

# **Chapter 1 – Introduction**

## ***1.1 Company Background***

### ***1.1.1 Company History & Operational Overview***

Samancor first began producing ferroalloys in 1938 as Amcor Limited in a small blast furnace in Newcastle. In 1942 the operations expanded and the first furnaces at the Vereeniging plant were commissioned. The group's existing manganese alloys operations at Meyerton dates back to 1951 when Amcor's ferroalloys works at Vereeniging closed down and was relocated to Meyerton.

Today the Metalloys plant is one of the largest producers of manganese alloys in the world. The Metalloys plant of Samancor, a joint venture between BHPBilliton and Anglo American, is resourcefully operated by BHPBilliton - one of the major resource companies in the world.

Metalloys is situated in an industrial area with access to a sophisticated labour force; the national power grid, an efficient transport network and well-established supporting industries.

All the raw material required by Metalloys apart from coke and quartzite, are supplied by operations within the BHPBilliton Group. High-grade manganese ores are sourced from mines in the Kalahari and Groote Eylandt in Australia.

The submerged arc furnaces employed are highly adaptable. Five of the eight furnaces can be deployed for the production of either ferromanganese or silicon manganese, depending on market demand. Computer controlled weighing and mixing of materials ensures that the correct proportion of the ores, reductants and fluxes are fed into the furnaces. In the furnaces, electricity is introduced through self-baking electrodes. Chemical reactions take place and the metal oxides are reduced. The furnaces are tapped, the slag or waste material

removed and the molten alloys are then casted in layers or onto a casting machine.

In a further operation molten ferromanganese is transferred to an oxygen-blown converter where the carbon content is reduced to produce lower carbon value added alloys.

The casted products are crushed and screened to exact customer specifications. These are then railed or trucked to local consumers or exported, either in bulk form or packed into drums, bags or containers.

Manganese alloys finds its application as an additive in the carbon steel making processes. The main properties of manganese are its ability to act as a de-oxidising and de-sulphurising agent in steel making processes. Both ferromanganese and silicon manganese are also utilised as alloying agents.

Examples of end products, having high-strength properties due to the incorporation of manganese, are structural steels, high tensile pipe steels and heavy plates, engineering steels and some manganese stainless steels.

Silicone manganese is employed in the place of ferromanganese or ferrosilicon mainly for economic reasons. It is also used whenever lower carbon or specific alloying characteristics are required.

The production of Ferro- and silicon manganese requires various raw materials that are sourced locally and internationally to ensure adherence to the strictest of quality considerations. Quality considerations typically might include material sizing, chemical composition, reactive as well as availability of the raw materials.

The production of Ferro-and silicon manganese requires quartzite, manganese ore and coke as reductants. Slag, which is a by-product for making manganese

alloys, is also circulated in small quantities. Most of these raw materials are sourced from within Metalloys' holding company, BHPBilliton.

Raw materials are transported to Metalloys by road and rail transport locally, and ocean freight internationally.

Metalloys' raw materials are stored in a single centralised raw material stockyard of 500 by 40 meters long. All eight furnaces located at Metalloys' works are fed from this single stockyard. Making use of a single raw material stockyard improves quality control, stock taking, reduces maintenance cost and simplifies the managing of this operation.

The various raw materials are reclaimed by a reclaimer which is computer controlled and then transported to storage bins located near the furnaces. Some of the raw materials are screened to remove fines before going to the storage bins. The various raw materials are then extracted from the storage bins according to ratios specified by the furnace-smelt balance, a raw material mix is made up to produce the required grade of manganese alloy. This material mix is transported to material storage bins located at the top of each furnace.

The smelting of raw materials to produce manganese alloys takes place in one of eight submerged arc furnaces located on site. The metal oxides that occur naturally in the ore, which reduced to give ferromanganese metal by adding heat, reductants coal and coke in the furnace. The heat is supplied through massive electrodes connected to the national electricity grid and penetrating deep into the furnace with the tips just above the metal bath inside the furnace. The manganese alloy is tapped from the furnace at regular intervals. The transformation of raw material into manganese alloy also results in metal oxide waste that is formed during the smelting process. This waste product, called slag, is also tapped from the furnace at regular intervals.

The hot manganese alloy tapped from the furnaces is poured into casting beds or onto a manganese-casting machine. The tapping process used in the casting beds is called layer casting and entail tapping consecutive taps at a specific thickness onto one another until the casting bed is full. The casting bed is basically a huge rectangular empty dam with half a meter high dam walls constructed of manganese alloy fines. The other tapping method is to tap directly onto a casting machine, which is basically a rotating metal conveyor with small metal ladles fixed to it.

After the manganese alloy has been casted, it is analysed and graded according to its chemical specification. Metalloys customer base have requirements in terms of chemical specification and also the size of the chunks of final product. For this reason the graded metal is crushed and screened to the various sizing requirements of the customer. After the various quality checks have been performed on the manganese alloy the metal is loaded in bags, containers or break bulk carriers and transported by road or rail to national customers or to the port for export to international customers.

During metal smelting in furnaces off gases are created as a by-product. These off gasses consist mainly of carbon monoxide that is flammable and when burn releases heat energy. The carbon monoxide coming from the furnaces is used to supply heat to a boiler, which is then used to generate electricity through an electrical power generator. The electricity generated through this process makes up about 20% of the electricity demand of Metalloys and creates a significant saving in cost and ensures the efficient use of natural resources.

Slag, then by-product generated in the furnaces, is stored on a huge stockpile. Metalloys are currently involved in research to find possible useful products that could be made from this untapped resource.

## **1.2 Problem Description & Definition**

### **1.2.1 The Maintenance Manager's Dilemma**

The business benefit or value delivered by efficient maintenance practice is widely published in mainstream maintenance literature. This is best described by Coetzee (1997:1) as follows "To have a maintenance organisation at all was deemed to be a necessary but costly luxury. This view of the maintenance function totally ignores the fact that a properly managed maintenance function creates and maintains high levels of availability, reliability and operability of plants. These high levels translate directly into production capacity, productive output and thus company profit". Despite this, the value delivered by efficient maintenance management is not universally understood across industry. Consequently, maintenance is not managed as a strategic business function but as an expense.

It is common for maintenance managers to complain about not being understood by business and financial managers and that they are subsequently being hindered in their efforts. The lack of understanding by business and financial management about the business benefit of maintenance management is the result of an inadequately defined linkage to the broader operation management context. If this is to change then it is up to maintenance managers to change the way they perceive maintenance management, and to educate business and financial managers.

Maintenance managers are generally unable to gain wide acceptance of maintenance as a strategic business function due to the continued use of the traditional asset management model. In order to address this problem, maintenance managers need to broaden their definition of the maintenance system beyond the technical issues of maintenance management. The solution to this dilemma lies in promoting and delivering maintenance management in the context of a manufacturing operation model. Ensuring the full revealing and understanding of all four quadrants of a typical polarity map will help with the management of the mentioned dilemma.

According to Johnson (1996:81) a dilemma is defined as an unsolvable problem that is ongoing and has two or more neutral poles that are interdependent. Table 1.1 clearly indicates that a one-sided approach will definitely not solve the dilemma as described above. Applying the theory of Johnson to the dilemma of maintenance managers, the polarity map as indicated in Table 1.1 can be obtained.

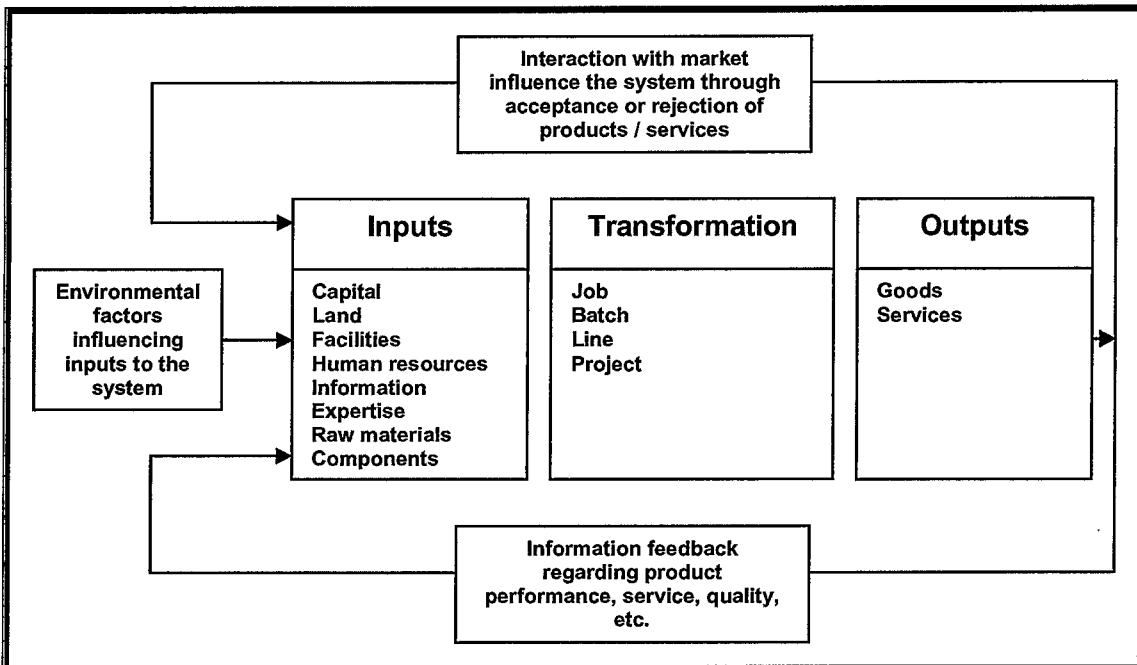
Delivering optimal business benefit from effective asset management			
<b>L+</b>	<ul style="list-style-type: none"> <li>• High levels of production throughput in the short term,</li> <li>• Reduced cost per unit of product,</li> </ul>	<ul style="list-style-type: none"> <li>• Incorrect / inefficient allocation of funds / resources,</li> <li>• Increased levels of equipment availability and reliability.</li> <li>• Correct application and use of production equipment.</li> </ul>	<b>R+</b>
<b>Operations</b>		<b>Maintenance</b>	
	<ul style="list-style-type: none"> <li>• Reduced reliability of equipment,</li> <li>• Use of equipment outside of design specifications,</li> <li>• Reduced levels of equipment availability,</li> <li>• Incorrect / inefficient allocation of funds / resources.</li> </ul>	<ul style="list-style-type: none"> <li>• Incorrect / inefficient allocation of funds / resources,</li> <li>• Low levels of production due to increased downtime for maintenance of equipment,</li> <li>• Increased cost per unit of product due to low throughput.</li> <li>• Reduced utilisation of <i>equipment capability</i></li> </ul>	
<b>L-</b>	<ul style="list-style-type: none"> <li>• Process instability due to breakdown of equipment.</li> </ul>		<b>R-</b>

**Table 1.1: Polarity matrix for the establishment of a sustainable operational environment.**

“The dilemma that many of us face – and mostly not of our own doing – is that we are managers in organisations which barely have sufficient resources to keep the plant working, let alone to find ways of improving reliability. When this is the case, scarce maintenance resources are rationed to meet the changing requirements of the plant and our recurring breakdowns persist in consuming what seems to be ever reducing maintenance resources. As a result, preventive maintenance suffers, which inevitably results in more breakdowns; then the vicious cycle continues.” (Hughes, 2000).

### 1.2.2 The Manufacturing Production System

Chase et al. (2004:8) defines the production system as the use of resources to transform inputs into some form of desired output. The operation function involves management of the conversion process with consideration of the requirements and feedback identified as a result of operation activity, and responding as appropriate. Figure 1.1 illustrates the value added process together with the maintenance processes.



**Figure 1.1 – Simplified Operations Management System (Adendorff & de Wit, 1997:5)**

The purpose of operation management is to “add (maximum) value” during the conversion process. The objective of operation management is to ensure that the conversion process is performed as efficiently as possible so that the ‘value’ of outputs are greater than the sum of all inputs. Added to this is the essential requirement to achieve this in a safe and environmentally sustainable manner. Clearly then, delivering optimal business benefit from effective asset management involves a demonstrated superiority by an operation in adding value during the conversion process.

In the manufacturing operation environment, production and maintenance are both responsible for achieving outputs, value added and performance (safety, environmental) targets together. The production function is primarily responsible for process performance (product quality and throughput), achieved by using equipment capability to deliver output targets at lowest possible conversion cost. The maintenance function responsibility is plant dependability (reliability and availability), achieved by assuring the capability of equipment to deliver operational targets at best possible return for expenditure. At the centre of this manufacturing operation model is a radically different relationship between production and maintenance that delivers optimal business benefit from effective asset management. Understanding this concept of the manufacturing operation provides a focus on how an operation will manage and deliver both equipment dependability and process performance.

The bottom line is that maintenance and production need to have a well defined, aligned goal in order to work together to have their products available at the right time, cost and quality for customers in order to meet desired long term contracts. All this needs to be achieved safely and in an environmentally friendly and sustainable way. The operation management system (Figure 1.1) provides a simple yet powerful medium to educate business, operational and financial managers.

The mentioned model is acceptable to all managers and makes it easy for managers to better understand their business. The overall problem is not with the model but often lies in the application thereof. The polarity matrix as defined above proves to be a powerful tool in order to define the viewpoints of both the operations and maintenance managers. With the higher goal defined as *Delivering optimal business benefit from effective asset management* the aligned goal between operations and maintenance can efficiently be defined.

### **1.2.3 The cost of maintenance**

Part of the problem as described above includes the fact that operational managers often see maintenance as a cost function hindering production outputs due to unnecessary planned downtimes, loading cost per unit of production due to preventative maintenance costs and reduced throughput. This reflects a one sided view as described in the polarity matrix (Table 1.1).

Management must always try to use the most effective method of maintenance. That is the lowest cost for the maximum reliability of equipment. The two major categories include corrective maintenance and preventative maintenance. Corrective maintenance is where equipment is run until failure after action is taken (a more reactive approach). Preventative maintenance aims at predicting and eliminating failures before they happen (Moubray, 1997:129), a more proactive approach. The major benefit from preventative maintenance is that jobs and equipment downtime can be planned and prepared in detail, eliminating unnecessary downtime of equipment due to spares availability, waiting time etc.

The major cost of maintenance is usually not due to the repair cost but due to the opportunity lost during the repairs. Thus preventing equipment failure can result in an immediate saving in maintenance costs. The challenge however is to effectively determine what the planned downtime frequency should be, what tasks should be done and what the downtime should be. Methods to be used in determining these aspects include processes like RCM II (Reliability Centered Maintenance).

In some cases it is viable to peruse the more reactive approach, this will mainly be in the following circumstances:

- Where market demand and / or price is expected to drop rapidly within the short term;
- Equipment will become redundant and is due for replacement within the expected remaining time to failure.

## **1.3 Goals**

The final outcome of this research is to establish a culture shift from a reactive approach to maintenance, towards a more proactive approach of maintenance throughout all the levels of the maintenance organisation. It is realised that this can only be achieved with close interaction between the different departments in the organisation, especially the direct customer of maintenance namely the production department. In order to successfully achieve the culture change the recommended research is required in order to establish a sound scientific approach, which will pave the way for the later organisational culture change required.

### **1.3.1 Primary Goals**

The primary goal of this study is to define how to effectively manage maintenance activities in order to obtain sustainable business improvement. This will be achieved by the following steps:

- Defining a maintenance strategy for Metalloys aligned with the overall business strategy.
- Defining maintenance as a profit business unit.
- Identifying and defining the maturity roadmap of maintenance.
- Defining key maintenance performance areas and elements of measure.
- Benchmarking different practices associated with key performance areas within Metalloys in order to define best practices.
- Development of a measurement process of defined areas of performance.

### **1.3.2 Secondary Goals**

Secondary goals relevant to this study include:

- Measure and evaluate different business units on the criteria set by best practices.

- Development of action plans (short, medium and long term) in order to improve the maintenance management process.
- Align different decentralised maintenance business units by adopting best practices from each other in order to move closer to being an effective learning organisation.

This dissertation will focus only on the establishment of a scientific, measurable system in order to achieve the greater goal of a culture change towards proactive maintenance aiming at minimising operational opportunity lost due to unscheduled downtime of production equipment.

### ***1.4 Boundary of Study***

Although this dissertation forms part of achieving a bigger goal of establishing a culture shift from reactive maintenance management towards a more proactive maintenance management approach, this study will focus only on the establishment of an overall direction for the Metalloys maintenance management team. Together with this a measurement tool (in order to determine the current state of maintenance management) must be developed and the desired future state be defined. This will be used in the process of gap analysis in order to define implementation plans that will cover the necessary improvement areas identified.

This dissertation touches on but does not include the following:

- Organisational change management process after determination of the management gap within the overall maintenance systems.
- Actual rollout of the defined action plans due to time constraint.
- Monitoring and tracking of improvement initiatives.

## **1.5 Research Mythology**

The first steps towards the research will be in defining the different areas of evaluation and internally benchmarking best practices for each of these, not losing track of the overall maintenance strategy developed for management within maintenance.

In order to evaluate the current state of the maintenance management system effectively, questionnaires will be developed in four dimensions:

- Approach towards management aspect / element.
- Actual execution of the current desired approach;
- Results achieved; and
- Improvement methodology used.

The data collected from the questionnaires is used in order to develop action plans to close the internal gap between departments. Research and data collection is done throughout all organisational levels of maintenance management in order to get an overall current perception and actual state of maintenance management.

The population includes the different maintenance departments within Metalloys. These departments are North & South Plants, Engineering services and West plant. Members from each department, representative of the whole department, were included in order to collect the data from the questionnaire set. Members were selected from the lowest level in the organisation up to management in order to obtain a realistic spread of all maintenance functions. The customer, namely production, was also included in the data collection exercise. Employees in each department respectively consist of 66 employees for North & South, 46 employees for Engineering services and 39 employees for West plant.

## **1.6 Conclusion**

Referring to Table 1.1, the higher goal of both the operations and maintenance teams should be defined as “Delivering optimal business benefit from effective asset management”. In order for a maintenance team to achieve this goal, assets need to be managed and maintained according to certain standards, usually best defined by the OEM. These standards need to be amended on a regular base according to the conditions of operation, application and age of the equipment.

The main conflicting interest between operations and maintenance departments is the fact that maintenance teams need equipment to be out of operation for proper maintenance and operational teams need equipment to be in operation to produce. As maintenance is thus seen as a cost function, production usually wins this battle resulting in equipment not being maintained properly resulting in future breakdown of equipment costing the organisation more than is necessary.

Part of effective maintenance thus includes a proper change management process in order to achieve the desired buy in from both top management and operations, in order to justify maintenance actions required.

In order to achieve this desirable result, a credible, scientific process needs to be established in order to measure the effectiveness of maintenance activities expressed in well known KPIs of the business. This requires that equipment be understood within the operations, maintenance and management environment.