STRATEGY – MAINTENANCE, CAPITAL AND RISK

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Summary: This paper presents various methodologies and issues associated with a total asset management process that embraces the use of capital and maintenance expenditure to ensure assets meet the full spectrum of operational requirements, including safety, performance and return on investment. The broad range of issues associated with implementing asset management mean that the work must be conducted within a cohesive framework, even though different elements may have little in common with each other. Pervading the entire process is a risk management process that is a function of the condition of the asset base and the responsiveness to identified needs.

1. INTRODUCTION

The Asset Management Plan (AMP) for an organisation embraces the following broad areas:

- Business requirements of the asset base
- Capital management
- Risk management
- Long range maintenance strategy
- Short term maintenance control
- Budget management

The tangibles of the AMP are physical documents and systems that make up the individual elements within the framework. In this case, they are the outward signs of a business process, which is comprised of many business rules. The business rules are defined in policy and then enforced through the information system, work procedures and the responsibilities listed in position descriptions.

The AMP has three objectives relevant to delivery of tangibles:

1. Creation and definition of a sequence of products and systems that are to be used in accordance with the responsibilities of a position and within the context of a team to ensure the defined business processes are enacted efficiently and with minimum risk
2. Provide physical substance to a strategy that allows people involved in the implementation of that strategy some simple goals and tools to assist in its achievement
3. Enforce the business rules that make up the strategy, no matter how intricate, interlinking or complex these rules are required to be since the simple use of the tangibles will ensure that they will be followed

A facility should be analysed wherever possible (pending data, time and access for interview constraints) for the following:

1. Top cost areas (i.e. opportunities for savings subject to further detailed analysis in these areas)
2. Work types and possible work efficiency
3. Reliability data in the form of defect trends
4. Responsiveness to backlog and rectification of defects
5. Risk management – as indicated by integrity considerations and responsiveness of maintenance providers
6. Budget analysis
7. Anecdotal notes of relevance regarding asset management of the facility

In seeking to recommend on possible cost optimisation of the asset management approach, an analysis should focus on determining specific high spend areas that would warrant a detailed engineering investigation in the future, and on aspects of the asset management highlighted by both data and interviews that should be reviewed as to effectiveness in terms of methodology, systems and resources.

Critical findings of past reviews have included:

- Provision of management practices that ensure a consistent approach to all aspects of the AMP, supported by an accurate and useable information system.
- Arbitrary reductions in budget, outside the context of the forward maintenance plan of a facility, should not be allowed in the future by an informed management team.
- Companies normally require greater discipline in the use of the existing information systems, and to improve the use of feedback and analysis in order to improve accuracy and content of the databases.
- The resource plans for major maintenance periods such as shutdowns and plus the work critical paths need to be tested for assurance that all scoped work will be completed within a scheduled overhaul. Changes due to unforeseen condition should be challenged by the maintenance team and over time reduced through improved tracking of condition.
- A means to improve the level of competitiveness in facility maintenance work, including major shutdown work, needs to be investigated with options to include the sub-contracting in of other major engineering organisations.

This paper considers aspects of a strategic asset management approach, the exploration of maintenance improvement and concepts in effective measurement of maintenance work performance.

2. STRATEGIC ASSET MANAGEMENT

The major steps in the Asset Management Plan include the following elements:

1. Business operational requirements for the assets to be maintained
    - Long range business planning

- Equipment capability requirements
- Long range asset management and development planning

2. Risk management processes to be established
   - Safety, health and environment
   - Operational performance losses and risks
   - Area Risk Register
3. Integration of the Capital Plan with asset management
   - Capital budgets
   - Capital projects
   - Improvement in equipment capability
4. Integration of engineering specifications (including statutory requirements)
   - Statutory checks
   - Engineering standards
   - Design specifications
5. Development of long range maintenance planning and short term maintenance controls
   - Long range maintenance plan
   - NDT and condition monitoring inspections
   - PM history (condition of plant data)
   - Short Term Maintenance Control
   - Day to day operations and resource/access management
6. Planned maintenance
   - MST schedule
   - Major maintenance plan
   - Shutdown planning
   - Investigations
7. Ongoing review of maintenance effectiveness
   - Scheduled corrective maintenance trending
   - Unscheduled corrective maintenance trending
   - Maintenance spending
8. Budget optimisation and continuous improvement
   - Capital/operations
   - Short term maintenance management
   - Long term maintenance spending
9. Inventory management
   - Inventory optimisation
   - Spare parts ordering – warehouse and Purchase Requests
   - Consumables (B2B processes)

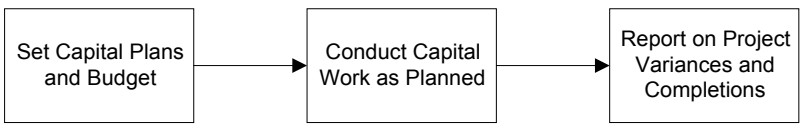
10. Use of support systems
    - CMMS
    - Zero-based budgeting
    - Inventory management
    - Maintenance optimisation tools
11. Technical procedures
    - Procedure optimisation (eg RCM, PMO)
    - Standard jobs
12. Reporting
    - Financial
    - Budget
    - Maintenance backlog
    - Work completion
    - Work quality
    - Diversion to schedule
13. Sustainable system considerations
    - Documentation
    - Auditing
    - Position Requirements
    - Training

3. CAPITAL MANAGEMENT

Capital management includes:

1. Annual Capital Budget
2. Capital Projects
3. Monthly CAPEX Forecast

The logic of this grouping follows standard capital management principles as shown in the flow chart below:



Within the AMP, the development of capital projects follows a three-stage process:

- Identify the need to be met and the scope of works
- Develop a suitable design

- Install that design within a project and commission the design

The element Capital Budget is concerned with the first stage of capital project work, namely identifying the necessary projects to be undertaken, their timing and allocated budget. These are driven by business imperatives established by the Equipment Long Range Asset Management and Development Plan (ELAP). Hence this element is concerned with matching planned outcomes from the Capital Plan with requirements from the ELAP.

The ELAP contains the following items: list of issues which represent long range limitations to the capability of the asset to perform safely and with no threat to the environment, long range limitations in process capability to be considered for improvement, and the list of corrective actions, investigations and investment to address the issues and limitations described above

Capital Projects is concerned with reporting back on the improvement in asset capability and what operational performance levels can be expected as a result of the capital work. Hence we are not so much concerned with the day-to-day management of capital projects, which is the subject of a company's project management guidelines, but rather how the outcomes of the capital works can be used operationally.

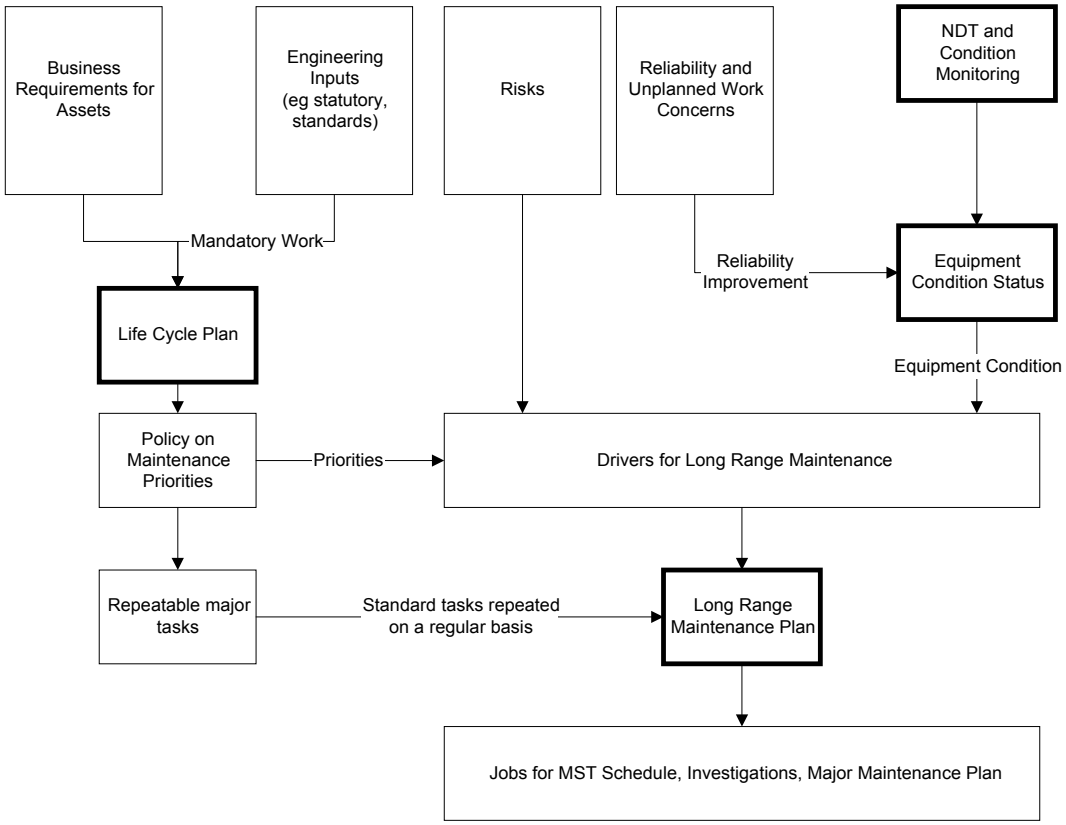
The Monthly CAPEX Forecast is associated with monitoring the capital expenditure and assisting with identifying opportunities for savings.

4. LONG RANGE MAINTENANCE MANAGEMENT

The management of the long-range maintenance plan covers:

1. Life Cycle Plan
2. Equipment condition status
3. Expert services such as NDT and condition monitoring
4. Long Range Maintenance Plan

The logic of this grouping is shown below. There are a number of inputs to the Long Range Maintenance Plan, and it is managed in an interactive manner with other elements of the maintenance strategy, namely execution of works and the Short Term Maintenance Control (refer Section 5). This section has been confined to the key inputs regarding overall strategy and plant condition. Relevant inputs such as Engineering requirements (including statutory checks) and reliability analysis are treated elsewhere. This also is indicated on the diagram below.



As can be seen from the diagram, the Long Range Maintenance Plan will draw information from elements covered in other sections of this paper. The logic with respect to the placement of the reliability elements in Section 5, which is the Short Term Maintenance Control, is that reliability reporting including corrective actions is a key element in the continuous improvement loop of the short-term maintenance approach. The reliability reporting is allocated to people more concerned with the short term than the long-term perspective, even though the local area personnel will consider the reliability data in formulating the Long Term Maintenance Plan.

The three key inputs into the Long Term Maintenance Plan are policy, repeatable major tasks and plant information. Policy is concerned with priorities and requirements of performance that have to be met. The plant information, whether it is statutory demands, reliability or condition, identifies needs areas for work to be done.

4.1 Criticality considerations

The elements in the LRMP need to be sorted according to criticality considerations, such as those tabulated below:

Options	Priority	Consequences	Maintenance/ Capital Spend
M - Must do	1 - High	S - Safety P - Production Capacity	
L - Long Term (Item will probably be viable in the long term, but	2 - Medium	Q - Process Efficiency	M - Maintenance

open for consideration) O - Optional (Do not do if item is not viable in long term	3 - Low	C - Maintenance Cost	C - Capital

There is a strong correlation between the Options and Priority criteria. The explanation of the Priority criteria is:

High	Must do within twelve months
Medium	Must do within three years
Low	Should be considered within the next three years

There is also a strong correlation with the Consequences options, which may be considered to provide more of an explanation of the reason for the task. For example, Safety tasks will in general carry a High priority.

Often capital issues considered under the Capital Plan are included within the LRMP. This is because the timing of the tasks will coincide with periods of major maintenance, and there is some advantage in determining lump sum monetary requirements for a given year or month. The definitions for maintenance and capital spend can beset according to the following:

Capital Expenditure **- Improvement expenditure**	**Maintenance** **- Repair expenditure**
Replacement of asset	Rebuild to original condition
Rebuild to a condition which improves subsequent maintenance	Replacement of a part with a modern equivalent
Rebuild to a condition which improves original capacity: this includes capacity, efficiency, life span or economy of operation	

4.2 Exhibit of a LRMP

An extract from a working LRMP is tabulated below. It can be seen that there are three kinds of work that need to be covered:

1. Ad hoc major tasks
2. Repetitive tasks, particularly inspections and overhauls
3. Tasks that can be anticipated at some time in the life cycle management – typically replacement or complete refurbishments driven by results from the inspection program

Kiln	Item	Equipment	Equipment Details	Equipment Number	Replacement Value $,000 per item	History		
						Last Replacement	Life (Yrs)	Last Replacement
Hydrate Feed System								
1	A1	Feed Bin		T661-11				
1	A2	Apron Feeder		AF661-101	50			48K refurbishment 9/00
1	A3	Spillage Conveyor		C661-101				
1	A4	Belt Weigher		BW661-102				
1	A5	Screw Feeder Drive, Screw and Tube	Liner	SF661-103	40			
			Screw Tube		35			Changed in 2000
1	A6	Feed End Hydrate Lifters	Elevator Pot	ELV661-346				
1	A7	Structural/platforms						
		Major maintenance						
		Routine maintenance						

Risk					Scope					Budget $,000				
Problem	Consequence	Risk Type (E,S,B)	Likelihood	Rating	Proposed Work	Expenditure Type	Cost ($,000)		Priority	2002	2003	2004	2005	2006
Hydrate slowly wears lining	Hydrate lost to environment	E	4	2										
					Refurbish	M	x	2004				x		
Screw feeder alignment is difficult	Screw feeder breaks	B	4	4	Change out tube liners every 3 years	M	x	2004				x		
Screw feeder alignment is difficult	Screw feeder breaks	B	4	4	Change out screw tube every 10 years	M	x	2010						
						M	x	R		x		x	x	

The exhibit demonstrates how clearly the ad hoc work stands out within a tightly specified asset base, plus some of the information collated to justify the long range expenditure.

The development of the costs for the repetitive major maintenance work is accumulated from historical spend profiles. This spending is allocated across each of the equipment areas contained within this scope of work.

5. SHORT TERM MAINTENANCE CONTROL

This area of the AMP covers:

1. Unscheduled corrective work
2. Planned work list
3. Maintenance schedule
4. Maintenance backlog
5. Inventory review

The elements here are concerned with the day-to-day maintenance of the asset base. The four main participants include:

Maintenance Supervisor – managing the planned (CMMS-generated) work plus aspects of the corrective work, and revise inventory holdings
Operations/Shift Superintendent – managing the corrective work and coordinating access to the plant
Planner/Scheduler – plan tasks and schedule work, coordinate plant-wide services
Engineering – provide engineering authorisations of work scopes as required

The intent here is to find means of assisting people in their tasks to ensure optimum efficiency and to manage residual risk such as associated with plant access priorities and backlog.

5.1 Backlog Management

Backlog criticality is determined by the following formula:

Risk = Asset Criticality x Task Criticality

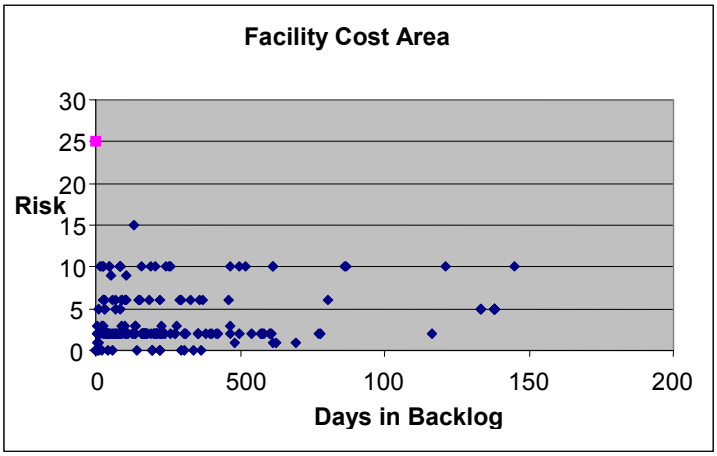
In one application a critical task on a critical item carries the maximum score of 25. The risk matrix is as follows:

	Asset Criticality				
Task Criticality	1	2	3	4	5
1	*1*	*2*	*3*	*4*	*5*
2	2	4	6	8	10
3	*3*	6	9	12	**15**
4	*4*	8	12	**16**	**20**
5	*5*	10	**15**	**20**	**25**

The policy for handling backlog should be:

Level	RIME	**Maximum time in Backlog**	**Remedial Action**
3	1 – 8	Up to 2 years	Review if task is necessary – delete if not; increase task criticality if it is
2	9 – 12	Up to 3 months	Increase task criticality to expedite attention
1	15 - 25	No more than 2 weeks	Urgent priority to address task

The snapshot of tasks in backlog for each cost area should be monitored with the following plot considered:



A monthly report on backlog should address the following:

1. Level 1 tasks in Backlog and time as to when that work will be completed
2. Level 2 tasks in Backlog and escalation of critical tasks to Level 1, and time when remainder will be addressed
3. Level 3 tasks discarded from Backlog

In the examples listed above, there is a considerable time spent in Backlog for many work orders. Obviously there will be establishment problems to tidy up the long term backlog work.

5.2 Work Type Analysis

Three dominant types of work are typically used:

1. Corrective Actions
2. Breakdown Maintenance
3. Preventative Maintenance (PM)

Corrective actions are predominantly driven by inspection work and operator feedback. We are concerned with the following issues:

- Time spent in various types of work – is maintenance proactive or reactive?
- Proportion of Breakdown work and Corrective work to PM work for different types of equipment.

In one example, the split of work for year 2000 was split as follows:

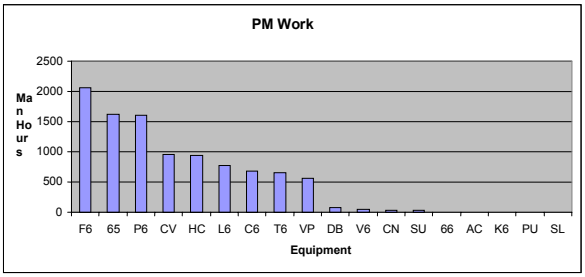
		Corrective	Breakdown	PM
Area 1				
	N work order	881	211	950
	N labour hours	26501.76	2446.28	10956.58
Area 2				
	N work order	361	51	579
	N labour hours	7594.98	3076.25	32648.13

Area 1 is distinguished by no redundant plant so keyhole maintenance and consequent high rates of corrective work are required. Area 2 consists of large assets, any one of which can be off-line in a planned shutdown. Redundant plant of this type has a consequent high work load in PM work, with the challenge to assure cost effectiveness of the work.

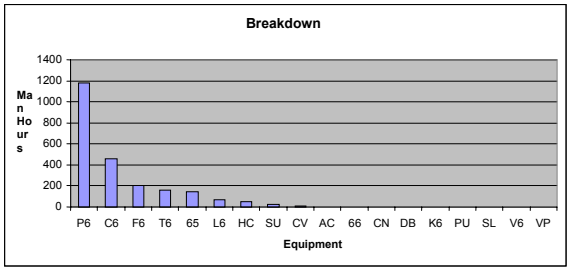
The proportion of proactive work to total work is defined as the sum of work types PM, major maintenance and inspection to the total body of work. The resulting KPI for the above data is:

Area 1 31.9%
Area 2 75.7%

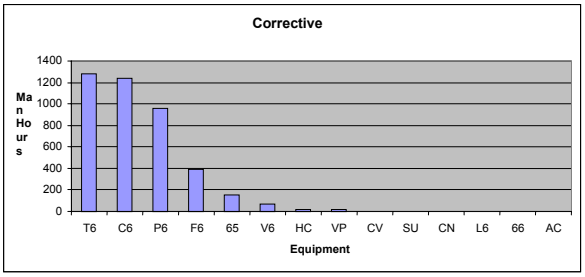
An appreciation of the distribution of work for various equipment types in Area 1 is shown in the plots below. The type of work within a calendar year are plotted for various equipment types, eg P6 (pumps) and so on.



PM Work



Breakdown Work



Corrective Work

The key issues that were identified in this analysis included:

1. C6 PM spending should be reviewed – is it sufficient for their current duty?
2. T6 corrective work is high – appreciate that there are access problems, but the total spending should be reviewed for effectiveness.
3. P6 breakdown spending is high – why isn't the corresponding PM spending addressing these problems?

6. CONCLUSION

The challenge for asset management is to provide a credible statement on a strategy that will ensure the organisation can sustain their asset base and its business mission in a long term cost effective manner. An imperative for this issue is the need to reduce overall expenditure to meet gaps between the sum of individual budget submissions from all areas across a facility and the total organisation maintenance and logistics budget guidance figures.

To achieve this the conduct of the asset management plan has to be guided with feedback on the following issues:

- Distribution of costs across systems and areas
- Efficiency of the expenditure – reactive versus proactive maintenance plus anecdotal notes on known problems

- Effectiveness of the expenditure – management of the reliability and capability of the systems, where capability represents ability of an asset to provide its intended function with expected levels of flexibility, efficiency and quality

Long-range maintenance strategy can reflect a plan that at a minimum forecasts out to 5 years hence and includes the following:

- Plant condition assessment and life assessment
- Identification of major maintenance improvements, where major maintenance normally refers to overhauls or shutdowns
- Investigations and management of long term risk
- Planning of major maintenance periods
- Review of the cyclic planned work lists, which may be called the Maintenance Plan, although this Plan may also include major maintenance improvements
- 5-year budgets

Normally the management of the long range maintenance is integrated with management of the Capital Plan of an asset base, since periods of major maintenance normally offer times of access for capital upgrades and configuration changes. There are also links between capital and major maintenance as capital change-out may address long-standing maintenance problems and capital refurbishment or change should lead to modification of the Maintenance Plan.

Short-term maintenance control is normally expected to have a twelve-month focus and is concerned with:

- Scheduling of work from the Maintenance Plan, outstanding requests for corrective maintenance and any non-urgent breakdown work into planned maintenance periods
- Response to equipment inspections and condition monitoring that identify items requiring immediate rectification
- Urgent attention of breakdowns that cause immediate loss of currently required capability
- Management of urgent risk issues that need attention within the next twelve months
- Certification, approval and logging of configuration changes
- Budget management and tracking of expenditures
- Development of budget for the following twelve month period
- Scheduling of the work packages and management of major maintenance periods that fall within the twelve month period, including resource management, expenditure and supply of materials and purchased services
- Developing detailed scopes and resource plans for major maintenance periods that are imminent

External to this set of work, but included within the overall business of asset management are:

- Interpretation of the broad overall business targets in terms of operational requirements for specific assets and groups of assets
- Planning ahead to check likelihood of asset capability being able to meet operational requirements
- Gap analysis between operational requirements and operational performance
- Risk identification including hazards to capital, mission, safety, health and environment
- Capital planning to improve the capacity, efficiency or cost impact of using the assets to achieve operational targets
- Engineering support including establishing standards to be met and design out of intractable problems or operational limitations

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Comments on this paper can be emailed to r.platfoot@covaris.com.au.