# Proposed manufacturing performance model for the South African Explosives Industry: Case Study, Somchem, Division of Denel (Pty) Ltd, South Africa.

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# DECLARATION

I, the undersigned, Cedric Lottering, hereby declare that the work in this dissertation is my own and that I have not previously in its entirety or in part submitted this document to obtain an academic qualification at an institution of higher learning.

Signature: ____________________

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# ABSTRACT

After 1994, when South African was welcomed back into the world economy, companies had to deal with increased international competition, not only on the traditional local markets, but also on the competitive global market. This trend is also applicable to the South African Explosives Industry.

Companies in the South African Explosives Industry must therefore ensure operational excellence and manufacture products that conform to world class standards. Superior product quality is becoming increasingly important as a decision-making criterion in the global explosives market, which implies a high demand on bringing products faster to the market at a lower cost.

To place world class products on the market, the challenge for companies like Somchem, a division of Denel (Pty) Ltd, is to adopt a manufacturing performance model that ensures compliance to world class manufacturing standards.

This research study evaluates different successful manufacturing models, and provides a benchmark for the current manufacturing model utilised by Somchem - Denel as evaluated against these models. The result of a gap analysis undertaken between the manufacturing performance at Somchem and the world class manufacturing standards is provided with a recommended strategy to reduce this gap in order to ensure compliance with these world class manufacturing standards.

An internal and external benchmark exercise was performed. The internal benchmark was based on the perception of the internal customers using the rapid plant assessment technique. The external benchmark was conducted with the practical programme for revolutions in factories (PPORF) technique. An analysis of the results of both exercises was conducted so as to recommend amendments to the existing manufacturing model at Somchem – Denel so as to ensure that world class manufacturing standards would be attained in a reasonably short period, namely, three (3) years.

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# CHAPTER 1: INTRODUCTION

## 1. BACKGROUND TO THE STUDY

Somchem, a division of the South African arms manufacturer, Denel (Pty) Ltd, has since 1998 embarked on the following 3-point strategy to improve business performance:

- positioning for growth;
- operational excellence; and
- continuous transformation.

Somchem is divided into eight business areas. Three of these host the marketing, research and development in specialised market segments of energetic raw materials and small calibre propellant (energetic materials), heavy artillery gun propulsion systems (gun propulsion) and rockets and missile technical warhead systems (rockets and missiles). Five other business areas support these three business areas, namely: human resources, financial services, technical services (incorporating maintenance, quality and risk management), supply chain management and the operations section. The operations section administers the production facilities and is therefore responsible for the manufacture of products developed and marketed by energetic materials, gun propulsion and rockets and missiles.

The sharp decline in the defence budgets world-wide and thereby the expenditure on arms procurement, has led to a sharp increase in competition in the global defence industry. Against this background, all companies in the defence industry need to become more customer focused and to strive towards operational excellence.

This research study reviewed the performance of existing international manufacturing models for the purpose of benchmarking against world class standards and assessing the effectiveness of the existing system at Somchem against these benchmarks. In terms of this research study an amended manufacturing model is proposed which complies to world class manufacturing standards.

## 1.1 Explanation of world class manufacturing standards

Different definitions of world class manufacturing are presented in the available literature. Bititci (2002:09) defines it as follows:

> *World Class Manufacturing is a different set of concepts, principles, policies and techniques for managing and operating a manufacturing company.*

A more descriptive definition is provided by Derivitsiotis (2001:687):

> *World Class Manufacturing is an attitude, concept and process of continuous improvement in maintenance and manufacturing processes, equipment conditions and performance to improve overall equipment effectiveness, operations efficiency, output quality, consistence and worker safety.*

Derivitsiotis (2001:690) argues further that a "world class competitor" should possess the following characteristics:

- *Being successful in the chosen market against any competition, regardless of size, country of origin or resources.*
- *Matching or exceeding competitors on quality, lead-time, flexibility, cost or price, customer service and innovation.*
- *Compete where and when and on own terms.*
- *Being in control of processes and resources, in control of your markets and customers and in control of your information.*

Derivitsiotis (2001:690) also claims that the successful implementation of world-class manufacturing strategies depends on seven key operational objectives. They are explained below.

### *1.1.1 Reduce lead-time*

Shorter lead-time increases flexibility, reduces the need for inventory buffers and lowers obsolescence risk. Derivitsiotis (2001:691) argues that the best combination of price and lead-time comes from a stable buyer-supplier relationship based on long-term contracts with deliveries according to a forecast that is shared with the supplier, and updated frequently.

### *1.1.2 Reduce operational cost*

Companies with a lower operational cost structure enjoy an obvious advantage in profitability and the ability to adjust pricing to meet competitive pressure, which is necessary to maintain or gain market share. Most manufactured products today have relatively little direct labour content, generally less than 20% and often less than 10%, whereas the material content of most products is more than 50% of cost-of-goods sold (COGS). The rest is factory overheads.

### *1.1.3 Increase visibility of business performance*

Derivitsiotis (2001:693) states that a well-implemented and effective enterprise information system is essential in any world class manufacturing organisation. An enterprise information system (EIS) delivers overall visibility of business results and operations and provides detailed information of performance measurements, process management and problem identification.

### *1.1.4 Reduce time-to-market*

Derivitsiotis (2001:694) argues that companies should be focused on making sure that the new products meet market needs (marketing and sales), are priced to sell and generate a profit (marketing and finance), can be manufactured efficiently (production, quality and purchasing) and can be maintained and serviced (technical services). Customer expectations and demands are increasing continuously and competition in the marketplace is becoming tougher on a daily basis, with new companies entering every day, world wide. Therefore, bringing better and cheaper products faster to the market is more crucial than ever.

### *1.1.5 Satisfy customer expectations*

The ultimate key to success in any business is to meet or exceed the customer's expectations. Derivitsiotis (2001:694) is of the view that successful manufacturers manage the entire customer relationship – from prospect to post-sales and service and support. This involves the entire organisation in a customer focus business. Communication is of importance – neglect is the most likely reason why customers terminate relationships.

Agility is of extreme importance. A solid collaborative partnership provides advanced information and earliest warning of upcoming changes in customer needs. The most important aspect of customer service is on-time performance. There are two sides to on-time delivery: promising a realistic date, then delivering on that promise. Derivitsiotis (2001:694) states that the accepted world-class manufacturing standard for delivery reliability is a 98% - 99% success in meeting agreed shipment dates. Quality is considered a given parameter in a world-class manufacturing organisation. The focus must be on continuous improvement initiatives that will allow the organisation to achieve or even surpass expectations.

### *1.1.6 Streamline outsourcing processes*

Derivitsiotis (2001:695) claims that outsourcing of non-core manufacturing processes is a common practice in world-class manufacturing organisations. The main benefits of outsourcing lie in its offering of flexibility, the ability to change products or processes rapidly and the saving of money by exploiting the economies of scale.

### *1.1.7 Manage global operations*

The world is shrinking and virtually every business is now involved in some form of international trade. Derivitsiotis (2001:696) points out that the quest is to design new products that appeal to the international market and to search for suppliers globally. It is also important to develop a good understanding and corporate knowledge base on international trade legislation, regulations and protocols. Derivitsiotis (2001:696) also emphasises that attention should be given to even the finer details like language changes in labelling, liaison documentation and marketing. Establishing new sales channels and co-ordinating manufacturing operations across geographies and time zones is the challenge.

## 1.2 Literature Study

The literature study has revealed that recent industrial trends show a shift in approach and adoption of various manufacturing models. Three models are identified which emphasise the change in trends:

- the mass manufacturing model;
- the lean manufacturing model; and
- the extended enterprise manufacturing model.

### *1.2.1 The mass manufacturing model*

Forza (1996:41) states that in the early days of the industrial revolution, the mass manufacturing business model (also known as the Henry Ford model) was dominant. Its main characteristic was to push production downstream in line with predetermined production plans, producing functional products in mass at low prices.

### *1.2.2 The lean manufacturing model*

In the 1980s a research group from the Massachusetts Institute of Technology (MIT) in the United States of America (USA) conceptualised Japanese "waste elimination" business models such as Just-In-Time (JIT) and Total Quality Management (TQM) and affirmed the universal validity of these. The end result was the development of a new manufacturing model referred to as the Lean Production model. The main characteristic of this model, according to Forza (1996:42), is a market driven demand-manufacturing system that aims to reduce the time from customer order to manufacturing and delivering products by eliminating non-value-added waste. Continuous improvement is a key objective of the Lean Production model.

### *1.2.3 The extended enterprise manufacturing model*

A more modern approach to manufacturing is found in the research done by O'Neil and Sackett (1994). O'Neil and Sackett (1994:44) argue that with the use of modern communication technologies such as cell phones, internet and e-commerce there are, more opportunities for enterprises to become more collaborative, decentralised and integrated. The O'Neil and Sackett model (1994:45) is referred to as the Extended Enterprise Manufacturing Model, which is based on the premise that companies are increasingly using electronic communication systems to automate business transactions. O'Neil and Sackett (1994:46) further argue that the extensive use of electronic data interchange would enable a faster transfer and exchange of information.

According to O'Neil and Sackett (1994:44) the natural extension of such an approach will result in a wide area network, connecting all firms in a transaction chain (supply chain) to create the networked enterprise. In this extended manufacturing environment, customers enter the manufacturing process and look for customised products flexible enough to cope with future needs. A characteristic of this approach is that it caters for the increasing impact of ecological values on the manufacturing process through the product design phases, where the emphasis is placed on re-usability, customer configurations and specifications.

## 1.3 Research Purpose Statement and Objectives

The purpose of the research was to assess the performance of the existing manufacturing model at Somchem-Denel, in terms of world-class standards as propagated by the three international models discussed above.

The following three objectives were formulated to achieve this purpose:

- to measure the internal customer's perception of the existing manufacturing model;

- to perform a benchmarking exercise of the existing manufacturing model against world-class manufacturing standards; and

- to perform a gap analysis of the results obtained from the customer perception analysis with the results from the international benchmark exercise and recommend interventions to narrow or eliminate the gap and thereby propose an amended model as the final deliverable.

## 1.4 Research design

The research will be descriptive in nature. A case study approach was adopted with the purpose of evaluating the performance of the existing manufacturing model within the action research paradigm.

The research population is constituted within the operations business area, namely the three strategic business areas hosting the marketing, research and development disciplines. However, two distinct levels of decision making exist in these business areas. They are the more strategic level (the business area leader and his direct subordinates, called group leaders) and the lower task execution level, the technical staff, which includes development scientists, chemists and engineers. Both levels are referred to hereafter as the internal customers.

Respondents have been selected randomly and stratified in accordance with the two levels as explained above. Refer to the sample plan attached as Annexure A.

Two exercises were performed. In the first exercise the internal customers' perception was assessed by utilising a measurement tool referred to as the rapid plant assessment system. This group assessment was undertaken in a survey format so as to gather primary data. The tool was conceptualised and designed by Goodson (1999). The rapid plant assessment consists of a database with operational performance indicators covering 150 operations. A series of operational efficiency check sheets and questionnaires were utilised to perform a self or group internal perception assessment of performance and to compare them with this benchmark within the database.

The second exercise was a self-assessment by the operations management team utilising the world-class benchmarking/instrument contained in the methodology referred to as the practical programme of revolution in factories system (PPORF).

The PPORF system utilises a series of 20 check sheets. The current manufacturing performance data is compared against world class manufacturing standards and practices and is rated from levels one to five. Level one represents the worst workplace level and five the best workplace. Each check sheet thus has a series of questions subdivided into the five levels. The questions relate to the implementation of operational best practices regarding each of the 20 Keys and a score of five points is awarded for compliance to best practices. The levels one to five are then calibrated to different scores of best practice per level. The results of this assessment are graphically presented for analysis purposes in Chapter 5.

The reason for using two independent benchmarking tools was to crosscheck the validity of the results obtained from the two methodologies and thereby check for alignment or discrepancies (gap analysis).

Finally, interventions are recommended to eliminate or close those areas that reflect large discrepancies. Based on this recommendation the existing manufacturing model will be adapted or developed accordingly.

## 1.5 Plan of Study

The report chapter outline is presented below:

### *1.5.1 Chapter 2*

This chapter reviews the historical development of manufacturing models since the industrial revolution. The chapter comments on the various distinctive characteristics of the traditional and modern manufacturing approaches and trends. The concept of world-class manufacturing is also explained in this chapter, which underpins these results. The chapter concludes with an explanation of the best characteristics of all the manufacturing models which are consolidated in the manufacturing model proposed by Kobayashi (1998).

### *1.5.2 Chapter 3*

This chapter provides an explanation of the research design process and methodology, the sample design method and data collection methods utilised.

### *1.5.3 Chapter 4*

This chapter comprises a discussion, presentation and interpretation of the results through the utilisation of statistical electronic programme tools and spreadsheets.

### *1.5.4 Chapter 5*

An analysis of the research results as well as an analysis between the existing and the preferred model is provided.

### *1.5.5 Chapter 6*

The findings, conclusions and recommendations of the study are presented in this final chapter.

# CHAPTER 2

# REVIEW OF THE DEVELOPMENT OF MANUFACTURING MODELS

## 2.1 Introduction

This chapter provides an overview of the development of manufacturing models since the industrial revolution in Europe in the 1800's. The various characteristics of the traditional and more modern manufacturing approaches are compared in order to provide a clear understanding of the paradigm shift in the development of manufacturing models to ensure greater performance. The extent to which the PPORF manufacturing model proposed by Kobayashi (1998), incorporates the best characteristics of these manufacturing approaches, is also explained.

## 2.2 Manufacturing Models

The following three manufacturing models, as identified in the literature, are explained under separate headings, namely the mass manufacturing model, the lean manufacturing model and the extended enterprise-manufacturing model.

### *2.2.1 The mass manufacturing model*

Forza (1996:42) indicates that this production model was active and popular at the start of the industrial revolution in the early 1900's. It was mostly active in the automobile industry of North America, where Henry Ford of the Ford Motor Corporation introduced the idea of a "synchronised factory".

The idea revolves around a manufacturing strategy that promotes the idea to produce as much as one can internally, so as to increase economies of scale and to keep ownership of production processes.

Forza (1996:43) states further that Henry Ford made a decision in 1909, to manufacture on a large scale only, one model of car, the Model T. Initially the Ford Motor Corporation took 14 hours to assemble a model T car. With the implementation of typical mass production methods (shift working hours, long unchanged production runs, synchronised activities in a assembly line format), Ford Motor Corporation was able to reduce the car assembly standard to 1 hour and 33 minutes. This approach lowered the overall cost of each car (economy of scale benefit) and enabled the Ford Motor Corporation to undercut the price of other cars on the market. Between 1908 and 1916 the selling price of the Model T fell from $1000 dollars to $360 dollars.

### *2.2.2 The lean manufacturing model*

Mathaisel,D and Clare,L (2000:248-256) described lean manufacturing as "...reducing the time from customer order to manufacturing and delivering products by eliminating non-value added waste".

Other than the Ford Mass Manufacturing Model which promotes a one-piece flow system the lean manufacturer according to Liker (1995:50) is continuously improving towards the ideal. Womack (1990:34) provides some characteristics of lean practices according to studies that were predominantly performed in the automobile industry:

- *Lean is a dynamic process of change driven by a systematic set of principles and best practises aimed at continuously improving manufacturing performance.*

- *Lean refers to a total enterprise: the shop floor to the executive suite and the supplier to the customer value chain.*

- *Lean requires rooting out everything that is not value adding.*

- *Becoming lean is a complex business. There is no single thing that will make an organisation lean.*

Dankbaar (1997:5) states that lean production makes optimal use of the skills of the workforce, by giving workers more than one task, by integrating direct and indirect work, and by encouraging continuous improvement activities. As a result, lean producers are able to manufacture a large variety of products, at lower cost and higher quality, with less input requirements, compared to traditional mass production.

Watson (1993:40) "...contends that in order to be competitive, companies now realise that they must have, *quality beyond the competition, technology before the competition, and cost below the competition."*

According to Kobayashi (1998:10) companies must therefore be better, faster and cheaper than their competitors.

Lean production is a complex organisational principle that requires major changes in a company. In many areas a company may experience difficulties in implementation. Karlsson and Alhstrom (1995:20) found that difficulties in the remuneration system could be an obstacle to lean production and hence changes need to be made in the system.

In terms of the time element, Bower and Hout (1988:12) reveal that the concept of a fast cycle time could provide a substantive competitive advantage. Bower and Hout (1988:12) suggest that companies need to take several steps to become fast cycle time firms. They should for example:

- *examine the company's cycle times and set new standards;*
- *explore slow cycle times until the root of the problem is found;*
- *develop information systems to track value-adding activities; and*
- *accelerate employee training.*

Bartezzaghi (1992:11) studied the impact of the just-in-time (JIT) approach in 173 industrial companies in Italy and found that the adoption of JIT techniques are often complemented by the inclusion of management resources planning and the installation of flexible automatics. Bartezzaghi (1992:12) further concluded that the application of JIT techniques and methods increased productivity, improved readiness and heightened delivery punctuality in the 173 industrial companies that participated in the study.

Flynn,B and Sadoa,R (1995:10) developed a framework that specified the relationship between quality management practices and quality performance as a means of becoming "lean". This manufacturing model eliminated weak linkages and indicated quality-marketing outcomes, which were related to the product design process and statistical control and feedback systems.

Similarly, Emilliani (1998:15) focused on how individuals created value, with the goal of eliminating waste in both intra- and interpersonal relationships. Emilliani (1998:15) considered five concepts that determined lean thinking: namely flow; perfection; value specification; and pull and value stream identification. The results indicated the importance of lean behaviours in producing healthy work environments.

### 2.2.3 *The extended enterprise manufacturing model*

Manufacturing models that are able to describe state-of-the-art practices are fundamental to the understanding of the extended enterprise-manufacturing model.

O'Neil and Sackett (1994:42) studied the manufacturing practices active in the early 1990's and argued that a new manufacturing model, the Extended Enterprise approach, should emerge. O'Neil and Sackett (1994:42) based their argument on the increasing pressure felt by manufacturers to satisfy the needs of the customers who placed an increasing demand for tailored products with world class capability in every functional aspect. The Extended Enterprise model is made both possible and usable by the progress made in the development of manufacturing processes and information technology systems.

Kobayashi (1998) states that it is a fact that companies are increasingly using electronic communication systems to automate business transactions. The extensive use of electronic data interchange enables a fast transfer and exchange of information. In most cases however, technology just overlays the organisation. O'Neil and Sackett (1994:47) argue that the natural extrusion of this approach to a wide area network connecting all firms creates a networked enterprise. This technology application, however, is merely an enhancement of existing business operations. To create new organisational forms requires the use of information technology, in a different perspective combined with non-traditional practices.

In the automotive industry, Henry Ford , 1909 revolutionised manufacturing practice by using the available technology at the time in a different way, as did the Toyota Motor Corporation (1988) when they adopted the Lean Manufacturing Model.

However, O'Neil and Sackett (1994:46) claim that their Extended Enterprise Model is more ambitious than automated transaction processing. O'Neil and Sackett (1994:46) contend that it reduces cost, which drives the requirements of communication technology in manufacturing to new levels.

O'Neil and Sackett (1994:47) further state that the Extended Enterprise Model encompasses the compression of the customer lead-time by introducing just-in-time supply chains and logistics support throughout the product or service life cycle.

In the manufacturing arena, a competitive edge can be provided by access to creative information processing centres such as specialist design or component manufacturing houses. O'Neil and Sackett. (1994:40) argue that it is no longer possible or even desirable to embrace world class capability in all the key functional areas wholly within a single manufacturing-based enterprise. Class-leading competitiveness flourishes in an environment of dependency and interdependency with other providers of components, services and ideas. O'Neil and Sackett (1994:49) claim that their Extended Enterprise Manufacturing Model offers exactly this functionality, although, it demands a new organisational concept. O'Neil and Sackett (1994:48), explain that in the flat, geographically distributed and transient structure of the Extended Enterprise Manufacturing Model, power is weakened through a conventional hierarchy associated with mass production enterprises.

## 2.3 Comparative analysis of the three manufacturing models

A comparative analysis was undertaken to identify and capture the strengths in each model which is still applicable today. The strengths of each of the three models is encompassed in the model proposed by Kobayashi. The Kobayashi model established the premise of the research study, as it reflects the world class benchmarks, against which the current Denel system was assessed.

The three manufacturing models are compared to each other in accordance with the following manufacturing characteristics, as submitted by O'Neil and Shackett (1994:42):

- Customer's political and economical values;
- Management philosophy;
- Management and focus;
- Business strategy;
- Manufacturing strategy;
- Production type; and
- Production planning and control.

### *2.3.1 Customer's political and economical values*

#### *2.3.1.1 The mass manufacturing model*

Forza (1996:42) states that customers are provided with products that give functionality at low cost price. Forza (1996:43) further argues that a lack of competition limits the customer's choice of alternative products. The process suits the command and control social structure.

#### *2.3.1.2 The lean manufacturing model*

Watson (1993:41) states that customer selection criteria include cost, quality and response time and further emphasises that customers enjoy an advantage of choice.

#### 2.3.1.3 *The extended enterprise manufacturing model*

O'Neil and Sackett (1994:42) state that customers entering the manufacturing process, look for customised products that are flexible enough to cope with future needs. An increased impact of ecological values encourages the development of re-usable and customer reconfigurable products.

This model supports the globalisation of companies and a knowledge-based manufacturing structure.

### 2.3.2 *Management philosophy*

#### 2.3.2.1 *The mass manufacturing model*

Forza (1996:43) states that Taylor's scientific management principles and the synchronised assembly line approach to manufacturing by Henry Ford set the management philosophy for mass manufacturers.

#### 2.3.2.2 *The lean manufacturing model*

Bartezzaghi (1992) proved that management strategies in this model are based on the Japanese philosophy of just-in-time (JIT) that aims to eliminate waste in the manufacturing process. Bartezzaghi (1992) further states that the knowledge base within a company where this manufacturing model is active is widely distributed.

#### 2.3.2.3 *The extended enterprise manufacturing model*

According to O'Neil and Sackett (1994:43) this model follows a philosophy where people throughout the business supply chain participate in the decision-making process. A characteristic of this approach is the development of products that best fit the physical and intellectual needs of the individual users. O'Neil and Sackett (1994:44) emphasise that this distinctive characteristic demands the development of social skills that enable knowledge integration and that it requires a deep change in the power structures in the enterprise to cope with the level of flexibility that customers expect. O'Neil and Sackett (1994:45) argue that the investment in employee training and education and the development of strong and proud team values increase the participation of all employees in the decision-making process. Communication provides the means for excellence.

### 2.3.3 *Management focus and scope*

#### 2.3.3.1 *The mass manufacturing model*

Forza (1996:50) indicates that in this model management directs its activity within the physical boundaries of the enterprise. Management scope is primarily functional and concerned with local optimisation. Forza (1996:51) also points out that a large percentage of management activity relates to control, executed vertically, from top–down. Capital is regarded as the most important resource. People are trained to perform specialised tasks.

#### 2.3.3.2 *The lean manufacturing model*

Dankbaar (1997:50) states that the importance of the different horizontal levels that make up the value chain of the company is realised by the management of a lean manufacturer. The focus is therefore on an internal integration with a horizontal perspective. The development of collective values, and practices like teamwork, contribute to increased cohesion. Dankbaar (1997:51) states that the most important management activities in a lean manufacturing organisation are marketing, engineering and human resources.

#### 2.3.3.3 *The extended enterprise manufacturing model*

O'Neil and Sackett (1994:47) state that the extended enterprise is a knowledge-based organisation that uses the distributed strength of its members, suppliers and customers. Knowledge and trust are the key resources. The management scope is global, looks for the integration of the skills and contributions of every component of the value network, namely companies and individuals. O'Neil and Sackett (1994:48) also indicate that in the extended enterprise, continuous exploration is done to find the synergy necessary to satisfy the diversity demanded by customers, not only in terms of the delivered product, but also in management practices. Senior management's most important strategic role is setting purpose, promoting change and defining generic procedures. Middle management is more concerned with tactical and operational decisions.

The sequential classification of strategic and tactical decisions loses significance in an extended enterprise. Management hierarchy is flat and decision-making is widely distributed.

### *2.3.4 Business strategy*

#### *2.3.4.1 The mass manufacturing model*

Forza (1996:45) states that this manufacturing model flourishes in times of product stability. In the later development of the industrial revolution the front-runners of this type of manufacturing model acknowledge that management is a science, and that it can utilise the same techniques as applied in the industrial world of manufacturing. Forza (1996:50) further mentions that this change of management thinking meant that mass manufacturing companies considered investments in areas not related to their original core business and considered options such as geographical expansion and the development of multinational structures.

#### *2.3.4.2 The lean manufacturing model*

Flynn,B and Sadoa,S (1995) argues that implementers of this manufacturing model explore hidden areas in core business and create new markets for further development, and points out that global marketing is a strong consideration. Long-term alliances with customers and suppliers may take on the form of a joint venture or joint capital investments in an attempt to develop new products and/or to enter new market segments.

#### 2.3.4.3 *The extended enterprise manufacturing model*

O'Neil and Sackett (1994:46) state that the business strategy formulation in an extended enterprise is an incremental process; planning, implementation; evaluation and revision represent small steps which are almost simultaneously taken. Potential business partners are searched for in organisations that have complementary skills to those of the organisation that is not in the same industry. Furthermore, developments in the technological field in terms of communication have reduced the constraints of geographical separation.

### 2.3.5 *Manufacturing strategy*

#### 2.3.5.1 *The mass manufacturing model*

Forza (1996:57) states that the manufacturing strategy is simple; internal production opportunities are exploited to the full in order to increase the economies of scale benefits and to keep ownership of production processes.

#### 2.3.5.2 *The lean manufacturing model*

According to Womack (1990:33) the focus is on core production areas. Womack (1990:34) further emphasises that continuous improvement is a key objective of lean manufacturing. Products with increased options are offered, and the organisational structure and production processes are prepared to adapt to this diversity.

#### 2.3.5.3 *The extended enterprise manufacturing model*

O'Neil and Sackett (1994:45) state that the manufacturing strategy is a natural outcome of the business strategy. According to O'Neil and Sackett (1994:46) manufacturing is a specialised form of service, where the integration of competencies of all those involved in the manufacturing process achieve economies of scale. O'Neil and Sackett (1994:47) refer to this approach as co-operative or pro-service manufacturing. This manufacturing model is directed to offer low volume or unitary products.

### *2.3.6 Production Type*

#### *2.3.6.1 The mass manufacturing model*

Forza (1996:51) states that standard, low variety and high volume products are produced. Forza (1996:52) indicates that the phases in a long product life cycle are youth, maturity and decline. Products are exploited until a fall in sales triggers the launch of the next product generation.

#### *2.3.6.2 The lean manufacturing model*

Womack (1990:36) states that a new product generation is introduced at the product maturation stage. Womack (1990:37) stresses the fact that this approach shortens the product life cycle but takes advantage of technological developments incorporated incrementally in consecutive product generations. The customers perceive these product offerings as new; a perception that creates new needs and develops new markets.

#### *2.3.6.3 The extended enterprise manufacturing model*

O'Neil and Sackett (1994:48) promote this model as being able to provide tailored products that satisfy the specific needs of the individual customer. O'Neil and Sackett (1994:48) emphasise that diversity levels demand that products be designed with a capacity to evolve. The need to keep control of the individual item introduces the concept of "total product life cycle". The manufacturer may remove a product when its capacity to evolve has reached a limit. Then some of its components may be recycled, or the product may be repackaged and used again.

### *2.3.7 Production Planning and Control*

#### *2.3.7.1 The mass manufacturing model*

Forza (1996:48) states that mass manufacturers "make-to-stock". This is consistent with the existence of standard products that aid stable growing markets. The tool that enables this approach is Material Requirements Planning (MRP) utilised in association with a push manufacturing system.

#### 2.3.7.2 *The lean manufacturing model*

Womack (1990:36) states that these models link production planning and control with market needs by "making-to-order". Womack (1990:37) further argues that this approach controls the fluctuations in market conditions better and eliminates the potential amount of waste created by a " make-to-stock " approach. Production may use a Materials Resource Planning (MRPII) system for planning which assures firm customer orders in the master plan. At an operational level the production schedule and control may be undertaken by utilising visual techniques like KANBAN that facilitate the development of a pull system.

#### 2.3.7.2 *The extended enterprise manufacturing model*

O'Neil and Sackett (1994:49) state that this model utilises the "make-to-order approach but that it is also able to "engineer-to-order". According to O'Neil and Sackett (1994:49) this approach utilises flexible techniques for production planning and control.

## 2.4 Results of the comparative analysis of the manufacturing models

In the comparative analysis of the three models above, it is acknowledged that these models were utilised in three different stages of the industrial revolution. The task is thus to find a triple base line from the three models, and apply it to the micro environment within the South African Defence Industry, specifically the case-study reality of Somchem, Denel.

An adapted model was developed from the triple base line derived from the three models that not only strives for cheaper (Ford Model, 1909), better (Lean Production, Forza: 1996) and faster production and delivery (Extended Enterprise Model, O'Neil, Sackett: 1994), but also places a strong emphasis on continuous improvement and innovation.

The Practical Program of Revolutions in Factories (PPORF system) developed by Kobayashi (1998) includes and acknowledges the characteristics of the three models above. This manufacturing model will be adapted for this research project. The PPORF system is also known to the western business world as the 20 Keys to Workplace Improvement Programme.

According to Kobayashi (1998:2) this manufacturing model is based on the premise that in the fast-changing industrial world of the "factory revolution" the emphasis is on higher productivity and a stronger overall enterprise.

These characteristics are a necessity for the stable, long-term development of manufacturing companies. To survive in this modern industrial age, companies continually set and strive towards a variety of new goals.

Kobayashi (1998:3) states that in the late 1980s, the re-engineering business process became a very dominant feature in the industrial world. The most success stories in this approach were evident in North America. However, re-engineering is not a practical method, but rather a trial-and-error application of various methodologies used by numerous companies and consulting firms. This trial-and-error approach means that every sparkling tale of success reflects the many failures, which slows down the progress made.

Kobayashi (1998:5) points out that most of the "revolutionary " techniques proposed as part of the re-engineering process are too difficult to implement, or are likely to yield an inadequate, scattered effect of various incremental improvements. Although some operational improvements may be achieved, insurmountable hurdles and / or a lack of direction for the future negatively affect further efforts.

Kobayashi (1998:6) proceeds to explain that the factory revolution itself is a vague concept describing an activity that never seems to end. It is acknowledged that improvement can be endless and that companies need targets for evaluation of past work and preparation for future work. Appropriate improvement goals that suit the business circumstances must be set and the means found for achieving those goals. Kobayashi (1998:9) is of the opinion that the modern economic environment is undergoing rapid change and that management need to determine to what degree the business can rapidly respond to these changes and regard such responsiveness as a standard for evaluating corporate strength.

According to an assessment undertaken by Koboyashi (1998:11) management cannot improve business performance, unless they know how to improve areas that are in need improvement, Kobayashi (1998:11) argues that by evaluating the degree to which manufacturing companies can rapidly respond to change requires more than simply looking at a company's plant investment commitments. Evaluation also requires assessing how strong and stable a company can remain while dealing with these changes. Furthermore, it requires recognition of key priorities at every level of the company in the factory and management. In response to the foregoing the PPORF is the approach developed by Kobayashi (1998) to guide companies in their efforts towards change and continuous improvement.

The PPORF system brings the above manufacturing improvement methods together in one model and integrates these separate methods into a closely interrelated whole. The separate, independent application of conventional manufacturing improvement methods brings some initial gain, but other obstacles crop up and make these methods harder to implement, and their targets remain out of reach. The PPORF workplace improvement programme, however, integrates 20 key methods for 'revolutionising factories' into a balanced whole that can be implemented rationally and effectively. The PPORF therefore, pushes improvements to ever-higher levels, achieving ever-higher goals. To create strong manufacturing quality and adaptability to change, the PPORF approach ranks the workplace on a five - point scale, with level one designating the worst workplace and level five the best world class workplace. This evaluation forms the standard by which improvement is measured.

However, no comparison is undertaken between one company and others in the same industry, but rather one company versus others in all industries throughout the world. An example may be that in the manufacturing industry in South Africa it may be good practice for a company to carry a two-to-three day supply stock on hand, but what if this South African company is compared to a world class company that keeps less than one day's stock for the same operating activity level? The point is that what is considered a good standard for a local company may be less than what is required to be a truly world-class competitor.

Kobayashi (1998:14) explains that high-ranking companies on the world stage in terms of quality, cost and delivery (QCD) have reached very high levels of world class manufacturing standards. However, even some of these high-flying companies have a lack of vision of what it takes to satisfy customers. Looking at global competition, the PPORF manufacturing model combines a quality, cost and delivery (QCD) approach (making products better, cheaper and faster) with a customer-focused approach (quality at the source – including customers in the process) to create world-class products. The 20 Keys system evaluates customer satisfaction so as to establish world class manufacturing quality.

PPORF is a thus an improvement method with concrete and systematic steps to drastically reform and strengthen every aspect of the manufacturing model. The 20 Keys is the methodology used for implementing PPORF. Each of the 20 Keys will be briefly explained hereunder, as from Kobayashi (1998):

*Key 1 – Cleaning and Organising the Workplace*

This key deals with all the various aspects of industrial housekeeping. It forms the basis for success in the other 19 keys.

Workers will want to do "cleaning and organizing" in their workplace to make their work easier, as opposed to viewing housekeeping as something being forced upon them.

*Key 2 – Goal Alignment or Management Objectives*

The first requirement in implementing the PPORF manufacturing model is that everyone in the organisation agrees to work together to ensure success. In this key the platform is created for top managers, frontline managers and shop floor workers to work together to set goals, own these goals and to pursue it with dedication.

*Key 3 – Dedication Team Activities*

Key 3 deals with the creation of workplace harmony through team building morale boosting, activities and projects. Different improvement teams are created. The teams work on issues that matters to management, as well as to their own jobs. The improvement teams consist of shop floor workers that utilise their hands-on expertise to set appropriate that deals with the work environment, human relation issues, other bottom line influence goals issues.

*Key 4 – Reducing Inventory (Work-In-Progress)*

Key 4 deals with ways and means of getting rid of unnecessary inventory in a manufacturing environment. Shortening the lead time at all stages from processing orders to product development, design, production and shipment will boost the overall manufacturing performance and ensure customer satisfaction.

Work in process is a major source of long lead times. Work in process eats up manufacturing assets and factory floor space, as well as consuming labour costs in managing it, transporting and storing it.

*Key 5 – Quick Changeover Technology*

The optimum balance benefit is derived from the adaptability and improved productivity of wide variety, small lot production, and the economics of scale benefits of large lot production.

Quick changeover is an essential part of any manufacturing system that wants to adapt promptly to change.

*Key 6 – Manufacturing Value Analysis (MVA)*

The manufacturing value analysis method is utilised to analyze the functions of individual manufacturing steps or motions and analysis whether these steps add value to the final product. Any motion that does not add value to the product being manufactured is considered waste that should be eliminated. The application of this method brings a double benefit, it raises the entire factory's productivity while lowering manufacturing costs.

*Key 7 – Zero Monitor Manufacturing*

Kobayashi (1998) states that the focus is on getting operators to understand that a monitoring machine is not a value adding activity. To establish unassisted, unmonitored operations the first task is to determine what makes it necessary for the machine to be assisted or monitored, then find ways to eliminate these factors.

*Key 8 – Coupled Manufacturing*

Kobayashi (1998) explains that the focus of this key is to break down the silo effect that staggers co-operation between different departments in a manufacturing organisation. This "silo" blocks the flow of goods and information literally through the company that could have uncovered problems and obstacles. Close co-operation in manufacturing companies will help make the company able to adapt quickly to change.

Production lines in manufacturing plants set up "stores" between processes so the operator from the downstream process "goes shopping" there for inventory items. Everyone thus sees the "next process step" as the customer. Each process must therefore provide quality products in the desired amounts to the in "coupling points" or stores, so their next process customer can get exactly what is needed next.
This is called "pall" production.

In other companies a "push" system is more applicable. A "push" system is when the production schedule determines how many products each process will turn out and send to the next process. At the next process operators keep busy to use the delivered inventory.

*Key 9 – Maintaining Equipment*

The benefits brought about by a preventative maintenance programme to improve overall manufacturing performance is described in this key.

When factory workers and managers use equipment without properly maintaining these machines will eventually run into a bigger problems, breakdowns, downtimes and line stoppages. The prevention of this equipment downtime the three machine levels of contamination inadequate and disoperation must be eliminated.

Factory workers and managers must further understand that the practise of preventative maintenance can help to identify and fix minor problems in critical equipment before they cause breakdowns. A thorough maintenance management system requires the co-operation of equipment operators, who can promote a preventative maintenance system on their equipment by checking equipment conditions against a check sheet provided by the maintenance technicians.

*Key 10 – Workplace Discipline (Time Control and Commitment)*

This key deals with the importance of employee discipline and commitment to ensure success of the company's manufacturing goals.

Work floor policies are the essential first step toward revolutionising manufacturing quality, only when time polities are established and enforced can manufacturing quality revolution truly take hold. This key is the most difficult to implement as it deals with attitudes as much as it deals with policies.

*Key 11 – Quality Assurance System*

Key 11 deals with the implementation, improvement and sustaining of an effective quality assurance system in the manufacturing organisation.

To obtain improvement in the quality assurance system, progress is required in areas of the business that impacts on the quality assurance system such as reducing equipment breakdowns; improving changeover speed and reliability and invigorating team activities.

The PPORF manufacturing model's approach focus on improvements efforts in all those areas and is therefore well suited as a method for building stronger quality assurance system. When building a strong quality assurance system various paradigm shifts are brought about like changing the focus from "avoiding defects" to "zero defects" work processes, from achieving "zero customer complaints" to "zero next process complaints"

The PPORF model also differs from other models in that use an abnormality rate as the benchmark of product quality than the traditional "defect rate"

"Defect rate" includes only rejects no defective they must be scrapped but minor defects requiring rework are not counted. "Abnormality Rate" accounts for each defect to minor scrapping, but correctable through rework.

Since the abnormality rate is higher than the defect rate, it motivates improvement.

*Key 12 – Developing Your Suppliers*

Co-operation is promoted between a manufacturer and its suppliers have an important impact on the manufacturer's quality, cost and delivery.

The idea that supplier relationships are simply sales transactions must be abandoned. Recognition is giving to the wisdom of providing technical assistance to help suppliers improve their technology and manufacturing quality.

Close co-operation like providing the supplier's employee training in value analysis and value engineering will improve their processes and products. Sharing cost cutting expertise is a further co-operation area that could be of mutual benefit. These initiatives are of dual benefit nature: the supplier becomes more competitive and the manufacturer is able to purchase higher quality goods at lower costs and with more reliable delivery.

*Key 13 – Eliminating Waste (Treasure Map)*

The removing all non-value adding (wasteful) activities or step from the manufacturing process is the focus.

In the PPORF-model the "Treasure Map" approach is used to help everyone understand what waste is and learn how to identify its various forms. Employee teams identify operations with improvement potential and set-up a map style chart indicating current conditions around the plant and improvement goals. This technique makes waste hunting fun and positive by labelling problem area "gold", "silver" or "copper" mines – "gold" meaning the most serious waste and the biggest value to be saved. The result of applying this technique is made obvious to everyone.

As wasteful operations are reduced more time is freed for actual value adding operations that boost productivity.

*Key 14 – Empowering Workers to Make Improvements:*

The idea that employees are empowered is promoted when they are giving the opportunity to perform small improvement tasks, activities or projects by themselves in their own workplace.

The PPORF model accommodates this idea by the creation of "Improvement or Kaizen Corners", near the shop floor. Workplace improvement is thus devised and implemented by the employees themselves; improvements made by others are likely to meet employee needs.

Improvement corners must have tools and workspace for employees to use in implementing their ideas. When a team completes an improvement it is displayed visually in the Improvement Corner which highlights their success and helps other teams learn from their approach.

*Key 15 – Skills Versatility and Cross Training:*

The idea that every worker should understand each other's job so that the factory can gain the manufacturing strength and competitive excellence of being truly change-adaptive is promoted.

*Key 16 - Production Scheduling*

The planning of manufacturing activities in an orderly and sequential manner to ensure that goods and / or information are provided to customers on time is attended to in this key.

In an ideal world scenario, every production manager desires to always be able to meet delivery deadlines without idle, standby or overtime for workers or equipment. These are only a pipe dream; however, as in the modern day plant environment uncertainty in demand predictions, diversification of customer needs, challenging process and product specifications, shorter lead times and greater fluctuations of demand is hard realities.

The PPORF approach to production scheduling is rooted in the principle that the next process is the customer; therefore each process should be responsible for delivering on the time to the next process. Each process involved in the manufacturing of the final product, is evaluated and scored on how much it contributes towards on-schedule delivery.

*Key 17 - Efficiency Control*

The visual presentation of the contribution factory workers and managers make to manufacturing performance of the company is included in this key.

These visual presentations are called efficiency control systems, and it must be understood and supported by the shop floor workers as well as management.

One methodology is the use of simple graphs that shows goals as numerical values, and graphically displays efficiency changes so everyone can clearly see the effects of their improvement efforts.

Each employee's efforts must be displayed or represented by these efficiency control graphs. The PPORF approach to achieve this objective, is to present common goals for managers and shop floor workers and thus having everyone working together to achieve these goals.

Employees must be trained to identify improvement opportunities better and lay the ground work for enhancing efficiency control.

*Key 18 - Using Information Systems*

The use of information technology systems to strengthen the overall manufacturing quality of the company is dealt with in this key.

In modern plants micro processors are applied in labour saving numerically controlled machines, and in advanced automation equipment such as industrial robots, welders and painters. This application range widens elders as new sensor and image processing technologies are applied in manufacturing equipment.

The human factor is however very important in the successful implementation and utilisation of such information systems. Training and user friendly programmers on shop floor level interface level becomes critical to ensure success.

The PPOFR approach is to co-ordinate the development of computer software applications, with the current level of achievement in improving manufacturing quality, so that new software application can be put to effective use, immediately with confusion or failures.

*Key 19 - Conserving energy and materials*

The realisation of cost saving opportunities in the manufacturing process, is attended to in this key, by focusing on conserving, energy and material resources used in the process.

Breaking down costs by section, department, and setting waste reduction goals for each group has the potential to greatly reduce manufacturing costs. If managers and shop floor workers focus is however, reactive in nature, by means of sorting out mishaps or snags in the production process, energy and material conservation will take a back seat.

The PPORF approach is to first quantify and report cost and to emphasize the importance of conservation companywide.

*Key 20 – Leading Technology and Site Technology*

The entire manufacturing organisation is evaluated in this key on the use and application of leading and site technologies and against its competitors.

Site technology, is a set of skills, knowledge and devices that people in a manufacturing organisation acquire as the manufacturing processes are developed. It is an intangible asset, in other words, it does not necessarily increase when new equipment is introduced in the plants. The application of site technology principles enables a manufacturing organisation, to function strategically and ensure competitiveness by making the best use of new equipment in a short time. In the modern world of intense market competition and short product life-cycle, it becomes important for manufacturing organisations to be able to switch over to a new product rapidly and smoothly. That is a prominent feature in the application of site technology. Site technologies, however, is people-dependant. Therefore it is important to have a system for transferring site technologies to new worker, while new generation workers must also be encouraged to add their own contribution. The strength of site technologies can be seen in the speed with which the company is able to successfully incorporate new technology in its manufacturing process.

Every company should continuously benchmark itself in terms of its use and application of leading technologies, against that utilised by its competitors.

If the benchmark indicates a negative gap between the in-house leading technologies and industry leaders, a detail analysis should be made of technology gap and catch-up measures should be planned.

Even industry leaders in application of leading technologies, cannot afford to become complacent, as any technological edge can be lost in a space of months.

## 2.5 Conclusion

It is clear that there has been a major shift in manufacturing approaches over the years. However, there are good characteristics of each manufacturing model that should not be ignored. The clear emphasis that comes through is the "global valley" effect on modern business. This effect is all about the globalisation of markets. As described in the previous chapter, the effect of these globalisation phenomena is already being felt in the South African Explosives Industry. The challenge therefore is to develop a manufacturing performance model that can take advantage of all existing manufacturing models, but that can also adequately address the "global valley" effect, and establish a platform for shop floor (operator) involvement in an attempt to create a customer focus organisation that continuously strives to improve its performance.

The PPORF manufacturing model proposed by Kobayashi (1998) consolidates all these good characteristics of the three different approaches in its Quality, Cost and Delivery (QCD) and customer-focused approaches to create world-class manufacturing quality. This model establishes the basis for the application of the data capturing techniques in this research study.

# CHAPTER 3

## RESEARCH METHOD AND DESIGN

### 3.1 Introduction

The chapter provides an explanation of the research method and design, which includes the research sample and sampling methods. To achieve the first research objective, namely to assess the perception of the internal customer, the Rapid Plant Assessment technique was utilised. The Practical Programme for Revolution in Factories was utilised to perform the benchmarking exercise as expressed in the second objective. This chapter will conclude with an explanation of both data collection techniques.

### 3.2 Research Method

An action research approach was adopted (research was conducted during the period June till November 2003), due to the usefulness of this approach. Bell (1993:07) has defined action research as follows;

> *The essential practical, problem-solving nature of action research makes this approach attractive to practitioner-researchers who have identified a problem during the course of their work, see the merit of investigating it and, if possible, of improving practice.*

However, Bell (1993:07) further states that:

> *There is nothing new about practitioners operating as researchers, and the teacher as researcher model has been extensively discussed by authors such as, Bartholomew (1971), Cope and Gray (1979) and Raven and Parker (1981).*

According to Cohen and Manion (1998:226) action research is not limited to projects carried out by teachers in an educational setting. It is appropriate in any context when "*...specific knowledge is required for a specific problem in a specific situation, or when a new approach is to be grafted on to an existing system...*"

The explanation provided by Cohen and Manion (1998:226) is relevant to this research project, as the specific knowledge that is required in this instance relates to the manufacturing performance data concerning the current manufacturing model of Somchem-Denel, and the "... *new approach to be grafted on to an existing system...*" relates to the new developed or adapted manufacturing model that must transform the performance levels of the current manufacturing model of Somchem – Denel, to one that complies with World Class Manufacturing standards.

Finally, Bell (1993:07) points out that action research needs to be planned in the same systematic way as any other type of research and that the methods selected for gathering information will depend on the nature of the information required. Action research is not a method or technique. The research techniques utilised in this research project were performance benchmark tools, operational performance rating sheets and questionnaires.

Bell (1993:08) states that action research is practical, with the emphasis on performance and problem solving, which is directed towards a greater understanding and continuous improvement of operational practices.

## 3.3 Data Collection Techniques

The two data collection techniques utilised in this study is the rapid plant assessment and the practical program for revolution in factories. The two techniques are explained below.

Primary data regarding the internal customer's perception of the existing manufacturing model was gathered by a survey type method called the rapid plant assessment technique, as designed by Goodson (1999). The technique consists of an operational performance rating sheet and an operational assessment questionnaire. The results obtained (scores for the rating sheet and yes/no answers for the assessment questionnaire) are compared to operational performance indicators in an operational efficiency database, which contains over 400 operational efficiency reports covering over 150 different industries worldwide.

The rating sheet measures 11 operational performance domains. Each domain can be rated on one of six horizontal classifications (1 – poor, 3 – below average, 5 – average, 7 – above average, 9 – excellent and 11 – best in class). These are then scored per evaluation domain.

The performance rating sheet measures the rating and calculates the score of the following domains:

- Customer satisfaction;
- Safety, environment, cleanliness and order;
- Visual display management;
- Scheduling systems;
- Product and material flow, space use;
- Inventory, work-in-progress;
- People teamwork, skills level and motivation;
- Equipment, tooling state;
- Ability to manage complexity and variability;
- Supply chain integration; and
- Quality system deployment.

The assessment questionnaire includes 20 questions on best practice in world class manufacturing. A 100% yes for this assessment reflects full compliance with world class manufacturing standards. The rating sheet and assessment questionnaire are attached as Annexure B and C respectively.

## 3.4 Practical Programme for Revolution in Factories

The second technique utilised was the external performance benchmark tool as incorporated in the Practical Programme for Revolution in Factories (PPORF) developed by Kobayashi (1998). The technique was adopted to assess the Somchem-Denel manufacturing model against world class manufacturing standards. This external benchmark exercise took on the form of focus group discussion. The research focus group consisted of the operations management team and organised labour representatives. The operations management team comprised of one executive manager, four senior managers (production, costing and projects engineer) and eight plant managers, middle management.

This benchmark system utilises a series of 20 check sheets to evaluate the operational performance of any workplace in the world. The 20 check sheets are representative of the 20 key operational objectives of the P.P.R.O.F. manufacturing model as explained in Chapter 2. Each check sheet poses a series of operational performance questions that relate to the "best" or "world class" workplace, which represents a level 5 workplace, and to the "worst" workplace, representing a level 1. A check sheet consists of 20 questions, divided equally per performance level.

The operational performance benchmark tool measures the following 20 key objectives in terms of world class manufacturing standards:

- Key 1: Cleaning and organising to make work easy;
- Key 2: Goal alignment;
- Key 3: Small group activities;
- Key 4: Work-in-process management;
- Key 5: Quick change over technology;
- Key 6: Kaizen of operations;
- Key 7: Zero monitor manufacturing (degree of supervision required for production processes);
- Key 8: Coupled manufacturing;
- Key 9: Maintenance of machine and equipment;
- Key 10: Workplace discipline;
- Key 11: Quality assurance;
- Key 12: Supplier development;
- Key 13: Waste elimination;
- Key 14: Empowering employees to make improvements;
- Key 15: Skills versatility and cross - training;
- Key 16: Production scheduling;
- Key 17: Efficiency control;
- Key 18: Using information systems;
- Key 19: Conserving energy and materials; and
- Key 20: Leading technology / Site technology.

## 3.5 The Sample Method

Hill, Bnerley and Macdongall (1999:4) submit that the process of customer satisfaction measurement is dependent on two main factors, namely that of asking the right questions and asking the right people (the sample). Hill , Bnerley and MacDongall (1999:4) continue by stating that the sample must be representative, randomly selected and sufficiently large to be considered relevant. Various types of sampling methods are discussed, namely simple random sampling, systematic random sampling and stratified random sampling.

Simple random sampling, on the one hand, is the least complex form of sampling, but more applicable in small, homogeneous populations owing to the long time required to execute the procedure. On the other hand, it is also applicable to a heterogeneous population.

Systematic random sampling can extract large amounts of data applicable to a large population from a small sample in a short time frame, using sophisticated algorithms that are generally processed by a computer.

When a sample frame contains a population that is not homogeneous in its composition by virtue of the data one wishes to extract, a stratified random sample may be used. The population is then divided into groups of potential respondents, from which targets for sampling are randomly selected.

The stratified sample will be employed in this research study as two population groups exist as they differ distinctively in their decisions making authorities. The upper decision making group in the sample plan operates on an strategic level whereas the lower decision making level operates more more on a tactical, day-to-day decision making basis. The stratified sample method thus fits the situation better than the simple or systematic random sampling method. A representative sample from each stratified group must therefore be taken. A comparison of the results obtained, if stratification is applied to the survey sample, indicates that a larger sample would not have influenced the results of the survey in any way at all.

## 3.6 The Sample Design

The research population is comprised of the executive managers, group leaders, project and programme managers, design engineers, research and development scientists, technologists and technicians of the three strategic business areas of Somchem-Denel (Gun Propulsion, Rockets and Missiles and Energetic Materials). The research population is also referred to as the internal customers. The internal customers were then separated into two distinct levels: the more strategically focused executive managers, group leaders, programme and project managers and the lower task execution level (design engineers, scientists and technical staff). The two levels are referred to in this study as level one respondents and level two respondents, respectively. The total research population is the number of permanent employees employed at Somchem-Denel at the time the research was conducted, namely, 400. Forty-three (43) employees represent the highest decision makers in the organisation at the time. This sample therefore represents 10,78% of the popuplation. The level one respondents number 24, or 56% of the population, the level two respondents number 19 respondents or represents 44% of the population. The data presented in Annexure D reflects the highest response rate from the level one respondents on the Rapid Plant Assessment questionnaire. Level one and level two respondents represent a 75% and 25% split respectively.

## 3.7 Data Capturing and Editing

The response data from the rapid plant assessment exercise was captured on an electronic-based spreadsheet (Microsoft Excel), shown as Annexure D. The data was first sorted per response group and then per response level, that is first business area and then level one and two, respectively. The primary data from the World Class Workplace benchmark exercise was also captured on an electronic-based spreadsheet (Microsoft Excel).

## 3.8 Data Analysis

### *3.8.1 Rapid Plant Assessment Data*

The spreadsheet-captured data per response group was captured on an electronic statistical analysis programme, STATICA, to compute the data into useful interpretable information.

### *3.8.2 World Class Benchmark Data*

The spreadsheet-recorded data per operational key was further processed and presented in a graphic format to facilitate analysis and formulation of conclusions.

## 3.9 Conclusion

The research conducted was descriptive in nature in order to achieve the purpose of the study. The selected sample group was fully representative of the total population. A relatively small sample was drawn, as the sample universe was small, which rendered the sample design frame adequate for the purpose of this action research.

The research utilised two proven operational performance techniques. The use of the two techniques was purposefully undertaken, as a large degree of overlapping exists in its measurement criteria. The results obtained from the two respective techniques could also be validated. A gap analysis between the current manufacturing model performance and the desired world class manufacturing standard was then undertaken.

# CHAPTER 4

# RESEARCH RESULTS

## 4.1 Introduction

The results obtained from the application of the two-selected research techniques are being presented in this chapter. The results of the internal customer evaluation will be discussed first, followed by a discussion of the external benchmark results done in the areas of similarity and the areas of contradiction. The results are presented in both tabular and graphic format.

## 4.2 Results of the Internal Customer Evaluation

The results produced from the two instruments are presented below:

### *4.2.1 Rating Sheet*

The collected results are presented as numerical values, reflecting the total number of responses received per criterion, which is displayed in graphic format. A comparative base is established so as to facilitate further analysis. The total scores per criterion are graphically reflected in Figure 4. 1

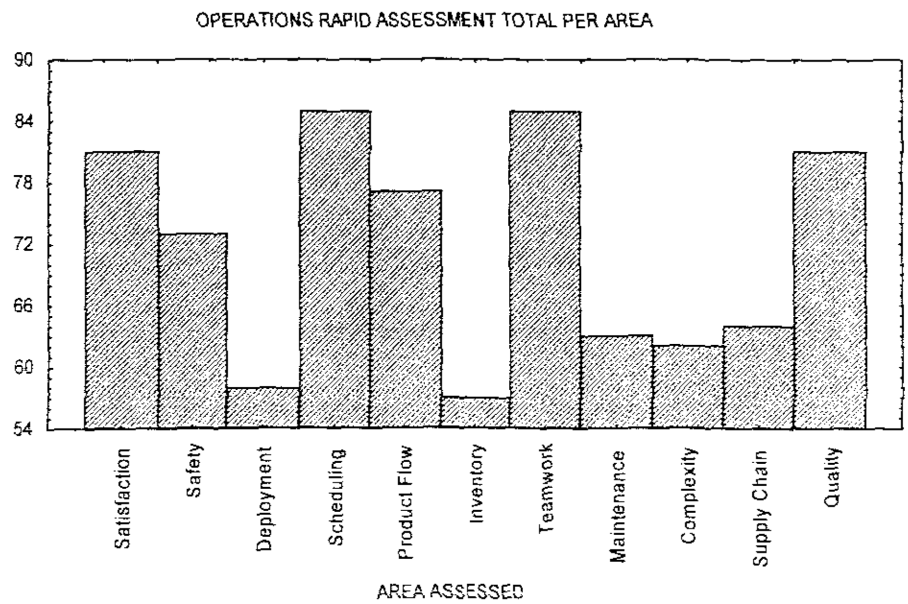
The following criteria were found to be satisfactory (total score in excess of 70) by the internal customers:

- Customer satisfaction;
- Operational safety;
- Scheduling system;
- Product flow;
- Teamwork; and
- Quality system.

The criteria that the internal customers found to be less satisfactory, (total score less than 70) were:

- Visual management deployment;
- Inventory;
- Equipment and maintenance;
- Ability to handle complexity; and
- Supply chain.

Figure 4.1: Graphic Representation of total responses per criterion.

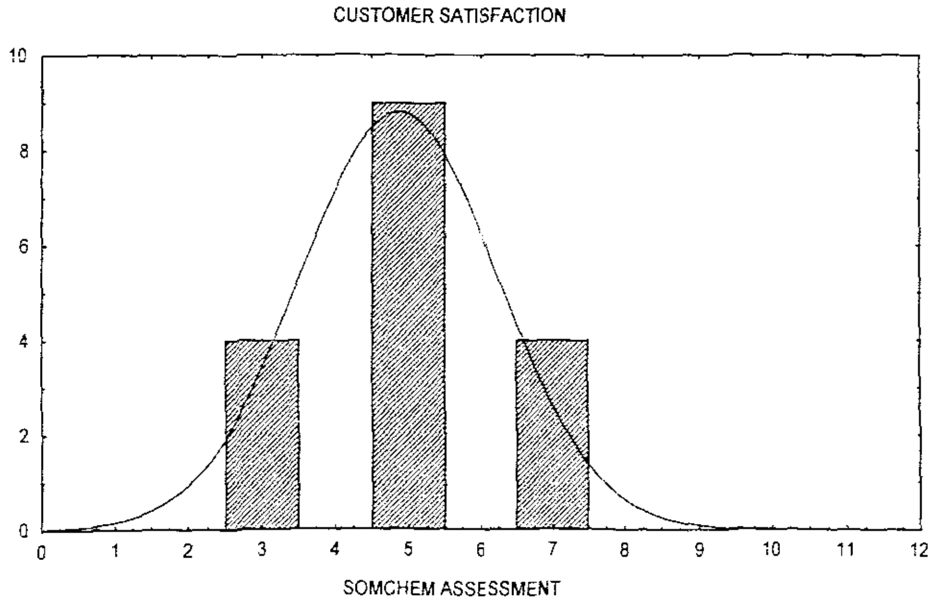



The results collected per criterion are presented and explained under separate headings.

#### *4.2.1.1 Customer Satisfaction*

The internal customers of the Operations Business Unit in general rated the customer satisfaction element as average with a normal distribution of results, as indicated in Figure 4.2.

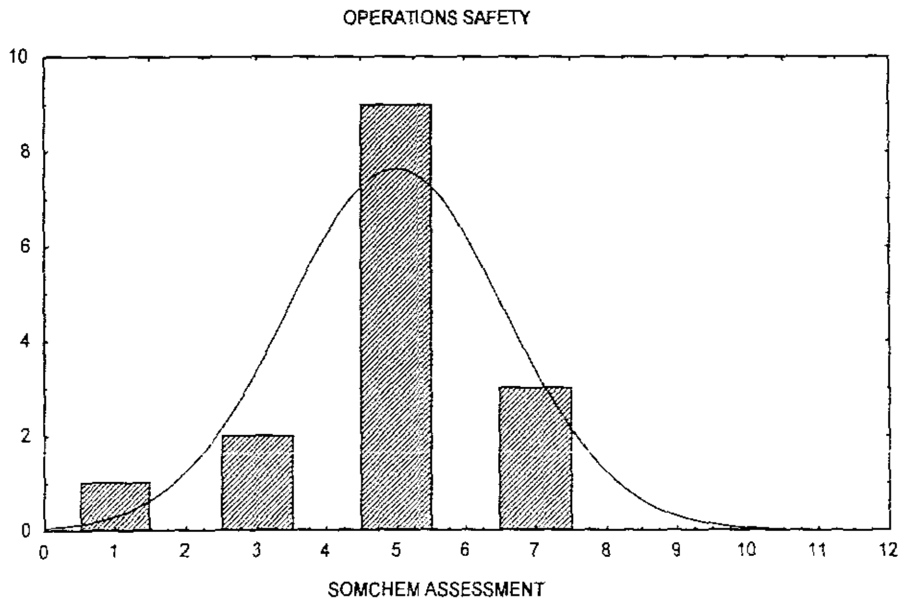
Figure 4.2: Customer Satisfaction




#### *4.2.1.2 Operations Safety*

The internal customers of the Operations Business Unit in general rated the safety element as average with a fairly normal distribution of results (Fig.4.3).

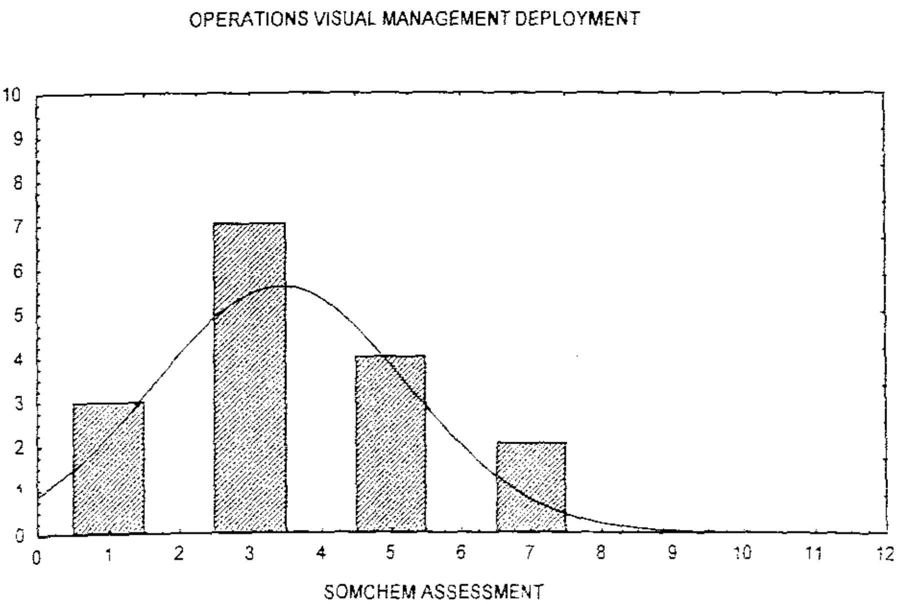
Figure 4.3: Operations Safety




#### 4.2.1.3 *Visual Management Deployment*

The internal customers of the Operations Business Unit in general rated the visual management deployment element as below average with a normal distribution of results.This is graphically represented in Figure 4.4.

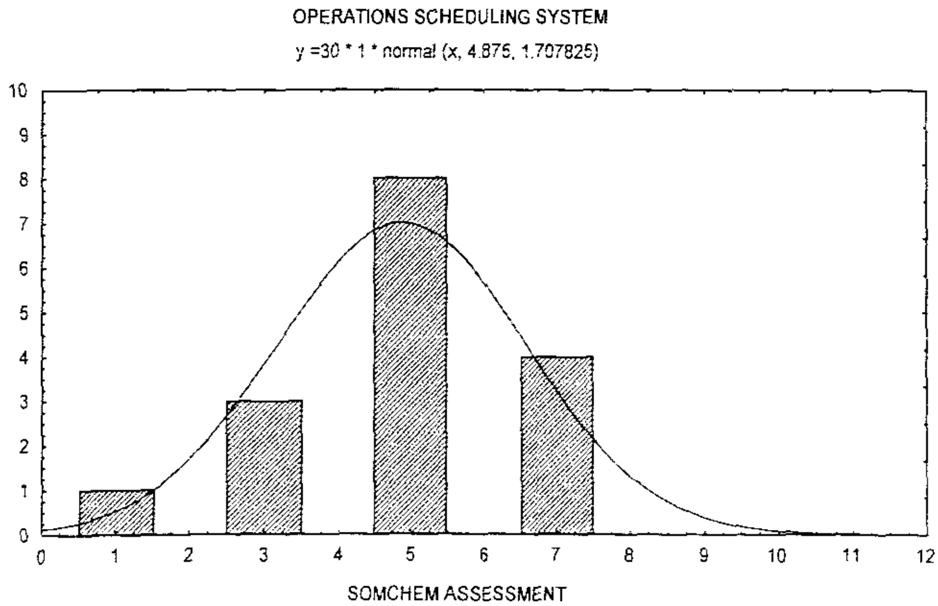
Figure 4.4 : Visual Management Deployment



#### *4.2.1.4 Scheduling System*

The internal customers of the Operations Business Unit in general rated the scheduling system element as average with a normal distribution of results. (see Fig.4.5).

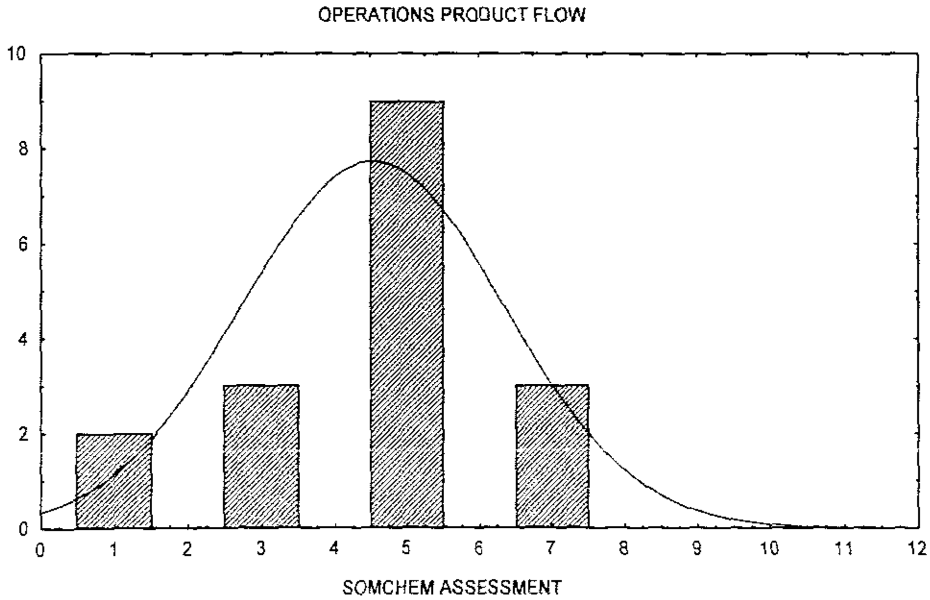
Figure 4. 5 : Scheduling System




#### *4.2.1.5 Product Flow*

The internal customers of the Operations Business Unit in general rated the product flow element as average with a fairly normal distribution of results.

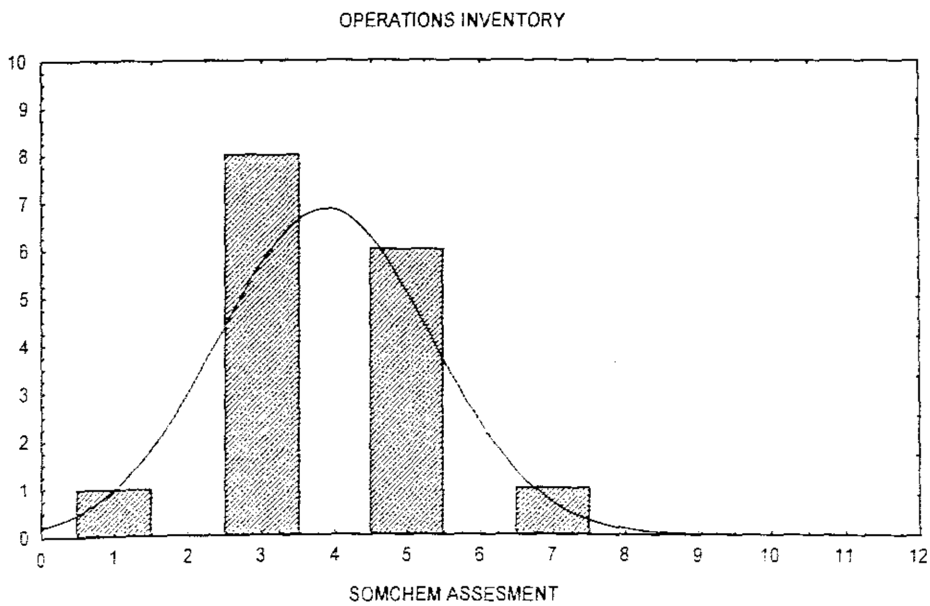
Figure 4.6: Product Flow




### 4.2.1.6 *Inventory*

The internal customers of the Operations Business Unit in general rated the inventory element as below average with a fairly normal distribution of results.

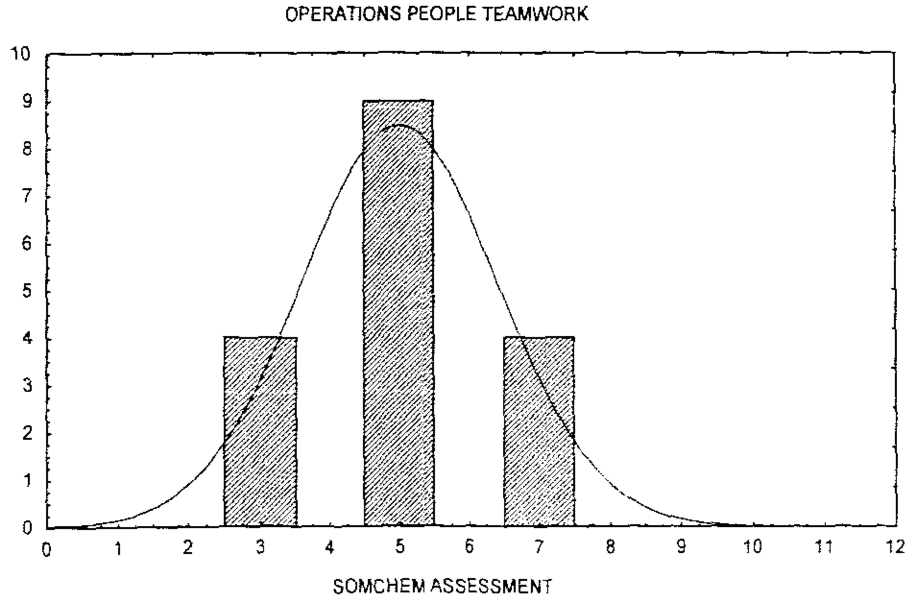
Figure 4.7: Inventory



### *4.2.1.7 Teamwork*

The internal customers of the Operations Business Unit in general rated the teamwork element as average with a normal distribution of results.

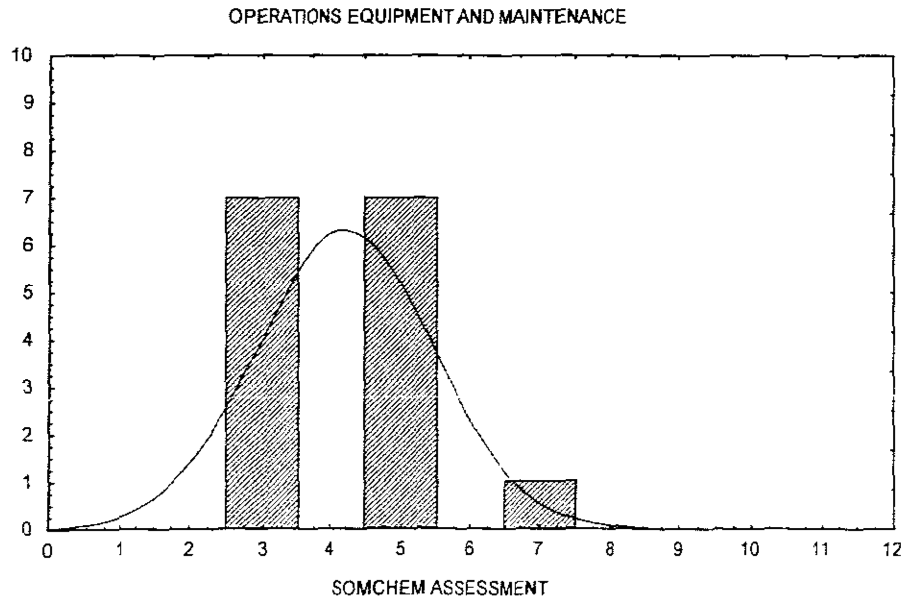
Figure 4.8: People Teamwork




### *4.2.1.8 Equipment and Maintenance*

The internal customers of the Operations Business Unit in general rated the equipment and maintenance element as below average with a fairly normal distribution of results.

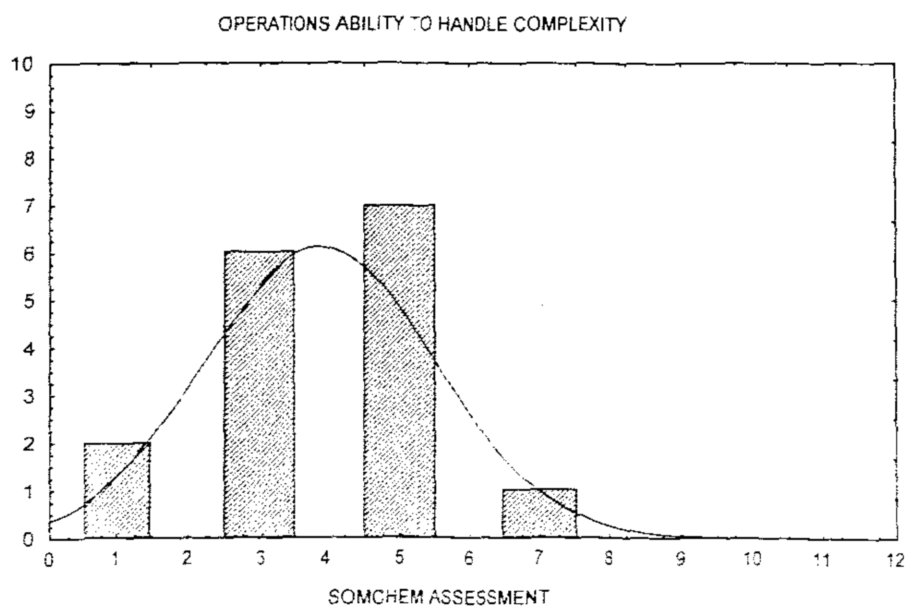
Figure 4.9: Equipment and Maintenance




### *4.2.1.9 Ability to Manage Complexity*

The internal customers of the Operations Business Unit in general rated the ability to manage complexity element as below average with a fairly normal distribution.

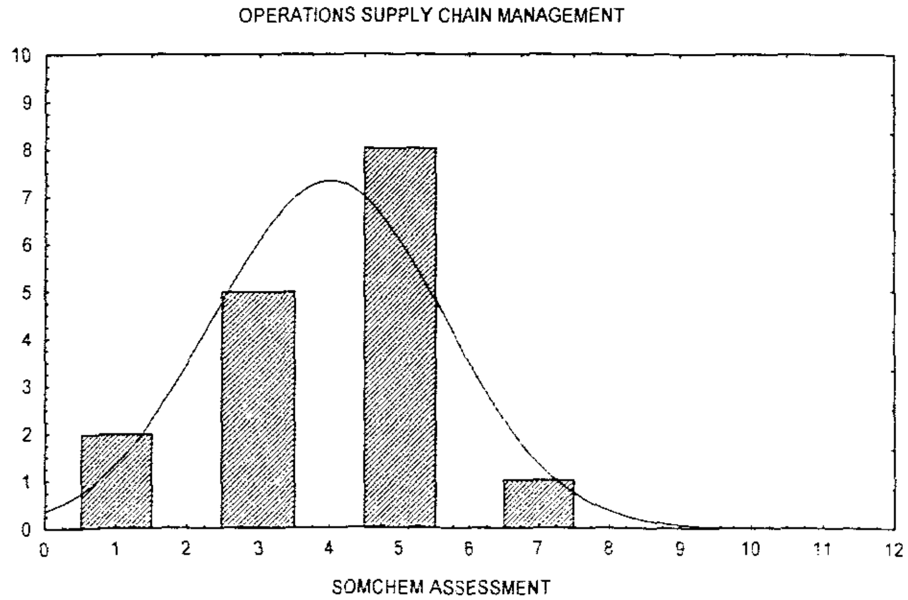
Figure 4.10: Ability to Manage Complexity



### 4.2.1.10 *Supply Chain*

The internal customers of the Operations Business Unit in general rated the supply chain element as below average with a fairly normal distribution of results.

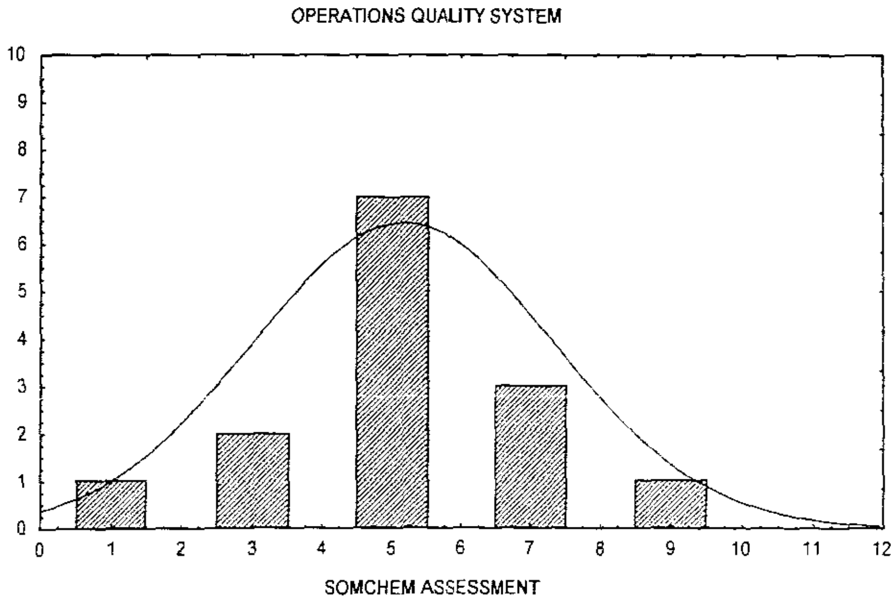
Figure 4.11: Supply Chain Management




### 4.2.1.11 *Quality System*

The internal customers of the Operations Business Unit in general rated the quality system element as average with a normal distribution of results.

Figure 4.12: Quality System




## 4.3 Results of Assessment Questionnaire

The rapid plant assessment questionnaire comprised of 20 questions relating to "best practice" standards to be found in world class manufacturing organisations.

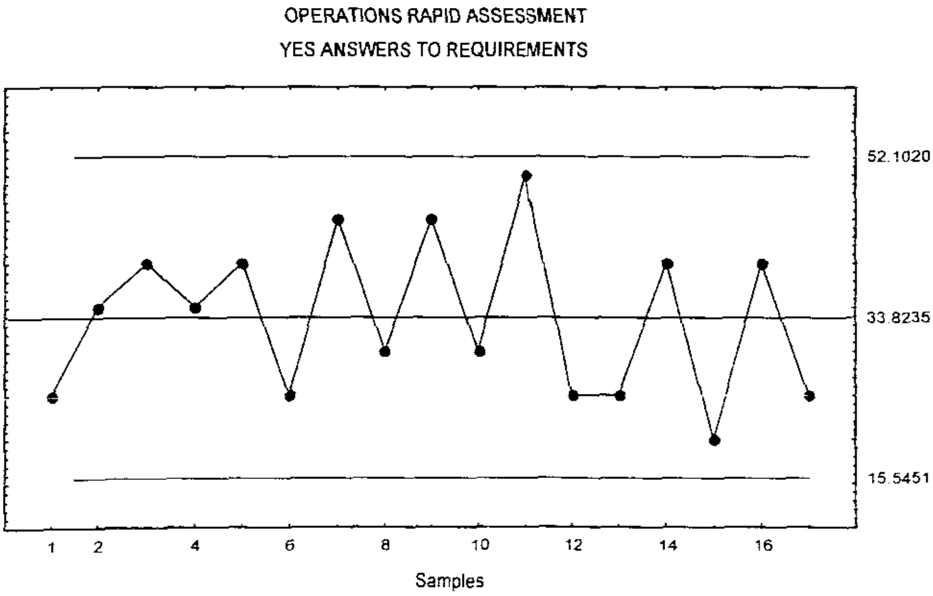
A score of 100% would reflect full compliance with world class manufacturing standards. The recorded numbers of yes responses per operational unit to the yes/no assessment questions are reflected in Table 4.1. The results in table 4.1 indicates that no response group per business area rated performance of the manufacturing model of Somchem-Denel as compliant to world class manufacturing standards. The highest rating per group was the 31% on the level one gun propulsion group and the lowest were the 8% of the energetic materials level two respondents. The tabular presentation of the detail response date on the assessment questionnaire is presented in terms of the sample plan in Annexure D.

Table 4.1: Total operational unit, Yes responses to the Assessment Questionnaire

| **Rapid Plant Assessment - Assessment Results** | | |
|---|---|---|
| | **Yes** | **% Yes** |
| Level 1 | | |
| Gun Propulsion | 36 | 31 |
| Energetic Materials | 14 | 12 |
| Rockets & Missiles | 31 | 27 |
| Level 2 | | |
| Gun Propulsion | 10 | 9 |
| Energetic Materials | 8 | 7 |
| Rockets & Missiles | 17 | 14 |
| **Total Yes Responses** | **116** | **100** |

Figure 4.13 below is a graphic representation (referred to as an X-bar graph) of the responses of the research population to the rapid plant assessment questionnaire. The world class manufacturing benchmark in the application of this instrument is a 100% result in terms of yes answers to all questions in the assessment. The results obtained in this survey vary between a maximum of 52% and a minimum of 15% to the yes answers, with a statistical average of 33.8%. Therefore there is gap of 66.2% (100 % - 33.8 %) between the current performance of the manufacturing model and the world class manufacturing standard.

Figure 4.13: Presentation of Assessment Questionnaire Results




## 4.4 Practical Programme for Revolution in Factories: Results of External Benchmark Exercise

The benchmark tool is designed to provide an indication of the performance of the existing operations in respect to world class manufacturing standards per operational area (referred to as "keys"). The responses are calibrated so that a score of five represents the "best" workplace in the world and one the "worst" workplace in the world.

The results are given as numerical values so as to depict them in graphic format and thereby establish a comparative basis for analysis.

As can be observed in Table 4.2 below, none of the individual keys obtained a benchmark score of more than 2.50, which is the halfway mark towards attaining the world class manufacturing Standard of 5.

Table 4.2: External Benchmark Scores

| Key no | Individual Key Description | Benchmark Score |
|---|---|---|
| 1 | Cleaning & Organising | 1.40 |
| 2 | Rationalising the system / Goal Alignment | 1.40 |
| 3 | Small Group Activities | 1.50 |
| 4 | Reducing Work-in-process | 1.50 |
| 5 | Quick Changeover Technology | 1.40 |
| 6 | KAIZEN of Operations | 1.00 |
| 7 | Zero Monitor Manufacturing / Production | 1.90 |
| 8 | Coupled Manufacturing / Production | 1.70 |
| 9 | Maintaining Machines & Equipment | 1.60 |
| 10 | Workplace Discipline | 1.30 |
| 11 | Quality Assurance | 1.00 |
| 12 | Developing Your Suppliers | 1.30 |
| 13 | Eliminating Waste | 2.00 |
| 14 | Empowering Employees to Make Improvements | 1.40 |
| 15 | Skill Versatility & Cross - Training | 1.00 |
| 16 | Production Scheduling | 1.10 |
| 17 | Efficiency Control | 2.10 |
| 18 | Using Information Systems | 1.60 |
| 19 | Conserving Energy & Materials | 1.60 |
| 20 | Using Technology for Strategic Advantage | 2.40 |
| | Total: | 30.20 |
| | Average: | 1.51 |

The following operational key areas reflect a score of below 1.51:

Key 1: Cleaning & Organising
Key 2: Rationalising the system / Goal Alignment
Key 3: Small Group Activities
Key 4: Reducing Work-in-process
Key 5: Quick Changeover Technology
Key 6: KAIZEN of Operations
Key 10: Workplace Discipline
Key 11: Quality Assurance
Key 12: Developing Your Suppliers
Key 13: Eliminating Waste
Key 14: Empowering Employees to Make Improvements
Key 15: Skills Versatility and Cross Training
Key 16 Production Scheduling

The operational key areas that scored above the overall average of 1.51 are:

Key 7: Zero Monitoring Manufacturing / Production
Key 8 Coupled Manufacturing/Production
Key 9 Maintaining Machines and Equipment
Key 13 Eliminating Waste
Key 17: Efficiency Control
Key 18: Using Information Systems
Key 19 Conserving energy and Materials
Key 20: Using Technology for Strategic Advantage

## 4.5 Conclusion

The results from both assessments reveal that the performance of the current manufacturing model does not conform to world class manufacturing standards. The gap analysis between the two assessment techniques is presented in Chapter 5 so as to facilitate the formulation of recommendations to improve the current manufacturing performance model.

# CHAPTER 5

# RESEARCH ANALYSIS AND FINDINGS

## 5.1 Introduction

The objective of the gap analysis between the two operational performance evaluation techniques utilised in the research project was to identify operational areas that required improvement. The results of this analysis are presented in this chapter.

## 5.2 Identified Operational Areas for Improvement

The results presented in Table 5.1 below reflect the operational areas that required attention. The two applied techniques identified and validated the operational areas that were below the required world-class manufacturing standard.

In the Rapid Plant Assessment (RPA) technique the affected operational areas were:

- visual management deployment;
- inventory; and
- supply chain management.

In the PPORF technique the operational areas that needed improvement that relates closest to these RPA indicators are:

Key 2 (Goal Alignment);
Key 4 (reducing work in progress); and
Key 12 (Supplier development).

There were certain operational criteria in the Rapid Plant Assessment technique aspect that had no match with any of the operational criteria evaluated in the PPORF technique, namely Ability to Manage Complexity".

*Table 5.1: Operational areas below average performance*

| Rapid Plant Assessment | PPORF Benchmark |
|---|---|
| • Visual management deployment<br>• Inventory<br>• Maintenance<br>• Ability to manage complexity<br>• Supply chain | Key 1 – Cleaning and organisms<br>Key 2 – Rationalising the system / Goal alignment<br>Key 3 – Small group activities<br>Key 4 – Reducing work-in-process<br>Key 5 – Quick changeover technology<br>Key 6 – KAIZEN of operations<br>Key 10 – Workplace discipline<br>Key 11 – Quality assurance<br>Key 12 – Developing your suppliers<br>Key 14 – Empowering employees to make improvements<br>Key 15 – Skills versatility and cross training<br>Key 16 – Production scheduling. |

## 5.3 Operational Areas: Above Average Performance

The operational areas rated, as above average in the application of the rapid plant assessment technique was production scheduling, customer satisfaction and quality system, operational safety, customer satisfaction, product flow and teamwork.

The operational areas identified as above average in the application of the PPORF technique were zero (0) monitor manufacturing (Key 7); coupled manufacturing (Key 8); maintaining machines and equipment (Key 9); eliminating waste (Key 13); efficiency control (Key 17); using information systems (Key 18); conserving energy and materials (Key 19) and using site technology for strategic advantage.

These operational areas of strength are summarised in Table 5.2 below.

The difference in the two assessments is in the areas of Safety. The Rapid Plant Assessment internal customer evaluation rated it above average, whereas the corresponding operational areas in the PPORF technique, Key 1, cleaning and organising , was rated below the average benchmark score of 1,51.

*Table 5.2: Operational areas above average performance*

| Rapid Plant Assessment Evaluation | PPORF Benchmark |
|---|---|
| • Customer satisfaction | Key 7 – Zero monitor manufacturing |
| • Safety | Key 8 – Coupled manufacturing |
| • Scheduling system | Key 9 – Maintaining machines and equipment |
| • Product flow | Key 13 – Eliminating waste |
| • Teamwork | Key 17 – Efficiency control |
| • Quality | Key 18 – Using information system |
| | Key 19 – Conserving energy and materials |
| | Using site technology for strategic advantage |

## 5.4 PPORF comparison between Current Operational Performance and Average Performance

Table 5.3 below shows that the Keys with the widest Gap percentage are:

- 151 %, Key 6, Key 11 and Key 15
- 128 %, Key 16
- 93 %, Key 10 and Key 12

Hundred percent (100%) compliance to world class manufacturing standards on the PPROF model relates to an average score of 5 per key. As a realistic short term target, an average score of 2,5 per key was selected, for a period of 3 years.

Table 5.3: Comparison between current and average performance

| | | Current Performance | Target Average Performance | Gap |
|---|---|---|---|---|
| Key 1 | Cleaning & Organising | 1.40 | 2.51 | 79% |
| Key 2 | Rationalising the System / Goal Alignment | 1.40 | 2.51 | 79% |
| Key 3 | Small Group Activities | 1.50 | 2.51 | 67% |
| Key 4 | Reducing Work-in-process | 1.50 | 2.51 | 67% |
| Key 5 | Quick Changeover Technology | 1.40 | 2.51 | 79% |
| Key 6 | KAIZEN of Operations | 1.00 | 2.51 | 151% |
| Key 7 | Zero Monitor Manufacturing / Production | 1.90 | 2.51 | 32% |
| Key 8 | Coupled Manufacturing/Production | 1.70 | 2.51 | 48% |
| Key 9 | Maintaining Machines & Equipment | 1.60 | 2.51 | 57% |
| Key 10 | Workplace Discipline | 1.30 | 2.51 | 93% |
| Key 11 | Quality Assurance | 1.00 | 2.51 | 151% |
| Key 12 | Developing Your Suppliers | 1.30 | 2.51 | 93% |
| Key 13 | Eliminating Waste | 2.00 | 2.51 | 26% |
| Key 14 | Empowering Employees to Make Improvements | 1.40 | 2.51 | 79% |
| Key 15 | Skill Versatility & Cross -Training | 1.00 | 2.51 | 151% |
| Key 16 | Production Scheduling | 1.10 | 2.51 | 128% |
| Key 17 | Efficiency Control | 2.10 | 2.51 | 20% |
| Key 18 | Using Information Systems | 1.60 | 2.51 | 57% |
| Key 19 | Conserving Energy & Materials | 1.60 | 2.51 | 57% |
| Key 20 | Using Technology for Strategic Advantage | 2.40 | 2.51 | 5% |
| | Total: | 30.20 | 50.20 | |
| | Average: | 1.51 | 2.51 | 66% |

## 5.5 Conclusion

The two evaluation techniques provided similar results in terms of identification of areas for improvement and areas of strength. The operational areas that need attention, according to the above comparison are:

The operational areas that require more focus in terms of performance increase priority, are the ones with a gap percentage larger than the average of 66:

Key 1 - Cleaning and organising;
Key 2 - Goal alignment;
Key 3 - Small group activities;
Key 4 - Reducing work-in-progress;
Key 5 - Quick changeover technology;
Key 6 - Kaizen of operations;
Key 10 - Workplace discipline;
Key 11 - Quality assurance;
Key 12 - Developing your suppliers;
Key 14 - Empowering employees to make improvements;
Key 15 - Skills versatility and cross training; and
Key 16 - Production scheduling.

# CHAPTER 6

## CONCLUSION AND RECOMMENDATIONS

### 6.1 Introduction

This chapter concludes the research project by providing recommendations with regard to the proposed manufacturing model and the implementation strategy thereof.

### 6.2. Proposed Manufacturing Model

As described in Chapter 2, the optimum manufacturing model will be one that combines the traditional models of Mass Production (Henry Ford, 1909), Lean Manufacturing (Bartezzeghi *et al.*, 1992) and the concept of the Extended Manufacturing Enterprise (O'Neil and Saskett, 1994:42). The best combination of these three manufacturing models utilised. The Practical Program for Revolution in Factories (P.P.O.R.F.), as developed by Kobayashi (1998) is proposed. It is a customer-orientated model and promotes a continuous improvement business strategy.

It is thus recommended that Somchem-Denel, adopt the PPORF manufacturing model in its entirety and not adapt the existing model. The adoption of the manufacturing model will then take on a 3-year implementation strategy, where goals for selected keys are prioritised for implementation in Year 1. The rest of the Keys will be phased in for Years 2 and 3. The first year commences in January 2005 and Year 3 ending December 2007. The PPROF manufacturing performance model is a continuous improvement model that will provide the platform for future growth. This 3-year goal setting strategy is aligned with strategic Somchem, Denel shareholder values.

## 6.3 Implementation Strategy

The proposed implementation strategy consists of three steps:

### *6.3.1 Step 1: Training Strategy*

When selecting the training strategy for the PPORF Manufacturing Model the following factors need to be taken into consideration:

- the extent of availability of existing resources (e.g. budget, experience and/or qualifications of leadership);and
- The link of this training to the strategic business direction of the Company.

There are three generic approaches to training in the PPORF Manufacturing Model:

- Train all employees in large multi-level groups;
- train frontline leadership (managers and supervisors) who then train their teams; or
- Appoint a Champion for the entire implementation project, and 20-Key Leaders and give them specialised, detailed training. Then hold them accountable to train the different teams.

Budget constraints rule out the option of training every person in the Operations. The risk of ineffective information transfers from a Manager or Supervisor to his/her sub-ordinates on all 20 Keys makes this option a high risk option. The preferred option will thus be to appoint and train a Champion and Key Leaders.

### *6.3.2 Step 2: Implementation Plan*

To implement all 20 Keys simultaneously, from Year 1, there is a risk of some keys progressing at a faster rate than others. All 20 keys are also not at the same level of urgency to implement. In Chapter 5 the keys that has a performance level gap larger than 66% from the targeted level in three (3) years will receive preference and higher focus in the earlier phases of the implementation schedule.

The basis of the PPORF Manufacturing Model is the first three keys in the 20-Keys Work Place Improvement Programme namely, Key 1 – Cleaning and Organising the workplace to make work easy; Key 2 – Goal alignment on all organisational levels, and Key 3 – Making workplace improvements through small group activities. Kobayashi (1998) recommends that these three keys be established first, before the rest of the programme is rolled out. The external benchmark has indicates the focus, and then it shifts to the area's urgent needs. The rest follows thereafter. Therefore the recommended implementation schedule is:

| Year No. | Year | Key Implemented |
|---|---|---|
| 1 | 2005 | Keys 1, 2 and 3 |
| 2 | 2006 | Keys 4, 5, 6, 10, 11, 12, 15 and 16 |
| 3 | 2007 | Keys 7, 8, 9, 13, 17, 18, 19 and 20 |

### 6.3.3 *Step 3: Project Team*

The PPORF or 20 Keys Work Place Improvement champion is appointed by Executive Management. This should be an energetic broad-minded person with a strong technical, and business background. The project Champion should, at least, preferably be a part of the Senior Management Group.

The Key Leaders should preferably be technical component persons with a strong supervising background. These persons are the most important persons in the implementation stage. They will be responsible for training their team members in Key material. They are thus accountable for the implementation of all the Keys in their areas of responsibility. In the case of Somchem - Denel these persons are referred to as "Plant Managers".

## 6.4 Concluding Paragraph

The implementation of the adopted manufacturing model should enable Somchem-Denel (Pty) Ltd to compete successfully in the global explosives industry. An interesting future study could be to determine the companies manufacturing performance in relation to its market position at the end of 2007, after completion of the PROFF manufacturing model implementation phase.

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# ANNEXURE A

*Sample Plan for an Internal Customer Survey*

ANNEXURE A

## SAMPLE PLAN

| BUSINESS AREA | ENERGETIC MATERIALS | GUN PROPULSION | ROCKETS AND MISSILES | RESPONDENTS NUMBERS |
|---|---|---|---|---|
| | | | | |
| **LEVEL 1** | | | | |
| • Executive Managers | 1 | 1 | 1 | 3 |
| • Group Leaders | 3 | 5 | 6 | 14 |
| • Programme Managers | 1 | 5 | 0 | 6 |
| | | | | |
| **LEVEL 2** | | | | |
| • Development Scientist | 2 | 7 | 3 | 12 |
| • Technologists/Technicians | 0 | 3 | 4 | 7 |

# ANNEXURE B

*Rapid Plant Assessment – Rating Sheet*

Rated by:______________ **Rapid Plant Assessment Rating Sheet** Dec-05

Ops/plant:____________

| | Ratings → | Poor | Below Average | Average | Above Average | Excellent | Best in Class | |
|---|---|---|---|---|---|---|---|---|
| **No** | **Measure ↓ Score →** | **1** | **3** | **5** | **7** | **9** | **11** | **Scores** |
| **1** | Customer satisfaction | | | | | | | |
| **2** | Safety, environment, cleanliness and order | | | | | | | |
| **3** | Visual management deployment | | | | | | | |
| **4** | Scheduling system | | | | | | | |
| **5** | Product flow, space use and material movement means | | | | | | | |
| **6** | Inventory and WIP levels | | | | | | | |
| **7** | People teamwork, skill level and motivation | | | | | | | |
| **8** | Equipment and tooling state and maintenance | | | | | | | |
| **9** | Ability to mmanage complexity and variability | | | | | | | |
| **10** | Supply chain integration | | | | | | | |
| **11** | Quality System Deployment | | | | | | | |
| | **Totals →** | | | | | | | |

# ANNEXURE C

*Rapid Plant Assessment - Questionnaire*

| Plant | Rapid Plant Assessment Date | Dec-05 |
|---|---|---|
| **No** | **Assessment Questionnaire** | **Yes/No** |
| 1 | Are visitors welcomed and given information about plant layout, workforce, customers, and products? | |
| 2 | Are ratings for customer satisfaction and product quality displayed? | |
| 3 | Is the facility safe, clean, orderly, and well lit? Is the air quality good and noise levels low? | |
| 4 | Does a visual labelling system identify and locate inventory, tools, processes, and flow? | |
| 5 | Does everything have its own place, and is everything stored in its place? | |
| 6 | Are up-to-date operational goals and performance measures for those goals prominently posted? | |
| 7 | Are production materials brought to and stored at line side rather than in separate inventory storage areas? | |
| 8 | Are work instructions and product quality specifications visible at all work areas? | |
| 9 | Are updated charts on productivity, quality, safety, and problem solving visible for all teams? | |
| 10 | Can the current state of the operation be viewed from a central control room, on a status board, or on a CRT? | |
| 11 | Are production lines scheduled off a single pacing process with appropriate inventory levels at each stage? | |
| 12 | Is material moved only once as short a distance as possible and in appropriate containers? | |
| 13 | Is the plant laid out in continuous product flow lines rather than in "shops"? | |
| 14 | Are work teams trained, empowered, and involved in problem-solving and ongoing improvements? | |
| 15 | Do employees appear committed to continuous improvement? | |
| 16 | Is a timetable posted for equipment preventive maintenance and continuous improvement of tools and processes? | |
| 17 | Is there an effective project management process, with cost and timing goals, for new product start-ups? | |
| 18 | Is a supplier certification process with measures for quality, delivery, and cost performance displayed? | |
| 19 | Have key product characteristics been identified and fail-safe methods used to forestall propagation of defects? | |
| 20 | Would you buy the products this operation produces? | |
| | **Total number of Yes responses** | |

# ANNEXURE D

*Internal Customer Response Data per Sample Plan*

**CUSTOMER SATISFACTION**

| | | Poor | Below Average | Average | Above average | Excellent | Best in Class | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 3 | 5 | 7 | 9 | 11 | |
| | Level 1 | | | | | | | |
| Gun Propulsion | T. Potgieter | | | 5 | | | | |
| | M. Weitsz | | | 5 | | | | |
| | A. Battisson | | | | 7 | | | |
| | E.Nieuwoudt | | | 5 | | | | |
| | M.Lorenzen | | 3 | | | | | |
| | M.Zikmann | | | 5 | | | | |
| | A. Daniels | | 3 | | | | | |
| Energ Materials | J.Beckett | | | | 7 | | | |
| | B.Botma | | 3 | | | | | |
| | B.Hess | | | | | | | |
| | W.Scimansky | | | 5 | | | | |
| | H.Rabe | | | 5 | | | | |
| Rockets & Missiles | J. Venter | | | 5 | | | | |
| | Level 2 | | | | | | | |
| Gun Propulsion | S. Goosen | | 3 | | | | | |
| | M. Gantana | | | 5 | | | | |
| | C. Wiehahn | | | | 7 | | | |
| Energ Materials | V. Fillis | | | | | | | |
| Rockets & Missiles | J. Du Bois | | | 5 | | | | |
| A.D Gericke | A.D Gericke | | | | 7 | | | |
| **Total** | | | 12 | 45 | 28 | | | 85 |

## SAFETY

| | | Poor | Below Average | Average | Above average | Excellent | Best in Class |
|---|---|---|---|---|---|---|---|
| | | 1 | 3 | 5 | 7 | 9 | 11 |
| | Level 1 | | | | | | |
| Gun Propulsion | T. Potgieter | | | 5 | | | |
| | M. Weitsz | | | | 7 | | |
| | A. Battisson | | | 5 | | | |
| | E.Nieuwoudt | | | | 7 | | |
| | M.Lorenzen | | | 5 | | | |
| | M.Zikmann | | | 5 | | | |
| | A. Daniels | | | 5 | | | |
| Energ Materials | J.Beckett | | | | | | |
| | B.Botma | | | 5 | | | |
| | B.Hess | | | | | | |
| | W.Scimansky | | | 5 | | | |
| | H.Rabe | | | | 7 | | |
| Rockets & Missiles | J. Venter | | | 5 | | | |
| | Level 2 | | | | | | |
| Gun Propulsion | S. Goosen | 1 | | | | | |
| | M. Gantana | | 3 | | | | |
| | C. Wiehahn | | | 5 | | | |
| Energ Materials | V. Fillis | | | | | | |
| Rockets & Missiles | J. Du Bois | | 3 | | | | |
| | A.D Gericke | | | 5 | | | |
| **Total** | | 1 | 6 | 45 | 21 | | 73 |

## VISUAL MANAGEMENT DEPLOYMENT

| | | Poor | Below Average | Average | Above average | Excellent | Best in Class |
|---|---|---|---|---|---|---|---|
| | | 1 | 3 | 5 | 7 | 9 | 11 |
| | Level 1 | | | | | | |
| Gun Propulsion | T. Potgieter | | 3 | | | | |
| | M. Weitsz | | | 5 | | | |
| | A. Battisson | | | 5 | | | |
| | E.Nieuwoudt | | 3 | | | | |
| | M.Lorenzen | 1 | | | | | |
| | M.Zikmann | | | 5 | | | |
| | A. Daniels | 1 | | | | | |
| Energ Materials | J.Beckett | | | | | | |
| | B.Botma | | | 5 | | | |
| | B.Hess | | | | | | |
| | W.Scimansky | | 3 | | | | |
| | H.Rabe | 1 | | | | | |
| Rockets & Missiles | J. Venter | | 3 | | | | |
| | Level 2 | | | | | | |
| Gun Propulsion | S. Goosen | | 3 | | | | |
| | M. Gantana | | 3 | | | | |
| | C. Wiehahn | | | | 7 | | |
| Energ Materials | V. Fillis | | | | | | |
| Rockets & Missiles | J. Du Bois | | | | 7 | | |
| | A.D Gericke | | 3 | | | | |
| | | 3 | 21 | 20 | 14 | | 58 |

## SCHEDULING SYSTEM

| | | Poor | Below Average | Average | Above average | Excellent | Best in Class |
|---|---|---|---|---|---|---|---|
| | | 1 | 3 | 5 | 7 | 9 | 11 |
| | Level 1 | | | | | | |
| Gun Propulsion | T.Potgieter | | | 5 | | | |
| | M. Weitsz | | | 5 | | | |
| | A. Battisson | | | 5 | | | |
| | E.Nieuwoudt | | 3 | | | | |
| | M.Lorenzen | 1 | | | | | |
| | M.Zikmann | | 3 | | | | |
| | A. Daniels | | 3 | | | | |
| Energ Materials | J.Beckett | | | | 7 | | |
| | B.Botma | | | | 7 | | |
| | B.Hess | | | | | | |
| | W.Scimansky | | | 5 | | | |
| | H.Rabe | | | | 7 | | |
| Rockets & Missiles | J. Venter | | | 5 | | | |
| | Level 2 | | | | | | |
| Gun Propulsion | S. Goosen | | | 5 | | | |
| | M. Gantana | | | 5 | | | |
| | C. Wiehahn | | | | 7 | | |
| Energ Materials | V. Fillis | | | | | | |
| Rockets & Missiles | J. Du Bois | | | 5 | | | |
| | A.D Gericke | | | | 7 | | |
| Total | | 1 | 9 | 40 | 35 | | 85 |

PRODUCT FLOW

| | | Poor | Below Average | Average | Above average | Excellent | Best in Class |
|---|---|---|---|---|---|---|---|
| | | 1 | 3 | 5 | 7 | 9 | 11 |
| | Level 1 | | | | | | |
| Gun Propulsion | T. Potgieter | | | 5 | | | |
| | M. Weitsz | | | 5 | | | |
| | A. Battisson | | 3 | | | | |
| | E.Nieuwoudt | | | | 7 | | |
| | M.Lorenzen | 1 | | | | | |
| | M.Zikmann | | | 5 | | | |
| | A. Daniels | 1 | | | | | |
| Energ Materials | J.Beckett | | | | 7 | | |
| | B.Botma | | | | 7 | | |
| | B.Hess | | | | | | |
| | W.Scimansky | | | 5 | | | |
| | H.Rabe | | | 5 | | | |
| Rockets & Missiles | J. Venter | | | 5 | | | |
| | Level 2 | | | | | | |
| Gun Propulsion | S. Goosen | | 3 | | | | |
| | M. Gantana | | 3 | | | | |
| | C. Wiehahn | | | 5 | | | |
| Energ Materials | V. Fillis | | | | | | |
| Rockets & Missiles | J. Du Bois | | | 5 | | | |
| | A.D Gericke | | | 5 | | | |
| | | 2 | 9 | 45 | 21 | | 77 |

## INVENTORY

| | | Poor | Below Average | Average | Above average | Excellent | Best in Class |
|---|---|---|---|---|---|---|---|
| | | 1 | 3 | 5 | 7 | 9 | 11 |
| | Level 1 | | | | | | |
| Gun Propulsion | T. Potgieter | | 3 | | | | |
| | M. Weitsz | | 3 | | | | |
| | A. Battisson | | 3 | | | | |
| | E.Nieuwoudt | | 3 | | | | |
| | M.Lorenzen | | 3 | | | | |
| | M.Zikmann | | | 5 | | | |
| | A. Daniels | 1 | | | | | |
| Energ Materials | J.Beckett | | | | 7 | | |
| | B.Botma | | 3 | | | | |
| | B.Hess | | | | | | |
| | W.Scimansky | | | 5 | | | |
| | H.Rabe | | 3 | | | | |
| Rockets & Missiles | J. Venter | | | 5 | | | |
| | Level 2 | | | | | | |
| Gun Propulsion | S. Goosen | | 3 | | | | |
| | M. Gantana | | | 5 | | | |
| | C. Wiehahn | | | 5 | | | |
| Energ Materials | V. Fillis | | | | | | |
| Rockets & Missiles | J. Du Bois | | | | | | |
| | A.D Gericke | | | 5 | | | |
| | | 1 | 24 | 25 | 7 | | 57 |

PEOPLE TEAMWORK

| | | Poor | Below Average | Average | Above average | Excellent | Best In Class |
|---|---|---|---|---|---|---|---|
| | | 1 | 3 | 5 | 7 | 9 | 11 |
| | Level 1 | | | | | | |
| Gun Propulsion | T. Potgieter | | | 5 | | | |
| | M. Weitsz | | | | 7 | | |
| | A. Battisson | | | | 7 | | |
| | E.Nieuwoudt | | | 5 | | | |
| | M.Lorenzen | | 3 | | | | |
| | M.Zikmann | | | 5 | | | |
| | A. Daniels | | 3 | | | | |
| Energ Materials | J.Beckett | | | 5 | | | |
| | B.Botma | | | 5 | | | |
| | B.Hess | | | | | | |
| | W.Scimansky | | | 5 | | | |
| | H.Rabe | | | | 7 | | |
| Rockets & Missiles | J. Venter | | | 5 | | | |
| | Level 2 | | | | | | |
| Gun Propulsion | S. Goosen | | 3 | | | | |
| | M. Gantana | | 3 | | | | |
| | C. Wiehahn | | | | 7 | | |
| Energ Materials | V. Fillis | | | | | | |
| Rockets & Missiles | J. Du Bois | | | 5 | | | |
| | A.D Gericke | | | 5 | | | |
| | | | 12 | 45 | 28 | | 85 |

EQUIPMENT AND MAINTENANCE

| | | Poor | Below Average | Average | Above average | Excellent | Best in Class |
|---|---|---|---|---|---|---|---|
| | | 1 | 3 | 5 | 7 | 9 | 11 |
| | Level 1 | | | | | | |
| Gun Propulsion | T. Potgieter | | 3 | | | | |
| | M. Weitsz | | | 5 | | | |
| | A. Battisson | | 3 | | | | |
| | E.Nieuwoudt | | 3 | | | | |
| | M.Lorenzen | | | | | | |
| | M.Zikmann | | | 5 | | | |
| | A. Daniels | | | 5 | | | |
| Energ Materials | J.Beckett | | | | | | |
| | B.Botma | | | 5 | | | |
| | B.Hess | | | | | | |
| | W.Scimansky | | 3 | | | | |
| | H.Rabe | | 3 | | | | |
| Rockets & Missiles | J. Venter | | | | 7 | | |
| | Level 2 | | | | | | |
| Gun Propulsion | S. Goosen | | | 5 | | | |
| | M. Gantana | | 3 | | | | |
| | C. Wiehahn | | | 5 | | | |
| Energ Materials | V. Fillis | | | | | | |
| Rockets & Missiles | J. Du Bois | | 3 | | | | |
| | A.D Gericke | | | 5 | | | |
| | | | 21 | 35 | 7 | | 63 |

## SUPPLY CHAIN

| | | Poor | Below Average | Average | Above average | Excellent | Best in Class |
|---|---|---|---|---|---|---|---|
| | | 1 | 3 | 5 | 7 | 9 | 11 |
| | Level 1 | | | | | | |
| Gun Propulsion | T. Potgieter | | | 5 | | | |
| | M. Weitsz | | | 5 | | | |
| | A. Battisson | | | 5 | | | |
| | E.Nieuwoudt | | 3 | | | | |
| | M.Lorenzen | | 3 | | | | |
| | M.Zikmann | | | | 7 | | |
| | A. Daniels | 1 | | | | | |
| Energ Materials | J.Beckett | | | 5 | | | |
| | B.Botma | | 3 | | | | |
| | B.Hess | | | | | | |
| | W.Scimansky | | | 5 | | | |
| | H.Rabe | 1 | | | | | |
| Rockets & Missiles | J. Venter | | | 5 | | | |
| | Level 2 | | | | | | |
| Gun Propulsion | S. Goosen | | 3 | | | | |
| | M. Gantana | | | 5 | | | |
| | C. Wiehahn | | 3 | | | | |
| Energ Materials | V. Fillis | | | | | | |
| Rockets & Missiles | J. Du Bois | | | | | | |
| | A.D Gericke | | | 5 | | | |
| Total | | 2 | 15 | 40 | 7 | | 64 |

| Rapid Plant Assessment<br>Table 2 - Assessment Questionare | | | |
|---|---|---|---|
| | | Yes | % Yes |
| | Level 1 | | |
| Gun Propulsion | T. Potgieter | 5 | 25 |
| | M. Weitsz | 7 | 35 |
| | H. Meyer | | 0 |
| | J. Kriel | | 0 |
| | A. Battisson | 8 | 40 |
| | D. v/d Walt | | 0 |
| | E.Nieuwoudt | | 0 |
| | A. Daniels | 7 | 35 |
| | M.Zikmann | 8 | 40 |
| | M.Lorenzen | 1 | 5 |
| | J. Parathyras | | 0 |
| | | | 0 |
| Energ Materials | J.Beckett | | 0 |
| | B.Botma | | 0 |
| | B.Hess | | 0 |
| | W.Scimansky | 5 | 25 |
| | H.Rabe | 9 | 45 |
| | | | 0 |
| Rockets & Missiles | J. Venter | 6 | 30 |
| | L. Feldman | 9 | 45 |
| | F. de Villiers | 6 | 30 |
| | R. Keyser | 10 | 50 |
| | F. Marais | | 0 |
| | T. Momberg | | 0 |
| | H. Rule | | 0 |
| | | | 0 |
| | Level 2 | | 0 |
| Gun Propulsion | C. Wiehahn | | 0 |
| | A. Dietrichsen | | 0 |
| | E. Swart | | 0 |
| | P. van Zyl | | 0 |
| | Dr. W. Michaels | | 0 |
| | M. Gantana | 5 | 25 |
| | G. Nieuwoudt | | 0 |
| | R. Thomas | | 0 |
| | S. Goosen | 5 | 25 |
| | G. Ackhurst | | 0 |
| | | | 0 |
| Energ Materials | V. Fillis | 8 | 40 |
| | J. Venter | | 0 |
| | | | 0 |
| Rockets & Missiles | D. Steyn | 4 | 20 |
| | D. van Zyl | | 0 |
| | A. Delport | | 0 |
| | J. Du Bois | 8 | 40 |
| | S. Krynauw | | 0 |
| | A.D. Gericke | 5 | 25 |
| Total Yeses | | 116 | |