: Example fish bone analysis



3 Review summary

The exercise involved 22 people for a full day and it was remarkably productive. With shutdowns costing tens of millions of dollars, the return from this investment of time would be considerable if all the lessons were applied for all similar projects across the group.

The review generated 62 separate lessons that the workshop participants agreed the mining group should learn. Some of these arose out of successful elements of the project while others involved aspects that did not go as well as they should. Although overall the shutdown was considered a success, it cost over twice the budget estimate. This was due to many unforseen costs and process inefficiencies.

It was obvious that some of the issues that arose made life very difficult for the project team and if they had not been resolved quickly, with ingenuity and hard work, significant delays and therefore substantial production loss would have occurred. Despite the costs incurred, if the intended work had not been completed, then the future availability of a crucial plant item and the revenue that depends on its continued operation would have been at risk.

4 Lessons

This case study demonstrates that:

- Preparation for such exercises, by establishing the context and then issuing a briefing note, is essential to make good use of participants' time;
- By following a carefully-developed structure and using a simple process for root cause analysis, a great number of useful results can be generated in a day;
- Participation by people intimately involved in the project, including contractors, is vital to generate meaningful and credible results;
- Even the relatively simple form of root cause analysis used here (fish bone analysis) can be powerful and highly productive when the exercise is facilitated well.

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5 Contact

If you would like further information about this topic please contact us. We will endeavour to reply promptly.

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