INVESTIGATING THE POTENTIAL FOR THE APPLICATION OF LEAN MANUFACTURING IN THE CAN COATING PLANT AT DUCO COATINGS

DEIDRE FELICIA ERASMUS

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INVESTIGATING THE POTENTIAL FOR THE APPLICATION OF LEAN MANUFACTURING IN THE CAN COATING PLANT AT DUCO COATINGS

DEIDRE FELICIA ERASMUS

Treatise submitted in partial fulfilment of the requirements for the degree Magister in Business Administration in the Faculty of Business and Economic Sciences of the Nelson Mandela Metropolitan University

Supervisor: Professor Koot Pieterse

November 2008
Port Elizabeth
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DECLARATION

I, Deidre Felicia Erasmus, hereby declare that:

- This work has not been previously accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

- This dissertation is being submitted in partial fulfillment of the requirements for the degree of Masters in Business Administration.

- This dissertation is my own work, except where otherwise stated. Other sources are acknowledged by complete referencing. A reference list is included.

- I hereby give consent for my dissertation, if accepted, to be made available for photocopying and for inter-library loan and for the title and the abstract to be made available to outside organisations.

________________________
D.F. Erasmus
Port Elizabeth
November 2008
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My heartfelt gratitude to the following individuals and organisations that have enabled me to complete this document:

- Duco Speciality Coatings for presenting me with the opportunity to research this topic.

- The production team at Duco Speciality Coatings who assisted me with information-gathering and the completion of the questionnaire. I thank you for taking the time and effort to supply data upon which I could base my recommendations and conclusion.

- My colleagues who supported and advised me during the typing of this document.

- My friends and family who encouraged me to finally complete my dissertation.

- My promoter, Professor Koot Pieterse and Dr. Annelie Pretorius, of the Business School, for their guidance and advice in completing my dissertation.

DEDICATION

This dissertation is dedicated to:

- My loving husband, Freddy, who has encouraged me to finally reach this milestone.

- My children, Keenan, Teswell and Deandre, who sacrificed our quality time together so that I can finally complete my MBA degree.

- My parents, Barkley and Desiree De Silva, who have always supported me in all my endeavors.
ABSTRACT

Companies are constantly expected to be more competitive while working in an environment in which time and cost are limited, thereby preventing such companies from taking the time required to be responsive. It is, therefore, important that companies understand that conventional knowledge and methods will not serve unless there is a concerted focus on improvement of organisational performance toward fulfilling increased expectations, not just maintaining that which is comfortable. A more sustainable approach may be the introduction of lean manufacturing techniques. The lean manufacturing process is one that continuously strives to eliminate waste, thereby increasing the percentage of time that may be devoted to value-adding activities.

Lean manufacturing principles were applied in the Can Coating Plant of Duco Speciality Coatings. This study was intended to identify waste in the current production process in the Can Coating Plant and then to use lean tools and principles to eliminate such waste. Implementation of these lean tools proved to result in a leaner and more value-adding process. The new process rendered a positive result on Duco Coating’s costs, quality and product performance. Recommendations on further improvements were also offered.
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INTRODUCTION TO THE RESEARCH AND PROBLEM STATEMENT

1.1 INTRODUCTION

Companies are constantly expected to be more competitive while working in an environment in which the time frame is shrinking, thereby preventing such companies from taking the time required to be responsive. High quality and high expectations are set whilst funding is reduced in a world which relentlessly changes. A company may be a master of change or victim thereof. It is, therefore, important that companies understand that conventional knowledge and methods will not serve unless there is a concerted focus on improvement of organisational performance toward fulfilling increased expectations, not just maintaining that which is comfortable.

Customers’ continuous demand for superior quality products, as well as increasing competition in world markets have imposed even more importance on the role of quality in the effectiveness of organisational performance.

Todd (1995:5) explains that, during the industrial revolution, manufacturing companies tended to compete mainly with similar firms, all trading in similar markets and having similar costs of production. The reduction of import restrictions and tariff barriers has resulted in an increase in international trade and has allowed overseas competition to operate in both home and traditional export markets. In short, the customer has realized that better, cheaper and quicker delivered products can be demanded than ever before.

According to Jones and Hines (1997:153), the last ten to fifteen years has seen a series of new business solutions, such as total quality management (TQM), material requirements planning (MRP), business process re-engineering (BPR) and many more. Each of these principles tends to be partial solutions, focused somewhat narrowly on specific aspects of the complex process of running a business. It is, therefore, perhaps not surprising that general business performance
is viewed by many as stagnating, rather than improving by leaps and bounds. This leads to employee cynicism and uncertainty about employment prospects.

A more sustainable approach may be the introduction of lean manufacturing techniques. According to Chaneski (2002:46), a lean manufacturing process is one that continuously strives to eliminate waste, thereby increasing the percentage of time that may be devoted to value-adding activities and ultimately resulting in a more effective operation.

Lean manufacturing (Six Sigma, n.d.) is also defined as a manufacturing improvement process based on the premise that work is accompanied by waste or non-value added effort that should be minimised or eliminated. A further definition of lean manufacturing is that it is a generic process management philosophy derived mostly from the Toyota production system (TPS), but also from other sources. It is renowned for its focus on reduction of the original Toyota “seven wastes” toward improving overall customer value (Lean, 2008).

The next section of this chapter introduces the main problem of this study, subsequent to which the following issues will be addressed:

- sub-problems;
- research objective;
- significance of the research;
- demarcation of the research;
- key terms and concepts;
- key assumptions;
- broad research methodology followed;
- contents of final report; and
- conclusion.
1.2 THE MAIN PROBLEM
According to Poppendieck (2002:1), Federal Express was innovative when they came up with the idea of delivering packages overnight in 1971. Lens Crafters was unique in the eyeglass industry when, in 1983, they started to assemble prescription glasses in one hour. LL Bean upgraded their distribution system in the late 1980s and came up with the concept of shipping products the same day the order was received.

All of these stories have one thing in common - lean thinking. Lean thinking looks at the value chain and removes all the wasteful steps, time and people that do not add value. All that remains are the value-adding activities.

This study is intended to identify wasteful practices in a current production process and to use lean tools and principles to eliminate such practices. Implementation of these lean tools is expected to create a leaner and more value-adding process. This leads to the following problem, which will be addressed by the author:

How can lean manufacturing principles and tools be used to identify and eliminate waste in the can coating production process at Duco Coatings?

1.3 SUB-PROBLEMS
To develop a research strategy to deal with and solve the main problem, the following sub-problems have been identified:

- What lean manufacturing principles and tools does literature provide which could be used to improve the can coating production process at Duco Coatings?

- Using these principles and tools, how can the current can coating production process be adapted toward a leaner process?

- What advantages were achieved by implementing lean principles to the can coating production process at Duco Coatings?
1.4 RESEARCH OBJECTIVE
The objective of this research is to eliminate waste in the can coating production process at Duco Coatings through the introduction of lean manufacturing principles.

1.5 SIGNIFICANCE OF THE RESEARCH
Can coatings are manufactured by Duco Coatings for the local South African market. The can coating market, in general, is a high-volume business. To be a key player in the market, the company has to remain ahead of the competition. Companies need to be effective and efficient to satisfy their customers. Jones and Hines (1997:153) mentioned that “innovation toward improving business operations is a vital ingredient for any company’s success. Effectiveness, efficiency and innovation are competitive strategies used by companies to keep existing customers and to gain new customers”.

This topic was selected for research as Duco Coatings currently experiences problems in supplying customers. Stock is not supplied timeously to customers due to time delays in the can coating production process. In order to keep its current customer base and maintain its position in the market, Duco Coatings needs to review its current can coating production process. Such review may require the removal of obstacles and wasteful practices within the production process. Once this has been achieved, Duco Coatings will be on its way to being an effective and efficient supplier.

The aim of this investigation is to improve the can coating production process, leading to better quality and removal of all areas of waste. This research will be relevant to Duco Coatings since the outcome of this research will motivate Duco Coatings to apply lean principles, not only to the can coating production process, but to all areas of the company's business to improve all of its operational processes.
Improvement of efficiencies will leave management with more time to concentrate on value-adding activities within the organisation. Adopting a lean mindset will take Duco Coatings one step closer to becoming a world-class performer.

1.6 DEMARCATION OF THE RESEARCH
Demarcation of the research serves the purpose of making the topic manageable from a research point of view. The following sections elaborate on this point.

1.6.1 Area of research
Duco Coatings is a paint manufacturer for the local and export market. The company supplies the automotive and can coating markets. The operation of the can coating business will be the main area of focus in this research since it is the efficiency of this particular area that needs to be improved.

Currently, all can coatings are manufactured in the Can Coating Plant, except for that of the Drawn wall iron (DWI) white coating. For this product, the premix is prepared in the Paint Plant, subsequent to which the millbase is made in the dispersion area and transported to the Can Coating Plant where the batch is completed. Producing parts of this product in different areas creates waste. This study will be concluded to provide an alternate route for production location of the DWI White.

Duco Coatings manufactures various internal and external can coating products for beverage and food cans, foil packaging and drum coatings. Technologies are sourced from international partner companies. For the purposes of this paper the production process of an external beverage can coating will be investigated. The DWI White product is a white coating applied to the external side of cans.

1.6.2 Geographic demarcation
The company studied operates in Port Elizabeth, South Africa. The factory is divided into three smaller manufacturing plants, namely the Paint, Cathodic and Can plants. All three plants are supported by a quality laboratory for final testing.
and a technical department for technical support and problem solving at customer level.

1.6.3 **Size of business**
The can coating team is made-up as follows:
- a sales executive and two sales representatives;
- a production manager, team leader, supervisor, operator/loader and forklift driver; and
- a technical support chemist.

In total, nine people are directly involved in the production of the can coating product.

1.6.4 **Operations**
This research will be limited to the:
- production process;
- filling off; and
- storage.

1.7 **KEY TERMS AND CONCEPTS**
Key terms and concepts used in Chapter One include:

1.7.1 **Process**
A process is the set of actions and conditions required to transform a batch of paint from one discreet state to another during its manufacturing process. An example of a process is the addition of raw materials to extend a millbase into paint.

1.7.2 **Can coating**
Can coating is a generic classification of all paint that finds application in the packaging industry. These include foil lacquers, drum coatings (internal and external) and tube coatings. Internal can coating is used for protection, whilst external can coating is used for anti-corrosive and decorative purposes.
1.7.3 Can Coating Plant
The Can Coating Plant is the area in the factory where all can coatings are manufactured. All can coating production processes are similar and manufactured with the same equipment, every time. It therefore seemed sensible for Duco Coatings to dedicate an area in the factory for the production of all the can coatings.

1.7.4 Paint Plant
The Paint Plant is, as described previously, a dedicated area of production where automotive paint coatings are manufactured for the local automotive companies. Since all production processes for automotive coatings are similar, but different to that of can coatings, automotive coatings are made in a separate. The Paint Plant at Duco Coatings is located 137m away from the Can Coating Plant.

1.7.5 Cathodic Plant
The Cathodic Plant manufactures all the intermediates or resins needed by the Paint Plant. Currently, most of these resins are imported and manufacturing in the Cathodic Plant has declined drastically and has, subsequently, led to equipment not being fully utilised. The importing of resins and intermediates has, therefore, resulted in the equipment in the Cathodic Plant standing idle for most of the time.

1.7.6 Technology
Technology, for the purposes of this study comprises the technical information on a product. It provides data on the material, as well as information on safety issues regarding the handling of such material. Technology further provides information on how to make and test the material. It gives information regarding the production requirements, such as equipment, raw material, the process and any other information relevant to making the material. Technology is usually obtained from a technology partner and thus the manufacturer, for example Duco Coatings, does not have to do the development on the product other than to work out an efficient process flow and routing. The technology partners for Duco Coating’s can coating production process are PPG Packaging Coatings and ICI. These technology
partners provide Duco Coatings with the technical information to make their technology available in South Africa for specific customers.

1.7.7 Routing
The routing of a product comprises the set of vessels and machines that are used to make a batch of paint. Can coatings are routed by the technical department through the most suitable equipment available. The routing of products is fixed and a product is manufactured using only the vessels and machinery specified on the batch card for that product. Advantages of using the same equipment for every batch of the same product is that the operator becomes familiar with the normal (usual) operating parameters and can, therefore, easily spot something unusual. It also minimises the likelihood of cross contamination and assists with problem solving should something go wrong (Van Der Bank, 2005).

Consistency of manufacture is very important in the can industry. Paints must be manufactured to the same processes, using the same route and within the same specification, every time. No changes in the formulation, standard processes or routing may be made without consulting the technical department. Duco Coatings requires permission from toll partners, and sometimes Nampak Research and Development, for any changes required. This will generally warrant the use of a formal change request.

1.8 KEY ASSUMPTIONS
It is assumed that the can coating operation is a business unit separate from the rest of Duco Coatings and that this business unit has its own clientele. It is further assumed that the can coating business has its own strategy, vision, goals and mission statement.

1.9 BROAD RESEARCH METHODOLOGY FOLLOWED
Chapter Two constitutes the theory part of the study. An extensive literature search was undertaken by means of using the Internet and published articles. The literature search was undertaken to address the sub-problems described earlier.
Chapter Three provides an overview of the current situation in the can coating production process. This is the process which requires improvement. The relevant information was obtained by means of face-to-face interviews and informal discussions with selected people. A questionnaire was also drawn up and issued to key people in key areas of the process under investigation. The questionnaire allowed for diverse opinions on the selected topic.

The research methods, and design thereof, are discussed in more detail in Chapter Four.

Chapter Five gives the results from the questionnaire and the chapter also applies the lean tools to eliminate waste in the current process. Input from production personnel toward solving the problem was a team effort. Additional information on the plant layout was obtained during daily production meetings. An alternative production flow process is recommended in Chapter Five.

1.10 CONTENTS OF FINAL REPORT

The following comprises a summary of the chapters making up the study.

- Chapter Two provides an overview of the literature review and theoretical framework.

- Chapter Three outlines the current production process followed in the Can Plant.

- Chapter Four explains the research design and methodology.

- Chapter Five uses the lean tools and principles, as described in the literature review, to identify and eliminate waste in the process under review. It also proposes a process flow alternative to the current process flow.

- Chapter Six concludes the study by looking at how the new process impacts on production, cost and quality. The chapter also provides
recommendations on further improvements to be conducted within the company.

1.11 CONCLUSION
The current can coating production process at Duco Coatings is complicated as a result of unnecessary stages and movement in the process. These stages create waste in the process flow. Lean manufacturing principles and tools will be used to identify and eliminate these wastes in order to make the current process flow more production friendly.

This chapter provided a layout of the study, including an introduction to the main problem, as well as the sub-problems intended to help solve the main problem. Key concepts and the demarcation of the research were also defined. The significance of the research was provided to explain the benefits of the study and the research objective stated the reason for the study. The assumptions were noted and an overview of the chapters was given.

Chapter Two provides a brief summary of the history of lean manufacturing, in addition to providing a description on lean manufacturing principles. The chapter continues with information on the tools available to do the lean exercise. This assisted the author in recommending the employment of a leaner and smoother production flow in the Can Coating Plant to the management of Duco Coatings. This will assist Duco Coating in supplying their customers with product on time.
CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK ON LEAN MANUFACTURING

2.1 INTRODUCTION

For manufacturers to survive, they have to be leaner, meaner and more aggressive. Manufacturers must employ shorter lead times, flexibility and speed. Manufacturers will no longer be able to maintain warehouses with high inventory levels tying up cash, capital and space that could rather be used for manufacturing. Companies throughout the supply chain are compelled to increase profit and to reduce costs. As a result, such companies are feeling pressurised. The question has to be posed on how these companies are responding to customer demands for shorter lead times and smaller quantities. The answer to this includes buying equipment capable of quick set ups; upgrading and maintaining machines to reduce breakdowns; providing employees with training and incentives; and practicing on-time delivery and lean manufacturing (Todd, 1995:7).

Lean manufacturing is a process to create value from the customer’s point of view. It focuses on removing waste from work that is performed by everyone at all levels in the organization (Todd, 1995:7).

The research problem was introduced to the reader in Chapter One. Sub-problems were offered to make the topic more manageable. A general layout of the research paper was provided. It was further stated that the problem will be solved by means of the implementation of lean manufacturing practices. This chapter follows with the theoretical framework of lean manufacturing. The demarcation of the literature study explains how the literature search was undertaken. This is followed by definitions of key concepts.
2.2 DEMARCATION OF LITERATURE SEARCHED
The literature search highlights the history and the development of lean manufacture. Only the main events as occurred in history will be discussed. A further discussion on lean principles and practices will provide the improvement tools required to successfully implement the lean exercise intended for this research paper. Only those lean principles and tools relevant to solving the main problem will be discussed in this chapter.

2.3 DEFINITION OF KEY CONCEPTS
The following comprises the various key concepts used in this chapter.

2.3.1 Value
Esain (2001:268) states that value is defined as a capability provided to a customer at the right time, at an appropriate price.

2.3.2 Value-adding
Value adding is defined as “where the customer’s requirements, both written and unwritten, are provided by the activity” (Hines & Rich, 1997:28). Value adding operations involve the conversion or processing of raw materials or semi-finished products through the use of manual labour (Hines & Rich, 1997:28).

2.3.3 Necessary but non-value adding
Necessary but non-value adding activities occur where the activity must take place in order that the product or service required can be manufactured, but adds nothing to the customer’s requirement (Hines & Rich, 1997:28). This type of operation is described as wasteful but necessary under current operating procedures.

2.3.4 Non-value adding
Non-value adding steps include those activities that add no value to the customer and can usually be easily removed from the process. This is pure waste and involves unnecessary actions which should be eliminated completely (Hines & Rich, 1997:28).
2.3.5 **Waste or Muda**
Muda is the Japanese word for waste. Waste comprises any activity which uses resources, but creates no value (Hines & Rich, 1997:28).

2.3.6 **Kaizen**
Kaizen is a continuous improvement tool, labeled by Bicheno (2001:182) as enforced incremental improvement which results in frequent, but small gains.

2.3.7 **Kaikaku**
Bicheno (2001:178) describes kaikaku as an “instant revolution” which aims at “spectacular and very rapid” productivity improvement in a focused area. He also labels kaikaku as “enforced break through” improvement. Womack and Jones (1996:307) mention that kaikaku results in large, but infrequent gains.

2.3.8 **Supply chain**
Slack, Chambers, Harland, Harrison and Johnston (1998:473) defines the supply chain as the flow of goods or services through a supply network along individual channels or strands of network. The supply network refers to all the operations which are linked to provide the supply of goods or services.

2.3.9 **Value chain**
According to Hines and Rich (1997:27), the value chain includes the complete activities of all the companies involved.

2.3.10 **Value stream**
According to Hines and Rich (1997:27), the value stream refers to specific areas of the firms that actually add value to the specific product or service under consideration. The value stream is a far more focused and contingent view of the value-adding process (Hines & Rich, 1997:27).

2.3.11 **Manufacturing**
Manufacturing is the “economic term for making goods and services that will be available to satisfy human wants and needs. Manufacturing creates value by
applying useful mental and/or physical labour and, thus, converting raw materials into useful products demanded by consumers”. (Black & Hunter, 2003:16).

### 2.4 THE HISTORY AND DEVELOPMENT OF LEAN MANUFACTURE

Eli Whitney perfected the concept of interchangeable parts in 1799 when taking on a contract from the American Army for the manufacture of 10,000 muskets (Just, n.d.). Issues of concern included:

- what happened between processes;
- the arrangement of multiple processes in a factory;
- how the chain of processes function as a system; and
- how each employee went about a task.

These issues were addressed in the early 1900s with the work done by Taylor, Gilbreth and Gilbreth. Taylor experimented with scientific methods. The result of Taylor’s work was Time Study and standardised work. The disadvantage of Taylor’s work was that he ignored behavioural sciences. Frank Gilbreth included motion studies and developed process charting which highlighted work elements, including non-value added elements. Lillian Gilbreth reviewed the psychological aspects by studying the motivation of employees and how attitudes affected the outcome of a process (Just, n.d.).

All the afore-mentioned studies on mass production paved the way for Henry Ford to devise a comprehensive manufacturing strategy where people, machines, tooling and products are arranged into a continuous manufacturing system (Just, n.d.). The problems of inflexibility and wastefulness due to mass production, as experienced by Ford, were overcome by General Motors. Alfred Sloan at General Motors took a more pragmatic approach by developing strategies for managing very large enterprises and dealing with variety (Just, n.d.).

During the 1950s and 1960s, American giants such as Ford and General Motors, dominated the global market through success factors such as market access and core competence of establishing dealer networks and, later, overseas production plants. Meanwhile, Japanese manufacturers who studied the mass production
concept concluded that it was not suitable for Japan. The Japanese developed competence in defect-free manufacture. Womack (Womack, n.d.) states that, in the early 1950s, Toyota had integrated the idea of takt time with Ford’s ideas on continuous flow and added the critical dimension of flexibility to make high quality products, in a wide variety, in small batches with very short lead times. These studies resulted in the birth of the concept of lean production.

By the mid 1970s Toyota was significantly outperforming Ford on quality and reliability. This became critical success factors in allowing them to achieve global sales. Although maintaining a global network was a success factor, which continued to distinguish Ford and the Japanese from many European companies, the production and supplier management activities underpinning quality were becoming threshold competencies (Womack, n.d.).

American executives traveled to Japan to study the Toyota methods of implementing lean manufacturing. Early attempts to simulate Toyota practices failed as such attempts were not integrated into a complete system. Additionally, few understood the underlying principles. Bodek, Hall and Schonberger, wrote popular books to transfer knowledge and build awareness of the lean manufacturing concept in the Western World (Just, n.d.).

2.5 LEAN PRINCIPLES AND PRACTICES
Womack and Jones (Principles, 2008) offer a set of five basic principles that may be used to achieve a lean strategy:

- Specify value where value is “determined by the customer in terms of product, service or both which meets the customer’s needs at a specific price at a specific time”. The manufacturer should focus on how to improve the performance and delivery quality of products at a lower cost. Lean thinking requires an enterprise to ignore current assets and technologies and to rather focus on product-line basis with a strong, dedicated product team (Principles, 2008).
• Identify the steps in the value stream – the value stream consists of all those actions required to bring a product/process through the critical management tasks, such as problem-solving from concept through to production launch; information from order taking to delivery; and physical transformation from raw material to finished product. This step exposes huge quantities of muda (Principles, 2008).

• Flow – the remaining value-creating steps must now be made to flow without interruptions, detours, back flows, waiting or scrap. During this step productivity is improved and mistakes and waste are eliminated. “Flow-production was an even more valuable innovation of Henry Ford than his mass-production model” (Principles, 2008).

• Pull – the result from the first three steps is that the company can now manufacture what the customer demands, rather than using a production schedule dictated by a sales forecast. The customer “pulls the product from you as needed rather than you pushing products (often unwanted) onto the customer”, resulting in the company producing according to just-in-time customer demand (Principles, 2008).

• Pursue perfection – once all the steps have been achieved further improvements can be made in terms of effort, time, space, cost and errors. Striving for perfection is enhanced by continually removing successive layers of waste as they are uncovered. Pursuance of perfection is a continuous improvement cycle. There is no end to this process (Principles, 2008).

The next section in this chapter looks at the value stream and the types of waste that can be found.
2.6 THE VALUE STREAM AND WASTE

The value stream includes those value-adding activities that are required to bring a product from raw material through delivery to the customer (Jones & Hines, 1997:153).

It is common to find that less than five per cent of activities in a factory actually add value; 35 per cent are necessary non-value-adding activities; and 60 per cent add no value at all (Jones & Hines, 1997:153). It is easy to see the steps that add value; however, it is much more difficult to see all the waste that surrounds them. Eliminating the 60 per cent waste activities and costs offers the biggest opportunity for performance improvement.

Optimising each piece of the supply chain in isolation does not lead to the lowest-cost solution. It is, in fact, necessary to look at the entire sequence of events, from the customer order right back to the order given to the raw material supplier, as well as forward through all successive firms making delivery of the product to the customer. When identifying possibilities for eliminating waste it makes more sense to do so for one particular product or product family, as well as for all the tributaries that flow into this stream of value creation (Jones & Hines, 1997:153).

Focusing on the whole chain is the first step; focusing on the product is the second; and focusing on the flow of value creation, and not on the more traditional performance measurement of departments and firms, is the third. Value stream is thus a new and more useful unit of analysis than the supply chain or the individual firm. Focusing on the flow of value creation challenges the notion that batches are necessary and better. The value stream concept extends both upstream from the product assembler into the supply chain and downstream into the distribution chain (Jones & Hines, 1997:155).

According to Jones and Hines (1997:155), Taiichi Ohno demonstrated that if one looks from the perspective of the whole value stream it is possible to organise activities so that the work moves from step to step in an uninterrupted flow at a rate that matches the pull of the customer. This was always thought of as a special
case that only applied to high volume production of a standardised product, such as a car. Ohno proved the general case and developed the tools and techniques necessary to achieve it. The tool kit for the manufacturing context is known as the Toyota Production System. Womack and Jones (1996:356) describe its generic form as lean thinking and have documented the impressive gains achieved by those firms which have followed this system (Jones & Hines, 1997:156).

According to Jones & Hines (1997:155) “the advantage of using Ohno’s tool kit is that one begins to rethink not only the organisation of the work, but also the appropriateness of the size of machines, warehouses and systems to fit the flow. As people, machines, warehouses and systems are rethought and combined in different ways, layers of previously hidden waste tend to be uncovered and removal (perfection) becomes the appropriate goal and not what your competitor is doing today. Perfection is defined as the complete removal of waste until every action and every asset adds real value for the ultimate customer. In theory, waste removal is a continuous process, operating cyclically and without end”.

Jones & Hines (1997:155) also mention that “Ohno demonstrated that a systematic attack on waste would also provide a systematic attack on poor performance within manufacturing and supply systems. He identified seven fundamental forms of waste”:

- over-production;
- waiting;
- transport;
- inappropriate processing;
- unnecessary inventory;
- unnecessary motion; and
- defects.

### 2.6.1 Over-production

This is regarded as the most serious waste as it discourages a smooth flow of goods or services and is likely to inhibit quality and productivity. Over-production also tends to lead to excessive lead and storage times. As a result defects may not
be detected early, products may deteriorate and artificial pressures on the work rate may be generated. In addition, over-production leads to excessive work-in-progress stock which results in the physical dislocation of operations, consequently resulting in poorer communication (Jones & Hines, 1997).

### 2.6.2 Waiting
Timing used ineffectively results in the waste of waiting. In a factory setting, this occurs whenever goods are not moving or being worked on. This waste affects both goods and employees, each spending time waiting. The ideal state should be one where no waiting time exists; consequently with a faster flow of goods. Waiting time for employees may be used for training, maintenance or kaizen activities and should not result in over-production (Jones & Hines, 1997).

### 2.6.3 Transport
The third waste, transport, involves the moving of goods. Taken to an extreme, any movement in the factory could be viewed as waste and transport minimisation, rather than total removal, is usually preferred. In addition, double handling and excessive movements are likely to cause damage and deterioration, with the distance of communication between processes proportional to the time it takes to feed back reports of poor quality and to take corrective action (Jones & Hines, 1997).

### 2.6.4 Inappropriate processing
This occurs in situations where complex solutions are found to simple procedures. Over-complexity generally discourages ownership and encourages employees to over-produce to recover the large investment in complex machines. Such an approach encourages poor layout, thereby leading to excessive transport and poor communication. The ideal, therefore, is to have the smallest possible machine; capable of producing the required quality; and located next to preceding and subsequent operations. Inappropriate processing further occurs when machines are used without sufficient safeguards, resulting in the production of poor quality goods (Jones & Hines, 1997).
2.6.5 **Unnecessary inventory**
Unnecessary inventory tends to increase lead time, preventing rapid identification of problems and increasing space, thereby discouraging communication. Thus, problems are hidden by inventory. To correct such problems they first have to be found. This can be achieved only by reducing inventory. In addition, unnecessary inventories create significant storage costs and, hence, lower the competitiveness of the company or value stream wherein it exists (Jones & Hines, 1997).

2.6.6 **Unnecessary movements**
This involves the ergonomics of production where operators have to stretch, bend and pick up when these actions could otherwise be avoided. Such waste is tiring for the employees and is likely to lead to poor productivity and, often, to quality problems (Jones & Hines, 1997).

2.6.7 **Defects**
The bottom-line waste is that of defects as these are direct costs. The Toyota philosophy is that defects should be regarded as opportunities for improvement, rather than something to be traded off against what is ultimately poor management. Defects are thus seized on for immediate kaizen activity (Jones & Hines, 1997).

In systems such as the Toyota production system (TPS), the continuous and iterative analysis of system improvements using the seven wastes results in a kaizen-style operation. The majority of improvements are small but incremental, as opposed to radical or breakthrough (Jones & Hines, 1997).

2.7 **LEAN MANUFACTURING**
The term lean manufacturing was adopted to describe the Toyota approach to manufacturing which was in contrast to the mass production approach of Western manufacturers. According to Taylor and Brunt (2001:3), companies adopting the new concept of lean manufacturing manage to decrease defects by ninety percent, inventory by three-quarters, and space cost by half.
Lean approaches have been explored and developed by many companies and researchers in America and the United Kingdom. Womack and Jones (1996) provide a vision of the lean company and gives guidance for firms that wish to move towards that vision.

Lean thinking strives to meet customer requirements by constantly attacking three enemies: waste, variability and flexibility. According to McCallum (2003:34), an American office furniture manufacturer, Herman Miller, transformed its business using lean principles in 1995 and now claims to build and deliver 99.5 per cent of its Internet orders within two days. This, according to the company, has resulted in an annual revenue growth of 30 per cent and an inventory turnaround rate of more than double that of its competitors.

2.8 LEAN TOOLS FOR PROCESS IMPROVEMENT

Literature offers various lean tools which could be of assistance in achieving a lean state. For the purpose of this study, only three of these tools will be used and discussed in detail. These tools are process flow charts, spaghetti charts and the 5S programme.

2.8.1 Process flow chart

As per Pieterse (2007:30), a flow chart illustrates what happens in numerical order and shows all the steps in the process. Flow charts are used to identify both the value adding and non-value adding steps in a process so that the non-value adding steps are eliminated. Value-added work is any step that contributes toward completing the process. Non-value added steps are those steps which do not assist in the completion of the batch or part being manufactured, such as inspection, delays, moving, rework or storage of material.

Completing a chart requires the definition of the process, the department where the process takes place, the date the chart was drawn up and the analysis number. Subsequent charts are numbered in sequence. The next stage comprises breaking the process down into individual steps and numbering each step. The time taken to perform each step is recorded, as well as the distance traveled between steps.
Next, it needs to be determined into which of the six categories of activity each step falls. These categories are (Pieterse, 2007)

- process (symbol •) - any value added work;

- transport (symbol 🔄) - moving the material from one location to another by any means of transport;

- inspect/rework (symbol ⚫) - inspection is any testing or comparison of the part to specification. Rework is any work done to make the part acceptable to the specification;

- delay (symbol D) - any waiting period where the machine or operator is not ready;

- store (symbol •) - this refers to long-term storage outside the area where the value-added work is performed; and

- record (●) - data entry or recording of findings.

Once the steps have been categorized, the number of steps is added up in each category. The number of value-added steps is then compared to that of the number of non-value added steps. The total process time is calculated by only adding the times for the value-added steps. The value-added time is then divided by the total processing time and multiplied by 100 to determine the percentage of processing time spend on value-added activities. This value is frequently less than 1 per cent.

The process flow chart tool is used in Chapter Five to determine the percentage value-added time in the current situation, as well as on the proposed process flow in the can coating production process at Duco Coatings.
2.8.2 **Spaghetti charts**
Spaghetti charts may be defined as “a two-dimensional drawing, based on a floor plan that includes lines that track the movement of an employee throughout the work area. Before and after spaghetti charts are often used to track 5S improvements” (Process, 2008).

The spaghetti chart is employed to create a scaled-up map of the facility layout under inspection for improvement. The next step is to trace the actual physical route of a particular process by drawing the route on the chart. For each step in the process a note is made of the physical distance traveled, including the time taken to do so. A sticky note is written or placed on the chart. Spaghetti charts are very useful for clearly pointing out how much distance or motion exists in a given process. Ways should be found for any distance or motion that constitutes waste.

Chapter Five illustrates the use of a spaghetti chart in both the current and new process flow.

2.8.3 **Housekeeping - the 5S programme**
The 5S programme may be defined as a basic, fundamental, systematic approach for productivity, quality and safety improvement in all types of business. The 5S programme focuses on visual order, organisation, cleanliness and standardisation (Hudgik, 2008).

According to Pieterse (2007:63), the 5Ss are derived from five Japanese words which describe a process of obtaining cleanliness, order and logic in a workplace, thereby facilitating the implementation of lean tools. These Japanese words are Seiri, Seiton, Seiso, Seiketsu and Shitsuke and can be translated as sorting, straightening, sweep, schedule and sustain (Pieterse, 2007:63). The following comprise a brief description of each of these principles.

a. **Seiri (Sorting)**
This refers to the act of throwing away all unwanted, unnecessary and unrelated materials in the workplace and only retaining items which are related to the work.
Items to be used for the day must be kept at hand and frequently used items must be kept close. Seiri results in tasks that are simplified; space which is used effectively; and careful purchasing of items (The 5 ‘S’ process, 2004).

b. **Seiton (Straightening)**
Seiton is all about efficiency. This step consists of putting everything in an assigned place so that it can be accessed or retrieved quickly. Quick access to an item or material makes the work flow efficient and the employee becomes more productive. Every item must be marked and its location labeled for easy identification of its use (The 5 ‘S’ process, 2004).

c. **Seiso (Sweep)**
This concept holds that “everyone is a cleaner” (The 5 ‘S’ process, 2004). Cleaning must be done by everyone in the organisation, from operators to managers. It is usually a good idea to have every area of the workplace assigned to a person or group of persons for cleaning. No area should be left uncleaned. Everyone should see the workplace through the eyes of a visitor and consider if the workplace is clean enough to make a good impression (The 5 ‘S’ process, 2004).

d. **Seiketsu (Scheduling)**
Seiketsu is the fourth step in the 5S programme. It consists of defining the standards by which personnel must measure and maintain cleanliness. Seiketsu encompasses both personal and environmental cleanliness. Personnel must therefore practice seiketsu, starting with their own personal tidiness. Visual management is an important ingredient of seiketsu. Colour-coding and standardised coloration of surroundings are used to facilitate visual identification of anomalies in the surroundings. Personnel are trained to detect abnormalities, using their five senses, and to correct such abnormalities immediately (The 5 ‘S’ process, 2004).

e. **Shitsuke (Sustaining)**
Shitsuke is the last step of the 5S programme. It denotes commitment to maintain orderliness and to practice the first 4 principles of the 5S programme as a way of
The emphasis of Shitsuke is on elimination of bad habits and the constant practice of good habits. It should become second nature to employees to continuously maintain orderliness and cleanliness, not only when there is an audit or important visitor pending. Once true Shitsuke is achieved, personnel voluntarily observe cleanliness and orderliness at all times, without having to be reminded by management (The 5 ‘S’ process, 2004).

Pieterse (2007:64) suggests the following as an implementation plan for the 5S programme:

- **Step 1:** Form, train and develop 5S grading/recognition teams. The grading team sets the standards that will be used to assess progress. The results are visually displayed for all to see (Pieterse, 2007:64).

- **Step 2:** Develop a 5S model to show to the rest of the factory how it should be done. Before and after photos should be taken to motivate other departments (Pieterse, 2007:64).

- **Step 3:** Announcement of the 5S initiative by top management to the employees. Management should emphasise the importance of the programme and how it will positively affect productivity and quality (Pieterse, 2007:64).

- **Step 4:** Train the workforce. Training needs to be cascaded down to the lowest level once individual teams have been trained and should include all employees (Pieterse, 2007:64).

Implementation of the 5S programme can be done in different ways; however, most companies find the PDCA (plan, do, check, action) procedure the most effective. It is further important to take note of the company’s health and safety policies regarding waste disposal when implementing the 5S programme (Pieterse, 2007:64).
The potential benefits of implementing the 5S programme include increased sales; savings in costs; a safer working environment; standardised operating procedures; and employee and customer satisfaction. Implementation of the 5S programme must be a team exercise and positive results can only be achieved if the entire team buys into the programme and give their input thereto (Chu, n.d.).

2.9 TEAM WORK AND CONTINUOUS IMPROVEMENT

Organisations delight the customer by consistently meeting customer requirements and achieving a reputation for excellence. Quality is a concept that can, however, only be realized through the intervention of continuous improvement and/or teamwork (Todd, 1995:8). The next section will discuss these concepts.

2.9.1 Teamwork

The complexity of most of the processes that are operated in industry places them beyond the control of any one individual. The only really efficient way to tackle process improvement or problems is through the use of some form of teamwork. Kreitner, Kinicki and Buelens (1999:397) defines a team as a mature group where leadership is shared; accountability is both individual and collective; the members have developed their own purpose; problem-solving is a way of life; and effectiveness is measured by collective outcomes (Todd, 1995).

Experts (Bennette, 1992) conclude that organisational success will increasingly depend on teamwork, rather than individual stars, as competitive pressures intensify. Companies such as Microsoft and Xerox have gone so far as to fill the position of corporate president with a team of executives, rather than an individual (Bennette, 1992).

Oakland and Porter (1994:197) outlines the following advantages of using a team approach to problem-solving:

- A great variety of complex problems, beyond the capabilities of any one individual or even one department, may be tackled by the pooling of expertise and resources.
Problems are exposed to a greater diversity of knowledge, skill and experience and are solved more efficiently.

This approach is more satisfying to team members and boost morale and ownership through participation in problem-solving and decision-making.

Problems that cross departmental or functional boundaries can be dealt with more easily and the potential or actual conflicts are more likely to be identified and solved.

Team recommendations are more likely to be implemented, rather than individual suggestions, since the quality of decision-making in good teams are high (Oakland and Porter, 1994).

When properly managed and developed, teams improve the process of problem-solving, producing results quickly and economically. Teamwork throughout any company is an essential component of the implementation of TQM, for it builds trust, improves communication and develops interdependence (Oakland and Porter, 1994).

Teamwork toward quality improvement comprises several components. It is driven by a strategy; needs a structure; and must be implemented thoughtfully and effectively (Oakland and Porter, 1994).

The team approach to managing organisations renders diverse and substantial impacts on organisations and individuals. Teams promise to be a cornerstone of progressive management for the foreseeable future. The use of the teamwork approach to problem-solving has many advantages over allowing individuals to work separately. Teamwork provides an environment in which people can grow and use all the resources effectively and efficiently toward continuous improvement. As individuals grow, the company grows (Oakland and Porter, 1994).
2.9.2 **Continuous improvement**

Llanes (1996:9) describes continuous improvement processes as customer-driven, on-going, empirical, quality-oriented, and research-driven processes which are carried out by a team empowered to improve the system.

Gaither (1996:674) is of the opinion that continuous improvement is a concept which allows companies to accept modest beginnings and make small incremental improvements towards excellence. Gradual and continuous improvement through incremental improvements means that companies can never accept that where they are, is the best that they will ever be.

Company practice is, therefore, never good enough. This results in companies, even world-class companies, struggling for an even higher level of performance. This result is essential in the competitive wars of global competition (Llanes, 1996).

Various approaches exist to continuous improvement. The choice in the approach followed by any company depends on the company’s nature, resources and problems experienced. Continuous improvement approaches offer advantages in terms of better customer relationships, improvement in product quality and reduced cost and time-to-market, thereby resulting in internal and external customers satisfied with the immediate product. Such approaches will only improve organisational performance if they are implemented comprehensively and remain focused on organisational objectives (Gaither 1996:674).

Continuous improvement is not a once-off process, but rather an ongoing one. It involves more than improving isolated processes or simply complying with existing procedures or methods. It has to become a way of thinking and acting that allows an organisation not only to do things right, but also to do the right thing (Gaither, 1996).

There are few things more natural and ethical than delivering goods or services that are both satisfying and useful. Whilst continuous improvement is designed to
satisfy the client, current continuous improvement approaches should be extended to deliver both satisfaction and continual well-being (Gaither, 1996).

The continuous improvement process is vital; an organisation’s survival depends on it being done correctly and consistently.

2.10 PROCESS LAYOUT
Facility layout and design is an important component of a business's overall operations, both in terms of maximising the effectiveness of production processes and meeting employee needs and/or desires. Weiss and Gershon (1989: 35) defines facility layout as “the physical arrangement of everything needed for the product or service, including machines, personnel, raw materials, and finished goods”. There are three basic types of facility layouts, namely product layout, process layout and fixed-position layout, and one hybrid type layout, a cellular layout. A brief discussion on these facility layouts follows.

2.10.1 Product layout
In this layout resources are arranged sequentially, based on the routing of the products, and allow the entire process to be laid out in a straight line. The advantage of a product layout is that it can generate large volume of products, thereby resulting in low unit costs; fixed routing; and a lesser degree of attention required by the operator. The disadvantage in this type of layout is that the work is repetitive, leading to low employee motivation. Additionally, the inflexibility of the layout makes implementation of changes difficult and places the system at risk from equipment breakdown and absenteeism (Inman, 2007).

2.10.2 Process layout
A process layout groups similar equipment or functions together. The part being worked on travels, according to the specific sequence of operation required, from area to area. The advantages are that the company has the ability to handle a variety of processing requirements; and employees are motivated as they can perform a variety of tasks on multiple machines, as opposed to the boredom of performing a repetitive task on an assembly line (Inman, 2007).
2.10.3 Fixed-position layout
This layout is suitable for a product that is too large or too heavy to move, for example battleships, hospital operating rooms, construction and aircraft. The manufacturing equipment is moved to the product, rather than the other way around. Due to the nature of the product, the user has little choice in the use of a fixed-position layout. Disadvantages include limited working space, material handling problems and difficulty in coordination (Inman, 2007).

2.10.4 Cellular layout
Dissimilar machines are grouped together into work centers in a cellular layout. These production work centers and equipment are arranged in a sequence that supports a smooth flow of materials and components through the production process with the minimum transport or delay (Cellular, 2008). Operators may need to load or unload pieces at the beginning or the end of the process, but are otherwise freed up to implement process improvements. Using a cellular layout allows for production capacity to be increased or decreased by adding or removing production cells (Cellular, 2008).

Employees in a cellular layout are cross-trained so that they can operate all the equipment within the cell and take responsibility for its output. Advantages of this type of layout includes faster processing time; less work-in-progress; and less material handling, all of which contribute to reducing costs. Employees are responsible for output and, as a result they take ownership in their work and are motivated because of the cross-training (Inman, 2007).

2.11 CONCLUSION
In the traditional manufacturing environment marketing strategy targets a specific market segment, whilst competitive advantage is based on price or quality, leading to companies operating in a constrained competitive environment. These constrained strategies are accompanied by unresponsive manufacturing processes. Long lead times require complex forecasting techniques which provide a poor basis for production decisions. The result is errors on all levels: inventories of the wrong items increase, as do the number of back orders (Gaither, 1996).
This chapter gave an outline of more recent approaches which can be used to simplify processes, such as lean manufacturing tools and principles, continuous improvement and teamwork. Through process simplification, these techniques solve most traditional marketing problems. According to Gaither (1996:674), multi-criteria strategies, based on flexibility, quality, cost, and defect-free production, allow firms to compete across multiple market segments. Decreasing lead times and increasing responsiveness at production level eliminate the need to rely on poor decision-making. The result: manufacturing becomes a strategic weapon, differentiating a company and its product from its competitors.

The current manufacturing process in the Can Coating Plant will be discussed in the next chapter. The current process requires improvement which will be achieved using the lean tools and concepts discussed in this chapter.
CHAPTER THREE

CURRENT SITUATION IN THE CAN COATING PLANT

3.1 INTRODUCTION
The previous chapter highlighted the history of lean manufacturing and the origin thereof. Chapter Two further provided information on lean manufacturing techniques, guidelines and tools which could assist an organisation in moving from a state of chaos to an organised state.

This chapter provides a brief description of the paint process. The current situation in the Can Coating Plant will be highlighted and discussed. The area in the can coating production process which requires improvement will further be identified.

3.2 DEFINITION OF KEY CONCEPTS
Definitions are next provided for concepts and terms used in this chapter.

3.2.1 Raw materials
These are all the materials used in making up a batch of paint. Paint is composed of pigments, solvents, resins and various additives. The pigment gives the paint colour; solvents make it easier to apply; resins help it dry; and additives serve as everything from fillers to anti-fungicidal agents (Van Der Bank, 2005).

3.2.2 Formulation
A formulation is the recipe according to which the product must be made. It specifies the raw material to be used, as well as the quantity required (Van Der Bank, 2005).

3.2.3 Batch card
The batch card is a card given to production to make a product. The batch card contains information regarding the formulation; the tests to be performed by the Quality Control (QC) laboratory once the batch is completed; and the specified limits the customer requires the product to be at (Van Der Bank, 2005).
3.2.4 **Dispersion**
This comprises the breaking up of agglomerate pigment particles and wetting the pigment particles with the resin to form a concentrated paste, also known as a millbase. The millbase is ground until it is at the required particle size and viscosity (Van Der Bank, 2005).

3.2.5 **High speed disperser (HSD)**
The HSD is a stirrer which stirs at a high speed. It consists of a stand with a shaft to which a special blade is attached. The shaft and blade rotates at high speed for mixing materials. The premix is prepared in the HSD. Refer Addendum 1A for a photograph of a HSD.

3.2.6 **Catch pot (CP)**
This is a portable pot which range in size, normally one ton, into which material can be placed/decanted for intermediate holding. Some CPs are fitted with wheels to facilitate ease of movement. The bottom of the CP is fitted with an outlet to which a hose can be attached to pump out the content. Refer Addendum 1C for a photograph of a CP (Van Der Bank, 2005).

3.2.7 **Mill or Netschz**
The mill breaks down the pigment conglomerates into primary particles, to the required particle size or fineness of grind. The premix, which is prepared in the HSD, is ground in the mill. Refer Addendum 1B for a photograph of a mill (Van Der Bank, 2005).

3.2.8 **Fineness of grind (FOG)**
This is a measure of the degree of dispersion or particle size of the milled pigment paste (Van Der Bank, 2005).

3.2.9 **Blending tank**
This is a 12-ton vessel used for mixing big quantities of materials. The blending tank is normally bigger in size than the HSD. The content of the HSD is decanted into the blending tank where further extention of the batch occurs by addition of
more raw materials. Refer Addendum 2 for a photograph of a blending tank (Van Der Bank, 2005).

3.2.10 Storage tank
This is the tank where the finished product is stored until required by the customer. Refer Addendum 3 for an illustration thereof.

3.2.11 Road tanker
The road tanker is a 20-ton tanker, put on a truck trailer bed for transportation of bulk material to the customer. Refer Addendum 4 for an illustration thereof.

3.3 THE PAINT MANUFACTURING PROCESS
A simple layout and explanation of the paint manufacture follows next to provide clarity on the process. This will also assist understanding of the dramatic changes required to the can coating production process.

The function of the Paint Plant is the technical transformation of raw material into finished product. Finished products are to be supplied to the customer in the desired quantity; at the correct time; at acceptable quality and at the lowest cost possible.

The paint manufacturing process is illustrated in Diagram 3.1.

3.3.1 Stages of paint manufacture
A flowchart, illustrating the various stages in the paint manufacture process, is depicted in Diagram 3.1.
Diagram 3.1: Paint manufacturing process

Source: (Van Der Bank, 2005).
The following steps are used in the paint manufacturing process, as depicted in Diagram 3.1. These processes start from the receiving of raw materials from suppliers, through to the packing of the finished product.

a. **Stages 1 to 4**
   Raw material is received from suppliers. The raw materials are tested to see if they meet customer requirements and either pass or fail the test. Material that passes the test is stored in storage areas, whilst material which fails the test is returned to the supplier, giving the reasons for failure.

b. **Stages 5 to 13**
   Formulations, or batch cards, are issued to the weigh-up section. The raw materials are weighed and passed to the premix section. The raw materials are premixed, as per the instructions on the batch card. Dispersion is done if the product needs to be dispersed and tests are done to test that the product is at the required specifications. The let-down stage takes place immediately after dispersion testing. Colour is tested by coating metal panels or plastic panels using a spray gun. Corrections decided on are written on the batch card.

c. **Stage 14**
   The sample is taken to the Quality Control laboratory for testing. The tests include viscosity measurements, non-volatile content determination, hide determination, specific gravimetric determination and gloss measurements. There are limited specifications provided by the customer for the afore-mentioned tests. Test samples are sent to the customer for approval.

d. **Stages 15 to 16**
   The finished product is reworked if it fails to meet customer approval. There are several factors that result in failures, such as colour failures, adhesion failures or seeding in paint. The technicians solve these problems until the customer accepts
the product. The product is regarded as a reject, until such time the product is reworked, if the problems cannot be solved.

e. **Stages 17 to 18**
The products, once passed, are filled in containers and dispatched to the warehouse, ready for delivery to the customer.

### 3.4 PREMIX AND DISPERSION STAGE

The area under consideration for improvement in the Can Coating Plant is that of preparation of the premix and dispersion of the premix (steps 7 and 8 in Diagram 3.1). A detailed description of what is supposed to during these steps follows:

- A premix is usually made up on a high speed disperser (HSD) where pigment wetting agents and resin are blended together to produce a free running paste or concentrate.

- This premix is next pumped through a bead mill, after viscosity adjustment, to obtain the required degree of dispersion.

- The QC laboratory-approved millbase is then pumped or dropped into a blending tank or mixer and further extension takes place by adding the remaining ingredients, as called for in the formulation.

- After mixing is complete, and QC approval is given, the batch of paint is filtered and filled to bulk storage tank.

### 3.5 THE CURRENT SITUATION IN THE CAN COATING PLANT AT DUCO COATINGS

The process for making DWI white does not occur as described above. Currently, the batch is started in the Paint Plant, milled in the dispersion area and then completed in the Can Coating Plant. The acrylic resin is weighed out into three Catch Pots (CPs) in the Paint Plant, transported 38 meters on the same floor to the HSD and then loaded into the HSD in which the solvent and pigments are added.
and mixed. Once well mixed, the premix is filled into three CPs which are placed on the floor below the HSD (7 meters).

These pots are then transported 10 meters to the mill which is located in a different building, the dispersion area, where the premix is milled from one CP into another until the millbase is approved by the QC laboratory. Each of the three pots is sampled so that the QC laboratory may test if the required fineness of grind has been attained. This is to ensure that the entire batch has a uniform particle size. The CPs, containing the millbase, needs to be transported from the dispersion area to the Can Coating Plant, 137 meters from where the millbase is pumped into a blending tank.

The empty CPs are then used to weigh off more of the same acrylic resin for the extension stage. The scale to weigh this material is located in the Green Area, outside the Can Coating Plant (7 meters). The CPs, with the acrylic resin, are then transported back to the blending tank (another 7 meters) and pumped into the tank with the rest of the raw materials, as per the batch card. After mixing is completed and QC approval is given, the batch of white can paint is filtered and pumped to the bulk storage tanks.

The storage tanks are located 70 meters away from the Can Coating Plant. The storage tanks consist of three 10-ton tanks located in the Paint Plant, at a height of 15 meters, thereby making it difficult to check the stock levels. One has to climb up a ladder to reach these tanks. The side glass is always clouded and one can hardly see if the tank is empty or not. A dip stick is used to measure the stock level; however, stock levels are seldom checked since it is a difficult task. All transport of CPs is done via forklift.

In the current process, as depicted in Diagram 3.2, the following bottlenecks exist:

- the premix is prepared in the Paint Plant, milled in a different location (dispersion area), and then completed in yet another area (Can Coating Plant);
- loading of the acrylic resin into smaller pots and then transporting it back and forth from scale to vessel or from one plant to another; and
- the storage tanks where it is almost impossible to control stock levels with the current set-up.

Diagram 3.2: Layout of the current process

Source: Researcher's own construction
Diagram 3.2 illustrates that there are extra and unnecessary steps, when compared to the preferred manufacturing method, which complicate the current production process, thereby giving rise to many other problems and negative factors.

3.6 CONCLUSION

The entire paint production process was illustrated in this chapter. The first reason for this was to provide a basic understanding of the paint manufacturing process. The second reason was to identify the problem areas in the paint production process where improvement needs to occur.

The problem areas were identified as:

- the fact that parts of the batch are made in different locations, thereby creating unnecessary movements;

- loading, weighing and transporting of the acrylic resin into CPs by moving back and forth from scale to vessel or from department to different locations; and

- the location and the set-up of the storage tanks which makes controlling of stock levels difficult, leading to production variances and losses.

An overview of what should occur at the dispersion and premix area was provided. The current process flow does not conform to this process and, hence, the need exists for lean manufacture.

This study will identify the waste created by the current process and suggest an alternative process flow in Chapter Five by using lean tools. This study will also define how the new process flow impacted on cost, quality and overall product performance.
CHAPTER FOUR

RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

Three problem areas were identified in Chapter Three, namely that parts of the batch are made in different locations, thereby creating unnecessary movements; loading, weighing and transporting of the acrylic resin into smaller pots creates unnecessary movement in the process; and finally the storage of the final product.

Improvement will be achieved by means of lean principles and tools, as discussed in Chapter Two. The layout of the current process was provided in Chapter Three. This current process hides a lot of waste which will be eliminated by using lean tools to create a smoother flow in the process flow.

This chapter provides a brief layout of the research design and research methods used to obtain information to solve the main problem and the sub-problems related thereto.

4.2 RESEARCH HYPOTHESIS

Hypothesis may be defined as “a logical supposition, a reasonable guess, and an educated conjecture. It provides a tentative explanation for a phenomenon under investigation” (Aylesworth, Christopherson, Freidhoff, Johnson, Mauthe, Nair & Whalen, 2004). A hypothesis gives guidance to the researcher and comprises the specific testable predictions made about the variables in the study. Hypotheses can not be confirmed. The investigator can only support or reject a hypothesis. Applying this definition of a hypothesis, the following hypothesis was formulated for this study.

4.2.1 The main problem

Literature states that lean manufacturing is an improvement process based on the premise that work is accompanied by waste or non-value added effort that should be minimised or eliminated to be more efficient (Six, n.d.). This gives rise to the
research problem: How can lean manufacturing principles and tools be used to identify and eliminate waste in can coating production process at Duco Coatings?

4.2.2. The sub-problems
In order to solve the main problem, the following sub-problems must be addressed:

- What lean manufacturing principles and tools does literature provide which could be used to improve the can coating production process at Duco Coatings?

- Using these principles and tools, how can the current can coating production process be adapted toward a leaner process?

- What advantages were achieved by implementing lean principles to the can coating production process at Duco Coatings?

4.3 RESEARCH DESIGN
Chapter Two comprised a literature search to explain the theory and history behind lean manufacturing. A literature search was done by making use of the Nelson Mandela Metropolitan University library facilities. Relevant information was extracted from textbooks, published articles and journal articles.

The Internet was used extensively to gain information about how other companies successfully introduced lean principles in their organisations and to give the author insight on how to approach the problem at Duco Coatings.

The information on the current process and the paint manufacturing process as, described in Chapter Three, was obtained by means of group- and individual interviews with the Production Manager, Production Supervisor, Technical Support Chemist and all the operators involved in the process.

Organisational documents were also used as a means to gain information on the current process.
A questionnaire was compiled and distributed to the team involved in the can coating production process. The aim of this questionnaire was to highlight the areas of waste within the current can coating production process. Refer Addendum 5 for the questionnaire. The questionnaire was accompanied by a cover letter explaining the procedure for completing said questionnaire.

The author also called a meeting with the team leader and operators to explain why the exercise was done and how to complete the questionnaire. During this meeting a list with the definitions of the different waste was placed on the notice board of the Green Area where the team meets every morning. This meeting proved to be successful since the entire team gave their personal commitment to assist with this project. Summary of feedback on the questionnaire is discussed in Chapter Five.

Once the waste was identified, the lean tools were applied in Chapter Five. An advisory team was formed to provide information on the layout of the plant and the equipment available in the plant which was not currently in use. Based on this information the author could propose a possible alternative process flow to the current production process to eliminate the current waste and to create a better process flow. The current and proposed process flows was displayed in the production Green Area where it was visible to all employees. The new process flow is discussed in more detail in Chapter Five.

The advisory team consisted of the people involved in the manufacture of this specific product, together with the Technical Support Chemist and the author. A change agent, the newly appointed production manager Mr. V. Pinto, was identified as the champion of the project. The champion has good knowledge of lean manufacturing techniques and was determined to motivate his team. The first action identified was that of drawing a layout of the current process. Refer diagram 2 in Chapter Three.

A follow-up meeting was held with the Project Co-coordinator, Mrs. L. Van Antwerp, together with the author, Production Manager and Supervisor to set up a
project plan. Refer Addendum 6 for a copy of the project plan. This project plan documented the changes to the production facilities for the new process flow, as agreed upon, with due dates and tasks allocated to each team member of this project.

The entire project was a success due to the fact that it was a team effort. All of the activities involved required team work. The theory on teamwork, as discussed in Chapter Two, was used as a tool to guide the team and to solve the problem as quickly as possible. This project, once formally accepted as a project, took two months to complete. That is, improvements were implemented two months after starting the lean exercise.

4.4 ADVANTAGES AND DISADVANTAGES

The following sections describe the advantages and disadvantages experienced with each of the research methods, as described previously, followed.

4.4.1 Literature search
The literature search provided the theoretical background for the research topic. This means of research was fairly easy to conduct, but time consuming. Library hours were specific and had to be adhered to, making this method difficult at times. The literature search provided a good foundation and a clear understanding of the topic under investigation.

4.4.2 Internet
On-line research offered a variety of resources at the click of a button. The Internet search was conducted more quickly, effectively, cheaply and easily than the conventional modes, such as the literature search. It provided access to unique populations, that is, group and individuals who would be difficult, if not impossible, to reach through other channels. The Internet will continue to grow in importance for conducting research surveys. Many academic libraries allow access to their facilities via the Internet. One can access materials from libraries across the world, but not all of these libraries allow free access.
4.4.3 **Group and individual interviews**
Interviews build involvement and support. It provides relevant data and also provides visibility. The group interviews elicited key topics not expected and it also allowed for on-the-spot sharing and synthesis of different views. The individual interviews conducted allowed for clarification and uncovered information that would not be normally brought up in a group.

A negative factor about the group interviews is that it was moderately time-consuming, but less so than the individual interviews. It was also more difficult to conduct group interviews, in comparison to individual interviews. Individual interviews, however, can be expensive in terms of time. It further requires interview skills and prior preparation. Interviews, in general, may sometimes be difficult to analyse and to quantify the data provided.

4.4.4 **Organisational documents**
The use of these documents was advantageous since it provided relevant, quantifiable data fast. It was an inexpensive method to search for information since such information was readily available within the organisation. The use of organisational documents also involved management.

The disadvantage of using these documents is that they do not build employee involvement. In addition, use of information was limited since management permission has to be granted to the researcher to use company information.

4.4.5 **Questionnaire**
This method of research reached many people in a short time. It built involvement and was relatively inexpensive. The questionnaires yielded relevant, quantifiable data that was easy to summarise. Anonymity encouraged honest opinions and resulted in honest feedback. The downside of this method is that it requires time and skill to develop. The response rate was low and there is the possibility that the information provided could be inaccurate. The person who fills in a questionnaire does not have the opportunity to clarify his/her viewpoint. A questionnaire also restricts freedom of response and may lead to unrealistic expectations. The
questionnaires were controlled by the author. This was done to ensure confidentiality of the participants and, thus, gives the author reliability and objectivity. The questionnaire was constructed from information gained from literature.

4.4.6 **Advisory team**
This type of research method built management involvement and sponsorship. It was an inexpensive method to gain information and it allowed synthesis of opinions of key decision-makers. This method also helped identify useful resources. The disadvantage experienced with this method was that it proved time-consuming and difficult to manage logistically. It failed to build lower-level employee involvement and it was a poor source of quantifiable data.

4.4.7 **Meetings**
In a meeting, two or more people come together for the purpose of discussing a (usually) predetermined topic. At Duco Coatings, meetings are an important vehicle for personal contact but sometimes these meetings are so common and pervasive that many take them for granted. People sometimes forget that, unless properly planned and executed, these meetings can be a waste of time and resources.

4.5 **SAMPLE SELECTION**
The questionnaire was distributed to a group of 18 people. The selected sample consisted of different levels in the organisation, that is, operators, a team leader, a supervisor and also management. The response rate for the questionnaire was 44 per cent. The author believes that this sample (for the problem under investigation) is adequate to draw a valid conclusion since 17 per cent of the 44 per cent was at management level. The same sample was used in meetings and interviews. The response rate for this research method was 83 per cent. This improved response rate resulted in a higher standard of information being generated.

4.6 **CONCLUSION**
Chapter Four outlined the research design and methodology followed to address the main- and sub-problems. The literature search conducted was applicable and
provided a good base for the practical exercise. All research methods used for this project were applicable and relevant.

In Chapter Five the lean tools will be applied and a new process flow will be recommended.
CHAPTER FIVE

RESULTS: PRESENTATION AND DISCUSSION

5.1 INTRODUCTION
The development of global competition over recent decades has increased awareness amongst companies that they must change the way they operate and do business in order for them to be more competitive in the global arena. Change has become a necessity to survive in today’s business environment. In order for any business to be successful and a world class performer, the business must constantly review its status and be innovative. The latest trend, lean manufacturing principles, provides businesses with this opportunity of competing with the best.

The current production process was explained in Chapter Three. A questionnaire was issued to a team of people to identify the waste in this process, according to the seven waste categories as defined by Toyota. Chapter Two described these seven waste categories in more detail. The results of this questionnaire and process improvements are highlighted in this chapter.

This chapter also provides the results after implementation of lean tools in the can coating production process at Duco Coatings.

5.2 SUMMARY OF QUESTIONNAIRE / WASTE IDENTIFICATION
The results of the questionnaire will be discussed as per the seven waste categories defined by Toyota. These results comprise the feedback for the questionnaire issued to production people involved in the current process flow. The questionnaire was completed individually by the team members. The team leader compiled all the results and a summary of the results follows.

5.2.1 Over-production
- Extra manpower is required to make part of the batch in Paint Plant; mill in the Netschz area; and then completing the batch in the Can Coating Plant.
An extra man is required to drive the forklift. If this step is eliminated from the process, the forklift driver would not be required. This would free up the forklift to be used elsewhere since a limited number of forklifts are available in the factory. There would also be some cost saving in respect of diesel, as indicated in Table 6.1 in Chapter Six.

The volume demanded by customers is higher than the capacity of the three 10-ton storage tanks. Spillages are a regular occurrence in trying to fit the material into these storage tanks.

### 5.2.2 Waiting

- There is a waiting period for the machines in the Paint Plant to be available before starting.

- The mill in the Paint Plant has to grind a few times before correct fineness of grind is obtained. This task can take up to two days to complete before the operator can move on to the next production stage.

- CPs must be cleaned before use. Time is, therefore, wasted waiting for available clean CPs.

- Waiting for an available forklift or a driver also contributes to waste.

- The warehouse and logistics functions are outsourced to a private company. There are occasions when the plant has to wait for raw materials to be issued from the bulk raw material store.

Note the time saving achieved with the new process in Chapter Six.

### 5.2.3 Transport

Three full CPs are transported via forklift from the Paint Plant to the Can Coating Plant. These plants are almost 140 meters apart from each other. Spillages were inevitable, leading to incidents reports and eventually impacting on Safety, Health
and Environment (SHE) statistics from month to month. Bad weather conditions also make transportation in the current process difficult, resulting in quality problems.

5.2.4 Inappropriate processing

- Poor layout is the main problem in the current process. The high speed disperser (HSD) should be located next to the mill and should be in-line with the mill. In the current process the HSD is located one floor above the mill. This results in long-distance pipes and longer process time since the paste has a longer distance to travel from the HSD to the mill.

- The QC laboratory has to test the CPs individually for fineness of grind. If one homogenous sample was tested it would result in less work for the laboratory and also less time waiting for the approval of the batch.

- Standard production loss should be 2 per cent, however, 5 per cent production loss is currently experienced due to both loss of material during decanting into CPs and materials which cannot be recovered from the long pipes between the HSD and the mill.

- CPs has to be cleaned and this process generates hazardous waste which has to be disposed of through the hazardous waste system.

- CPs are open pots and the operator is exposed to fumes and vapours from the content of these pots. Splashes and spillages occurred on numerous occasions during transport of pots from the Paint Plant to the Can Coating Plant. This resulted in chemical burns to the operator; ground and air pollution; and contamination to the storm water system.

- Manufacturing in different plants, using different operators, leads to poor communication and, ultimately, wasting of time.
The length of the process also contributes to issues regarding not meeting deadlines and targets, as set out for performance measures.

5.2.5 **Unnecessary inventory**
- Raw materials for this product are supplied in bulk by the supplier. Not all materials are used before the expiry date. Raw materials which cannot be used due to its shelf life must be discarded, thereby resulting in waste disposal cost and loss in terms of cost of material.
- Due to bulk supply these raw materials also takes up space that could have been used for other purposes.

5.2.6 **Unnecessary motion**
- The weighing of the acrylic resin into CPs creates a lot of unnecessary motion. The CPs must first be transported to the HSD; then downstairs to fill off the content in the HSD into the CPs; then to the mill; from the mill to Can Coating Plant; from the Can Coating Plant to the scale in the Green Area; and then back to Can Coating Plant. This unnecessary movement requires extra manpower.
- The distance traveled with the CP from the Paint Plant to the Netschz area; and from the Netschz area to the Can Coating Plant is time consuming and wasteful. These movements could possible be minimised.
- The distance from the blending tank to the storage tank is 70 meters. Traveling of material in pipes, over such a long distance, also contributed to variances in stock level.
- Raw materials, in powder form, are supplied in 25kg bags. The operator has to manually load 27 of these bags per batch. Stretching, bending and picking up of these bags put a lot of strain on the operator, resulting in back problems and high absenteeism due to this medical condition.
5.2.7 **Defects/losses**

- Bad weather conditions result in rejects when rain water comes in contact with product during transportation or when windy conditions prevail.

- The three CPs have to be decanted into the HSD in the Can Coating Plant. Not all material is recovered from this process. The material loss factor is high, as illustrated in Diagram 6.2 in Chapter Six.

- Pumps are used to pump the material from the CPs to the blending tank. Material is also lost in the pipes.

- Stock levels in storage tanks are not controlled properly, leading to variances which are written off as losses.

- Inaccurate weighing off of the raw material for the mill base stage results in defects in the final product.

5.3 **APPLYING THE LEAN TOOLS TO THE CURRENT PROCESS**

After identification of all the waste, was described above, the author applied the lean tools to the current process to highlight the value-adding, non-value adding and necessary but non-value adding activities in the current process. The purpose of this exercise was to develop an alternate process or a better way of doing things.

The lean process improvement tools to be used for this study include process flow charts, the 5S programme and spaghetti charts. These tools will help to remove the waste identified from the questionnaire.

5.3.1 **Process flow charts**

The theory on process flow charts, as discussed in Chapter Two, was applied to the current process, as set out in Chapter Three.
This tool enabled the researcher to calculate the amounts of value-added time spent on the current process, as well as the total distance traveled for the entire operation. With all the steps documented it was easy to see which steps could be eliminated or improved, as indicated in Diagram 5.1.

Only eight of the 18 steps are value-adding steps (steps 1, 4, 5, 6, 8, 11, 14, and 15). The total time taken for these steps is 395 minutes. Thus, the percentage of value-added time is calculated as follows:

\[
\% \text{ VA} = \frac{\text{Total Value-added time}}{\text{Total Process time}} \times 100
\]

\[
= \frac{395 \text{ minutes}}{888 \text{ minutes}} \times 100
\]

\[
\% \text{ VA} = 44.5\%
\]

The total waste is thus 55.5 per cent. It is clear that more than half of the steps in the current process do not add value. This state of affairs requires drastic improvement. Of the remaining 10 non-value adding steps, five steps are used for transporting; two for inspection; one for delays; one for storage; and one step for record. This indicates that 50 per cent of the non-value added time is spent on transport and that this represents the biggest waste. The focus should thus be on decreasing the amount of movement in the current process. This waste is due firstly to the moving of the smaller pots (CPs) to different plants, and secondly to manufacturing parts of the batch in different locations. The ideal would be to manufacture the entire process in one plant/location.

Of the total distance traveled, only 6.9 per cent contributed to value-added movement. This again emphasises that too much movement represents the greatest waste and one which needs to be addressed and eliminated.
Diagram 5.1: Process flow chart - current process

**PROCESS FLOW ANALYSIS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Process</th>
<th>Transport</th>
<th>Inspection</th>
<th>Delay</th>
<th>Storage</th>
<th>Record</th>
<th>Process Detail (lab = laboratory)</th>
<th>Time (minutes)</th>
<th>Distance (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>Acrylic resin is weighed out in the Paint Plant into 3 CPs.</td>
<td>30</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>Waiting for clean CPs</td>
<td>180</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>CPs are transported to the HSD on the same floor.</td>
<td>3</td>
<td>38</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>CPs are emptied into the HSD.</td>
<td>15</td>
<td>1.5</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>Other raws are added to the HSD and mixed under high speed to form the premix. The premix is filled from the HSD into CPs placed on the floor below the HSD.</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>CPs filled with premix are moved to dispersion area.</td>
<td>50</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>The premix is filled from the HSD into CPs placed on the floor below the HSD.</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>Premix is milled from CP to CP to form the millbase.</td>
<td>240</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>The millbase is checked and passed by the QC lab before the process is continued.</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>The CPs containing the millbase is moved to the Can Coating Plant.</td>
<td>60</td>
<td>137</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>The millbase is pumped into the blending tank in the Can Coating Plant.</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>The empty CPs are moved to the Green Area to weigh out more acrylic resin.</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>The CPs containing the resin are moved back to the blending tank.</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>The acrylic resin is pumped into the blending tank.</td>
<td>10</td>
<td>2.5</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>More raws are added in the blending tank for further extension of the batch.</td>
<td>15</td>
<td>1.5</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>After extension is completed, QC approval is required.</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>QC lab records all the final test results on the QC record cards.</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td></td>
<td></td>
<td>The batch is filtered and sent to bulk storage tanks.</td>
<td>120</td>
<td>70</td>
</tr>
</tbody>
</table>

**TOTALS** 888 348

Source: Researcher’s own construction
5.3.2 Spaghetti chart
The application of this tool to the current process indicated a complicated process with a lot of unnecessary movements by the operator, as illustrated in Diagram 5.2.

Diagram 5.2: Spaghetti chart - current process

Source: Researcher's own construction
5.3.3 **Housekeeping: 5S**

It was difficult to implement housekeeping on the current production process since the process took place in various different departments. The author decided to implement the 5S programme on the team’s Green Area.

The current Green Area, where the team meets to conduct meetings and discuss the actions for the day, is a small area with a small notice board and a few broken chairs, as can be seen in photographs 5.1 and 5.2 below. The idea was to convert this area to one exhibiting a standard of excellence which would be the benchmark for other departments within the organisation.

**Photograph 5.1: Notice board (before changes)**
The lean team gathered information on what equipment, space or areas were under-utilised or not used at all. Such areas would then be made useful in the
proposed process. The plan was to create a new separate production process layout to be used only for the manufacture of DWI White.

The following information or suggestions was offered by the team:

**a. HSD and blending tank**

There is an HSD with a blending tank available in the Cathodic Plant which would manufacture larger volumes than the equipment in either the Paint Plant or the Can Coating Plant. This would save both production time and electricity cost. This HSD can be used to prepare the premix and the extension stage can be done in the blending tank. Production will then be able to complete the entire batch in one plant, the Cathodic Plant and less human resources will be required. The only reason why this equipment is not in use is because there is no mill in the Cathodic Plant. The HSD are two floors above the blending tank.

**b. Mill / Netschz**

There is space for a mill behind the HSD in the Cathodic Plant. Milling time will be reduced if a mill can be moved from the Paint Plant to the Cathodic Plant and placed in this spot. The milling distance will also be shorter and milling could circulate from the HSD to the mill and back until the correct fineness of grind is obtained. Once QC passes the millbase, the circulation line can be closed and the direct line to the blending tank can be opened to drop the millbase directly to the blending tank. The benefits are that the entire batch will be at a uniform particle size and that QC will only have to test one sample, instead of four samples. This will reduce testing and, ultimately, processing time since this stage has to obtain QC approval before the process can proceed to the next step in manufacturing this batch.

**c. Loading of acrylic resin to HSD**

A line should be laid from the acrylic resin storage tank to the Cathodic Plant and into the HSD so that the resin is pumped directly into the HSD. This means no more traveling with CPs; no more spillage and unsafe actions; and no health risk to the operator.
d. Loading of acrylic resin to blending tank

Another line can be laid from the acrylic resin storage tank, along the wall, to the ground floor in the area at the bottom of the blending tank. A scale, on which a CP can fit, can be put below this line so that filling of the resin occurs directly into the CP. This CP can then be pumped into the blending tank. This will eliminate the step of using the CPs. No more spillages or forklifts will be needed in the operation and less traveling will take place, thereby resulting in a cost saving on forklift diesel, as well as training of the forklift driver when the license has to be renewed.

Results obtained from the questionnaire; application of the lean tools to the current process; and the above information gathered by the team gave birth to a proposed process layout for the manufacture of DWI White, as illustrated in Diagram 5.3.

Diagram 5.3: Proposed process

Source: Researcher’s own construction
5.4 APPLYING THE LEAN TOOLS TO THE PROPOSED PROCESS

5.4.1 Process flow charts

Using Diagram 5.1 and the information regarding obsolete production equipment and space, a new process flow chart was drawn up, as depicted in Diagram 5.4. The new flow chart displays only half of the steps of the current process. The total time spent on the new process is remarkably less and the distances to be traveled decreased dramatically.

Diagram 5.4: Process flow chart - proposed process layout

<table>
<thead>
<tr>
<th>Step</th>
<th>Process</th>
<th>Transport</th>
<th>Inspection/ Rework</th>
<th>Delay</th>
<th>Storage</th>
<th>Record</th>
<th>Process Detail (lab = laboratory)</th>
<th>Time (minutes)</th>
<th>Distance (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>D</td>
<td>•</td>
<td>•</td>
<td>Acrylic resin is weighed out directly into the HSD.</td>
<td>15</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>D</td>
<td>•</td>
<td>•</td>
<td>Other raws are added to the HSD and mixed under high speed to form premix.</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>D</td>
<td>•</td>
<td>•</td>
<td>The premix is circulated to the mill for dispersion to form a millbase.</td>
<td>180</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>D</td>
<td>•</td>
<td>•</td>
<td>The millbase is checked and passed by the QC lab before the process is continued.</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>D</td>
<td>•</td>
<td>•</td>
<td>The circulation line to the HSD is closed off and the millbase is dropped directly to the blending tank which is two floors below the HSD.</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>D</td>
<td>•</td>
<td>•</td>
<td>The acrylic resin and other raws are added directly into the blending tank for further extension and completion of the batch.</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>D</td>
<td>•</td>
<td>•</td>
<td>After extension is completed, QC approval is required.</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>D</td>
<td>•</td>
<td>•</td>
<td>QC lab records the final test results on QC record cards.</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>D</td>
<td>•</td>
<td>•</td>
<td>The batch is filtered and sent to bulk storage tanks.</td>
<td>40</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>TOTALS</strong></td>
<td><strong>315</strong></td>
<td><strong>47.5</strong></td>
</tr>
</tbody>
</table>

Source: Researcher's own construction
Only five of the nine steps in the new process flow chart were identified as value-adding. These were steps 1, 2, 3, 5 and 6. The total time for these steps is 245 minutes. Thus, the percentage of value-added time for the new process can be calculated as follows:

\[
\% \text{ VA} = \frac{\text{Total Value-added time}}{\text{Total Process time}} \times 100
\]

\[
= \frac{245 \text{ minutes}}{315 \text{ minutes}} \times 100
\]

\[
% \text{ VA} = 77.8\%
\]

The total waste has now been reduced to 22.2 per cent, as per the new process flow chart. This reflects an overall improvement on waste reduction of 34 per cent. The remaining four steps which are non-value adding include two steps for inspection; one step for delays; one step for storage; and one step for recording.

The previous 50 per cent of non-value added time spent on transport was eliminated in the new process, thereby indicating that there are no more unnecessary movement in the new process. The biggest waste is thus totally removed from the current process. The elimination of this waste can only be achieved if the new process is followed and completed in one location where all the equipment are in close approximately to each other. According to the new process flow chart, the total value-adding distance traveled could improve from 6.9 per cent to 38.9 per cent. This confirms that traveling constitutes the biggest waste in the current process.

A summary of the results on the process flow chart exercise follows below. This summary provides the figures for the time spent on the current process (before) and compares them to the figures for the time spent on the proposed process (after). Table 5.1 clearly illustrates that both transportation and delay waste can be
completely eliminated from the system. All other waste remains the same. These, such as inspection, storage and recording, are part of the process; cannot be eliminated from the system; and can, therefore, be classified as necessary, but non-value adding.

Table 5.1: Comparison of time spent before and after applying the process flow chart tool

<table>
<thead>
<tr>
<th></th>
<th>Before (%)</th>
<th>After (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Value-adding</strong></td>
<td>44.5</td>
<td>77.8</td>
</tr>
<tr>
<td><strong>Non-value adding</strong></td>
<td>55.5</td>
<td>22.2</td>
</tr>
<tr>
<td>Transport</td>
<td>27.9</td>
<td>0</td>
</tr>
<tr>
<td>Inspection</td>
<td>11.1</td>
<td>11.1</td>
</tr>
<tr>
<td>Delays</td>
<td>5.5</td>
<td>0</td>
</tr>
<tr>
<td>Storage</td>
<td>5.5</td>
<td>5.5</td>
</tr>
<tr>
<td>Record</td>
<td>5.5</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Source: Researcher’s own construction

5.4.2 *Spaghetti chart*

Based on the waste identified, and the application of this tool, Diagram 5.5 outlines the ideal state for movement in this process.
5.4.3 **Housekeeping: 5S**

The first task was to explain to the team the importance of cleaning, organising and making work easy. The team was trained in the steps and techniques of the 5S programme. Goals were developed and an overall plan was created by the team to achieve a clean and well-organised workplace, thereby making work easier, more meaningful and creating a sense of pride in the workplace. Each member of the team gave suggestions as to what improvements could be made. An audit
A sheet was also created to audit this area on a weekly basis to establish progress. Refer Addendum 7 for the audit sheet used for this purpose.

Implementation of the 5S programme, as discussed in Chapter Two, resulted in a place of excellence in which the team members took personal pride. The outcome of this exercise, as depicted in photographs 5.3 and 5.4, not only set the standard for other departments, but also for Duco Coating’s customers and suppliers. Employees’ morale and motivational levels increased as all other departments embarked on their 5S journey.

**Photograph 5.3: Meeting area (after changes)**

Source: Researcher’s own construction
5.5 TEAMWORK AND CONTINUOUS IMPROVEMENT

The following sections provide a brief description on the advantages gained through teamwork and continuous improvement.

5.5.1 Teamwork

The positive changes and atmosphere created by lean implementation in the manufacture of DWI White cascaded down to all the different departments within the company, none of which would have been made possible without team work. Teams also got to know one another on both a professional and personal level.
5.5.2 Continuous improvement
A suggestion scheme was started by the company as further motivation to the employees. Any implemented improvement, suggested by an employee, results in financial gain to the employee, as well as recognition toward the “Employee of the month” award. At the end of the year an overall winner and two runners up were selected. These achievements were published in the company’s quarterly magazine which was distributed free of charge to all employees.

5.6 PROCESS LAYOUT
The current process layout can be classified as a product layout as equipment and processes are arranged according to the progressive steps through which the product is manufactured.

The proposed process layout is that of a cellular type layout where dissimilar machines are grouped into a work station to make a product of similar requirements. The new set-up will only be used to manufacture the same product, thereby reducing both the cleaning cycle of the machines, as well as potential contamination. The new process layout was displayed in the Green Area for all employees to view the proposed changes. The new process will be followed in the Cathodic Plant. The Cathodic Plant layout is totally integrated as all lines are connected to each vessel and the mill has a drop-down flow system. The new operation is a close-loop system.

5.7 PROGRESS ACCORDING TO PROJECT PLAN
A project meeting was set up to discuss the proposed changes. All the facility changes required was noted down during this meeting and a project plan was devised. Tasks, with associated due dates, were allocated to team members. These tasks comprised all the proposed changes required to be done in the factory toward implementing the proposed process for the can coating production process. The Engineering Department was also involved in this project meeting. The project commenced in June 2006; was completed within two months; and implemented in the Can Coating Plant in August 2006.
5.8 CONCLUSION

This chapter used the lean tools offered by literature and applied it to the can coating production process at Duco Coatings. The process analysis tool identified existing waste at a level of 55.6 per cent. This was reduced to 22 per cent. The spaghetti chart highlighted a lot of unnecessary movement which were further decreased to limit movement. The 5S programme resulted in considerable improvement in the housekeeping of the Green Area where all information is visually displayed.

The use of these tools not only eliminated waste, but also led to a new process proposal. The proposed process change resulted in a leaner operation and set a benchmark for other departments within the organisation. The proposed changes also solved the three problems highlighted in Chapter Three:

- Different parts of the batch are now manufactured under one roof and no longer in different plants.

- Loading, weighing and transporting of acrylic resin was identified as non-value adding steps and was eliminated from the process.

- The location and the set-up of the storage tanks was no longer an issue. Two new storage tanks (refer Addendum 3), each with a 25-ton capacity, were identified by the advisory team as ideal tanks. These tanks were used for other products in the past and were no longer in use. The only cost involved for the storage tank, therefore, was to source a cleaning service to clean the inside of the tank and to paint and stencil the outside of the tank. The tanks used for the old process had a total capacity of 30 tons and was located 70 meters from the blending tank. With the proposed process the storage capacity is 50 tons and the distance from the blending tank is four meters, thereby reducing material losses occurring in long pipes.

Implementation of lean principles at Duco Coatings gave rise to an innovative culture, promoting continuous improvement at all levels. The results of this chapter
answered the first two sub-problems of the study. The first question, What lean manufacturing principles and tools does literature provide which could be used to improve the can coating production process at Duco Coatings?, was answered by means of the three tools used, namely process analysis, spaghetti charts and the 5S programme.

The second question, Using these principles and tools, how can the current can coating production process be adapted toward a leaner process?, was answered through the proposed process layout.

The final question toward solving the main problem will be addressed in Chapter Six. This chapter will give feedback on the advantages achieved in terms of cost, quality and product performance.
CHAPTER SIX

SUMMARY, DISCUSSION, RECOMMENDATION AND CONCLUSION

6.1 INTRODUCTION

Chapter Five addressed the first two sub-problems. The third sub-problem needs to be answered to complete the study. Chapter Six provides a discussion on how the changes introduced in the can coating production process impacted on cost, quality and product performance. This chapter will also summarise the study and give further recommendation for improvement. The conclusion will highlight the main aspects of the investigation.

6.2 SUMMARY

The benefits of lean manufacturing and the tools available for applying lean principles was emphasised, and used in this investigation to eradicate waste in the can coating production process toward creating a leaner and smoother flow in the production process. The main purpose behind abolishing waste in the Can Coating Plant was to enable Duco Coatings to improve supply response to the can coating market. Waste identification was made possible by means of a questionnaire. Application of the chosen lean tools simplified the process and a new process was proposed by the author, together with the advisory team.

The new process is more flexible and results in a better quality product. The reduction in costs, as well as the considerable decrease in time spent on movement and unnecessary tasks, were achieved after implementation of the process flow chart and the spaghetti chart. Execution of the 5S programme created an environment for the employees to take pride in. Lean implementation transformed the Can Coating Plant from a state of chaos to an organised state. It created an atmosphere and culture of continuous improvement, across the organisation.

This study has provided Duco Coatings with valuable information toward implementing lean principles in any of the other departments within the company.
Based on the results observed in the Can Coating Plant, this study has created an excitement which was not previously present in the organisation.

The remaining issue is to discuss how the new changes impacted on cost, quality and product performance.

6.3 DISCUSSION

Manufacture of the DWI White, using the previous process, took place from January 2005 until July 2006. The previous process was, therefore, used for a period of 19 months. The new process was implemented in August 2006. The following section will report on the results before and after the new process was implemented. A discussion on the benefits achieved by these improvements follows.

6.3.1 Cost saving

Annual cost savings amounted to almost R190 000, as summarised in Table 6.1.

Table 6.1: Cost saving

<table>
<thead>
<tr>
<th>Reductions</th>
<th>Annual cost saving (Rands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>60 000</td>
</tr>
<tr>
<td>Diesel</td>
<td>28 800</td>
</tr>
<tr>
<td>Forklift (maintenance and service)</td>
<td>5 800</td>
</tr>
<tr>
<td>Waste removal due to spillages</td>
<td>26 700</td>
</tr>
<tr>
<td>Discard expired raw materials</td>
<td>67 560</td>
</tr>
<tr>
<td><strong>Total cost saving</strong></td>
<td><strong>188 860</strong></td>
</tr>
</tbody>
</table>

Source: Researcher’s own construction

Although this is a small saving, bigger savings can be achieved if lean principles are exercised across the entire company. This bigger savings will contribute directly to the company’s profit margin, creating a prosperous business.

6.3.2 Time saving

Total time saved per batch of DWI White was almost 17 hours, as summarised in Table 6.2.
Table 6.2: Time saving

<table>
<thead>
<tr>
<th>Reductions</th>
<th>Time saving (minutes), per batch manufactured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiting for machine</td>
<td>240</td>
</tr>
<tr>
<td>Traveling</td>
<td>123</td>
</tr>
<tr>
<td>Milling</td>
<td>60</td>
</tr>
<tr>
<td>Cleaning of CPs</td>
<td>180</td>
</tr>
<tr>
<td>Waiting for forklift</td>
<td>40</td>
</tr>
<tr>
<td>Waiting for raw materials</td>
<td>140</td>
</tr>
<tr>
<td>QC testing</td>
<td>50</td>
</tr>
<tr>
<td>Weighing of raws</td>
<td>15</td>
</tr>
<tr>
<td>Decanting into/out of CPs</td>
<td>80</td>
</tr>
<tr>
<td>Sending to storage tanks</td>
<td>80</td>
</tr>
<tr>
<td><strong>Total time saved</strong></td>
<td><strong>1008</strong> or <strong>16.8 hours</strong></td>
</tr>
</tbody>
</table>

Source: Researcher’s own construction

The result of this is that operators are now freed up to focus on more value-added tasks. In addition, time is now available for on-the-job training, an activity which was difficult to achieve in the past.

6.3.3 Quality improvement

Testing time in the Quality Control laboratory was reduced to 38 per cent, thereby reducing time spent on testing DWI White batches from 80 minutes to 30 minutes.

The formal conditions for First-time-right (FTR), as agreed upon by Duco Coatings, are:

- a batch is considered FTR if additions made does not exceed 3 per cent of the planned batch quantity, for example, if the batch size is 1000 kg, the total additions made to the batch must not exceed 30 kg;
- concessioned or rejected batches are not considered FTR; and
- a batch containing a work-off and requiring more than a 3 per cent addition will be considered FTR.

First-time-right figures are reflected in the Diagram 6.1. This comprises batches not made according to the batch card.
The average FTR figure for 2005 was 69 per cent. This figure increased to 77 per cent for 2006 due to the production changes arising from the implementation of lean manufacturing in August of that year. Diagram 6.1 illustrates a drastic change for 2007 when the figure averaged at 87 per cent, that is, above the 80 per cent target.

**6.3.4 Product performance**

Manufacturing variance data was recorded five months before the process changed and again six months after the process changed to demonstrate the effect of lean manufacturing on the process. The previous process required additions to obtain the same batch size, due to loss of materials in the long pipes. This was no longer an issue with the implementation of lean manufacturing, resulting in a significant decrease in additions required. Diagram 6.2 illustrates the manufacturing variances for DWI White.
Diagram 6.2: Manufacturing variances for DWI White

Before lean manufacturing, the yield on the batches was low due to high losses. Diagram 6.2 illustrates how more batches of the DWI White had a low yield in comparison to the batches made during the period August to December 2006. The number of rejected batches was minimal due to the improved way of doing things. Fewer raw materials had to be discarded due to expired shelf live. This is also evident from Table 6.1. The milling time or milling passes is usually specified. In the previous process, the most passes recorded were nine. Now a batch had to be at the correct particle size after only one or two passes through the mill. The mill in the new process is much more efficient and milling is improved due the new location of the mill.

6.3.5 Other benefits

Additional benefits arising from the implementation of lean manufacturing principles include:

- One of the major improvements originated from the storage tanks for DWI White. Not only has capacity increased, but the location (when compared to that in the old process) was closer to the blending tanks and also safer. The
tanks were previously located at an elevated height and ladders had to be used to get to the tanks, thereby making it an unsafe operation.

- The potential risk of forklift accidents were eliminated since the use of a forklift is no longer required in the new process. In addition, a reduction was achieved in employee exposure to volatile solvent fumes when handling and pushing the CPs.

- Operators and staff were freed up to focus on value-added tasks, such as continuous improvement initiatives.

- Employee morale was boosted; communication between managers and employees was enhanced to a different level of mutual respect; and employees were empowered to initiate process improvement.

- A suggestion scheme for improvements was started throughout the organisation.

- Product quality and consistency were improved as a result of improved accuracy when weighing off raw materials.

6.4 RECOMMENDATIONS FOR FUTURE IMPROVEMENTS

The following comprise recommendations for future improvements:

- Streamline and standardise the storage of raw material to lessen potential waiting time.

- Develop a new labeling system for the storage shelves.

- The process temperature of the milling stage must not rise above 30°C. During milling the process temperature increases and cooling water needs to be applied to maintain the process temperature. It is currently difficult to control the process temperature, although cooling water of 18°C runs through
the mill during processing. The future plan is to replace the cooling water with chilling water which runs at 8-12°C. This change will reduce the cycle time further. Currently, the mill and the process have to be stopped when the temperature is too high until such time as the temperature decreases sufficiently for the operator to continue with the batch.

- Agitation during the final blending stage creates heat and this increases the batch temperature. The cooling water in the blending tank will also be replaced with a water chiller system to maintain the final batch temperature.

- Management and stakeholders must buy into the lean concept and extend the lean manufacturing exercise to all the departments within the company.

- For employees to fully appreciate the lean concept there is a need for all employees to be trained in lean principles. The Human Resource department must incorporate lean training into employee skills development and encourage management to provide for this training in the company budget.

6.5 CONCLUSION

This report was toward investigating the potential of lean principle implementation at Duco Coatings. The three sub-problems were solved as follows:

- What lean manufacturing principles and tools does literature provide which could be used to improve the can coating production process at Duco Coatings? The tools used to improve the process were process analysis, spaghetti charts and the 5S programme.

- Using these principles and tools, how can the current can coating production process be adapted toward a leaner process? A new process was proposed after waste was eliminated through the use of these tools.

- What advantages were achieved by implementing lean principles to the can coating production process at Duco Coatings? The proposed process
generated an annual cost saving of R188 860; a time saving of 16.8 hours per batch of DWI White manufactured; laboratory testing was reduced to 38 per cent; first-time right increased from 69 per cent in 2005 to 87 per cent in 2008; and an overall decrease was experienced in manufacturing variances. The storage tanks were improved both in terms of capacity and location. Employee morale improved and a continuous improvement culture was born.

The many advantages achieved addressed the main-problem: How can lean manufacturing principles and tools be used to identify and eliminate waste in the can coating production process at Duco Coatings? In addition, the advantages gained also supports the hypothesis that lean manufacturing is an improvement process based on the premise that work is accompanied by waste or non-value added effort that should be minimised or eliminated to improve efficiency.

Based on the benefits achieved, as discussed above, it can be concluded that the implementation of lean manufacturing at Duco Coatings has been successful and that it has raised the company to better heights. Implementation of lean principles has not only resulted in the Can Coating Plant achieving success, but also the company as a whole.

The study saved Duco Coatings money; improved the Can Coating Plant; increased the efficiency of the company; eliminated waste; and improved health and safety in the workplace. Furthermore, the project provided the participants with the opportunity to learn more effective tactics for workplace improvement. Finally, the project infused a continual improvement culture among the employees at Duco Coatings. Duco Coatings can now be counted among the innovative companies, such as Federal Express and Lens Crafters. Duco Coatings has proved that effectiveness, efficiency and innovation are key strategies to remain in business and to expand their operation in the market place.
REFERENCES


ADDENDUM 1: PHOTOGRAPH OF HSD, MILL AND CP

Source: Researcher’s own construction
ADDENDUM 2: PHOTOGRAPH OF BLENDING TANK

Source: Researcher’s own construction
The two DWI blending tanks facing to the front. Each tank has a capacity of 25ton.

Source: Researcher’s own construction
In fulfillment of my MBA degree I am doing my project on Lean Manufacturing. I want to conduct a study to improve the current can coating production process for DWI White (coded 952-3000).

I will firstly define the process, subsequent to which I would need the people involved in the process to identify possible areas of waste in the current process. The aim of this exercise is to, once waste has been identified, eliminate all the wasteful steps to create a leaner and smoother process flow.

For this exercise, waste will be defined as:
- any activity which uses resources but does not create value, or
- anything other than the minimum amount of equipment, materials, parts, space and time which are absolutely necessary to add value to the product.

Toyota identified the seven categories of waste as overproduction, waiting, transport, inappropriate processing, inventory, motion and defects (refer definitions on the different wastes).

In the current manufacturing process the millbase is prepared in the Paint Plant; decanted into CPs; and transported to the Paint Plant for further manufacture. In term of the seven waste categories, please name anything in
this process which you consider to be wasteful. Use the table below to fill in your results.

If possible, could you please complete the information request questionnaire by the 31st July 2008?

I appreciate your time and effort in assisting me with this query and look forward to your response.

Your help with this exercise will not only be useful to my studies, but also to the company in the implementation of lean principles.

Yours Sincerely
Deidre Erasmus
## INFORMATION REQUEST QUESTIONNAIRE FOR THE PRODUCTION OF DWI WHITE 952-3000

<table>
<thead>
<tr>
<th>NAME</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>POSITION IN THE COMPANY</td>
<td></td>
</tr>
<tr>
<td>THE PART YOU PLAY IN THE PROCESS</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1. OVERPRODUCTION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2. WAITING</td>
<td></td>
</tr>
<tr>
<td>3. TRANSPORT</td>
<td></td>
</tr>
<tr>
<td>4. INAPPROPRIATE PROCESSING</td>
<td></td>
</tr>
<tr>
<td>5. INVENTORY</td>
<td></td>
</tr>
<tr>
<td>6. MOTION</td>
<td></td>
</tr>
<tr>
<td>7. DEFECTS/REJECTS</td>
<td></td>
</tr>
</tbody>
</table>
Definition of wastes

1. **Overproduction** is regarded as the most serious waste as it discourages a smooth flow of goods or services and is likely to inhibit quality and productivity. Overproduction also tends to lead to excessive lead and storage times. As a result defects may not be detected early, products may deteriorate and artificial pressures on work rate may be generated. In addition, overproduction leads to excessive work-in-progress stocks which result in the physical dislocation of operations with consequent poorer communication.

2. When timing is being used ineffectively, then the waste of **waiting** occurs. In a factory setting, this waste occurs whenever goods are not moving or being worked on. This waste affects both goods and workers, each spending time waiting. The ideal state should be no waiting time with a consequent faster flow of goods. Waiting time for workers may be used for training, maintenance or kaizen activities and should not result in overproduction.

3. The third waste, **transport**, involves the moving of goods. Taken to an extreme, any movement in the factory could be viewed as waste and so transport minimisation, rather than total removal is usually preferred. In addition, double handling and excessive movements are likely to cause damage and deterioration with the distance of communication between processes proportional to the time it takes to feed back reports of poor quality and to take corrective action.

4. **Inappropriate processing** occurs in situation where complex solutions are found to simple procedures. The over-complexity generally discourages ownership and encourages the employees to overproduce to recover the large investment in the complex machines. Such an approach encourages poor layout, leading to excessive transport and poor communication. The
ideal, therefore, is to have the smallest possible machine, capable of producing the required quality, located next to preceding and subsequent operations. Inappropriate processing occurs also when machines are used without sufficient safeguards so that poor quality goods are able to be made.

5. **Unnecessary inventory** tends to increase lead time, preventing rapid identification of problems and increasing space, thereby discouraging communication. Thus, problems are hidden by inventory. To correct these problems, they first have to be found. This can be achieved only by reducing inventory. In addition, unnecessary inventories create significant storage costs and, hence, lower the competitiveness of the organisation or value stream wherein they exist.

6. **Unnecessary movements** involve the ergonomics of production where operators have to stretch, bend and pick up when these actions could be avoided. Such waste is tiring for the employees and is likely to lead to poor productivity and, often, to quality problems.

7. The bottom-line waste is that of **defects** as these are direct costs. The Toyota philosophy is that defects should be regarded as opportunities to improve rather than something to be traded off against what is ultimately poor management. Thus defects are seized on for immediate kaizen activity.
# ADDENDUM 6: Project Plan for DWI White

**Date:** 10/07/2006  
**Present:** Ronnie von der Bank  
Brian Buttner  
Sylvie Kramary  
Eliesse National  
Liezl Gebhard  
Addenda 6 Team

<table>
<thead>
<tr>
<th>ID</th>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DW White Production Area Changes</td>
<td>21 days</td>
<td>2006/06/21</td>
<td>2006/08/14</td>
</tr>
<tr>
<td>2</td>
<td>Concept and Definition</td>
<td>3 days</td>
<td>2006/06/21</td>
<td>2006/06/23</td>
</tr>
<tr>
<td>3</td>
<td>Reformulate formulation and issue the report</td>
<td>1 day</td>
<td>2006/06/21</td>
<td>2006/06/23</td>
</tr>
<tr>
<td>4</td>
<td>Investigate feasibility of moving scale adjacent to HSD BB, BU and EN</td>
<td>2 days</td>
<td>2006/06/22</td>
<td>2006/06/23</td>
</tr>
<tr>
<td>5</td>
<td>Review WI's and link to batchcard</td>
<td>5 days</td>
<td>2006/06/23</td>
<td>2006/06/28</td>
</tr>
</tbody>
</table>

**Apologies:**  
Goofy Fouche

<table>
<thead>
<tr>
<th>Action</th>
<th>Responsibility</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RvB</td>
<td>CW32</td>
</tr>
<tr>
<td>2</td>
<td>B.B.</td>
<td>CW29</td>
</tr>
<tr>
<td>3</td>
<td>L.G.</td>
<td>CW32</td>
</tr>
<tr>
<td>4</td>
<td>M.L.</td>
<td>CW31</td>
</tr>
</tbody>
</table>

**Diagram:**

- Ronnie von der Bank  
- Brian Veltmans  
- Goofy Fouche  
- Liezl Gebhard  
- Brian Buttner  
- Sylvie Kramary  
- Eliesse National
# SUPPLEMENTARY CHECKSHEET:

**KEY 1: CLEANING & ORGANISING TO MAKE WORK EASY**

<table>
<thead>
<tr>
<th>No.</th>
<th>Level</th>
<th>Evaluation Criteria</th>
<th>Judgement Calls</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>No unneeded items lying around</td>
<td>There are no items without clear identification labels lying around. No items are covered in dust. No unneeded items are lying on top of shelves. There are no items lying around that have fallen off shelves, or which are leaning against windows. Nothing on shelves has fallen over. There are no unneeded items on desks and in drawers. There are no unneeded documents on shelves.</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Cleaning equipment is stored neatly / everything has its place</td>
<td>Cleaning equipment is available at the point where it is needed. There are brushes and dusters located in each area. List should be cleaned up immediately. A closed cabinet is not recommended for cleaning equipment. Rather hang equipment from a fixed hook. A storage cart with wheels is recommended in some areas. Old brooms should regularly be replaced.</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>There is no garbage, dirt of paper on the floor. There is no danger of slipping and no trash in floorwells</td>
<td>All tools should be used. Look out for any oil leaking from hydraulic points. There should be no oil on the floor. Oil-soaked clothes should not be lying around. There should be no slippery surfaces. No clutter in a press or similar equipment is lying on the floor. Contact is maintained to a walkable surface of debris from falling on the floor. No loose screws or other consumables are lying on the floor. There is no dirt on the floor, and the floor is painted everywhere.</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>No outstdated, torn, or soiled announcements are displayed. Papers are straight and neat. There are no torn corners of tape marks left over from old displays</td>
<td>There should be no outdated documents on bulletin boards. There is no overlapping on display boards. All four corners of documents are pressed down. Documents are only posted on the display boards. No documents should be posted on doors or windows with cell tape. Documents are organized in straight lines. No unnecessary documents are posted on the side of benches and shelves. Documents that are not on a display board are framed with tape.</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Nothing is obstructing the access to fire extinguishers and water hoses. Nothing is in front of emergency exits or corridors. Location and use of switches and breakers are posted. Zebra marks are posted on safety risk areas</td>
<td>Signs for fire extinguishers and fire hoses should be seen 20m away. Fire extinguishers must be properly supplied. Doors of places where fire hoses are stored can be opened easily and there is enough space around them. There are no foreign objects (like bolts or paper) in electrical switchboards, switchgears or garbage cans. Signage marks are provided for different types of rubbish and waste.</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Working process and tools are not placed directly on the floor</td>
<td>Nothing should be placed on the floor to prevent double handling. Tools must be set up close to machines and be replaced after use. No tool should be leaning or blocks, even when a new person is doing the job. Tools must be placed in designated areas close to machines, even when machines are not operating. Tools must be placed on the floor, as it becomes an obstacle. Make use of a cart to shorten transportation distances. Keep carts close to the point of use.</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>Nothing is placed on partition lines, and nothing extends over them. The layout of walkways is safe before</td>
<td>Nothing should be placed in such a way that it will be an obstacle in case of an emergency. Nothing should extend across painted lines. Nothing should touch a person's body when walking within the painted areas. Fire extinguishers must be placed in their own designated areas.</td>
</tr>
</tbody>
</table>
## ADDENDUM 7: AUDIT SHEET

### Supplementary Checksheet (cont.)

**SUPPLEMENTARY CHECKSHEET:**

**KEY 1: CLEANING & ORGANISING TO MAKE WORK EASY**

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Wallways can be found at a glance and are shaded at right angles. The painted lines marking the walkways are not chipping off and not faded.</td>
<td>Assets are appropriate and take logistics into account. There should be a set of rules in the company in terms of the width of carts, pallets and forklifts. The width of walkways is standardized. A guideline is that main assets should be 100mm wide and sub-assets 50mm. The width of lanes and aisles comply with the company standards. The aisles layout is done by straight lines. Assets along walls have painted lines on both sides. These lines are maintained on a regular basis. Lines should not be stepped on. Assets should also be made in offices. Desks should be lined up straight.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Items are stored and stacked properly in containers, and they are not placed directly on the floor. Cardboard boxes and work-in-process are placed in a straight line. Nothing in cardboard boxes is placed directly on the floor. Sea lot is possible to place parts directly into a cart when received from the supplier. Nothing should be on the top of cardboard to eliminate unnecessary handling.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>The factory and equipment are painted. There are no places in the factory (less than 2 meters on vertical surfaces) that are not painted. Paint, wipes, and clean as needed. Painting and cleaning up to a level of 2 meters can be done without a ladder. There is a system in place to keep the walls clean. Walls have support columns in order that paint and products do not touch the wall, even when pushed right to the wall. Nothing is posted directly onto the wall with pins. There are no shoe marks on columns or walls.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Machinery, platforms, carts, equipment, and walls are not soiled. Machines are not covered in dust. Oil or other objects around machines or on shelves do not cause dirt. Machinery is periodically painted and kept clean. No dirt, chips, and dust have been left around for a long time.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Nothing leans against the walls, windows, pillars, or equipment. Nothing that can dirty walls is leaning against it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>The department controls and cleans the areas on the inside of the factory. It is responsible. Confirm that all areas in the building will be subject to a 4S patrol. There are no unnecessary items or clutter within 1m of the outside walls (roads, stairs, conditions). Workplaces have no outside walls, doors, and the bottoms of columns are clean.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Desks, carts, and pallets are parked straight. There are designated areas inside the aisles to place items in a straight line. Desks must be placed straight. This is made easy by demarcation, for example lines.</td>
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<tr>
<td>13</td>
<td>4 Storage places are clearly shown with sign panels. Work-in-process parts and pieces are placed in storage. Storage is designed in such a way that is easy to retrieve parts. Level 3 stores may not have reorder levels and control points yet. Level 3 stores must have a reorder system clearly labeled and kept to a minimum, without shortages occurring. Stock is retrieved on a first-in, first-out basis.</td>
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<tr>
<td>14</td>
<td>Storage places of tools are clearly shown with sign panels. Frequently used tools are placed on a cart to avoid searching for them or having to take them out of a toolbox. Tools are easy to use according to MODAF (S) principles.</td>
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<tr>
<td>15</td>
<td>Necessary tools and jigs are placed in each shopfloor area. Tools are placed at the point where they are required. All machines are energized in this way.</td>
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<tr>
<td>16</td>
<td>All shelves and desks are partitioned and labelled so that it is clear where things are and where thing should be returned to. All desks and worktables are certified modular desks and worktables. Everything is within easy reach and there is no waste of searching. Desks are always kept clean.</td>
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</tbody>
</table>

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