STRATEGY TO MAXIMIZE MAINTENANCE OPERATION

by

Michael Espinoza
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APPROVAL

Name: **Michael Espinoza, P.Eng.**

Degree: **Master of Business Administration**

Title of Project: **STRATEGY TO MAXIMIZE MAINTENANCE OPERATION**

Supervisory Committee:

Dr. Michael Parent
Senior Supervisor
Associate Professor
Faculty of Business Administration

Dr. Mark Selman
Second Reader
Executive Director, Learning Strategies Group
Faculty of Business Administration

Date Approved: _____

SIMON FRASER UNIVERSITY

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ABSTRACT

This project presents a strategic analysis to maximize maintenance operations in Alcan Kitimat Works in British Columbia. The project studies the role of maintenance in improving its overall maintenance performance. It provides strategic alternatives and specific recommendations addressing Kitimat Works key strategic issues and problems.

A comprehensive industry and competitive analysis identifies the industry structure and its competitive forces. In the mature aluminium industry, the bargaining power of suppliers is moderate; bargaining power of customers is high; threat of substitute is high; rivalry among competing producers is high; while potential of new entrants is low. The overall industry is extremely competitive.

Maintenance is a controllable cost. Maximizing maintenance effectiveness and equipment uptime will result in higher profit margins and low operating cost. Kitimat Works must develop a competitive advantage, given the significance of maintenance in today's operating environment where excellence in maintenance performance becomes a strategic issue for competitive organizations.

DEDICATION

This paper is dedicated to my to my wife, Celia whose love and support has been the most valuable resources throughout the four year program. Thank you, Celia, for taking more than your share of the work in raising our two young sons while I spent my weekends in our basement home office completing assignments and the late study work with friends. I love you more than I'll ever have words for.

To my parents, Pedro and Dora for sacrificing so much for me, showing me the importance of having long-term goals and for drilling into me the value and importance of education. I love you both.

My debt of gratitude goes to my sister, Erika who has been a great source of motivation and inspiration since the beginning of my studies. Your constant support and encouragement is much appreciated. Last, but not least, I dedicate this paper in loving memory of my grandparents.

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GLOSSARY

Alloy	A substance with metallic properties, composed of two or more chemical elements of which at least one is a metal, such as aluminum, and produced to have certain specific characteristics.
Alumina	A white, powdery substance produced from bauxite by a chemical process during which aluminum oxide is extracted from the ore. Between four and five tonnes of bauxite are required to produce about two tonnes of alumina, which yield one tonne of aluminum.
Aluminum	The most common metal on earth, constituting 8% of the earth's crust but never found naturally in its pure form. Aluminum metal is produced by separating aluminum from oxygen in alumina.
Asset	The physical resources of a business, such as plant, facilities, fleets or their parts and components.
Availability	The period of scheduled time for which an asset is capable of performing its specified function, expressed as a percentage.
Bauxite	An ore or rock composed of hydrous aluminium oxides and aluminium hydroxides. The most economic source of aluminum, it is predominantly found in tropical and subtropical regions.
Breakdown	Failure to perform to a functional standard.
Corrective maintenance	The maintenance carried out after fault recognition and intended to put the equipment into a state in which it can perform a required function
Direct Maintenance Cost	Costs incurred when purchasing parts, hiring labour or equipment, to perform maintenance.
Downtime	The period of time during which equipment is not performing its intended function.
EVA	Economic Value Added. It is the after-tax cash flow a firm derives from its invested capital less the cost of that capital.
Failure	When equipment seize to perform its required function to a specific standard.
Inspection	A function that is performed by maintenance personnel to establish the condition and maintenance requirements of equipment.

Inventory	All spare parts, tools, equipment and undelivered goods.
Maintainability	The rapidity and ease with which maintenance operations can be performed to help prevent malfunctions or correct them if they occur, usually measured as mean time to repair.
Maintenance	An activity carried out to retain an item in, or restore it to, an acceptable condition for use or to meet its functional standards.
Maintenance schedule	A comprehensive list of planned maintenance and its sequence of occurrence based on priority in a designated period of time.
Preventive maintenance	It is an equipment maintenance strategy based on replacing, overhauling or remanufacturing an item at a fixed interval, regardless of its condition at the time.
Predictive maintenance	Rather than looking at a calendar and assessing what attention the equipment needs, the 'vital signs' are examined and assessed what the equipment is trying to highlight. The term 'Condition Monitoring' has come to mean using a piece of technology (vibration analyser, ultrasonic analysis) to assess the health of the equipment.
Reliability	The ability of a system or component to perform its required functions under stated conditions for a specified period of time.
Reliability Centred Maintenance (RCM)	Maintenance optimization to ensure risks are managed and counter - action is planned through scheduled maintenance.
Repair	Restoring a failed item by replacement, repair, or renewal.
Work Order	Documentation that describes all the task associated with a specific job. Work orders include parts used, repair of components, labour hours etc.

1 DESCRIPTION OF THE ORGANIZATION

Alcan is not only the world's second largest producer of primary aluminium, but also a technology leader in this sector and a predominant global producer of value-added engineered products and composites, supplying key market sectors such as aerospace, automotive and beverage cans.

Intense competition on the supply side and heightened volatility in customer requirements on the demand side are the characteristics of the current business environment. Confronted with such a reality, the organization is under intense pressure to enhance their capability, to create value to customers and improve the cost effectiveness of their operations on a continuous basis. With this in mind, maintenance becomes an important support function in this industry. With significant investments in plant and machinery, maintenance plays an important role in meeting this crucial objective. In the Kitimat Plant, significant effort is placed in cost minimization. This includes the cost of maintenance and the cost of lost of operations due to scheduled and unscheduled downtime.

The objective of this project is to develop and address strategic alternatives that focus best on improving the current maintenance program as well as the maintenance performance for the Kitimat smelter. The alternatives result from an analysis of the organization competitive environment, industry driven forces and a situation analysis of the organization. The recommendation strategy provides the most potential for resolving the organization challenges and establishes a strategic intent.

1.1 Overview of Kitimat Works

Kitimat Works, located in Kitimat-British Columbia is a production unit of Alcan Primary Metal Group and it is the only aluminium smelter in Western Canada. The Kitimat smelter consists of a powerhouse, a casting center, a wharf operations/APP, and 7 Operational potlines. The smelter employs 1638 employees and currently produces 242,000 tonnes of aluminium of which 90% is sold to markets located in the Pacific Rim. The smelter produces high-quality metals- sheet ingot; trilok ingot and extrusion ingot, to the Asian markets.

The smelter meets and surpasses customer expectations by providing a unique combination of expertise, excellent customer support and meeting the customer's requested delivery times. To this end, the smelter has undertaken productivity and cost-reduction initiatives to improve equipment and operational performance. The smelter has been implemented with continuous improvement programs essential for maximizing value creation and it is committed to creating a safe work environment. In 2001, the smelter embarked on an extensive effort to revitalize its maintenance program with the introduction of reliability principles for reducing the high cost of unreliability and improving the smelter business performance.

1.2 Markets

The markets for most aluminium products are highly competitive. Aluminium competes with such materials as steel, plastics and glass, among others, for various applications in Alcan's key markets.

In the aluminium industry of today, the market dictates that only those facilities that focused on lowering cost would remain competitive in a global market economy. Thus, past expectations that raising production would result in an increased in profitability no longer hold. Indeed by reducing cost and improving operating efficiencies at Kitimat Works ensures that it will continue to be a

long term provider of billet, sheet and remelt ingot. Effort has been placed by the maintenance organization to significantly improve plant maintenance and equipment reliability as this is critical to driving down the overall cost of manufacturing, and thus ensuring the smelter position in the market place.

1.3 Customers

The Global competition and an increase in customers' requirements, has produced the need in Kitimat Works to reduce the number of breakdowns and failures to improve production. The increment in the number of orders and the need to respond quickly to them places a premium on the smelter ability to respond quickly to customer demands. The ability to satisfy customer requirements in a timely fashion results from the application of schedule and reliability maintenance programs that lead to reduced breakdowns and failures in the production of molten aluminum.

For example, extrusion and sheet ingots are considered to be value-added products as the alloys are treated to the customer's specifications by Kitimat Works. The plant remelt ingots, known for their high purity, are shipped to customers who will remelt them for use in a variety of processes other than extruding or rolling. In 2000, Kitimat Works shipped 51 percent of its exports to Japan, 23 percent to Korea and 21 percent to the US.[i]

1.4 Suppliers

Most aluminium plants are vertically integrated and have operations covering all aspects of the industry, from research facilities to mines, refineries, smelters, and casting establishments. This is the case of the Kitimat operation as it transforms imported raw materials to finished products.

The smelter however does work with local maintenance contractors and specific suppliers of maintenance equipment as it strives to realize savings through more efficient maintenance and procurement operations. Kitimat Works is committed to improving, optimizing and maintain its assets as well as managing the inventory and purchasing requirements, allowing it to compete in the areas of cost, quality and delivery.

1.5 Strategic Issues

Today's Alcan is committed to maximizing value for all its stakeholders. This focus on value is complemented by the Company's commitment to environment, health and safety and the continuous improvement of business processes. Kitimat Works strategic issues centres around these core values as a means of balancing growth and profit while still meeting the needs of all stakeholder groups. In terms of EHS (environment, health and safety) the smelter is aligned with ISO 14001, a globally accepted environmental standard. The smelter is committed to managing climate change issues by reducing greenhouse gases from smelting activities. The EHS program represents an attitude, a mindset and an acceptance by all employees of their responsibility and accountability towards implementing EHS best practices. The Continuous Improvement (CI) initiatives are aimed at maximizing opportunities by improving the Kitimat Works competitive position. The CI system integrates Lean Manufacturing, with its goal of reducing waste and improving process speed, and Six Sigma, with its goal of improving performance on critical criteria for customers.

Kitimat Works has worked to demonstrate maintenance is a major contributor to the business by improving equipment reliability. Higher plant reliability reduces equipment failure costs. Failures decrease production and limit gross profits. Boosting reliability, by reducing the cost of unreliability, improves the smelter performance. The motivation for improving reliability

is straightforward for a business plan: Improve reliability, reduce unreliability costs, generate more profit, and get more business.

Lastly, the smelter is driven to continually improve energy efficiency and reduce cost to better compete with aluminium imports, in global aluminium markets, and other materials. The smelter is vertically integrated as means to control the cost, quality and availability of carbon, coke, pitch and other raw materials for aluminium production as well as the electricity required to operate the plant.

1.6 Outline of Paper

Chapter 2 provides a description of the aluminium industry and its economics characteristics. A value chain analysis is used to better understand which segments or distribution channels in the Kitimat Works value chain yield the greatest competitive advantage. This is followed by discussion of Porter's Five Forces model to understand the degree of competition within the business environment. The chapter concludes with an assessment of key competitors with a framework for assessing the overall attractiveness of the aluminium industry.

Chapter 3 discusses the role of maintenance and the significance of achieving maintenance best practices. The discussion is used to measure the importance of maximizing profits by properly managing the physical assets in a way that provides the optimum level of equipment availability and reliability. The discussion enables the identification of current challenges facing maintenance in the industry.

The remaining chapters focus on Kitimat Works, its competitive environment and current strategies. In Chapter 4, analysis of the financial statements for Alcan and its key rival – Alcoa, is conducted to gain a sound understanding of the industry's competitive dynamics.

Chapter 5 discusses and evaluates the maintenance organizational performance. A SWOT analysis is used to identify the current strength and weaknesses of Kitimat Works relative to its competitors. The chapter addresses key strategic issues and problems facing the Kitimat Works maintenance organization and concludes with recognizing the need for change management in order for Kitimat Works to sustain a competitive advantage. Lastly, chapter 6 recommends specific courses of action that result from Kitimat Works internal and external analysis.

2 EXTERNAL ANALYSIS

2.1 Chapter overview

In order to assess the competitive aluminium industry dynamics, a working definition of the industry is required in conjunction with an overview of its economics characteristics. Such is the purpose of this chapter.

The discussion will be followed by Porter "Five Forces" framework as this will be used to examine the competitive forces that shape the aluminium industry and market. These forces will help us to analyse everything from the intensity of competition to the profitability and attractiveness of the industry. Each of these forces will be discussed in detail and methods for assessing the strength of each force defined.

2.2 Defining the industry

Alcan Inc., incorporated in June 1902, is a multinational producer of primary aluminium and a global producer of value-added engineered products and composites, supplying sectors including aerospace, automotive and building and construction.[ii] In addition, the company is engaged in packaging and recycling. Alcan has operations in primary aluminium, specialty packaging, aerospace applications, bauxite mining and alumina processing. The company operates through four business groups: Bauxite and Alumina, Primary Metal, Engineered Products and Packaging.

The aluminium production chain involves bauxite, alumina and aluminium. Because all of the stages of aluminium production are capital intensive, it has been essential for companies to either have their own alumina supply or to secure long term supply commitments for alumina. Thus, historically, large vertically integrated companies essentially control the production of aluminium in the western world. In the 1980's and the 1990's, several independent smelters started operations and grew, relying primarily on long-term contracts with periodic price reviews in order to ensure project financiers that operating costs would remain constant. The alumina supply was provided by companies with low-cost refineries that had excess capacity, or by commodity traders that were able to arrange short-to medium-term alumina supply.

Furthermore, the industry faced increased competition as a result of deregulated energy markets and the technical aspects of maintenance are subject to significant financial constraints. To safeguard their own successful competitive position, smelting industries are being forced to rethink their entire spectrum of maintenance strategy and to adapt them to meet the new challenges. One aspect of this process – which, in many cases, amounts to a complete reorientation of the company – is the need to implement an effective maintenance program to respond to the changing expectations.

For instance, traditional maintenance approaches mostly consisted of pre-defined activities carried out at regular intervals (scheduled maintenance). However, time proved that such a maintenance policy to be quite inefficient: it may be overly costly (in the long run), and may not extend component lifetime as much as possible. In the last ten years, therefore, many smelting facilities replaced their fixed schedule maintenance routines with more flexible programs based on an analysis of needs and priorities, or on a study of information obtained through periodic or continuous condition monitoring (predictive maintenance). Some of these routines are named Reliability-Centered Maintenance, commonly abbreviated to RCM. In an RCM approach, various alternative maintenance strategies can be compared and the one most cost-effective for sustaining

equipment reliability selected. The maintenance organization at Kitimat Works is aware of the extent to which equipment failures affects safety and the environment, and acknowledge the connection between maintenance and product quality. Given the nature of the smelter: old production technology; heavy industrial equipment and the increasing pressure to achieve high equipment availability and to contain cost, RCM was selected as the best approach to maintenance.

2.3 Economics Characteristics

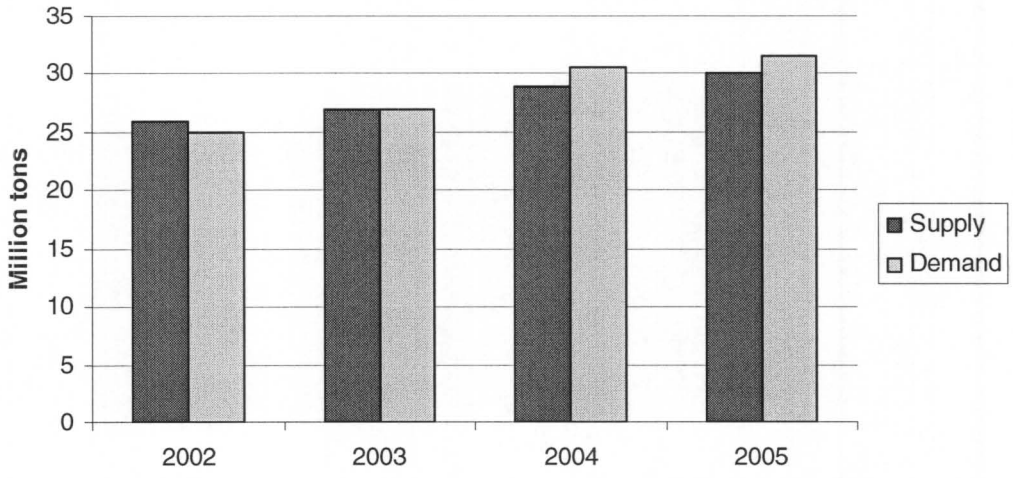
The aluminium industry is a mature, commodity based industry whose financial health is tied directly to economic cycles. Prices are subject to constantly varying supply/demand factors, such as global output, economic growth, and strength of the US dollar.

Global overcapacity has plagued the aluminum industry for years, leading to oversupply and weak prices. However, in the last few years global producers have competed on cost of energy, forcing older smelters to shutdown. This has been successful and benefited all remaining players, but lately the trend has reversed. Russia, a perennial contributor continued its high export volumes, and the economic downturn reduced demand. The combinations of these factors have resulted with a strong supply/demand imbalance that has led to gradual erosion in aluminum prices. Primary aluminum consumption long-term growth is forecast at 3-4 % annually. The growth is accredited to global capacity additions in regions with abundant energy resources and the Chinese primary aluminum demand growing strongly.[iii] See Figure 2.3.1.

Efforts to improve efficiencies through scale and to obtain better pricing discipline have led to several mergers over the last five years (i.e., Alcoa-Reynold; Alcan Pechiney). Consolidation in the mature aluminum industry is the logical pursuit once growth prospects have been exhausted and industry player's look to drive earnings through building market share.

Merging with other companies remains one of the most effective ways to accomplish this goal, and will likely be a persistent trend in this industry.

Figure 2.3.1: World Primary Aluminium Supply and Demand Balance



Source: Author based on Alcan Investor Workshop. Alcan Presentation, December 7, 2004.

In addition, international aluminum prices, which had touched a low of US$1,140/MT in March 1999, improved sharply thereafter to a peak of $1,700 US in early 2000. This rise followed an improvement in the global economic outlook and the significant capacity closures in the Pacific North-West region on account of large-scale power related problems. However, a weak performance by the developed economies resulted in a downward correction in aluminum prices after mid-2001. Global aluminum prices remained in the region of US$1,350/MT during 2002, but have been increasing steadily since 2003 to reach the current level of around US$1,727/MT in 2005, due to anticipation of stronger growth in economies around the world, especially the United States. Refer to Figure 2.3.2 to visualize the five-year aluminum trend.

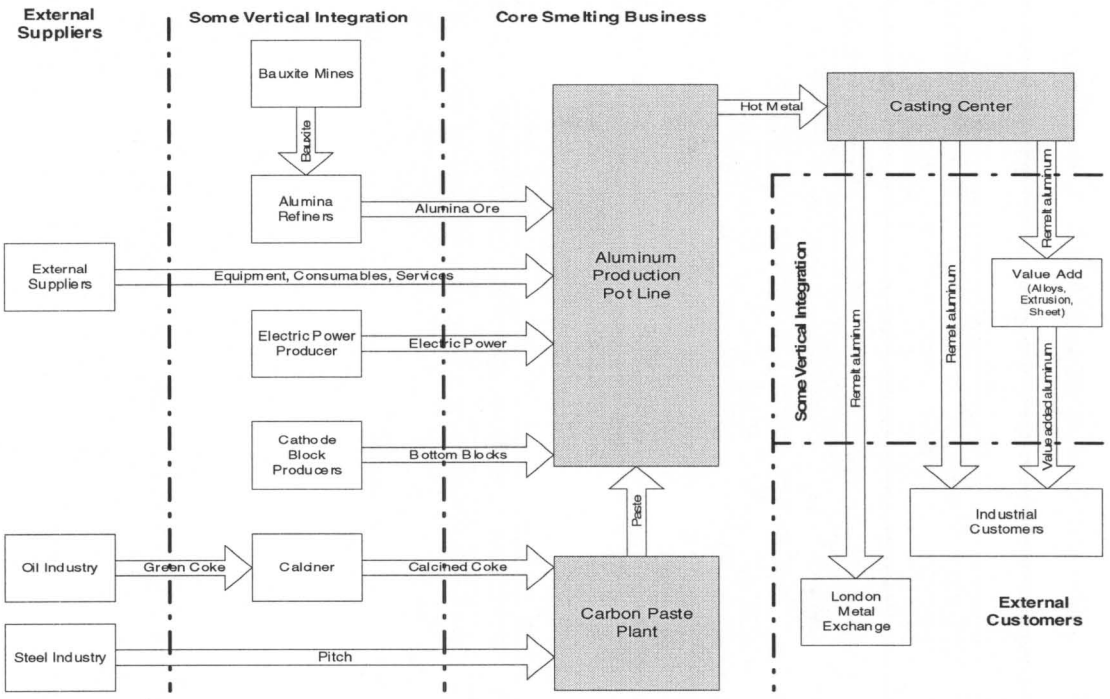
Figure 2.3.2: Aluminium Price Trend 2000-2005

Source: Adapted from Alcan, Global Aluminium Industry: A Mid-Year Assessment, by permission.

2.4 Industry Supply Chain

The system starts with the mining of bauxite and ends with the aluminum as the product. The graphic in Figure 2.4.1 represents a simplified view of the aluminum industry in the world of Kitimat Works. The basic raw material –bauxite ore, is first mined, crushed and then refined to produce alumina (aluminum oxide powder). The alumina is then shipped to the smelter where an electrolytic process is used to remove the aluminum from it. The reaction takes place within large pots through which a continuous electrical discharge is directed. Alumina is dissolved within pots when electrical current is run through the mixture, from the anode to the cathode. Aluminium is drawn into a crucible at regular intervals and transferred to a holding furnace where alloys are prepared. Once its composition has been analyzed, aluminium is normally made into ingots whose shape depends on the transformation process for which they are intended.

Figure 2.4.1: Aluminium Industry Value Chain for Kitimat Works



Source: Author

To maximize the product value and to remain competitive in the market place requires all sections of the Kitimat value chain to operate competitively. For example, upstream aluminium is a highly energy and capital-intensive business, which competes principally on the basis of a few critical cost factors — bauxite reserves, logistics, and electrical energy. Downstream aluminium, while also relatively capital intensive, is driven to a large extent by customer needs and competes on a complex and dynamic mix of lead times, prices, product attributes, and customer perceptions of value. Value in the Kitimat chain exists in electricity and alloying primary aluminium with other elements.

Currently, the potrooms are increasing amperage and improving current efficiency, resulting in an increase in metal production without additional resources for production gains. This creates opportunities for improvement in operational efficiency and asset turnover that will have a positive impact on the EVA of the smelter value chain. Another activity that adds value is the

differentiated product that is produced in the casting centre. Alloying aluminium with other materials creates beneficial properties for many customers of the finished product. Operational efficiencies and working alongside customers to help them make the best use of our products and their unique properties adds value to the casting operation. The profitability of the casting centre value chain is dependant on the equipment reliability.

Furthermore, Alcan Kitimat Works process for producing aluminium (Vertical-stud Soderberg technology) is old, obsolete and very labour intensive. This places the smelter at a disadvantage when competing with low-cost aluminum producer having a modern pre-bake technology. Controlling its maintenance cost - labour, materials and contract services, and focusing on asset management towards improvement in reliability will add value to the operation. For example, high equipment reliability will lead to reduced failures, increased production and lower material costs. Maintenance has a huge impact on the performance of the smelter operation and therefore determines the profitability of the operation. It is important for the smelter to maximize the maintenance effectiveness and equipment uptime, as this will yield an increase in asset turnover and higher profits.

In the value chain, Kitimat Works is systematically focused on a sustainable management of waste, the main driving force is to minimize costs and avoid adverse environmental impacts.

2.5 Aluminium Industry Overview

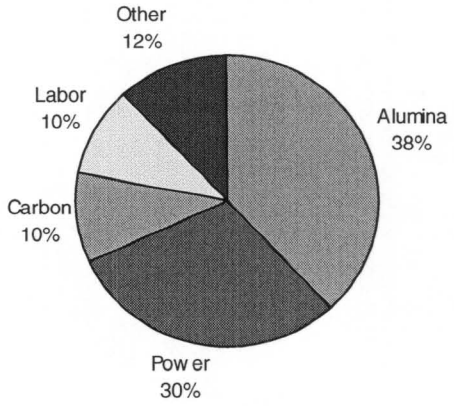
As markets expand, finite supplies of aluminum suggest an enduring need for primary aluminum in North America. The location of primary production facilities is contingent to a great extent on the cost and stability of electrical supply. High electrical costs and instability have led to the erosion of primary production in North America. The decreased availability and higher cost of energy in the United States and Canada have restricted the ability of the domestic aluminium industry to compete against those regions of the world where energy resources are readily available at low cost.

Worldwide smelter expansions and new plant construction have been focused on nations with low-cost energy and labour resources. Northern Brazil, Canada, Venezuela, Argentina, and Russia all have relatively low-cost hydroelectric power supply.[iv] In addition, countries in the Persian Gulf are using their abundant natural gas reserves to generate electricity to supply smelters. Aluminium producers are working to optimize operations and increase their energy efficiency through better process control and operating practices, including the use of point feeders in smelting. In addition, globalization has tied the economies of all nations more closely together, so that the direction of the North American economy has a greater impact on other nations and vice versa. The rise of larger, and often multinational, corporations has strengthened this connectivity. The mergers of Alcoa Inc. with Reynolds Metals Company and of Alcan Aluminum Limited with the Swiss company Algroup and Pechiney to form Alcan Inc. are examples of this trend.

Furthermore, primary aluminum producers are driven to continually improve energy efficiency and reduce cost to better compete domestically with aluminum imports. Thus, aluminum companies are seeking to enhance product quality while reducing cost, waste, and are

increasing the degree to which they are vertically integrated as a means to control the cost, quality, and availability of raw materials for primary production. Leading organizations are working more effectively by doing only the right, absolutely necessary work, to improve equipment reliability and close the value gap of maintenance effectiveness versus maintenance efficiency. The typical smelter operating costs are identified in Figure 2.5.1. Excluding the cost of alumina, then power, carbon and labour are the cost drivers as they represent more than 80% of production cost.

Figure 2.5.1: Typical Smelter Operating Cost Distribution



Source: Author based on Technology in the Global Primary Aluminium Industry. Alcan Presentation, February 15, 2004.

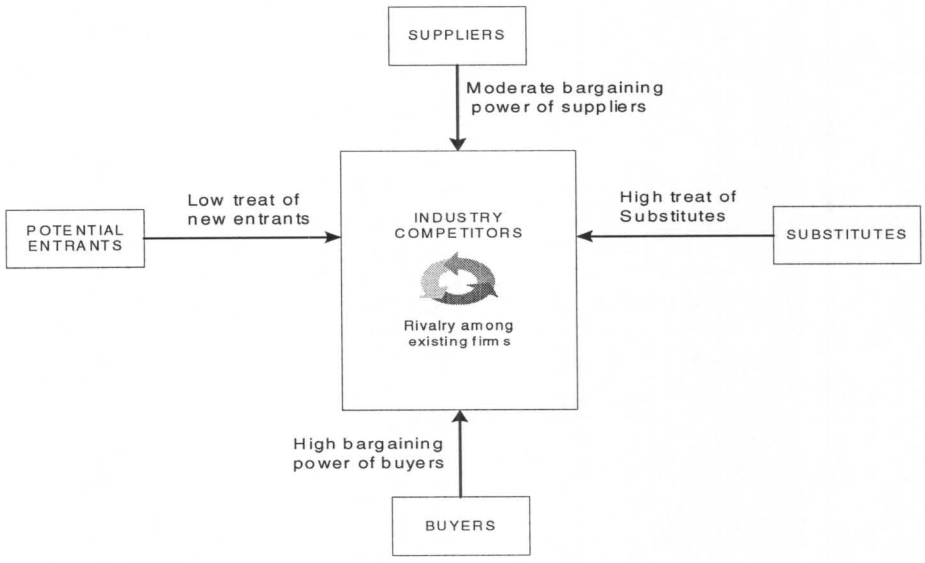
Currently, Kitimat Works has an established niche market and customers. The smelter location and closeness to consumer markets is advantageous. While the availability and low cost of electricity from its hydroelectric facility offers a competitive advantage. Kitimat Works expectations are placed in improving the health and safety of the workers and the physical function of maintenance. These two synergies are linked and play an important role in terms of the performance of the business. A positive performance will reduce the overall operating cost while boosting the productivity of the smelter. In an industry where cost plays a role as a major

competitive advantage it is important to improve on maintenance and equipment reliability as this has a direct impact in the profit margin of the smelter. Reduced failures directly reflect on fewer emergencies, which allows for more planned/scheduled work resulting in more productive workforce and an increased in equipment availability and reliability.

2.6 Porter's Five Forces

The Porter framework serves to analyse the relative strengths of the aluminium market. This model will show how maintenance practices can enhance the business by identifying and managing the competitive pressures. The metrics that are used to judge the aluminium commodity cover bargaining power over suppliers and buyers, threat from new entrants and substitutes, and ability to drive demand. Refer to Figure 2.6.1 to view the aluminium industry assessment in terms of Porter's Five Forces Model.[v]

Figure 2.6.1: Porter's Five Forces for the Aluminium Industry



Source: Porter 1985.

2.6.1 Bargaining Power of Suppliers

Supplier power in aluminium industry is moderate to high as the market is dominated by a few large suppliers rather than a fragmented source of supply and the suppliers customers are fragmented, so their bargaining power is low.

Alcan Kitimat Works is one of the few aluminum suppliers where the value added product extrusion ingot and sheet are produced specifically to customers in the Pacific Rim. Kitimat Works valued product has a niche market and the plant seeks to excel within this market segment. Catering to this market results in customers having a high bargaining power. The smelter seeks competitive advantage through its product differentiation and its customer service support. The alloyed billet and sheet product is also an important input to the buyers business and this exerts a threat on an industry where suppliers are an oligopoly. In order for Kitimat Works to provide customers with a high quality product it must continue striving toward differentiating itself from the competition. Maintenance plays a role in achieving this critical element and the organization has capacity to improve the maintainability of its assets by focusing more on elimination of defects and improving precision of all work. Improving maintenance results will increase productivity of the smelter assets, reduce cost of material/labor and lead to a competitive environment in the aluminum market. The following are the competitive pressures that creates a moderate to high bargaining power of suppliers in the aluminum industry

Electricity: Since electricity cost is the largest element of aluminium manufacturing production, securing sources of low cost electricity is critical to aluminium producers. Power makes up about 30% of the cost of aluminium production and must be available in the same geographical region as the smelter due to transmission losses. There is no threat of forward integration. Power has alternative uses, which may give power suppliers a big advantage over aluminium smelters when bargaining.

Bauxite: Even though bauxite could be found almost everywhere, large-scale commercial production is highly concentrated in a handful of mines in a few countries. In 2001, Australia, Jamaica, Brazil and Guinea produced 70% of bauxite total world production.[vi]

Alumina: Alumina is a high cost raw material. There is a lot of vertical integration in the aluminium production and it is specific to the aluminium industry; therefore, producers have less power over smelters than if there were alternate uses. Furthermore, alumina refineries are built close to bauxite mines because refineries have to be tailored to a particular ore characteristic of the mine and bauxite transportation is very costly ($22/ton). For that reason, alumina production is geographically concentrated as well. In addition, alumina from each refinery is different in particle characteristics and smelters prefer to use alumina from a single refinery.

Pitch: Pitch is a by-product of the steel industry and is used in the construction industry. Petroleum pitch is also available and switching cost is low. There is little threat of forward or backward integration.

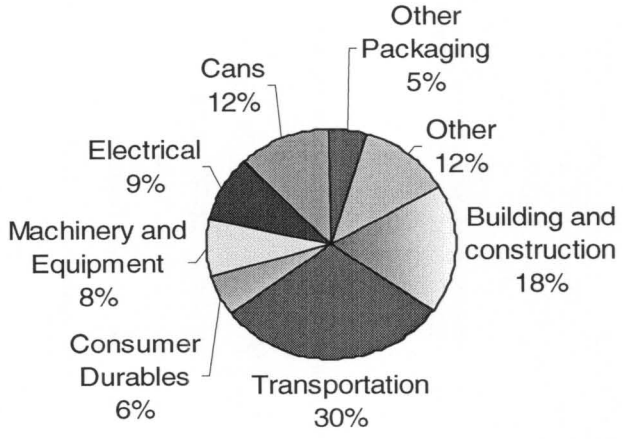
2.6.2 Bargaining Power of Customers

In the aluminium industry customer power is high due to the number of consumer groups that far outweigh the number of primary aluminium manufacturers and the low switching cost from one aluminum producer to another. Major customers for aluminium producers are transportation (30%), packaging and containers (17%) and the construction industry (18%)[vii]. Customer power is disproportionately strong in the aluminium industry and this is identified in Figure 2.6.2 where it shows the break down of aluminum demand on a sector-by-sector basis in the western world.

More significant is that some customers might choose a substitute such as plastic and steel when aluminium prices are too high. Since customers tend to be multinational manufacturers, they usually want to secure long- term large quantity contracts. No aluminium producer can afford to

lose those large-scale global customers because refineries and smelters cannot even temporarily shut down without incurring huge cost.

Figure 2.6.2: End-Market Usage of Aluminium (Western World)



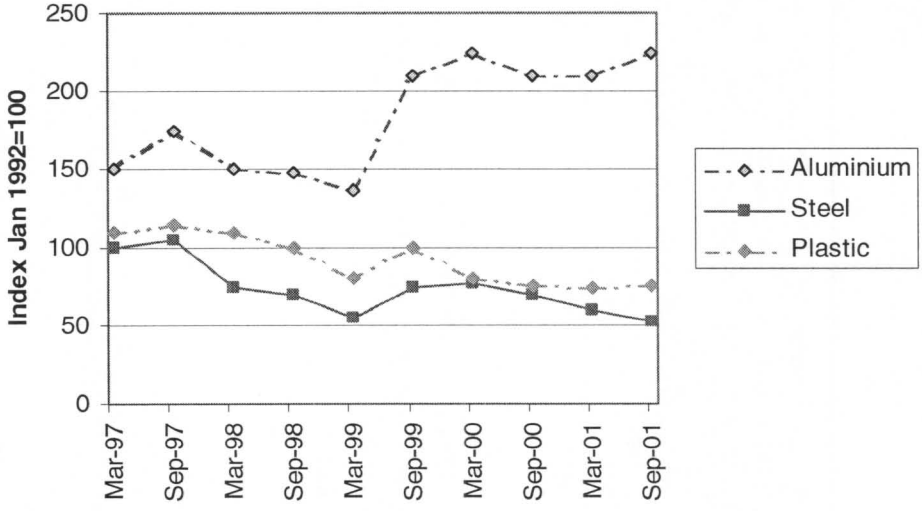
Source: Author based on China's Role in the Aluminium Industry. Alcan presentation, April 29, 2004.

In order for Alcan Kitimat Works to achieve a significant competitive advantage and keep cost under control it must continue to differentiate its product and have operational efficiencies. The ability to satisfy customer demands and understand clearly what are the customer needs and how to position the product for wide market application are critical in a competitive global market with an aging smelter. The smelter culture requires quality in all aspects of the company's operations, with processes being done right the first time and defects and waste quickly eradicated from operations. The elimination of failures and equipment downtime improves the competitiveness and effectiveness of the maintenance organization. This results in higher quality products, delivered on time and an increase in profitability.

2.6.3 Threat of Substitutes

Threat of substitutes refers to the ability of consumers to switch between commodities if the price of one rises. Substitute power in the aluminium industry is high due to competition with other materials for other end user. In the end-market usage sectors such as cans and cars, consumers can switch from aluminium cans to steel cans or plastic bottles and to steel or other materials for aluminium in car parts. For example, one of the strongest contributors to long term growth in the aluminium sector is the trend towards substituting steel products with aluminium, especially in the automotive industry. Currently in Canada automobiles account for 27% of aluminium shipments and government regulations will likely lead to increased shipments over time. Federal regulations mandating increased fuel economy, particularly in the truck/SUV segment, are leading carmakers to build lighter cars. Figure 2.6.3 shows how aluminium competes with other various end-users.

Figure 2.6.3: Aluminium, Steel and Plastic Stock Market Performance



Source: Author based on Global Industry Aluminium Overview. Alcan presentation, January 14, 2002.

In Alcan Kitimat Works, the threat from substitutes exists, as there are alternative products with lower prices or better performance parameters for the same purpose. These substitute products may potentially attract a significant proportion of market volume and hence reduce the potential sales volume for Kitimat Works. As more substitutes become available and affordable, the demand becomes more elastic since customers have more alternatives. Substitute products may limit the ability of the smelter to raise prices and improve profit margins. The threat of substitutes often impacts price-based competition and this is where maintenance can have a significant impact by controlling and reducing cost. The threat can be minimize from a maintenance strategy point of view by enhancing equipment reliability and better integration of operations and maintenance. Achieving superior maintenance results leads to reliability improvements that reduce production losses and continuously increase the return on production assets. This practice will represent significant savings in maintenance and will engage the smelter to compete at price with other substitutes or industries competing for the same market presence.

2.6.4 Potential of New Entrants

It is very difficult for a new firm to enter the aluminium industry. The industry is prohibitively capital intensive. Barriers to entry are high due to required capital to build a standard size smelter; capital is sunk into specific smelting equipment/site specific location and existing producers control critical resources. A new producer, if it wants to be vertically integrated, needs to find, for example, commercially viable bauxite mines, almost all of which are already owned by existing producers.

Incumbent producers have not found an easy way to expand and grow in the aluminium industry. Besides tremendous required capital for expansion, possibility of overcapacity has hindered the ability of companies to expand fast. As a result, Alcan has instead sought to expand through acquisition of existing companies and brownfield projects.

Alcan Kitimat Works increasing service and product differentiation in a niche market creates a competitive advantage by the development of their specific resources and capabilities. These approaches have created high barriers to entry for new firms seeking to enter the high-end alloyed product. In this specialized commodity segment, Kitimat has managed to reduce the rate of entry of new firms; thereby maintaining a level of profits. The barriers to entry can be viewed as enhancing the smelter competitive advantage and can be sustain by producing quality product at the lowest achievable cost for the targeted market segment in the Pacific Rim.

In order to sustain its alloyed market share and eradicate future threat of new entrants, the maintenance program must concentrate on manufacturing excellence as determined by uptime, unit cost of production, delivery performance, and safety throughout the organization. This will assure greater return on assets and further improve the smelter competitive edge by being a low-cost producer.

2.6.5 Rivalry Among Competing Producers in the Industry

Competition in aluminium industry is potentially very high. It stems mainly from two factors. First, aluminium is a commodity, for which product differentiation is hard to come by. Second, aluminium producers are basically price takers as prices are set by supply-demand balance in London Metal Exchange. However, lack of flexibility in assets and output, long lead time to add new capacity and the huge required capital imply that a company can not encroach on others' market share without risking prohibitively costly punishment by prolonged overcapacity and plummeting prices.

In addition, extremely high fixed cost and start-up cost have been a powerful protection against new entrants and helped stabilize the competitive picture. Increased supplies from major producer countries such as Russia and China have cut into Canadian companies sales. China, too,

has recently turned into a net exporter of aluminium. Furthermore, a strong dollar has made competing domestically harder as imports become cheaper, further eroding profits.

Currently, intense competition exists between the two major aluminium producers- Alcan and Alcoa. The high competitive pressure between these competitors results in pressure on prices, margins, and hence, on profitability. Both major aluminum players have similar strategies and there is not much differentiation between the two competitors and their products; therefore, competition gets in the form of cost control and operational efficiencies.

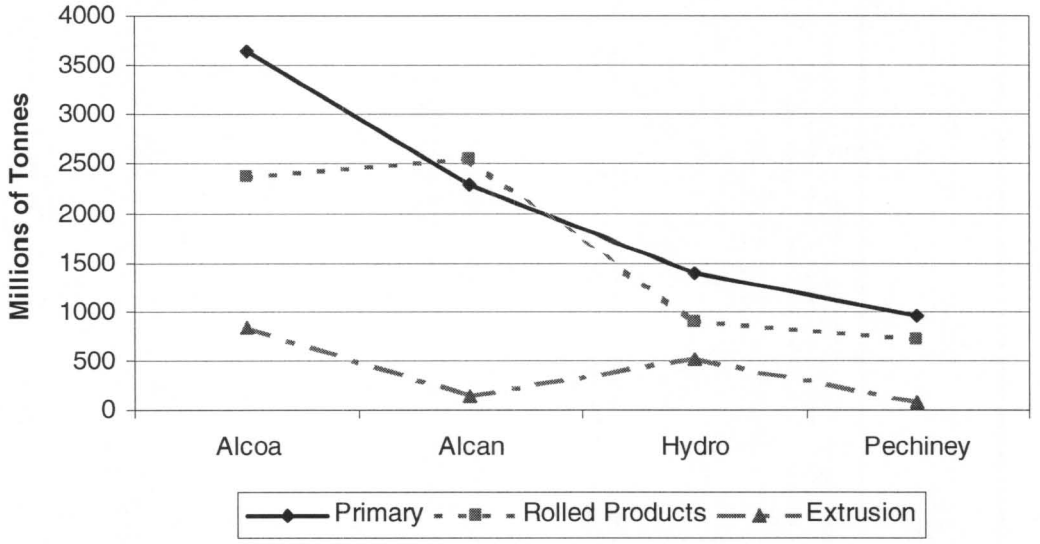
One way for Kitimat Works to contribute to achieving a competitive advantage with its major rival is by improving its maintenance program. The enhancement of the maintenance program plays a role in lowering the cost in terms of labour/material, spare parts and overtime. Achieving maximum efficiency in maintenance will lead to a reduction of emergencies, which results in equipment reliability/availability and high maintenance team efficiency.

2.7 Key Competitors

The global aluminium smelting industry is dominated by a handful of companies. Only in those economies that have been largely closed to foreign investment (e.g., China, Eastern Europe and the former Soviet Union) do the major aluminium multinationals have little influence. The four largest players, Alcoa, Alcan, BHP-Billiton and Norsk Hydro, control 52 per cent of capacity outside China and of the former communist-bloc countries. The top ten companies control almost three-quarters of Western capacity. Ownership is even more highly concentrated in major aluminium producing countries, where Alcoa and Alcan control around 40 per cent of production. In each region, most smelters use a similar amount of electrical energy per unit of aluminium metal produced, and electricity costs typically constitute of 20-30 per cent of production costs.[viii] Electricity prices therefore have an important influence on profitability.

Price, location, and technology are the principal competitive factors in Alcan's market. Figure 2.7.1 displays the key competitors before the Alcan-Pechiney merger in the aluminum industry.

Figure 2.7.1: Major Aluminium Competitors



Source: Author based on Company reports, production volumes 2002.

There has been considerable consolidation within the industry: Alumax, Inespal, Almix and Reynolds have been acquired by Alcoa; Alusuisse and Pechiney have been acquired by Alcan, Russian smelters and CIS refineries have been consolidated to form either Rusal or Sual, and all the Chinese alumina plants as well as some smelters have merged under Chalco.

In addition, Kaiser Aluminum and Alcan have divested a majority of their alumina assets and as a result Alcoa has become the major alumina supplier on a global level, and Chalco has become the major alumina supplier for China.

2.8 Attractiveness of the Industry

The major challenges facing the aluminium industry make it an unattractive industry even though production and consumption levels are on the rise. Currently, aluminium producers compete on cost reduction, price and energy improvements and productivity improvements. The threat of substitutes is high due to the possibility of the product being replaced by other end-users. As a result of this concern aluminium manufacturers are taking steps to reduce their production cost. Cost reduction and productivity improvements are essential in the aluminium industry for it to remain competitive in today's world markets. Furthermore, consolidation in the aluminium industry has increased competition and this has led to the formation of a number of very large and highly diversified global players (e.g., Alcan & Alcoa) as producers seek to benefit from economies of scale.

Competition between aluminium producers arrive in the form of cost control and the greatest opportunity lies with improved equipment productivity. These savings manifest themselves in the areas of increased equipment uptime/availability, improved product/service quality and finally, improved equipment/service reliability. In the area of increased uptime, savings can be realized through the implementation of programs resulting from: Breakdown analysis; Failure analysis; Rationalizing PM frequencies; Predictive maintenance; Planning and scheduling of work. Competitors are shifting their maintenance department to develop modern maintenance practices that can produce dramatic bottom line improvements as the industry is driven by simultaneous demands to reduce cost and increase profitability.

The potential of new firms entering the market is very low and difficult due to the capital required to build a smelter. Lastly, supplier power is moderate as manufacturers are increasing the need to become vertically integrated in order to control the cost of raw materials and quality.

3 MAINTENANCE IN THE ALUMINUM INDUSTRY

3.1 Industry Maintenance Context

Maintenance is the most critical business process in terms of its potential impact on the bottom line. In the primary aluminium industry, excellence in the maintenance performance becomes a strategic issue for the organization. Maintenance can play a major role in reducing quality defects, increasing production capacity and throughput, and improving overall plant productivity and profitability, as a primary contributor. But for maintenance to make that contribution, it must be recognized as an integral part of the plant production strategy -- an integral component of the overall plan by which the plant provides its product to the customer.

In the late 1980's, DuPont benchmarked their performance against companies in the United States, Europe and Japan. This study produced a detailed, dynamic model of plant operations and reliability to better understand how the "best of the best" companies achieved their performance and the true cause-and-effect relationships. DuPont maintenance benchmark is used in the aluminium industry, and Kitimat Works maintenance program recognizes the importance of this benchmark as it strives to become a world-class maintenance facility.

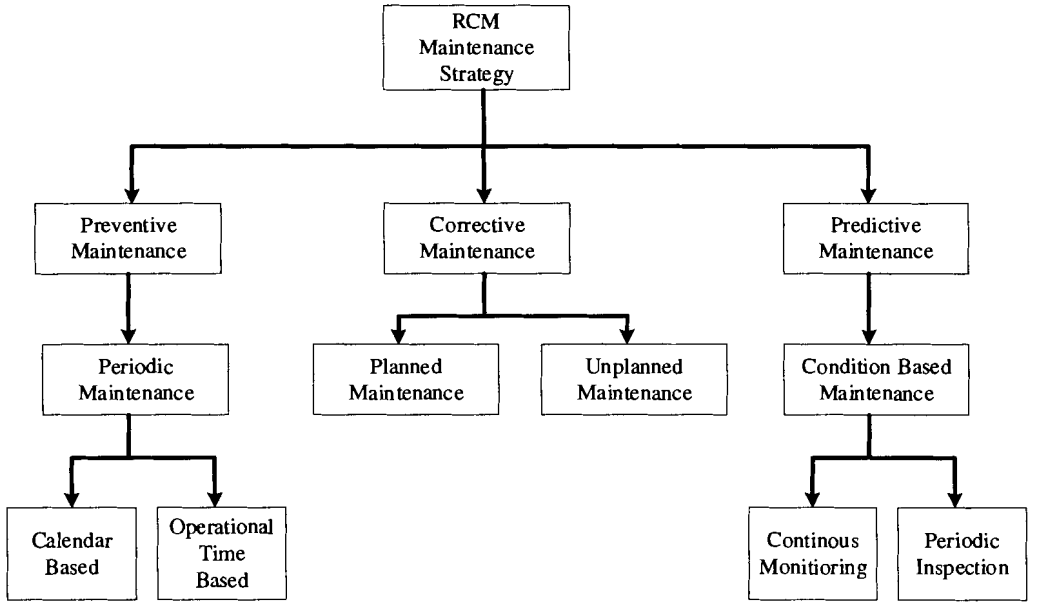
3.2 Industry Maintenance Program

The maintenance program specifically is designed to enhance operating efficiency of the plant. Major competitors in the industry share this practice as they embark on a maintenance program focusing on improving the maintenance processes and increasing the effectiveness or productivity of asset and human resources. The focus of any maintenance program is to have a

well run maintenance organization with low labour and material cost, that makes effective use of predictive maintenance programs to predict, prevent and correct equipment failures. Managing failures and their consequences results in high equipment reliability, satisfaction from customers, owners and users as well as an increase in productivity.

In managing potential failures, the industry has typically focused on several types of maintenance work to assist plant improvement programs for reducing the high cost of unreliability. See Figure 3.2.1.

Figure 3.2.1: Typical Maintenance Program



Source: Author based on Maintenance Strategy for Enhancing Profitability.

RCM is the maintenance technique of choice for many primary aluminium industries. It is a structured process used to determine optimal maintenance requirements for equipment in a particular operating environment. It combines the strategies of corrective maintenance, preventive maintenance and predictive maintenance, and applies these strategies where each is appropriate, based on the consequence and frequency of functional failures.

The Kitimat Works maintenance program is in alignment with the evolution of maintenance practices. The performance of maintenance is focused and centered on profitability.

The goal of maintenance in the Kitimat Works organization is to strive for high reliability, which will optimizes equipment availability and increase labour productivity. The optimizing or blending of maintenance is driven by the quality and quantity of the existing maintenance program. It uses maintenance effectiveness assessments, reliability centered maintenance (failure modes and effects analyses) and root cause analyses as tools.

How is it possible then for Kitimat Works to have failed in sustaining significant improvements in maintenance and reliability and perform well below world-class standards in spite of the fact that all of the components of world-class are known to the organization? Not achieving success in the maintenance organization is attributed to the lack of communication of the maintenance objectives and strategy to the trades, shop and production employees; untapped capacity of trades; and the poor integration of maintenance and operation activities.

Maintenance objectives must be clearly stated. Ensuring that people perform the correct function on the right equipment. The communications of maintenance strategy must address the context, content and the courses of action for achieving superior maintenance performance. These are answers to the 'Why', 'What' and 'How' of the maintenance strategy. The message should articulate the reasons for adopting the strategy in terms of the organization's internal environment as well as the realities of its external environment. While Kitimat Works management realizes the rationale for embracing the strategy, the justification is often lost on the rest of the organization as they, from their much more limited perspective, only see part of the whole picture. When the message is clearly expressed and widely communicated it can rally the entire organization around a shared mission. Content describes what needs to be accomplished - the strategic objectives and their target values, expressed in terms meaningful to people at working level.

The trades in the smelter have a significant amount of experience. The majority of the trades have been with Alcan Kitimat Works their entire career and they evolved their skills to maintain the asset, which in some cases is obsolete. The smelter has a strong unionized culture and this creates lack of trust with management. Managing the strong resistance is required to change the beliefs and attitudes of the trades. The development of new relationships between management and the union will allow both sides to function as a learning organization, and increase its capacity to generate step change breakthrough results.

Furthermore, within the maintenance organization, there needs to exist a comprehensive plan as to how the maintenance department should function together with operations to increase overall profitability for Kitimat Works. A well functioning maintenance program must be developed and managed in close collaboration with operations. Involvement of operators in maintenance issues would be desirable in terms of increasing understanding and preventing operator failure. Operations should also take part in maintenance activities, for example through analysis of failures and design of PM programs as they have considerable knowledge of the equipment that might be helpful in those situations.

3.3 Maintenance Best Practices

The pressure for customer responsiveness and profits has changed the role of maintenance. The metric of plant maintenance is on the ability of the plant to meet the strategic goals of the company beyond mere cost savings, such as improved plant output, predictability, quality, customer service, safety, and environmental control. The global competitive industry environment has lead to the creation of the optimization of maintenance in order to achieve world -class performance. DuPont's maintenance model 'to achieve excellence' is summarized in six points:

- Eliminate defects
- Improve precision of all work
- Redesign equipment so that it fit for purposes of the business today
- Focus more on long term value and sustainability, not on short term cost
- Have the discipline, in the whole organization, to pursue the right things for proactively, every day in every decision.
- Make "don't just fix it" improve it" a daily reality.[ix]

Furthermore, DuPont suggest that if a company focuses on planning only they will improve their uptime by 0.5%. If they focus only on maintenance scheduling, uptime will improve by 0.8%. If they focus on preventive and predictive maintenance only, uptime will actually get worse by 2.4%. If organizations focus on all of these three aspects, they will receive a 5.1% improvement in availability. These results may well sound appealing in their own right, but DuPont has found that by adding defect elimination to the initiatives undertaken, then a 14.8% improvement in availability may be achieved in their plants.[x] This information is provided in the Table 3.3.1.

Table 3.3.1: Effect of Different Reliability Engineering Activities

Strategy	Change %	Uptime %
Reactive		83.50%
Planning Only	+ 0.5%	
Scheduling Only	+ 0.8%	
Preventive/Predictive Only	- 2.4%	
All Three Strategies	+ 5.1%	88.60%
Plus Defect Elimination	+ 14.8%	98.30%

Source: Author based on manufacturing game.

To achieve maintenance optimization in Alcan Kitimat Works requires an evaluation process that examines current functions, tasks, and activities to achieve the proper investment balance between reactive, preventive, predictive, and proactive maintenance activities. This can only be achieved through a fundamental understanding of the predominant failure modes of the equipment. By understanding the failure mode and looking at the probability of failure for a particular sub-component, the best judgment can be made regarding the appropriate long-term and short-term corrective actions.

In some cases, a preventive maintenance approach is inappropriate for equipment where the design life of the parts involved in the failure mode is less than the expected minimum maintenance cycle. In this case, a change in the design specifications is often necessary to achieve reliability improvements. Other cases that show a PM strategy as inappropriate as a result of failures caused by inadequate or improper repair procedures. These failures show up as "infant mortality" or "early wear-out" problems. Diagnostic technologies (vibration, thermography, or performance tests) can play a role in identifying symptoms associated with problems before a machine is put back into service. However, unless this information is readily available to the workers performing repairs, these kinds of problems are rarely identified before re-commissioning.

Maximizing individual worker effectiveness will result in an increase to the overall reliability of the smelter. This improves the work environment because each worker has a greater share of the success of the smelter. The term "optimization" implies the goal of maximum plant production capacity at minimum cost. Thus, Kitimat Works goal of maintenance optimization is to achieve the highest level of reliability for the least investment in parts and labor.

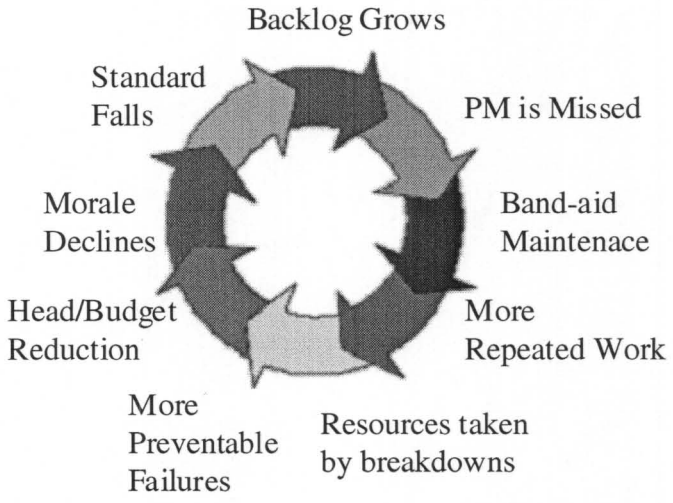
3.4 Challenges of Maintenance

Maintenance in Kitimat Works is one of the largest controllable operating costs in our organization. It is also a critical business function that impacts on commercial risk, plant output, product quality, production cost, safety, and environmental performance. For these reasons, maintenance is regarded in best practice organizations not simply as a cost to be avoided, but together with reliability engineering, as a high leverage business function. It is considered a valuable business partner contributing to asset capability and continuous improvement in asset performance.

The dilemma face by the maintenance supervisors in the organization is that they barely have sufficient resources to keep the plant working, let alone find ways of improving reliability performance. When the organization encounters a maintenance emergency, scarce maintenance resources are rationed with breakdowns having first call on resources. In these cases Preventive maintenance suffers, which inevitably results in more breakdowns and the cycle continues. In addition to lost productivity through unplanned maintenance, the fix-it-quickly mentality promotes band-aid maintenance, or temporary repairs, that often worsen the situation. Temporary repairs take additional labour to correct, or in the worst case, fail before correction. Often in an effort to control costs, personnel numbers are reduced and morale declines as the fewer remaining personnel almost give up in despair. With this, work standards drop. The vicious cycle feeds on

itself and gradually the organization becomes almost entirely reactive. This situation is depicted in Figure 3.4.1.

Figure 3.4.1:Maintenance Vicious Circle



Source: Adapted from Maintenance Contribution to the Business. Alcan presentation, by permission.

The performance demanded of maintenance has been made more challenging by the following developments in the contemporary business environment:

3.4.1 Emerging Trends of Operation Strategies

An increasing number of organizations in the Aluminum industry have switched to lean manufacturing, just-in-time production, six-sigma and RCM programs. These trends highlight a shift of emphasis from volume to quick response, elimination of waste, and defect prevention. With the elimination of buffers in such demanding environments, breakdowns, speed loss and erratic process yields have created an immediate problem to the timely supply of products and services to customers. Optimizing the maintenance of these assets, and effective deployment of

manpower to perform the maintenance activities are crucial factors in supporting these emerging trends of operation strategies.

3.4.2 Social Expectations

There is widespread acceptance to the need to protect the environment and safeguard people's safety and health, especially in the developed countries. As a result, a wide range of regulations has been enacted in countries to control industrial pollution and prevent accidents in the workplace. Scrap, defects, and inefficient use of materials and energy are sources of pollution. They are often the result of operating plant and facilities under less than optimal conditions. Apart from producing waste material, catastrophic failures of operating plant and machinery are also the major cause of industrial accidents and health hazards. Keeping facilities in optimal condition and preventing failures are an effective means to meet the ever more demanding society challenge of pollution control and accident prevention.

3.4.3 Technology Changes

Technology has always been a major driver of change in diverse fields. It has also changed at a breathtaking rate in recent decades, with no signs of slowing down in the foreseeable future. Maintenance is no exception in being under the influence of rapid technological changes. Non-destructive testing, transducers, vibration measurement, and thermography make it possible to perform non-intrusive inspection. By applying these technologies, the condition of the equipment can be monitored continuously or intermittently while it is in operation.

Similarly, power electronics, programmable logic controllers, computer controls, transponders and telecommunications systems are increasingly being introduced to substitute electro-mechanical systems. They offer the benefits of improved reliability, flexibility, compactness, light weight, or low cost. Wire less technology, utilizing software controlled electronic systems,

has become a design standard for the current generation of aircraft. Computer integrated manufacturing systems are gaining acceptance in the manufacturing industry.

The deployment of these new technologies is instrumental in enhancing system availability, improving cost effectiveness of operations, and delivering better or innovative services to customers. At the same time, the move also presents new challenges to maintenance. New knowledge has to be acquired to specify and design the new systems taking advantage of these emerging technologies. New capability has to be developed to commission, operate and maintain such new systems. During the phase-in period, interfacing old and new plant and equipment is another challenge to be handled by maintenance.

3.5 Maintenance Effectiveness in the Aluminum Industry

The manufacturing strategies being used, coupled with new technology, has placed the need for maintenance effectiveness clearly on the radar screen of many aluminum manufacturing business. Maintenance in world class organizations is engaged in a strategic partnership with other functions of the organization to identify and support the plant specific ways in which reliability focused maintenance process can contribute to the achievement of predetermined, practical and achievable business goals.

In an effort to gain a competitive advantage over key rivals, the industry uses a number of maintenance performance indicators by means of which its effectiveness can be continuously monitored (i.e., equipment reliability, availability and utilization). The purpose of effective maintenance is to move the ratio of activity from unplanned to planned. As the balance swings in favor of planned maintenance it will indicate that the maintenance strategy is effective. Furthermore, maintenance budget pressures and fierce competition in the industry are driving organizations to move to a proactive, condition-based approach to maintenance. The benefits of a

reliability driven organization are strategic and include increase revenue and output, improved customer satisfaction, safety and environmental integrity.

Kitimat Works strives to achieve excellence in maintenance by control and prevention of failures that will lead to reduce equipment cost and improve operations. The maintenance organization shares the vision that in order to have a competitive business plan, the organization needs to focus on performing proper equipment reliability as this will optimize cost efficiencies and improve maintenance effectiveness.

4 INTERNAL ANALYSIS

4.1 Chapter Overview

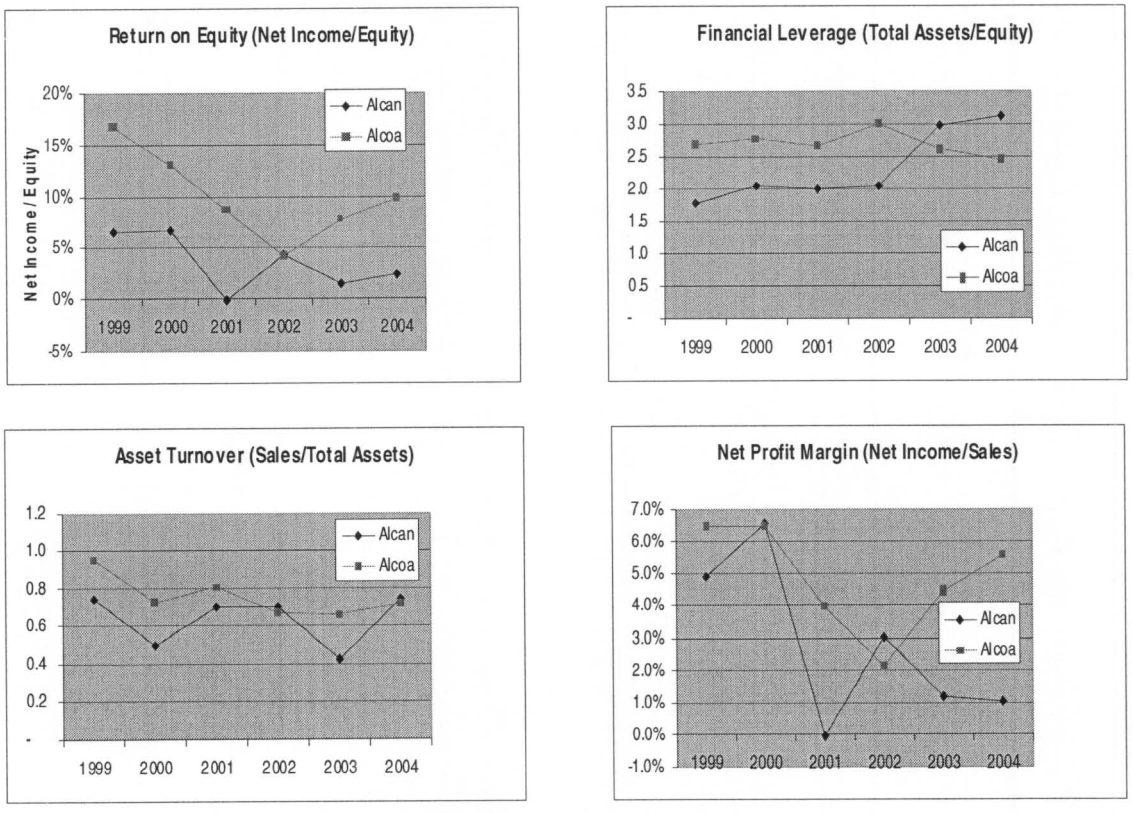
The purpose of the internal analysis is to assess Alcan's competitive position in the aluminum industry. In addition, Alcan Kitimat Works strategies provide insight as to how well it is a) positioned in the industry and; b) meets the demands of changing competitive landscape. A financial analysis is conducted measuring Alcan's financial performance and comparing its performance with its main rival, Alcoa.

4.2 Financial Analysis

Since 2002, Alcoa has shown better financial performance when compared to or against Alcan's ROE. A downward trend on Return on Equity for Alcan during this period displays a worsening financial health; where as, Alcoa has demonstrated in the last two years a rising trend. The asset turnover is comparable for each company. The Financial leverage shows that Alcan is increasing in debt and therefore increasing ROE by doing so. The Net Profit Margin points to the cause of the poor ROE number. While Alcan and Alcoa both trended down from 1999 to 2002, Alcan has continued to move downwards while Alcoa's profitability has climbed. Indeed the performance of Alcan, in 2004, at 1.0% net income of sales is no match against Alcoa performance of 5.6%. Refer to Figure 4.2.1.

Furthermore, a comparison of Operating Profit Margin still shows Alcoa to be steadily improving and Alcan continues to decline in part as a result of the weaker U.S. dollar and high costs for energy and raw materials.

Figure 4.2.1: Financial Analysis for Alcan and Alcoa



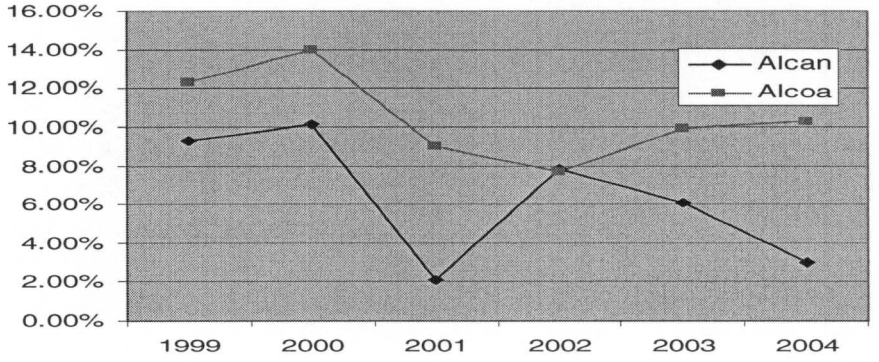
Source: Author based on Company reports 1999-2004.

In North America, Alcan smelters are largely located in Canada, yet ship to the United States. The stronger Canadian dollar against the American dollar would have had a detrimental effect on sales versus cost to Alcan. Alcoa, on the other hand, produces their commodity in the States selling it back mainly to an American consumer thus they are not affected or impacted by the fluctuating monetary exchange rates. Refer to Figure 4.2.2. This is one of the many reasons why Alcoa is accomplishing better financial results than Alcan.

Alcan leverage to profitability and financial standing can be achieve by reducing cost and increasing productivity; increasing efficiency of fixed costs; inventory reduction, or improving accounts receivable turnover.

Maintenance is a key player in this equation as improvement in reliability of assets will lead to fewer breakdowns, more efficient use of resources and an increase in productivity which will result in superior asset turnover. Effectively managing its assets to maximizing profits in conjunction with an improved maintenance program is the key to achieving a higher profit margin.

Figure 4.2.2:Alcan & Alcoa Operating Profit Margin



Source: Author based on Company Reports, 1999-2004.

4.3 Competitive Advantage

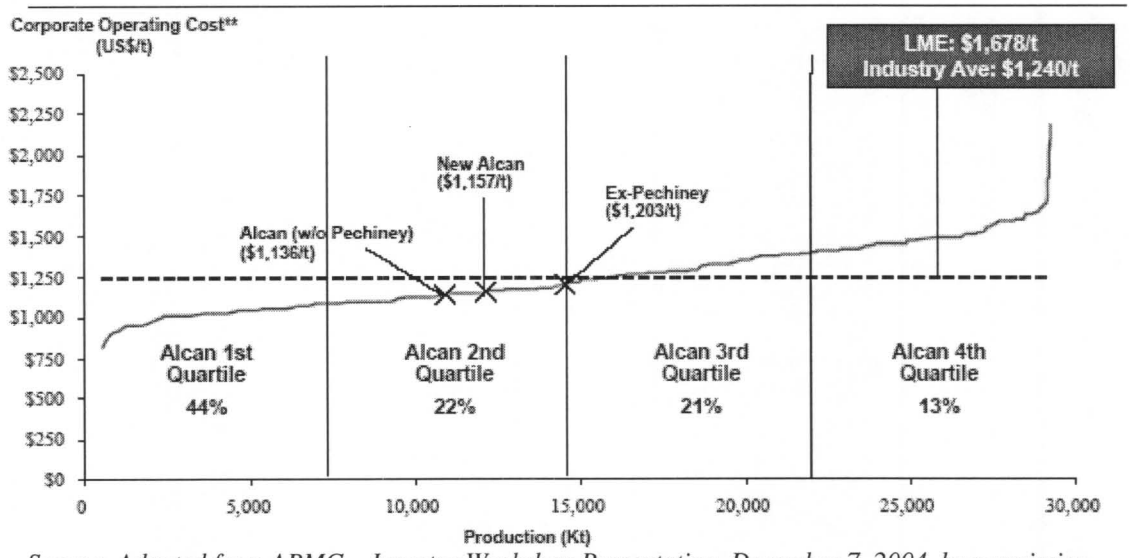
The synergies of the Alcan-Pechiney merger gives Alcan the opportunity to take Pechiney superior smelting technology and operating practices to improve Alcan's aging facilities. This would place Alcan in the same league as industry leader Alcoa, which has been making headway in its anode technology. It would also increase Alcan's size, bringing it closer to Alcoa while exposing it to higher value and higher margin areas of aerospace and technology markets. The

timing is very good for Alcan to get back into the aerospace market, while it is still depressed. The merger has created sources of competitive advantage for the business as Pechiney has advantages in primary aluminium producing technology, while Alcan has lower power costs since it owns its own dams. The strategic fit makes the company more of a global producer, which could finally result in the company performing better financial results and established itself as the leader in the aluminium industry.

The Continuous Improvement (CI) efforts is now contributing very significantly to the realization of cost-reduction and productivity improvements for the company, by combining the complementary approaches of Lean Manufacturing and Six Sigma to provide a full range of improvement tools to the company's businesses. The Continuous Improvement (CI) is aimed at maximizing improvement opportunities and enhancing the company's competitive position and operating efficiency. The acquisition of Pechiney has allowed Alcan to further strengthen its CI process by leveraging the combined knowledge and expertise of both companies. Alcan has also established itself as a sustainability leader as they aim to be the best at creating value. This means finding new ways to manage resources (i.e., water) more efficiently; to make safer workplaces; to enhance the skills of employees; and to work more effectively in the host communities. In the long term, it positions Alcan for enduring growth and helps anticipate and prepare for the forces that will shape the markets in the future.

In the Primary Metal group, approximately 50% of its capacity is supplied by company-owned power, which is a major competitive advantage when compared to the industry average of only 20%. With a sharp focus on cost reduction, productivity improvement and technology development, Alcan seeks to continuously reinforce its low-cost primary metal position. Close to 50% of the company's smelter capacity is in the first quartile of the industry cash cost curve.[xi] Alcan's position is driven by efficient low-cost facilities and favourable energy. See Figure 4.3.1.

Figure 4.3.1: Alcan Primary Metal on the Industry Cost Curve



Source: Adapted from APMG – Investor Workshop Presentation, December 7, 2004, by permission.

4.4 Kitimat Works Strategies

Alcan Kitimat Works strategies are focused on further developing the smelter's footprint in growing economies and enhancing global leadership in the aluminum industry sector. The smelter currently is trying to compete globally and focus more on safety, the environment and production performance. These strategies are discussed in further detail in the following pages in order to understand why Kitimat Works was unable to achieve superior results that would have improved the financial performance of the smelter.

4.4.1 Workplace Safety

In the area of safety, the smelter goal for 2005 is zero lost time accidents, and the target for lost time accident frequency is set at 0.6 per cent. At this rate, the forecasted number of LTA (Lost Time Accidents) for the year is nine. Last year the smelter had 28 and as of this year in July, the plant is already at five.

Safety remains the number one challenge for Kitimat Works. Management strives to have the employees engage in making safety their primary focus daily as the employees have an opportunity to improve operational, organizational and individual safety performance. The pedestrian / vehicle separation initiatives is a strong evidence to the hard work done by many employees to showcase management aggressive action plan to improve safety results.

The challenge facing management is to change the existing culture. The majority of the accidents occur as a result of employees taking short cuts or assuming they are working under safe conditions. This behavior represents a heavy risk and is the main reason for Kitimat Works having a poor safety record.

4.4.2 Environment

The smelter devotes substantial resources to monitoring and reducing emissions to air, land and water. In light of the fact that the Kyoto Accord on Greenhouse Gases has come into effect in Canada, the reduction of greenhouse gas emissions is an important objective for Kitimat Works. Currently, the smelter has a team of process engineers and technical support staff working closely with their counterparts at the Arvida Research and Development Centre (ARDC) on a Continuous Improvement project to reduce anode effects (AE) in the potroom operations. The project will help lower the smelter GHG emissions, improve employee health and safety, increase productivity and reduce operating costs.

In addition, Alcan Kitimat Works has developed a Pollution Prevention (P2) Plan for its British Columbia operations. This plan is aimed at moving beyond regulatory compliance through the reduction or elimination of pollutants at source. A variety of specific opportunities are also being pursued. The P2 Plan was developed with the input of a multi-stakeholder public advisory committee, and was endorsed by the committee and the provincial government. Overall, Kitimat

Works has improved specific aspects of its environmental performance. This approach is intended to ensure that the company is on track on its goal on maintaining environmental safeguards/safety/awareness.

4.4.3 Production Performance

The production performance for Alcan B.C.'s strategic plan for the 2004 season was in line with Alcan Inc.'s MaxValue goal. This plan involved the doubling of shareholder value over the next five years, and included the following components: the re-start program (restoring 60,000 tonnes of production taken off-line in 2001-2002 during a period of acute water shortage and reduced electricity production), cost reductions, and market strategy.

Although production remained below full capacity, Alcan Kitimat Works succeeded in meeting value-added production in casting that year where 254,000 tonnes of cold metal was produced from remelt production and purchase of extra remelt. This strategy allowed the smelter to continuously supply to their customers; however, it affects the financial cost negatively as it is not sustainable in the long term. However, hot metal production targets were not achieved due to low current efficiency in the potrooms that resulted in a shortage of 400 tonnes per month.

In terms of power, reservoir inflows were below the long-term average. As a result, Kitimat Works reduced power generation in mid-February to conserve water and all third party sales were stopped. The strategy to reduce power generation was to protect the smelter — unfortunately this affected the 2004 revenue, as the plan was based on sheet ingot, billet and power sales. Therefore, to improve production performance the smelter needs to get the process back under control. Kitimat Works must continue to target its production for markets considered likely to generate premium returns through 2005.

5 KITIMAT WORKS MAINTENANCE STRATEGY

5.1 Chapter Overview

Kitimat Works Maintenance organization current strategy is described and analysed in terms of maintenance performance. Its key ratios are benchmarked to those of other industry firms to assess the effectiveness and success of its current strategy. Internal competitive strengths and weaknesses as well as external opportunities and threats are assessed. The plant maintenance strengths are discussed in terms of the key success factors for the industry. The chapter concludes with the identification of the maintenance organization key strategic issues and problems as highlighted by the analysis of industry and competitive factors.

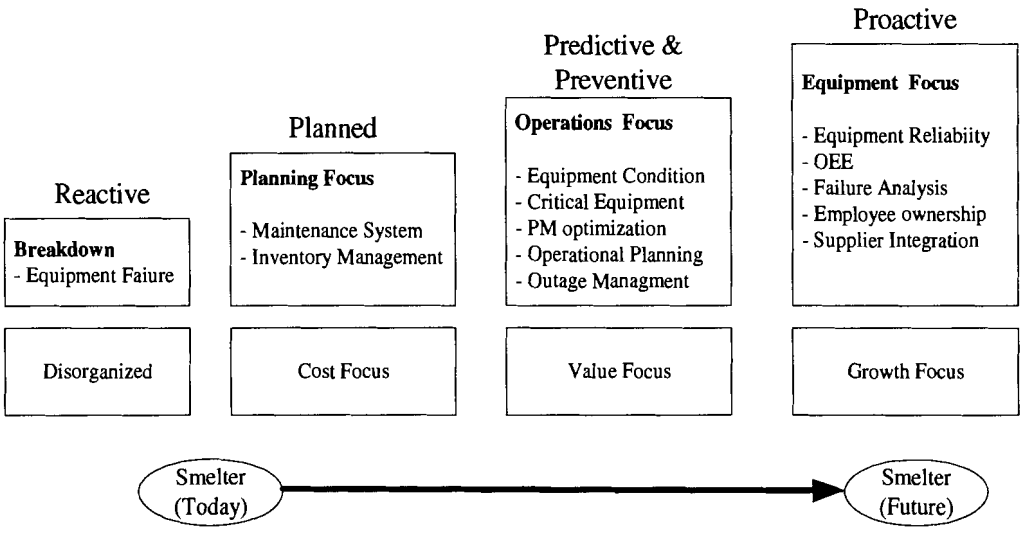
5.2 Current Strategy

The maintenance strategy in the organization is a balanced integration of the reactive, preventive, predictive and proactive stages. It emphasizes the elimination of breakdowns in the system that disrupts production and causes high losses from the maintenance costs and loss of gross margins from the organization. The maintenance focus is on improving the equipment reliability, lowering material cost and producing higher profit margins.

Over the last 3 years, there has been a significant improvement in equipment reliability. This is a result of the tremendous amount of reliability work that has been performed on critical equipment in the plant with the expectation to target for production growth and cost reduction. There has been a push from management towards zero downtime or zero in service breakdowns to maximize the business results. The maintenance department task has been to ensure that the

asset continues to perform its intended function, repair the equipment that has failed, or restore it to favourable operating condition. Maintenance teams identify major opportunities for improvement with the use of maintenance tools such as Reliability Centered Maintenance (RCM) and Root Cause Failure Analysis (RCFA), which are applied to achieve maintenance objectives. The maintenance department strives to support operational goals and add value by contributing to profitability through extended life of assets; improved reliability and availability; enhanced and consistent product quality, and quick response and repair times. Figure 5.2.1 provides an overview of Kitimat Works maintenance development model and the steps for the maintenance function to progress in order to maximize the potential of the maintenance activity.

Figure 5.2.1: Kitimat Works Maintenance Development



Source: Author based on The Journey to Proactive Manufacturing.

Furthermore, it is expected that the existing maintenance policies can reduce the frequency of service interruptions and the many undesirable consequences of such delays. Maintenance clearly impacts on component and system reliability: if too little is done, this may result in an excessive number of costly failures and poor system performance and, therefore,

reliability is degraded; done often, reliability may improve but the cost of maintenance will sharply increase. In a cost-effective scheme, the two expenditures must be balanced and this is where maintenance program approach needs to be optimized. The end result will shift the existing maintenance program to one that will balance maintenance cost and production losses.

The organization still performs in a reactive mode due to the unsupported activity of the trades and operations. The reactive mode results in unscheduled stoppages, disruption of production, and extended downtime due to unavailability of resources. The consequential loss of equipment downtime results in lost aluminum production; non-recovery of overheads; process restart costs; loss of sales and loss of customers. For instance, PM work does not get fully completed; work orders do not include feedback or notes as to what did failed and how it was corrected; work orders are filled as completed but the job is still outstanding. Most of the maintenance crew lacked the resources to properly diagnose and repair the failed or damaged equipment. This results in an increase in the mean-time-to-repair and yields higher equipment downtime, which leads to unavailability of equipment and a decrease in productivity.

To achieve the maintenance objectives, the organization is showing initiatives that support trades and operation involvement. The approach is to engage the front-line people as they have the biggest impact on reliability. Thus, maintenance organization in Kitimat Works is slowly shifting the culture from one that accepted defects as a normal part of operating to one where people are actively seeking to eliminate defects. It is very important for the maintenance organization to maximize their maintenance effectiveness and equipment uptime, as this will enable the plant to remain competitive as a low cost producer of aluminium — breakdowns cost money which results in equipment downtime and this destroys competitiveness.

5.3 Maintenance Performance

A number of performance measures have been put in place to improve maintenance performance in Kitimat Works and is aimed at improving the smelter competitiveness. These include measuring uptime and the causes of lost uptime, as well as implementing certain maintenance improvement tools such as optimization of maintenance planning and scheduling; routine preventive maintenance (PM) activities; several predictive maintenance technologies and more proactive efforts, such as root cause failure analysis. Maintenance performance in Kitimat Works can be classified into three categories - equipment, cost and process performance.

5.3.1 Measure of Equipment Performance:

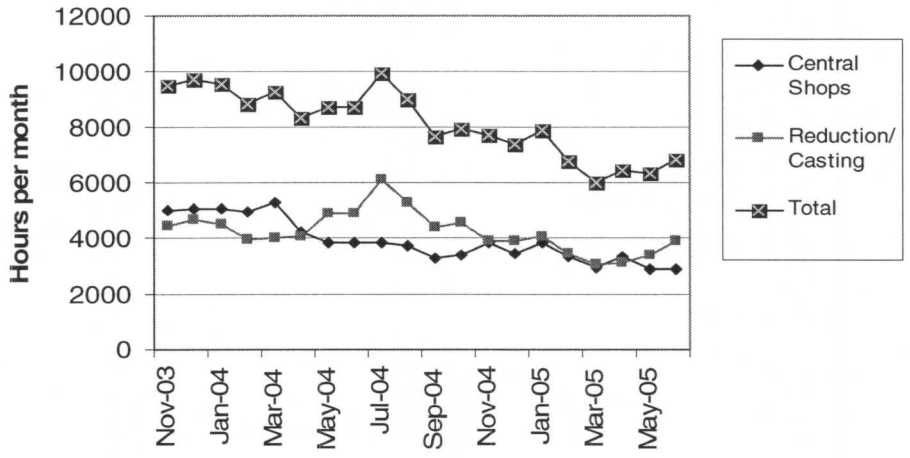
Reliability awareness within the maintenance organization is moderate and the cost of failures is clearly identified as a major opportunity for improvement by working out the numbers to justify the improvements. Reaching a reliability-driven maintenance is required for the plant to sustain its competitive advantage — as reliability improves, failures decline, availability improves and this satisfies customers with on-time delivery of products.

In an effort to improve equipment reliability results, the maintenance organization began analysing and measuring the number of times the equipment was stopped, together with the reasons for those stoppages. Pareto Analysis was done on the data collected that identified the few reasons that accounted for the majority of the stoppages. The focus was placed on these stoppages, because a small improvement in reliability in these areas will have the greatest impact on overall equipment performance.

The high frequency stoppages in the Pareto analysis identified opportunities for improving the asset. These opportunities to improve the asset and resource performance have

resulted in a slight improvement in the performance of the assets as urgent work orders are declining. Refer to Figure 5.3.1.

Figure 5.3.1: Maintenance Corrective Urgent Work



Source: Author based on Alcan Maintenance Scoreboard.

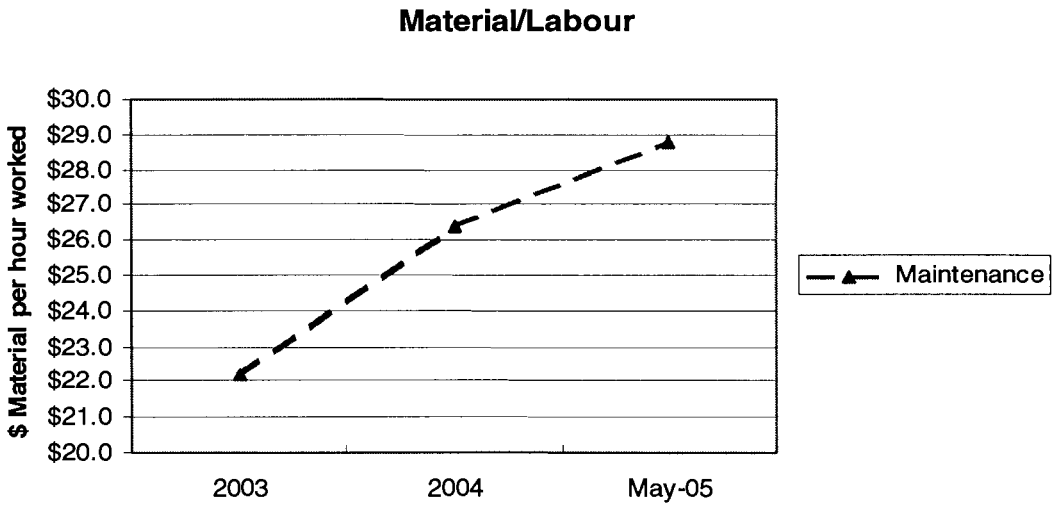
The reductions in work order also indicate that the organization is performing more planned work and less time on repair work. Currently, Kitimat Works is taken steps to optimize the physical function of maintenance and to resolve recurring maintenance problems so that the need for maintenance can be reduced.

5.3.2 Measure of Cost Performance

Maintenance costs consist of labour and material. Labour activities such as contractors, overtime, number of employees, and projects can be controlled; however, material cost is more difficult as this is prompted by the maintenance strategy balance between rebuild versus replace. Since 2003, Kitimat material/labor cost has been on an increasing trend, as a result of continuous improvement projects; and more preventive/ predictive activities. See Figure 5.3.2.

These planned work activities include lubrication, servicing, overhaul, inspection, adjustment, tightening, scheduled replacement and cleaning. When correctly applied, the PM program is successful in extending the interval between failures and maintains equipment at high performance. Unfortunately, it also reduces availability by intentionally taking equipment offline to perform the actions. Maintenance increases and more labour and parts are needed.

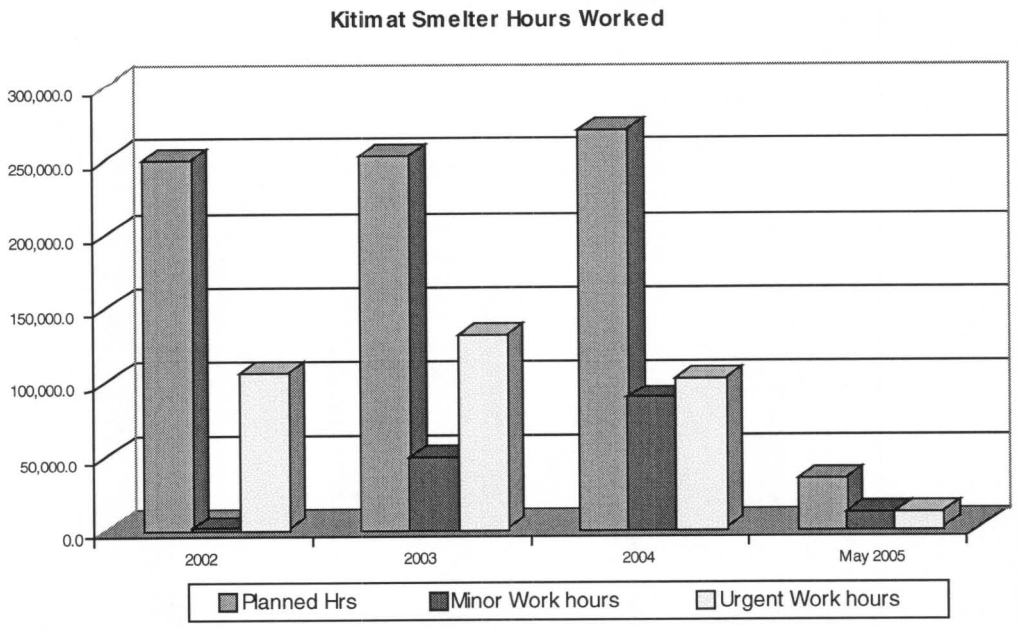
Figure 5.3.2: Material and Labour Cost for Kitimat Works



Source: Adapted from Maintenance Cost Review Presentation, May 2005, by permission.

The largest disadvantage in a PM activity is that poor maintenance practices (i.e.; taking short cuts or using "band-aid" solutions) have created more problems than if the maintenance were never performed. Even if the action was done correctly, statistics show that 68% of those actions might cause "infant mortality" on relatively good equipment. This is why so many problems exist immediately after returning equipment into service following maintenance. Maintenance action should be performed only if the benefit of restoration outweighs the risk and consequences of mortality. [xii] Performing too many PM activities is an expensive option because it requires constant inputs of labor, material and downtime. Refer to Figure 5.3.3.

Figure 5.3.3: Kitimat Smelter Hours Worked



Source: Author based on Alcan Maintenance Scoreboard.

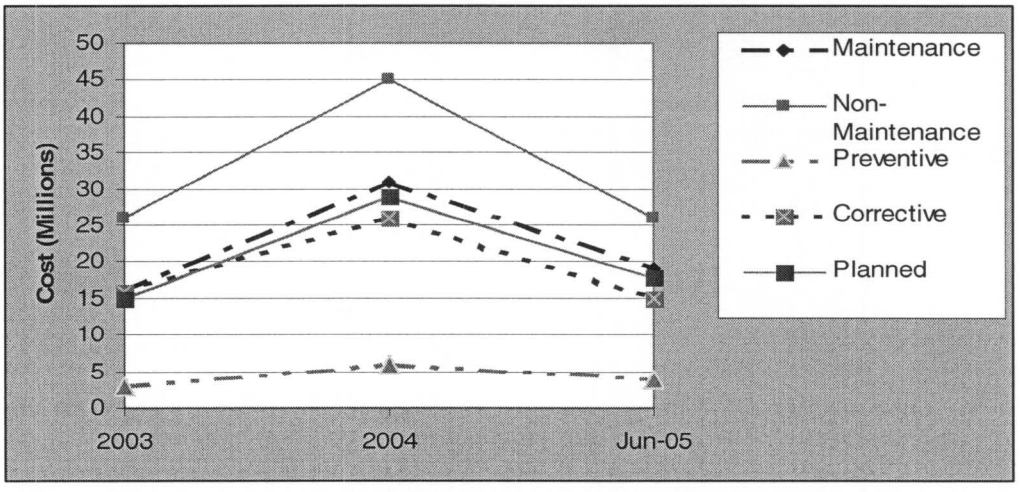
The success of the smelter is dependent on the condition, availability and reliability of plant assets. Thus, to gain a competitive advantage, there must be an improved maintenance contribution: do more with less; increase operating effectiveness; and reduce costs by controlling overtime; cut back the use of outside contractors; or performing deferred maintenance without additional expenditures.

5.3.3 Measures of Process Performance

The maintenance organization is shifting from breakdown mode to planning mode. This improvement is highlighted by reducing from unplanned to planned maintenance from 2.33 in 2002 to 1.41 in 2005. Maintenance resources are spending more time performing PM work and less time on breakdown activities; thus, slightly improving the reliability of the asset. However, over maintaining the asset – beyond what is required, does not extract optimum value for the plant and increases maintenance cost. The total maintenance cost varies with increasing amount

of preventive maintenance. It is not in the best interest of the organization to dedicate such a large portion of the maintenance budget to a PM program that fails to deliver the desired level reliability and low cost of ownership. The PM program must be reviewed and updated based on failure history, changing operating circumstances, and the advent of new predictive maintenance technologies. Figure 5.3.4 highlights the maintenance cost distribution in terms of predictive and preventive activities.

Figure 5.3.4: Maintenance Cost Distribution



Source: Author based on Alcan Maintenance Scoreboard.

In response to competitive pressures in an industry where cost control is required to be competitive in the global market, it is critical for the Kitimat Works to control and find the optimum level of 'preventive maintenance' that corresponds to the 'minimum total maintenance cost'.

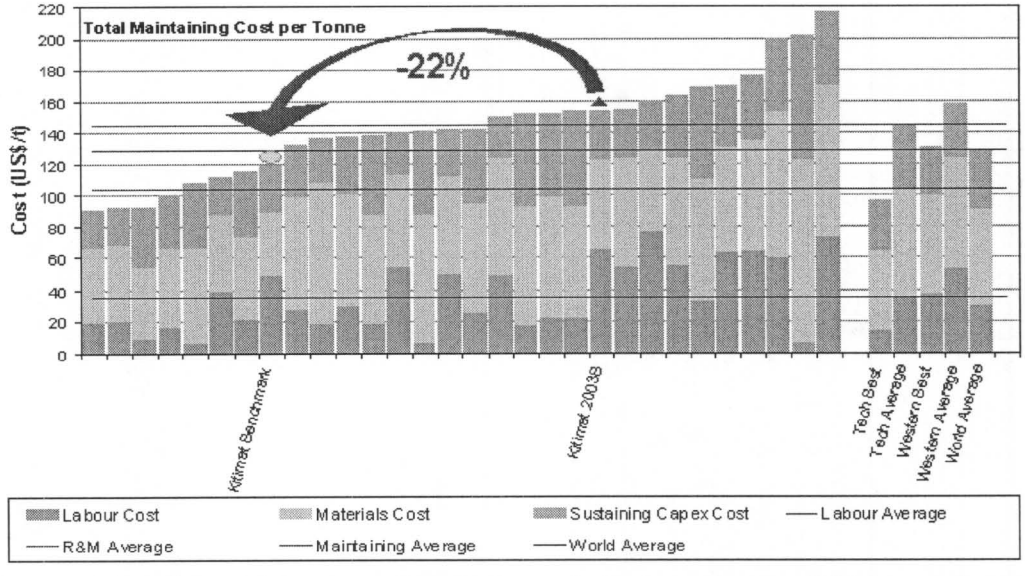
5.4 Benchmarking Study

Benchmarking methodologies are primarily a tool for organisational continuous improvement. As competitors provide challenge within marketplaces, they also provide insight

into how operating costs can be reduced and efficiency increased. Benchmarking through objective competitor analysis has allowed Kitimat Works to measure products and services against competitors and best-in-class companies in the aluminium industry. The benchmarking of Kitimat Work's maintenance cost and data with those of competitor's plant are used to assess the effectiveness and success of Kitimat current maintenance strategy. The objective is to assess how well the maintenance strategy in Kitimat Work's has worked overall (i.e., as measured by these performance indicators) and to identify areas where it has and has not performed well.

The competitive benchmarking study was completed in 2003 and has identified key areas where there are opportunities for improvement in Kitimat Works. Cost control and maintenance best practices are critical as the plant attempts to improve its financial performance in a competitive environment. See Figure 5.4.1.

Figure 5.4.1: Smelting Benchmark



Source: Adapted from Maintenance Contribution to the Business, October 2004, by permission.

5.4.1 Maintenance Cost-Labour

The Kitimat Works preventive and predictive costs have been increasing and the maintenance (PM) requirements are exceeding the labour resource availability. For example, when a PM activity is missed, preventable failures occur and unplanned maintenance work consumes more labour than necessary. As a result, this leads to an increase in cost for minor work repair and creates inefficiency in our maintenance resources. The high cost of labour in Kitimat Works is attributed to the high concentration of manpower to operate the aging smelter; high cost in contracting out resources in a northern town; and inadequate maintenance labour to deal with unexpected events.

Most of the lost maintenance productivity in the Kitimat Works can be categorized into the following kinds of delays:

- Waiting for parts.
- Waiting for information, drawings, instructions, etc.
- Waiting for equipment to be shut down.
- Waiting for rental equipment.
- Waiting for other crafts to finish their part of the job.
- Running from emergency to emergency.

While 100% maintenance productivity is an unrealistic goal for any maintenance organization, 60% is achievable at Kitimat Works. The productivity of maintenance can be improved by concentrating on basic management techniques, such as:

- Planning jobs in advance.
- Scheduling jobs and coordinating schedules with operations
- Arranging for parts to be ready.
- Coordinating the tools, rental equipment, etc.,

- Reducing the emergency work.

In an effort to reduce the cost of labour and maximize business results, the maintenance organization must consider more strategic planning to select the proper time for restoration efforts and as well as coordinated jobs with operations. This will result in more time for strategic preventive maintenance activities, which in turn helps to reduce the amount of emergency; breakdown activities and mean time to repair. This leads to fewer schedule changes and increased productivity (by reducing travel and waiting times). The Kitimat maintenance organization needs to succeed in achieving good maintenance labor control, as this will significantly increase labor productivity.

5.4.2 Maintenance Cost-Material

Material costs are related to the frequency and size of the repairs made to the smelter assets. The sheer number of parts, in addition to stores policies, purchasing policies, and overall inventory management practices are contributing to overall costs of maintenance materials. In some sections of the plant, little attention is paid to maintenance materials, and inventories may be higher than necessary. This increases inventory-holding costs and makes materials unnecessarily expensive. Sometimes, the inability of stores to service the maintenance departments needs results in pirate or illegal storage depots of just-in-case spares. This practice is also driving up the cost of maintenance materials in the smelter.

In addition, the existing PM program is based on replacing parts that are in good standing. The strategy is based on replacing parts before they fail; however, this increases the material cost and is not an effective way of managing our bench stock. To function as a low cost producer of products or services, the maintenance organization in Kitimat Works needs to implement a PM program that results in influencing the EVA positively. To reduce material cost,

the maintenance organization focus needs to be more in controlling breakdowns; improving operations by extending MTBF on equipment; and having good inventory control.

Overall, the smelting benchmark has identified Kitimat as a smelter operation that is not competitive in the aluminum industry. Its financial performance in terms of EVA reflects a negative economic value added facility that is not sustaining a competitive advantage. In order for Kitimat Works to compete globally, it must reduce its cost per tonnage by 22%. To achieve this, it may reduce manpower resources by outsourcing non-core maintenance competencies in shops such as the rewind shop, welding shop and the fabrication shop, as it does not financially make sense to keep them in-house.

Depending on the criticality of the maintenance work and the competence required, some maintenance activities (i.e.: radios, telephones, pages, fire alarm panels) can be outsourced to external personnel. Outsourcing maintenance activities will enable Kitimat Works to focus maintenance department resources more strategically on predictive maintenance measures. The organization can successfully capture return on investments from its predictive maintenance efforts by ensuring the equipment is available, operating efficiently and strategically by deploying maintenance resources. This will increase profits in two ways: decreasing material/labour expenses and increasing capacity (availability of asset).

5.5 SWOT Analysis

This sections analyses Kitimat Works internal strengths and weaknesses, and the main threats and opportunities in the external environment. The purpose of a SWOT analysis is to help identify business' strengths, minimize and correct the weaknesses, and take the greatest possible advantage of potential opportunities while formulating a plan to deal with potential threats.

5.5.1 Relative Strengths

Superior Management Team: Kitimat Works management is focused on a long-range strategic business plan with specific annual goals. This plan takes into consideration economic factors, customer needs and other market rivals. The management team exhibits knowledge of the competitive environment; recognition of challenges facing the organization and sets realistic plans to address them. The smelter operation has a clear capital plan that identifies and prioritises new capital projects and defers upcoming maintenance work.

Location: The smelter is supplied with low cost power generated by its own hydroelectric power station in Kemano and takes advantage of its close proximity to the Pacific Rim, bringing raw materials from overseas and selling most of the production to the Asian market. The plant strives to differentiate from other aluminium competitor as it offers customers a high-end alloy product that adds value to the business.

Good Reputation: Kitimat Works has established a good reputation in the marketplace for its product quality. Quality is incorporated into all activities of the organization with a clear customer focus. Customer satisfaction is the number one company priority; emphasis is placed on meeting or exceeding external customer expectations in every transaction. Management understands the customer to the greatest extent possible to ensure that the customer's quality is met.

Team Work Environment: The smelter encourages teamwork and top management is executing the concept of team-based recognition. Staff employees have been employed with the company for many years and the continuity of core employees have enable good teamwork to develop. There is continuous commitment and awareness to improve maintenance performance and safety results, as these initiatives are directly link to one another.

5.5.2 Relative Weakness

Shortage of Skilled Employees: Kitimat Works is experiencing an increasing shortage of skilled workers, while at the same time fighting for survival in today's highly competitive global marketplace. The maintenance workforce in the smelter is not up-to-date with most current technology. In most cases, they lack the ability to properly know how to troubleshoot and maintain the equipment as a result of the evolution of new technology in the workplace. Knowing the right training option to meet the needs of the plant, maintenance organization, or individual employee is sometimes difficult. Kitimat Works have spent thousands of dollars for training without obtaining the expected results.

Lack of Motivated Workforce: The union employees exhibit frustration as they feel uncertainty about the future of the smelter. The deficiencies in the workforce have lead to low moral, an unenthusiastic work environment and a decrease in commitment to achieve goals of the business. This has resulted in missed PM work, lost spare parts, and higher MTTR. This attitude is preventing the maintenance organization from achieving its objectives.

Lack of Accountability: The Kitimat workforce has grown accustomed to a lack of accountability, leading to increased in damaged equipment. There is no accountability in the system – employees don't have to perform, and this part of the overall working culture. Difficulty exists in trying to correct this type of behavior and this contributes to poor workmanship practices.

5.5.3 Opportunities

Opportunities can be materialized by achieving a more motivated workforce; the organization will work harder and exhibit more commitment to the goals of the business. A

system that captures employee performance, puts in a review mechanism, and ensures rewards and recognition is a crucial factor in ensuring motivation in Kitimat Works environment.

The maintenance organization can enhance its position by ensuring employees have the expertise and tools they need to be, and feel, competent to do the job that's been entrusted to them. Management needs to enhance workforce skills and capabilities as this is determined by the basic need for world-class skills in specific disciplines. Opportunities exist in communicating strategic maintenance planning or objectives to all employees, enabling them to have a clear understanding of what management is trying to achieve. The main strengths provide an opportunity for Kitimat Works to enhance workplace productivity; performance; and position itself as low-cost producer. At that time management can decide whether it wishes to pursue a strategy of increasing market share through lower prices and reliability of supply, yet still achieving good profit margins.

5.5.4 Threats

The smelter faces union contracts every three years. In this unionized environment, the employee's loyalty is often shifted from the organisation to the union. Once again resulting in reduced employee commitment, lower morale, resistance to change, and sublimation of the organisation's goals to those of the trade union.

Management can induce the work culture to evolve by changing the cultural force field. They can do this by changing how they lead – i.e., showing openness, trust, and participation in the initiatives. Changing this type of culture and behaviour is essential for success in a changing marketplace and will minimize external threats. This will also help stimulate creativity in the workforce and lead to a competitive advantage.

In order for Kitimat Works to continue to compete in its marketplace, it must minimize its threats and leverage its strengths to increase employees' productivity; otherwise it will not be able to face competition in the market. Strategic decisions will define how the organization will align itself to meet the challenges and opportunities of the future since it is in the future that the organization can affect its fate by making good decisions today. This will enable Kitimat Works to avoid surprises, manage crises, and take a proactive stance with respect to its working environment and its competition.

5.6 Key Strategic Issues and problems

The analysis of the industry and competitive factors and the firm's competencies highlights four key strategic issues and problems that the maintenance organization in Alcan Kitimat Work's currently faces. The organization must address and overcome the challenges presented if it is to support performance excellence of production operations. In so doing, it would increase its performance positively affecting internal efficiency, productivity and service quality.

5.6.1 Preventive Maintenance

A successful preventive maintenance program reduces the amount of reactive maintenance to a level that the other components of the maintenance strategy can be effective. It is the key to any successful maintenance strategy. However, this is not the case for the Kitimat maintenance organization as it demonstrates problems keeping the PM program focused. For example, the majority of equipment failures in the plant are related to the neglect of PM basics, such as proper inspections, adjustments and torquing, and lubrication. The organization needs to focus on the basics of maintenance if they are to achieve any type of asset management process.

An effective PM program will reduce the amount of reactive maintenance to a level that allows other practices in the maintenance process to be effective. The preventive program would require the maintenance organization in Kitimat Works to have the following condition: trades have detailed job instructions, trades understand and know why the work is being done, materials and tools are available, operations cooperate and are involved with generation of PM procedures.

In supporting business excellence measurements, the maintenance organization must eliminate, or at least minimize, unscheduled downtime; and strive for improving scheduled downtime using a PM optimization process that combines preventive, predictive, and proactive methods with equipment histories and knowledge of current condition to assure doing only what is necessary, when it is necessary.

5.6.2 Work Flows and Controls

This practice involves documenting and tracking the maintenance work that is performed. Improvements need to be made to the existing work order system that is used to initiate, track, and record all maintenance activities. Normally, once a request is made for the work, it then needs approval. Upon receiving its approval then the work is planned, scheduled, performed, and finally recorded. Ideally, this is how the maintenance work order should flow.

However, currently there are no effective planning and scheduling for all the maintenance activities, as there exist bottlenecks with the work orders system. For instance, even when the repair order was completed the work orders are often not closed out. And work orders where work was not completed often are closed out with incomplete documentation of the uncompleted work. The solution would require comprehensive use of the work order system to record all maintenance activities. Unless the work is tracked from the request made through to its

completion, the data will be fragmented and useless. If the proper procedure is not followed productivity decreases and gains made to reduce equipment downtime never occurs.

5.6.3 Reliability Centered Maintenance

Kitimat Works has adopted the classical RCM process that involves identifying the systems to be studied, their functions, functional failures, failure modes, failure causes, and the maintenance task selection. Currently, there are Reliability Centered Maintenance (RCM) techniques being applied to both the preventive and predictive efforts design. However, there is not enough buy-in from the trades to improve the reliability figures as they feel that in many instances the RCM recommendations are in excessive or in some cases inappropriate. As a result the morale and motivation among maintenance trades employees have been affected as they are told to perform tasks that they believe are totally pointless or even wrong. In addition, operations personnel cannot envision the real value added in performing the RCM analysis, as they do not see huge improvement on the equipment.

To improve the business performance, and to close the culture gap in the maintenance organization, the trades must better understand the reliability index, how it works, highlighting the opportunities for each improvement. A way to accomplish this is to further develop teamwork in maintenance by changing the culture. This implies that each group must understand the language of reliability and work in a cooperative manner for a common goal. That goal is to identify the problems of cost as it relates to workmanship and repair and establish a work priority for quickly correcting the vital few issues. Also, there needs to be a clear understanding of the customer needs in terms of reliability, safety, power quality, and cost. These attributes must be weighted to determine the optimum maintenance policy to deal with these internal customers. In order to optimize the maintenance program, all relevant information must be used to most

effectively initiate, schedule, record, and analyze maintenance tasks. The maintenance organization in Kitimat Works needs to create a better structure process to determine optimal maintenance requirements for equipment in a particular operating environment. For instance, it needs to combine the strategies of corrective maintenance, preventive maintenance and predictive maintenance, and apply these strategies where each is appropriate, based on the consequence and frequency of functional failures. This combination will produce a maintenance program that optimizes reliability, cost effectiveness and increases Kitimat Works competitive position.

5.6.4 Inventory and Procurement

The inventory and procurement program needs to focus on providing the right parts at the right time. The goal is to have the right quantity of spare parts without having too many spare parts. Currently, there does not exist a method of measuring the service level; however, it is not uncommon for critical stock levels to run out without prompting the user or maintenance representative. This level of service leaves maintenance personnel fending for themselves, stockpiling personal stores and circumventing the standard procurement channels to obtain their materials. To prevent this situation, the organization must institute the type of stores controls that will allow the service levels to be measured accurately. The more Kitimat Works can optimize and maintain its assets - facility, fleet, production processes, resources — as well as manage the inventory and purchasing requirements, the more it can compete in the areas of cost, quality, and delivery of its product.

5.7 Maintenance Management Changes

The maintenance organization has traditionally strived to play a major role in improving overall plant productivity and profitability. Maintenance improvements are visible in the reduced number of breakdown and realized equipment reliability targets. However, the need for change is

necessary, as these maintenance improvements do not materialize in increase production capacity, throughput or profits. The organization needs to move from a reactive mode towards being a reliability driven organization where maximize business results occur from the elimination of equipment breakdowns.

In order for Alcan Kitimat Works to sustain a competitive advantage it must focus on competing on cost by maximizing value and optimizing the physical function of maintenance to achieving better operational efficiencies. To achieve superior maintenance results, management needs to engage the entire organization in eliminating the defects existing in the aluminium making process. The key to accomplish this is by explaining the value of change in a way that is meaningful to people and building the passion to change the situation towards world-class performance.

Furthermore, to achieve maintenance effectiveness there needs to be more control of the PM work and the maintenance department needs to be more aggressive at eliminating the failures. For example, the maintenance program should establish responsibilities, priorities, and procedures to respond promptly to unscheduled events. Work orders should be documented, reviewed, and followed up to assure the work was done. Likewise, a work order review would help to identify weaknesses in the scheduled maintenance system. In addition, a maintenance business plan will need to be generated in order to keep the production and maintenance teams focused. The aim or goal of both teams is on improving the plant performance, defining what should be accomplished, when it should be accomplished, and how it is to be accomplished. Improvements can be made within the maintenance organization by providing the maintainers with more adequate tools to diagnose problems; and more training on critical equipment to close the gap between the level of non-experience and knowledge tradesmen.

Managing Kitimat Works assets strategically will require that every department in the smelter organizational function work toward the same goals. The achievement of organizational alignment will result in building a case that motivates every level of the organization to become involved. This means constantly communicating and demonstrating the benefits of the strategy. Lastly, management must leverage the existing maintenance framework to aim at profitability through the maximization of their production while maintaining low cost, high level of quality, service and safety.

6 RECOMMENDATIONS

6.1 Chapter Overview

The preceding discussion provides Alcan Kitimat Works with three possible options to improve maintenance results, stay competitive as a low-cost producer, and maximize its maintenance effectiveness. Recommendations on implementation issues are offered to guide the smelter through key components of the strategy.

6.2 Strategic Initiatives

The major challenge confronting Kitimat Works is the growing need to build and sustain competitive advantages over their rivals. To achieve a competitive advantage, management must focus on – strategic partnership with trades; quality culture change; and engaging the plant in asset reliability. The main driver of profitability and sustained competitiveness will be the ability to effectively utilize human, material, plant and machinery resources. The strategy will improve smelter performance resulting in higher profit margins and low operating cost.

6.2.1 Partnership with Trades

To assure future success, Kitimat Works needs to have the capability to improve and create value continuously through development of their most precious assets - the employees. Kitimat Works needs to develop an internal process to further develop the trades to a set of distinctive core competencies that will enable them to achieve their business objectives.

Kitimat Works management must embraced empowerment in their change program. To get internal commitment, management must involve employees in defining work objectives, specifying how to achieve them, and setting achievable targets. If employees have little control over their destinies, the organization only gets external commitment, which is akin to contractual compliance. Employee participation and autonomy must be in place for empowerment to take root.[xiii] Empowerment is also a necessary condition to ensure a motivated workforce. Managers at Kitimat Works must effectively communicate with employees and provide them with empowerment to ensure continued progress. This will lead to the employees trusting and supporting Kitimat Works business goals.

6.2.2 Quality Culture Change

In order for the Alcan Kitimat Works to achieve world-class performance and have a competitive edge in the marketplace it must successfully engage in quality cultural change. Quality control is a vital link in the total reliability process. Quality control will assure conformance to specifications and this reduces manufacturing variance, which can degrade reliability. From a maintenance point of view, equipment cannot perform reliably without the inputs of quality control task from maintenance activities. Kitimat Works must redefine the organization of maintenance by applying the following principles:

- Cultivate a sense of ownership in the operator by introducing autonomous operator maintenance - the operator takes responsibility for the primary care of his equipment. The tasks involved include cleaning, routine inspection, lubrication, adjustments, minor repairs, as well as cleanliness and tidiness of the operator's workspace.

- Optimize the operator's skills and knowledge of his equipment to maximize operating effectiveness. The operator is thus mobilized to detect early signs of wear, misadjustment, note oil leaks, or loose parts. The operator is also involved in making improvement and suggestions to eliminate the losses due to breakdowns.

- The use of cross-functional teams consisting of operators, maintainers, engineers and managers to improve people and equipment performance.

Being relieved of the primary care activities, the expertise of the maintenance department can be redeployed to focus on more specialized work such as major repairs, overhauls, tracking and improvement of plant performance, creation, replacement and modification of physical asset. Instead of having to attend to numerous chores, the maintenance organization can devote its resources to address strategic issues like formulating maintenance policies and practices; implementing maintenance information systems; and introducing new maintenance technologies.

A successful quality culture change has to be started by an educational program that begins with management, followed by all employees. Trades in the organization should be continually developed and given adequate training and education on methods and the concept of quality that usually includes TQM principles, team skills, and problem solving. In the decision-making process, all levels of workers must be trained to work together in an atmosphere that nurtures individual initiative.

In order for Kitimat to sustain a competitive advantage, it must concentrate on introducing a quality culture, which has the potential of leading the smelter to: exceed customers' expectations; productive employees; high employee loyalty; and an increase in productivity of its assets; thus, maximizing profits.

6.2.3 Engaging Kitimat Works in Reliability

Currently, all of Kitimat Works, from the plant manager to the bottom of the hierarchy, are engaged in improving the smelter safety performance. Everyone is working together to achieve better results and this is the same philosophy that must be applied when engaging the entire organization in eliminating the defects in the system. Improved reliability can produce dramatic bottom line improvements but to achieve world-class performance a fundamental shift in the nature of the work is needed at all levels in the organization.

By engaging the entire production organization in improving reliability, Kitimat Works will be able to achieve substantial results with less inherent risks and in a shorter time frame than the traditional approaches to reliability improvement. To improve the maintenance effort in the smelter, the following strategies must be imposed:

- Improve the existing maintenance practices, as they are often ineffective at identifying and correcting equipment reliability problems. The reason for this goes back to the lack of emphasis on data collection (i.e., work order containing no feedback from trades; drawings not up-to-date.)

- Provide trades with the proper tools to diagnose equipment. Empowerment will degenerate into abandonment if employees fail to get the right tools, training on their use, and support in their implementation. Educational resources, which include technical consultation as well as training must be budgeted and use for employees with needs.

- Continuously improve the clarity of communication between production and maintenance staff to ensure that the decision making for both task groups is

optimized. Critical communication between the workers is the key to understanding reliability problems.

- It is pivotal that both maintenance and production managers realign their individual strategies to complement each other through a common focus. This approach is aimed at combined efforts, with a view to improve plant performance. Combining operations and maintenance strategy, through its inherent motive to promote mutual collaboration, will drive the plant towards a competitive edge, by developing a team culture within all its ranks.

Kitimat Works must focus on maximizing the capacity available by not only applying best practices but also assuring reliability in design, operations, maintenance, and through debottlenecking opportunities. Once this stage is achieved, the smelter can target after additional market share, with little or no capital investment. The minimization of defects, which result in failures and additional costs, translates to lower operating and maintenance costs. This helps further assure low cost production and competitive position.

6.3 Organizing for Implementation

To introduce the three strategies mentioned in section 6.2 requires a change in employees' attitude and their values, which takes time to accomplish. Therefore, it demands long-term thinking and planning. Quick and company-wide performance gains should not be stressed in the initial stage. Management must demonstrate their commitment to the initiatives by devoting time and allocating resources to create and sustain the cultural change and to provide necessary training to employees to achieve superior maintenance performance. It is imperative that management and union employees are committed to the implementation. Management must address intangible factors such as motivation, engagement, and acceptance, in order to nurture a

willingness to change. Increasing employee's motivation and competency will maximize equipment effectiveness and operation. The following is the critical path for implementation of the recommended strategic initiatives: partnership with trades; quality culture change; and engaging in reliability.

6.3.1 Strategic Path for Improvement

Management must create a work environment that supports the establishment and implementation of the three strategic initiatives. The first step in the strategic development is for management to make an official announcement to implement the new ventures to achieving superior performance and sustain a competitive advantage. Management must inform their employees of this decision and communicate enthusiasm for the project. This can be accomplished through a formal presentation that introduces the concept, goals, and expected benefits of the three strategic initiatives, and must also include management personal statements to employees on the reasons behind the decision to implement the initiatives. It is important at this point for Kitimat Works management to have a strong commitment and understand what that commitment entails. The next step is for management to launch an informative campaign to raise morale and soften resistance to change. This can be accomplished by establishing training retreats for staff engineers, group leaders, and supervisor. Union employees can be trained using slide presentation. The training can be enhanced by inviting supervisors and other managers to the small group meetings to relate what they have learned from their own retreat. The theme in the training is to have long-term profitability and competitiveness, by means of quality management and sustaining equipment performance. During the informative stage, a campaign to promote enthusiasm for implementation of the key three initiatives must be organized. This can be in the form of banners, signs, and badges bearing partnership-quality-reliability slogans to help create a positive environment.

Once this phase is completed, forming a promotional structure will follow. The promotional structure can be based on the existing Alcan Kitimat Works organizational matrix, forming horizontal groups such as committees and project teams at each level of the vertical management organization. The strategy is to have each group leader participate as a member in a small group at the next level. The group leaders will serve as a link between levels, facilitating vertical as well as horizontal communication. The integration of top-down, goal oriented management with bottom-up, small group activities on the work floor will be critical in the promotional structure.

The next step is for the management team is to establish goals to reduce downtime by improving maintenance performance as the quality of maintenance significantly affects business profitability. The goal must be quantifiable and precise, specifying the target (what), quantity (how much), and time frame (when). For example, Kitimat management may adopt a goal to reduce losses by lowering or removing breakdowns, defects, and accidents while enhancing the profitability of the smelter and creating favorable working condition for all employees. This goal is attainable; however, the actual level and characteristics of current breakdowns and rate of process defects per piece of equipment must be measured and well understood. When this has been established, then improvements must be predicted, contribution to the smelter business estimated, and the rate of return on estimated cost of improvement calculated. Once the medium- to long-range goals have been set for the smelter, they must be developed further in each department and at each level. For instance, annual goals determined by managers and supervisors must ensure that improvement themes and goals set independently by the floor workers are consistent with the overall goals of Kitimat Works.

The last phase is for management to formulate a master plan to rollout the key strategic business initiatives. The development must be centered on improvement activities (i.e., improving OEE, establishing quality in maintenance, increasing employee skills though education and

training). The master plan lays out the organization goals, what is required to achieve them and when they will be achieved. Despite the proposed widespread team training, implementation of the key initiative might make a lot of people uncomfortable. Thus, the master plan will help people overcome their reactions to change and also keep the workers focused. Multiple implementation teams, with dedicated leaders, will develop detailed action plans for each specific element of the master plan. This approach will be an excellent vehicle in fostering participation and producing the desired results. The organization will only succeed in the implementation of meaningful change when management is fully committed to creating an environment that allows change to occur, and is dedicated to its successful completion. Leadership is the key and the prerequisite for sustained change. The leadership team will provide the leadership structure for the overall change initiative and ensure compliance with Kitimat Works policies and practices.

It is expected that it will take 3 years to organize the strategic business initiatives from the preparation to implementation stage. However, this is dependant on the degree of eagerness to embrace "change" as this determines the rate of progress towards that goal. The strategic initiatives can only succeed if the organization is committed to providing the necessary training and time to monitor the success or failure of the ensuing improvement initiatives.

The aim of the recommended strategic initiatives is to make a contribution to the development of maintenance as a competitive instrument to improve the smelter effectiveness. As Kitimat Works management team seek to inculcate a competitive outlook in the plant, they need to posses a culture that deals more effectively with rapid changes. The implementation of the strategic initiatives will help management in achieving the goal - less energy and effort wasted, improved productivity and greater financial surpluses.

6.4 Closing Remarks

It is now obvious that the ability of Alcan Kitimat Works to achieve "world class" status depends largely on how well it can get all the various functions to work together simultaneously rather than sequentially. Likewise it depends on how well it manages to remove the walls (both figurative and actual) between departments and functions that cause mistrust, rivalry, and dysfunction, leading to waste, inefficiency, and chaos. That means to accomplish the maintenance mission in a world-class organization requires more than maintenance just "doing its job" or "getting its act together." It requires the cooperation of and the association with virtually all other departments within the smelter — but especially production, procurement, engineering, accounting, and human resources.

Not only must the roles and missions be well defined for maintenance itself, they must be directly related to or a derivative of the larger set of roles, missions, and strategic objectives of the overall organization. But getting "beyond the boundaries" is what proves so difficult. It is relatively easy to encourage improvement within maintenance; that has been the traditional approach. The challenge is to get other departments to adjust, to work out new arrangements that shift territories and responsibilities, to get departments or groups to recognize common goals and/or even accept each other's ideas.

In a competitive environment, Kitimat Works is forced to reduce their overall cost while maintaining the value and reliability of the assets. Furthermore, maintenance managers need to gain recognition, at all levels, in all departments, that maintenance is a strategic tool, too— recognized as an integral part of the smelter production strategy, an integral component of the overall plan by which the plant meets its marketplace.

Lastly, Kitimat Works needs to change its maintenance strategy to support the extended asset life until a major capital investment is made to upgrade reduction technology. This upgrade is required for a long-term sustainable business model.

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