

Critical Evaluation of Highveld Steel's product diversity strategy.

by

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Synopsis

The steel industry is characterised by heavy fluctuations in product demand and fierce competition from players across the globe. It is for this reason, important for Highveld Steel to ensure that their strategic decisions are both effective and that there is a good fit between market conditions and strategies. In this report, the product diversity strategy of Highveld Steel regarding coiled products is evaluated against its efficiency in generating positive contribution margins towards company profitability.

This was done by developing a model to quantify the real contribution margin of all coil products produced. In this model, processing time, product downgrading costs and the cost of production downtime due to production delays were quantified and a formula was derived to calculate the cumulative effect of all these variables on product cost. This formula was applied to historical yield information available for the past four years of production. From this, the real contribution of different product categories were calculated and used to identify products with negative or small contribution margins on the one side, as well as products with large contribution margins on the other.

It was found that 15 % of all products produced by strip mill at present, have a negative contribution margin and should for that reason, not be produced. The information gathered from the application of the model was used to furnish recommendations on how Highveld's marketing and production departments should go about improving the contribution of coiled products to company profitability.

It was proven empirically that Highveld could, in applying the recommendations furnished in this report, generate extra annual contribution on coil products of between 14 and 37 %. The strategy developed was recommended as an interim strategy and it was further recommended that the model developed should be continuously applied and used on a monthly basis to evaluate order acceptance strategies to ensure a good fit between these strategies and prevailing market conditions.

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Table of Contents

SYNOPSIS	II
ACKNOWLEDGEMENTS.....	III
TABLE OF CONTENTS.....	IV
LIST OF FIGURES	VII
LIST OF TABLES	VII
CHAPTER 1	1
INTRODUCTION & PROBLEM STATEMENT	1
<i>1.1. Introduction.....</i>	<i>1</i>
<i>1.2. Objectives</i>	<i>1</i>
1.2.1. Primary Objective	1
1.2.2. Secondary Objectives.....	2
<i>1.3. Background information</i>	<i>2</i>
<i>1.4. Description of Highveld's product diversity strategy regarding coil production</i>	<i>3</i>
1.4.1. Wide product range	3
1.4.2. Short lead times	4
1.4.3. High quality of output products	4
<i>1.5. Strategic gap</i>	<i>4</i>
<i>1.6. Evaluation method.....</i>	<i>5</i>
1.6.1. Step 1: Determine slab transfer price	5
1.6.2. Step 2: Quantify production costs per second of production time	6
1.6.3. Step 3: Determine the production yield to production time relationship	7
1.6.4. Step 4: Determine the production yield to downgrade cost relationship	8
1.6.5. Step 5: Assign both direct and indirect costs to the product	9
1.6.6. Step 6: Calculate the product contribution.....	10
<i>1.7. Literature Study.....</i>	<i>10</i>
<i>1.8. Summary.....</i>	<i>14</i>

CHAPTER 2	15
CRITICAL ANALYSIS.....	15
2.1. <i>Introduction</i>	15
2.2. Step 1: Determine transfer bar cost.....	15
2.3. Step 2: Quantify production costs per second of production time	16
2.4. Step 3: Determine the production yield to production time relationship	17
2.5. Step 4: Determine the production yield to downgrade cost relationship	21
2.6. Step 5: Assign both direct and indirect costs to the product	26
2.7. Step 6: Calculate the product contribution.....	27
2.8. <i>Summary</i>	27
CHAPTER 3	28
RESULTS.....	28
3.1. <i>Introduction</i>	28
3.2. <i>Classification of products</i>	28
3.2.1. Product width	28
3.2.2. Product gauge.....	29
3.2.3. Product quality	29
3.3. <i>Results per product category</i>	30
3.3.1. BR50.....	31
3.3.2. ES46	33
3.3.3. IL42	35
3.3.4. NS09.....	36
3.3.5. NS30.....	38
3.3.6. PT03	39
3.3.7. SS30	41
3.3.8. PM01	44
3.3.9. UM19	46
3.3.10. QC08	49
3.4. <i>Statistical analysis of contributions to profitability</i>	50
3.5. <i>Summary</i>	52

CHAPTER 4	53
CONCLUSION & RECOMMENDATION.....	53
4.1. <i>Introduction</i>	53
4.2 <i>Conclusion</i>	53
4.3. <i>Recommendation</i>	56
4.3.1. Order acceptance model.....	56
4.4. <i>Future Studies</i>	60
4.5. <i>Summary</i>	60
BIBLIOGRAPHY	62

List of Figures

FIGURE 2.1: <i>THE REVERSING STECKEL MILL AT HIGHVELD STEEL</i>	18
FIGURE 3.4.1. <i>PRODUCT MIX CONTRIBUTION MARGIN DISTRIBUTION</i>	51
FIGURE 3.4.2: <i>PRODUCT MIX DISTRIBUTION ACCORDING TO CATEGORY</i>	51

List of Tables

TABLE 2.1: <i>PRODUCTION TIMES PER TON REQUIRED FOR DIFFERENT COILING PASSES</i>	20
TABLE 3.3.1: SUMMARY OF BR50 PRODUCT CHARACTERISTICS	31
TABLE 3.3.2: SUMMARY OF ES46 PRODUCT CHARACTERISTICS.....	33
TABLE 3.3.3: SUMMARY OF IL42 PRODUCT CHARACTERISTICS	35
TABLE 3.3.4: SUMMARY OF NS09 PRODUCT CHARACTERISTICS	36
TABLE 3.3.5: SUMMARY OF NS30 PRODUCT CHARACTERISTICS	38
TABLE 3.3.6: SUMMARY OF PT03 PRODUCT CHARACTERISTICS.....	39
TABLE 3.3.7: SUMMARY OF SS30 PRODUCT CHARACTERISTICS	41
TABLE 3.3.8: SUMMARY OF PM01 PRODUCT CHARACTERISTICS	44
TABLE 3.3.9: SUMMARY OF UM19 PRODUCT CHARACTERISTICS	46
TABLE 3.3.10: SUMMARY OF UQ08 PRODUCT CHARACTERISTICS	49

CHAPTER 1

INTRODUCTION & PROBLEM STATEMENT

1.1. Introduction

In an attempt to retain market share, Highveld Steel has applied a product diversity strategy in order to distinguish itself from competitors. The question is whether this strategy is really effective in creating shareholder wealth? In the mature market that the steel industry finds itself in, it is of vital importance that players should effectively apply operating efficiencies and by doing so, ensure that their capital intensive equipment is utilised to generate optimal returns (Gorden & Calantone, 1991:6).

Large corporate companies have applied product diversity strategies in the past with varying impacts on their performance (Rameriz & Escuer, 2002:4). Product diversity strategies for this reason, should not be implemented blindly and should continuously be evaluated for relevance. When product diversity strategies are applied in a mature market and even more so when applied in a commodity market, it should be applied in the correct manner to ensure that it leads to company prosperity rather than letting it inconspicuously lead to the downfall of the company (Hearne, 1982:2).

1.2. Objectives

1.2.1. Primary Objective

The ultimate objective of this study is to critically evaluate the product diversity strategy of Highveld Steel in regards to coil production. This study will assess whether this strategy is congruent with operating efficiency principles (Tetzeli, 1993:1) to ensure optimal company profitability.

1.2.2. Secondary Objectives

This study will furnish a summary of different products and the contribution of these products. One of the outcomes of the study will be to furnish a model for quantifying costs of different product lines. This model will produce an empirical method of ascertaining the real contribution margin on different product lines. This will enable the marketing-, production- and financial departments of Highveld Steel to make decisions on how to accept/reject orders and also, enable them to optimise production facility utilisation to furnish optimal profitability at the strip mill.

1.3. Background information

Highveld Steel is a mature company with a history of more than 40 years. Highveld Steel is in the business of producing Vanadium-, ferro-alloy- and various other steel products. The carbon steel products include structurals, flat products and billets. Flat products include plate- and coil products. The total steel production of the steelworks is in the region of 900,000 tons per annum. Operating in the global market, producing in excess of 100 million tons per annum, Highveld contributes less than 1% to total global carbon steel production.

For reasons stated above, Highveld's competitive advantage cannot be situated in production capacity or, for that matter, market share. The steel industry is characterised by its maturity and because of this, known for its well-developed competition. Due to the fact that steel has a low per ton value when compared to other export commodities like for instance, gold, it is not profitable to export steel products due to high transportation costs. For this reason, the domestic sales contribute the most towards the profitability of Highveld. The most significant competition for Highveld is therefore, comprised of domestic steel producers. These include the various sub divisions of YSCOR, including the Vanderbyil-, Saldanha- and Newcastle steel works.

When considering the market capitalisation of Highveld and Yscor, it can be noted that Yscor by far, has a competitive advantage in volume, bringing with it, the advantages of economies of scale. For this reason, Highveld had to create its own competitive advantage, built on product diversity. Yscor being a high volume producer, decided that volume is more important than diversity and for that reason its production is characterised by long production runs resulting in long lead times for products offered. Customers ordering from Yscor should, for this reason be satisfied with accepting long lead times in the order of three months or longer and with minimum order quantities on different products. Smaller customers with low production volumes and short lead times, on a produce to order rather than produce to stock principle, does not view YSCOR as an attractive supplier.

1.4. Description of Highveld's product diversity strategy regarding coil production

Highveld has identified this niche market and targeted it by building on a strategy characterised by the concepts of a wide product range, short lead times and high quality of output products. These concepts will be discussed in more detail in the rest of the report.

1.4.1. Wide product range

Highveld designed its operations in such a way that it is characterised by flexibility, enabling it to produce a wide range of different products with minimal set-up time and cost. Highveld invested a substantial amount of capital to implement a state of the art computer control system for its reversing steckel mill to enable accurate modelling of the hot rolling operation. This has resulted in a continuous generation of customised models used to roll products of different metallurgical properties as well as various product sizes. This enables Highveld to accept small orders on different products. This can be illustrated by noting that three coils with a specific quality (referring to metallurgical

composition when used in this sense), gauge (coil thickness) and width can be produced and then directly followed by coils with a totally different quality, gauge and width combination with the production control parameters predicted by the models in the integrated computer control system.

1.4.2. Short lead times

Due to the fast transition of production runs for different products, it is possible for Highveld to accept orders with short lead times. The only determinant of the lead times on orders will therefore, be the scheduling of existing orders. This also enables Highveld to produce products on short notice for customers in crises, with delivery lead times as short as two weeks on urgent products.

1.4.3. High quality of output products

Highveld installed a temper mill, a skin pass mill, with the main objective to add value to coil products by increasing its quality by means of cutting off low quality coil pieces on the front and back ends of coils and also to correct minor defects on coils by processing the coils after cool down. All products delivered to customers are therefore of superior quality. Inferior quality coils are downgraded to seconds and scrap and sold at discounted prices.

1.5. Strategic gap

The strategy described above is undoubtedly effective in focusing on the target market segment consisting of smaller customers with the need for small order sizes, short delivery lead times and high quality products. The problem is that in addressing the objective of satisfying the customer needs, certain costs are incurred, some direct and some indirect. Direct costs typically include costs of raw materials, electricity

consumption, other consumables and handling costs. Indirect costs is more difficult to quantify and will include costs relating to production times, production yield losses and equipment damage.

The question arising from the discussion above is whether the strategy is effective in generating profit to the company and ultimately, whether it creates value for the shareholders of Highveld? To answer this question, an in-depth study should be conducted taking into account the product yield performance, product costs and ultimately the product contribution of all the different products on offer.

1.6. Evaluation method

The objective of this study is to evaluate the contribution margins of different products. In order to furnish broader applicable conclusions and recommendations, a per unit method of assigning costs and income will be used. For illustration sake, let's say the base is decided upon as R 3,000.00. Then a per unit value of 1.0 pu will depict a value of R 3,000.00, a value of 0.5 pu will depict a value of $R3,000.00 * 0.5 = R 1,500.00$ and a value of 1.5 pu will depict a value of $R 3,000.00 * 1.5 = R4,500.00$.

The method that will be used to derive the contribution margin of different products will include the following actions:

1.6.1. Step 1: Determine slab transfer price

Before a coil can be produced at the strip mill, a steel slab should be received from the steel plant. This slab will then be re-heated and after this, it will be rolled into a coil. The costs associated with each slab is simple to calculate and include the raw material costs, that is the iron ore, coal and other materials in its composition. Included in the transition price are the costs associated with producing the slab, that is melting the ore into pig iron, adding the correct materials to produce steel and casting the steel slab,

including all the supporting functions necessary to produce the slab, e.g. transportation and lab analysis. All these costs involved in producing a slab are easily quantifiable and is available from the management accounting department of Highveld.

After the slab is delivered to the Flat products division, it is re-heated in the walking beam furnace and rolled to a smaller transfer gauge by a roughening mill. It is then transferred to the strip mill where it is rolled to the final product gauge. The cost associated with processing a slab to be ready for rolling at the strip mill should therefore, be calculated and added to the slab transfer price to obtain the total transfer price of a slab. The assumption can be made that the transfer price of slabs to the strip mill is constant, for all the various products, without adversely affecting the accuracy of cost calculation. The reason for this is that losses occurring in the preparation stages will not be affected at all by the final product properties. Only the rolling losses at the strip mill will be dependent on the product specifications.

The slab in its final stage before processing starts at the strip mill, is called a transfer bar and will in the remainder of this report, be referred to as such. The total transfer price of the transfer bar will therefore, be considered.

1.6.2. Step 2: Quantify production costs per second of production time

The strip mill unit has certain costs associated with its operation. These costs will be incurred in order to make it possible for the strip mill unit to perform its operational functions, that is to produce a coil from a transfer bar. These costs can be summarised as follows:

- Plant maintenance costs.
- Salaries and wages of operational and engineering personnel.
- Capital costs of improvements.
- Normal running costs.

Some of these costs can be classified as variable costs dependent on production volume and others can be classified as fixed costs not dependent on production volume. The strip mill unit is characterised by a large financial leverage strategy mostly due to the high fixed costs associated with the inherent nature of the plant and equipment being a large capital-intensive investment. Only a small portion of the total costs associated with the production process can be regarded as variable. For effective cost analysis purposes, it is important to identify variable costs and fixed costs. The assigning of variable costs to products must be dependent on operational process time required.

It was decided that the most accurate manner to assign production overhead would be to do so on the basis of total production time per ton required by the different products. This will be done by calculating the total overhead cost of a typical month at the strip mill and then to divide this by the total amount of processing time of the mill during this month. Due to the fact that the total production time during each month will depend on the order load, the average over one year will be used to calculate this. For practical reasons, the last twelve months of operation will be used as input data.

This step will furnish a per unit cost per processing second at the strip mill. The costs will then be assigned to each different product by means of processing time required.

1.6.3. Step 3: Determine the production yield to production time relationship

As a first part of this exercise, it will be necessary to assign production time to different product categories depending on final product gauge and width, assuming that all products produced will be prime (When referred to as prime, the product is rolled to customer specification without major defects). After this, it is important to calculate the effect on production time when products are rolled to scrap. When products are rolled to scrap, something happens to the product while rolling it and this will reduce production throughput because there is a high probability that it can cause equipment to break and

cobles (This term refers to deformed products that is present in the mill and have to be removed by abnormal means form the mill before production can resume) to be removed.

1.6.4. Step 4: Determine the production yield to downgrade cost relationship

After processing each coil, a quality inspector will evaluate its quality and assign a specific code to the product. The most important product classifications include:

- **Direct despatch**

This coil is directly despatched to the customer with no further processing.

- **Temper mill prime**

This coil is processed through the temper mill before being despatched to the customer. During processing at the temper mill, small losses are incurred due to the cutting off of coil ends and scrapping of it. These off cuts should be accounted for by means of assigning downgrading costs to it. A certain percentage of coils processed are downgraded to scrap and seconds and should also be accounted for on an average percentage basis. Processing costs at the temper mill should also be assigned to these coils.

- **Temper mill cutback**

The temper mill also processes these coils, with the only difference from temper mill prime coils being that off-cut losses are larger and second and scrap generation are larger percentage wise.

- **Temper mill recovery**

These coils are the same as temper mill cutbacks with the difference that the percentage of off-cut-, second- and scrap generation is substantially larger.

- **Seconds**

These coils are dispatched to the customer directly, at a reduced price due to severe product deficiencies. No further processing is performed on these coils.

- **Scrap**

These coils are cut up into pieces and re-entered into the production line at the iron plant. Only the scrap value of these coils is recovered due to major product deficiencies.

During this stage, each product is evaluated to determine the percentage of production of the different product categories (referred to as product yield) as well as their effect on the total downgrade cost associated with the production of each product classification.

1.6.5. Step 5: Assign both direct and indirect costs to the product

During this stage, all the different costs associated with each product is integrated to determine the total cost of each product on a per-ton basis. This cost will then include both the direct cost of the transfer bar, the production time cost and the downgrade cost.

1.6.6. Step 6: Calculate the product contribution

During this stage, the contribution towards the profit of the company will be calculated by subtracting the product price per ton from the product cost per ton.

1.7. Literature Study

According to Michael Porter, five different competitive strategy approaches exist (Tompson & Strickland, 2001:150):

- *A low cost provider strategy:* This approach is appealing to a broad spectrum of customers based on being the overall low-cost provider of a product or service.
- *A broad differentiation strategy:* Seeking to differentiate the company's product offering from rivals' by means that will appeal to a broad spectrum of buyers.
- *A best-cost provider strategy:* Giving customers more value for their money by incorporating good-to-excellent product attributes at a lower cost than rivals; the target is to have the lowest (best) costs and prices compared to rivals offering products with comparable upscale attributes.
- *A focused (or market niche) strategy based on lower cost:* Concentrating on a narrow buyer segment and out-competing rivals by serving niche members at a lower cost than rivals.
- *A focused (or market niche) strategy based on differentiation:* Concentrating on a narrow buyer segment and out-competing rivals by offering niche members customised attributes that meet their tastes and requirements better than rivals' products.

The strategy chosen by Highveld and that will be discussed in more detail in the rest of this writing is a focused (or market niche) strategy based on differentiation. A niche market is a market identified with specific needs that can be satisfied by the company and

that is not at the present point in time, satisfied by other competitors. In order for a company to be able to successfully target such a market and adapt its marketing mix accordingly (Cateora,1996:337), the specific needs of the market should be identified and the company should design its operations to effectively satisfy these needs.

The needs will require some form of differentiation and can include such direct attributes as product functionality, product quality, product variety, quality of service and lower prices. It is important to understand that needs can also include attributes such as smaller delivery time, smaller minimum order sizes and customisation of products.

According to Tompson & Strickland, 2001:166 differentiation strategies is most effective when:

- There are many ways to differentiate the product or service and many buyers perceive these differences as having value; Without this condition, profitable differentiation opportunities are very restricted.
- Buyer needs and uses are diverse; Some buyers prefer one combination of features and other buyers another. The more diverse buyer preferences are, the more freedom firms have to pursue different approaches to differentiation and thereby avoid trying to out-differentiate one another on much the same attributes.
- Few rivals are following a similar differentiation approach; there is less head-to-head rivalry when differentiating rivals go separate ways in pursuing uniqueness and try to appeal to buyers on different combinations of attributes.
- Technological change and product innovation are fast-paced and competition revolves around rapidly evolving product features: Rapid product innovation and frequent introductions of next-version products help maintain buyer interest in the product and provide space for companies to pursue separate differentiating paths.

It is important to understand that differentiation does come with a price and for this reason, it is important to constantly evaluate the advantages and disadvantages of

differentiation to ensure that positive gain results from it. It is therefore, important to understand the pitfalls that is common in regards to differentiation strategies:

- Trying to differentiate on the basis of something that does not lower a buyer's cost or enhance a buyer's well-being, as perceived by the buyer.
- Over-differentiating so that price is too high relative to competitors or that product quality or service levels exceed buyer's needs.
- Trying to charge too high a price premium (the bigger the price differential the harder it is to keep buyers from switching to lower-priced competitors).
- Ignoring the need to signal value and depending only on intrinsic product attributes to achieve differentiation.
- Not understanding or identifying what buyers consider as value.

Differentiation is built on the buyer's perception; it is no use to add value to any product without adding value from the buyer's perception. For this reason, it is important to understand the target market well enough to be able to know what the customer will perceive as value-adding and what not. Thorough market research is, for this reason, of vital importance (Shao, 1999:12).

Living in a world where the only constant is change, the possibility of changing customer needs must be considered. The differentiating strategy should, because of this, be changed constantly to ensure the retention of a good fit between strategic focus and customer needs. It is important never to become complacent with any strategy even when it is at its peak of success. A strong marketing department with close contacts to customers is, for this reason, essential and their input into constantly crafting strategic focus should be regarded as very important.

The ultimate objective of any strategy is to improve the bottom line, that is to create wealth for shareholders. One of the main objectives of any commodity-producing organisation is to penetrate the market and then to retain as large a market share as possible, as this increases its turnover and profit. This objective can be seen as very

important, but it can also be dangerous to pursue blindly. A differentiation strategy is one means of obtaining this objective, but must be implemented under tight control. The danger is that market share might be increased in non-profitable sectors of the market. For instance, let us assume that the company under consideration produces one hundred different products. All of these products contribute positively to profits. This company now has identified the opportunity to produce ten other products in its field of expertise that will ensure a larger market share. This may seem a clear-cut opportunity, but with further investigation it may become apparent that five of the ten products will stretch the limits of the company's production capability in such a way that product throughput and yield might be influenced negatively and increased overhead costs may decrease company profitability rather than increase it.

Depending on the complexity of the production process under consideration, it might not always be easy to identify such negatively contributing products. The point is that market share gains do not necessarily increase returns. It is for this reason that products should be evaluated to ascertain real profitability and less profitable product lines should be discontinued even if it results in a reduction in market share.

It is sometimes necessary to produce products at a negative contribution with the sole purpose of retaining a customer that is also buying large quantities of profitable products. The starting point in evaluating different product lines must therefore, be to evaluate the real profitability of the product by calculating all direct and indirect costs incurred and then comparing this with income generated by the product to obtain the profitability figure.

Different products can then be classified in terms of real profitability. Premium prices can now be charged on products with lower contribution margins when offered to customers only ordering these products. Customers that order a large amount of products with high contribution margins can be offered products with lower contribution margins at a lower price, taking the fact into account that profit losses will be made up by the extra sale generated on higher contribution margin products.

At this stage it is important to explain what is meant by the term contribution. In order for any type of cost analysis to be effective and unbiased, costs should be assigned to where it is incurred. In formal managerial accounting, a term exists that is called the contribution margin. The concept of contribution margin (Drury, 2001:53) can be defined as being the amount of monetary value left after all variable costs are covered, that can be used to cover fixed costs and generate profit.

1.8. Summary

This chapter summarised the product diversity strategy applied by Highveld Steel on the operation of the strip mill. This strategy was explained by holistically integrating it with the environmental aspects surrounding its application within the strip mill. The methodology that will be applied in the remainder of this report to pursue the stated objectives, was also summarised and explained.

CHAPTER 2

CRITICAL ANALYSIS

2.1. Introduction

In a complex industrial environment akin to that of the strip mill at Highveld Steel, it is not always a painless exercise to determine the real contribution margin of select products within a larger product mix. Due to the fact that the different product ranges follow virtually the same path through the production facility it is difficult to correctly assign costs to the different products. For this reason, a model must be developed to ascertain the amount of operating capacity occupied by any one product and then use this to assign manufacturing costs and overhead to specific products.

In this chapter, historical production data was scrutinised in depth to furnish a model for assigning costs involved in producing different product lines. The outcome of this chapter is a model in the form of a set of formulae that can be applied to selected product production data to calculate the total variable cost associated with each product line. The information generated by this model can then be used to calculate the real contribution margin of each product produced by the strip mill.

2.2. Step 1: Determine transfer bar cost

It should be noted that the slab transfer price per ton is constant for all the different products on offer. The reason for this is that all slabs will undergo the same basic production process before they are transferred to Flat products for final processing. The only difference between slabs is that their metallurgical content will differ according to customer specification. The costs involved with the adjustment of metallurgical content between different slabs will lie primarily within the addition of various non-ferrous

elements to the steel mix before casting. These element additions is of such a small scale that it will have virtually no impact on the total slab material cost.

For simplification purposes it can therefore be assumed that all slabs have exactly the same transfer price. The production process involved in transforming a slab into a transfer bar, includes re-heating it through the walking-beam furnace and rolling it to transfer gauge in the roughening mill. The same process will again be implemented to obtain this goal on another slab, with the difference between the processing of different transfer bars almost non-existent. It is therefore further assumed, without substantial impact on accuracy, that the total transfer price of changing a slab into a transfer bar is exactly the same per ton for all different products.

It is now possible to calculate the total transfer bar cost by simply adding the transfer cost of the slab per ton and the transfer cost in producing a transfer bar from a slab. Both transfer costs being constant per ton, results in the total cost of the transfer bar also to be constant per ton.

At this point it is necessary to quantify the total transfer bar cost and it was arbitrarily decided to assign the value of 1 pu (per unit) to the transfer bar cost as the base quantity. The base quantity in all per unit quantities that will be used in the remainder of this text will therefore be the transfer bar cost. The transfer bar cost per ton of any transfer bar before entering into the strip mill for processing is therefore 1 pu.

2.3. Step 2: Quantify production costs per second of production time

To do this it will be important to consider the total overhead costs incurred to keep the strip mill rolling. The average monthly overhead costs should be calculated over the past twelve months and divided by the average total seconds of production time available for production during these months. The total average monthly variable costs can be divided

by the total average monthly production to obtain a per ton variable cost. This cost can then be added to the 1 pu cost of a transfer bar.

At this stage, the operating costs of the strip mill should be calculated. These operating costs include all costs associated with the production of the product. It comprises both fixed and variable costs. The fixed costs are costs that are incurred that are not dependent on the total amount of production and for this reason it will stay the same irrespective whether one ton or one million tons are processed. This variable will not depend on the production yield and for reasons of calculating the contribution margin of the different products, it can be discarded.

From the managerial accounting department, it was ascertained that the average operating cost per ton production is 0.2506 pu through the strip mill. This cost does not take into account the production time consumed to produce any specific ton, but rather, states the average cost per ton produced. The average processing time for any one ton was calculated to be 36 seconds. The cost per second processing is therefore $0.2506 \text{ pu} / 36 \text{ sec} = 0.00696 \text{ pu} / \text{second}$.

2.4. Step 3: Determine the production yield to production time relationship

Products can be classified into different categories depending on the final gauge and width. To understand the concept, it is necessary to consider a drawing of the strip mill under consideration in figure 2.1. When referring to figure 2.1 it is noted that the mill consists of a single mill stand with two coiler drums in steckel furnaces at both sides of the mill stand.

When a transfer bar enters into the mill area, it's front end will be cropped to ensure a rectangular front end. It will then enter the mill and the gauge will be reduced with a draft (amount of gauge reduction) determined by the models in the control system according to the transfer bar's metallurgical quality, width and final gauge.

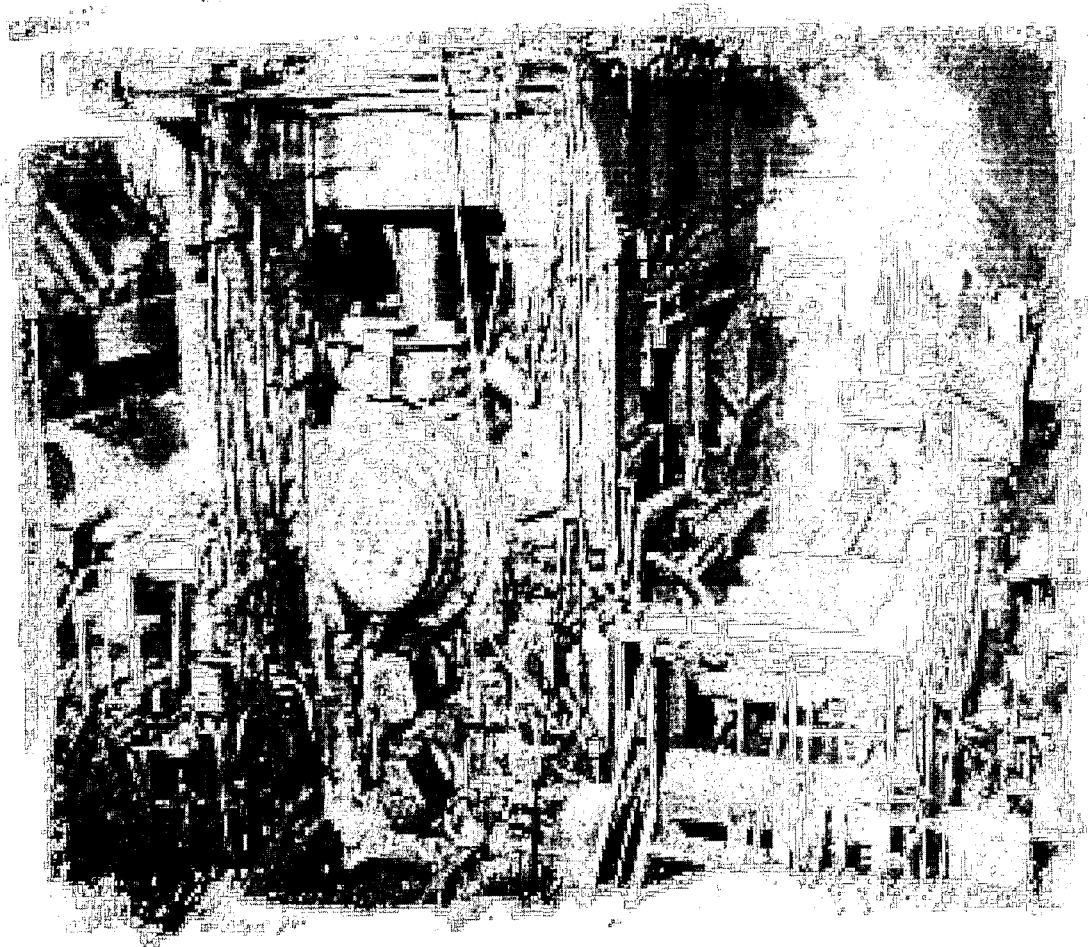


Figure 2.1: *The reversing steckel mill at Highveld steel.*

After the front end leaves the roll pack in the mill stand it will be coiled up on the back coiler drum. After the end of the coil leaves the roll pack, the direction of the roll pack will be changed and the coil fed back into the roll pack. After leaving the roll pack, the coil will be coiled up on the front coiler drum. When the coil end leaves the roll pack, the direction of the mill will again change and the coil will be fed back into the roll pack. Each time the coil goes through the roll pack in one direction, it is called a coiling pass.

Each coiling pass will reduce the gauge of the coil with a set amount depending on the model calculations. When the coil is on final gauge, it will pass underneath the back coiler drum and coiled up on the upcoiler as a finished product. The amount of passes

must for obvious reasons be odd and will be determined by the models in the mill control system. The specific product's metallurgical composition determines the hardness of the product and will cause it to react in a specific manner in the mill when rolled. Harder products will require more coiling passes and softer steel will require less coiling passes. The wider the product, the more force must be exerted onto it to realise a specified draft, and for this reason, wider products will require more coiling passes.

The smaller the final gauge, the more passes will be required to roll the product. Each coiling pass will require a certain production time depending on the mass of the coil rolled and the final gauge of the coiling pass. The time required per ton, per pass can therefore be calculated. The first pass will be a relatively short pass, with an increase in the amount of time required to roll subsequent passes due to the elongation of the coil as it is rolled through the mill.

It should be noted that the models determine the speed at which any specific pass is rolled. From the information above, the total production time required to roll any specific pass can be calculated on a per ton basis. The accumulative production time required to roll the required amount of passes can then be calculated and assigned to the products depending on the amount of passes required for each product.

The last pass production time is dependent on the metallurgical properties of the material being rolled. The reason for this is because products with different metallurgical properties require different cooling down-times. The product rolled must be coiled up on the upcoiler at a certain coiling temperature and on the back of the back furnace, cooling banks are situated where water is used to cool down the coils after being rolled. From the above, it can be noted that the production time required for rolling for the first few passes can be approximated to be constant per ton for all products produced. The last pass will not be and should be accounted for separately for each different product. The production times required per ton rolled are summarised in table 2.1.

Table 2.1: *Production times per ton required for different coiling passes.*

Pass Number	Production Time (s)
PM	13.0
1	2.05
2	2.31
3	2.56
4	2.82
5	3.13
6	4.20
7	5.93

At this stage, it should be noted that the above production time required is the minimum required production time for any specific product irrespective of what the final product classification is. Thus, whether the product is rolled to prime or to scrap it will require the minimum production time stated above. For the final product classifications of direct despatch, temper mill prime, temper mill cutback, temper mill recovery and seconds, this minimum production time required to produce the product will also be the total production time required to process the coil.

When a product is rolled to scrap, it will mean that something went wrong in the production of the coil. In most cases, this will result in production delays due to the fact that these defective coils must be removed from the mill, sometimes resulting in lengthy downtimes. The length of the production delay will depend on the specific problem that occurred and during which stage of the production process it occurred. It was decided to account for this added production time by adding all the production delays resulting for scrap rolled in the past year and then to calculate the representative amount of production delay time per ton scrap rolled within the year.

To calculate the total amount of production time required to roll each product the following formula can be applied.

$$PT = NPT + PSY \times SD \dots(2.1)$$

With:

PT : Total production time per ton required.

NPT : Normal production time equal to the time needed to roll all coiling passes.

PSY : Product Scrap Yield, the percentage of tons rolled to scrap in history.

SD : Scrap Delay, The production delay in seconds per ton scrap rolled.

Formula 2.1 can now be applied to calculate the total per ton production time required to process a ton of a specific product.

2.5. Step 4: Determine the production yield to downgrade cost relationship

The price charged for a coil depends on the physical quality of the coil rolled. The better the quality the higher the price and the lower the quality the lower the price. The easiest way to compare the income generated from the production and sale of different products is to assume that all products are sold at premium prices independent of their physical quality. The deficiency rolled into each coil will result in it not being sold as a prime product and this can be accounted for by assigning a downgrade cost to each one of these coils.

Per example, lets assume that a specific coil is sold at 1.5 pu when prime, at 0.8 pu when a second and 0.3 pu when scrap. Then the downgrade cost can be assumed to be the opportunity cost of producing a prime product. Thus, the downgrade cost of a second will be $1.5 \text{ pu} - 0.8 \text{ pu} = 0.7 \text{ pu}$ and for scrap $1.5 \text{ pu} - 0.3 \text{ pu} = 1.2 \text{ pu}$. This downgrade cost is then added to the other costs involved with producing the coil to obtain the total cost in producing the coil. The following variables can now be calculated:

C_{se} = Price difference between a prime coil ton and a second coil ton.

C_{sc} = Price difference between a prime coil ton and a scrap coil ton.

2.5.1. Direct despatch

This coil is directly despatched to the customer with no further processing and no downgrade costs are added to this coil.

2.5.2. Temper mill prime

This coil is processed through the temper mill before being despatched to the customer. During processing at the temper mill, small losses are incurred due to the cutting off of coil ends and scrapping of it. These off-cuts should be accounted for by means of assigning downgrading costs to it. A certain percentage of coils processed are downgraded to scrap and seconds and should also be accounted for on an average percentage basis. Processing costs at the temper mill should also be assigned to these coils.

The total downgrade costs that can be assigned to coils with this classification is:

$$C_{dtp} = C_{tp} + P_{cb} \times C_{sc} + P_{sc} \times C_{sc} + P_{se} \times C_{se} \dots (2.2)$$

With:

C_{dtp} : Total downgrade cost for Temper Mill prime

C_{tp} : Temper mill processing cost

P_c : Percentage off cuts generated at the temper mill

C_{sc} : Downgrade cost of scrap

P_{sc} : Percentage of scrap coils generated from prime coils at the temper mill

P_{se} : Percentage of second coils generated from prime coils at the temper mill

C_{se} : Downgrade cost of seconds

When processing a coil at the temper mill a certain amount of costs are incurred. These costs include the overhead costs associated with keeping the temper mill operating as well as the normal running costs of the temper mill. These costs are calculated as the total monthly costs of the temper mill operation divided by the average tonnage processed through the temper mill in a month. The constant C_{tp} accounts for these costs.

The pieces cut off at the temper mill is discarded as scrap and for this reason, the scrap downgrade costs are multiplied by the percentage of off-cuts generated from prime coil. During temper mill processing, some defects not picked up by the upcoiler quality inspector, are picked up and the coil are either downgraded to seconds or to scrap. The occurrence of the above are accounted for by the factors where the percentage of scrap coils generated from prime coils are multiplied by the downgrade cost of scrap and the percentage of second coils generated from prime coils are multiplied by the downgrade cost of seconds.

The downgrade cost of scrap, that is the difference between prime and scrap price is 1.2536 pu. Thus $C_{sc} = 1.2536$ pu. The downgrade cost of seconds, that is the price difference between prime and seconds is 0.6339 pu. Thus $C_{se} = 0.6339$ pu. The temper mill processing cost is $C_{tp} = 0.0006$ pu. The twelve month average of temper mill cutbacks generated is 5.65 % Thus $P_c = 0.0556$. The percentage of scrap coils generated at the temper mill is 0.658 %. Thus $P_{sc} = 0.00658$. The percentage of second coils generated at the temper mill is 2.898 %. Thus $P_{se} = 0.02898$.

Applying formulae 2.2 results in the following:

$$C_{dtp} = C_{tp} + P_{cb} \times C_{sc} + P_{sc} \times C_{sc} + P_{se} \times C_{se} \dots(2.2)$$

$$C_{dtp} = 0.0006 + 0.0556 \times 1.2536 + 0.00658 \times 1.2536 + 0.02898 \times 0.6339$$

$$C_{dtp} = 0.0969.$$

2.5.3. Temper mill cutback

The temper mill also processes these coils, with the only difference from temper mill prime coils in that off-cut losses are larger and second and scrap generation are larger percentage wise. Equation 2.2 can also be applied to calculate the total downgrade costs of this coil classification with the statistics of these coil classification used as input information. The constants for TMC (Temper Mill Cutback) processing are:

$$C_{se} = 0.6339 \text{ pu.}$$

$$C_{tp} = 0.0006 \text{ pu.}$$

$$P_c = 0.0856.$$

$$P_{sc} = 0.00658.$$

$$P_{se} = 0.02898.$$

Thus applying 2.2:

$$C_{dtmc} = C_{tp} + P_{cb} \times C_{sc} + P_{sc} \times C_{sc} + P_{se} \times C_{se} \dots (2.2)$$

$$C_{dtmc} = 0.0006 + 0.0856 \times 1.2536 + 0.00658 \times 1.2536 + 0.02898 \times 0.6339$$

$$C_{dtmc} = 0.1345.$$

2.5.4. Temper mill recovery

These coils are the same as temper mill cutbacks with the difference that the percentage of off-cuts, second generation and scrap generation is substantially larger. Equation 2.2 can also be applied to calculate the total downgrade costs of this coil classification with the statistics of these coil classification used as input information. The constants for TMR (Temper Mill Recovery) processing are:

$$C_{se} = 0.6339 \text{ pu.}$$

$$C_{tp} = 0.0006 \text{ pu.}$$

$$P_c = 0.1156.$$

$$P_{sc} = 0.00658.$$

$$P_{se} = 0.02898.$$

Thus applying 2.2:

$$C_{dtmr} = C_{tp} + P_{cb} \times C_{sc} + P_{sc} \times C_{sc} + P_{se} \times C_{se} \dots (2.2)$$

$$C_{dtmr} = 0.0006 + 0.1156 \times 1.2536 + 0.00658 \times 1.2536 + 0.02898 \times 0.6339$$

$$C_{dtmr} = 0.1721.$$

2.5.5. Seconds

These coils are directly dispatched to the customer at a reduced price due to severe product deficiencies. No further processing is performed on these coils. The total downgrade cost can be calculated by:

$$C_{dse} = C_{se} \dots (2.3)$$

With:

C_d : Total downgrade cost

C_{se} : Downgrade cost of seconds.

$$C_{dse} = 0.6339 \text{ pu}$$

2.5.6. Scrap

These coils are cut up into pieces and re-entered into the production line at the iron plant. Only the scrap value of these coils is recovered due to major product deficiencies. No further processing is performed on these coils. The total downgrade cost can be calculated by:

$$C_{dsc} = C_{sc} \dots(2.3)$$

With:

C_d : Total downgrade cost

C_{sc} : Downgrade cost of scrap.

$$C_{dsc} = 1.2536 \text{ pu}$$

2.6. Step 5: Assign both direct and indirect costs to the product

During this stage, all the different costs associated with each product is integrated to determine the total cost of each product on a per ton basis. The total variable cost per ton of coil produced can now be calculated by adding the three cost components:

- Transfer bar cost.
- Operational cost assigned according to production time.
- Downgrade cost.

The Resultant cost equation that will be used for cost analysis is:

$$\begin{aligned} C_{dt} &= \{\text{Downgrade Cost}\} + \{\text{Operational Cost}\} + \{\text{Transfer Bar Cost}\} \\ &= \{P_{tp} \times C_{dtp} + P_{tmc} \times C_{dtmc} + P_{tmr} \times C_{dtmr} + P_{sc} \times C_{dsc} + P_{dse} \times C_{dse}\} \\ &\quad + \{PT \times C_{pcs}\} + \{C_{tb}\} \\ &\dots(2.4) \end{aligned}$$

With:

C_{dt} : Total Product Cost

P_{tp} : Product Temper mill Prime percentage yield

C_{dtp} : Total temper mill Prime downgrade cost (0.0969 pu)

P_{tmc} : Product Temper mill Cutback percentage yield

- C_{dtmc} : Total temper mill Cutback downgrade cost (0.1345 pu)
 P_{tmr} : Product Temper mill Recovery percentage yield
 C_{dtmr} : Total temper mill Recovery downgrade cost (0.1721 pu)
 P_{sc} : Product scrap percentage yield
 C_{dsc} : Total Scrap downgrade cost (1.2536 pu)
 P_{dse} : Product second percentage yield
 C_{dse} : Total Second downgrade cost (0.6339 pu)
 C_{tb} : Total Transfer Bar Cost (1 pu)
 PT : Total Product Production Time
 C_{pcs} : Production cost per second (=0.00696 pu)

2.7. Step 6: Calculate the product contribution

During this stage, the contribution towards the profit of the company will be calculated by subtracting the product price per ton from the product cost per ton.

2.8. Summary

The model for calculating the total variable costs associated with the production of the different product lines was derived in this chapter. Equation 2.4 can now be applied in the rest of the analysis process to quantify the real variable cost associated with producing a certain product line. This is necessary in order to be able to calculate the real contribution margin of each individual product produced by the strip mill.

CHAPTER 3

RESULTS

3.1. Introduction

The model derived in chapter 2 will be applied to the different products produced by the strip mill. This will furnish the contribution margin on the different products and will be used to evaluate the viability of producing them. In order to make the analysis more manageable, the products will be classified into different classifications according to their attributes. All these main product categories will then be evaluated to determine the effectiveness of the prevailing product diversity strategy as applied at the strip mill.

3.2. Classification of products

Due to the large number of different products offered by Highveld Steel, it was decided to classify the products into different categories and to evaluate the product mix accordingly. To be able to do this effectively, the correct criteria should be applied in order to classify various products. Criteria that should be considered is those that directly influence the product yield. These include:

3.2.1. Product width

Due to the physical design of the strip mill, the product yield is very dependent on the width of the product. There exists an inverse proportionality between the yield and product width, e.g. the wider the product the lower the product yield. The main reason for this is due to the fact that the mill is designed for a maximum product width of 2100 mm. When mill instability occurs, the product tends to drift to one of the sides of the mill and because of this, the coil may be scrapped due to it being rolled too off-center of the

roll pack. The wider the coil, the larger the probability of the occurrence of drift and ultimately the larger the severity of the drift.

All the width ranges rolled can be classified into three distinct categories without impacting the accuracy of the analysis. These three categories include:

- Width \leq 1200 mm
- 1200 < Width < 2000 mm
- Width \geq 2000 mm

3.2.2. Product gauge

The smaller the product gauge, the more the amount of passes that the product is rolled in. The more the passes the product is rolled in, the larger the possibility that something might go wrong and the product scrapped as a result. For this reason, a direct correlation exists between the product's yield and gauge. On the last few passes of thinner gauged products, the probability of the strip tearing or getting stuck in the roll pack area increases, with a negative effect on total product yield. The gauge range of products offered can be classified into three categories:

- Gauge \leq 4.5 mm
- 4.5 mm < Gauge < 10 mm
- Gauge \geq 10 mm

3.2.3. Product quality

Products with different metallurgical compositions are offered to the customer. This metallurgical composition depends on the amount of trace elements present in the steel structure. These elements include carbon, vanadium, copper, magnesium and chrome. It

is important to understand that the yield strength of the steel is dependent on its metallurgical composition. The yield strength of the steel, in turn influences the reaction of the strip in the mill when the coil is rolled.

The higher the yield strength the harder the mill has to work during passes. Some of the metallurgical compositions offered also have cooling properties that negatively influence the rolling process. One such example is BR50 that cools down quickly and when cooled down, has fragile characteristics causing the strip to tear in the mill whenever it is rolled too slow. Other metallurgical compositions offered is prone to surface defects after being rolled, when cooled down to targeted coiling temp at the laminar flow cooling banks. These variables will affect the product yield and should therefore be considered.

3.3. Results per product category

A total of 47 different products lines were identified according to the classification categories identified above. The application of equation 2.4 (Derived in Chapter 2) on these different product lines will in this chapter be applied to furnish contribution margins per product category.

Steel can be classified as a commodity, and as such it should be noted that the price of products are determined mainly by market forces and not by individual company policy. The only exception to the rule is cases where difficult products are manufactured and as a result thereof, where the manufacturing company may charge a price premium above the average commodity price to make up for yield losses incurred while producing the product. In order to generalise the findings of this report, it is important to choose a representative commodity price basis and then use this in the calculation across the board for all products.

The principle is therefore, that the price charged per ton on coil products is constant irrespective of the product produced. Cyclical changes in the prices of the coiled steel

commodity is not taken into account but is assumed to be constant at a chosen price for reference sake. It is important to choose a constant commodity price due to the fact that the price fluctuations of steel are large in magnitude, and unpredictable.

To illustrate, at the time of producing this report, the contribution on coil steel products were in fact negative mainly due to the South African government's monetary policy (relative strength of the Rand against the Dollar) and the economic slowdown due to a period characterised by high interest rates.

For the purposes of calculating the contribution per product, the commodity price is assumed to be 1.5 pu (This is a reasonable assumption during fair steel demand periods). The contribution of each product is therefore, equal to the sale price (1.5 pu), minus the variable product cost (including the sum of the transfer bar cost, downgrade cost and production time cost).

3.3.1. BR50

Table 3.3.1: Summary of BR50 Product Characteristics

CAT	Prime	TMC	TMR	SEC	SCRAP	DC	PC	TC	Contr.
WA_GA	0.49	0.16	0.22	0.04	0.09	0.25	0.55	1.80	-0.30
WA_GB	0.79	0.05	0.09	0.01	0.06	0.18	0.36	1.54	-0.04
WA_GC	0.78	0.03	0.11	0.03	0.06	0.19	0.31	1.50	0.00

Three different products are offered in this specific product quality. They include:

- **Width \leq 1200 and Gauge \leq 4.5mm (WA_GA)**

The prime rate of this product is low at only 49%. The bulk of product produced is produced as TMC's and TMR's. This will result in large cutback losses incurred at the temper mill. The main concern however is the fact that 9% of all products produced are lost as scrap. The latter statement is the main cause of the large downgrade cost associated with the product (0.25 pu). It is also the reason for the large amount of

production time costs associated with the product, due to the fact that all these scrap products produced must be removed from the mill before production can continue and for this reason, the large production time cost (0.55 pu) incurred.

The accumulative effect of the large amount of scrap produced is that the contribution margin on this product is at a very unhealthy value of -0.30 pu. This product should not be rolled if the negative contribution cannot be offset by at least a 0.30 pu in a price premium charged above the standard commodity price.

- **Width ≤ 1200 and $4.5 < \text{Gauge} < 10$ mm (WA_GB)**

A healthy prime rate of 79 % is maintained in the production of this product. The concern is that there is still a high percentage of scrap produced (6%). This is why the contribution is negative at -0.04 pu. Although the performance on this product is much better than that of its thinner counterpart, it still leaves much to be desired. A price premium should also be charged on this product to offset the negative contribution and secure a fair profit.

- **Width ≤ 1200 and Gauge ≥ 10 mm (WA_GC)**

This product is also characterised by a good prime yield of 78%. Again the bulk of the losses are situated in scrap losses (6%) and because of this the still dull, but more acceptable, contribution margin of 0.0 pu. This can be attributed to the fact that two products with the same prime yield may result in significantly different contribution margins, dependent on where the losses were incurred.

Obviously the more the scrap losses, rather than TMR and TMC losses, the greater the total loss, due to high scrap downgrade costs as well as added production time required to remove scrap material from the mill. With high losses associated with TMC and TMR production, the bulk of downgrade costs can be attributed to cutbacks. No additional

production time costs are incurred with the production of these products, due to the fact that it is not necessary to remove scrap from the mill.

Although this product at least does not have a negative contribution margin, it is not a good product to manufacture due to the fact that it will only contribute to company turnover, but not to shareholder wealth creation. It is also important to understand that large opportunity costs will be incurred due to the taking up of production capacity that could have been used to produce products with positive contribution margins.

- **BR50 performance overview**

From the three product categories evaluated above, the conclusion can be drawn that this product quality does not pose a very lucrative company contribution. Not one of the products evaluated furnished a positive contribution margin. The discontinuation of this product line should therefore be considered as an option if price premiums above the standard commodity price cannot be charged. To place this into perspective, it should be noted that this product quality line makes up only 1.01% of the total annual production of coil products. This might seem insignificant, but to quantify, it should be noted that with an annual coil production of 215,000 tons, it comprises 2,150 tons of production effectively generating negative profitability.

3.3.2. ES46

Table 3.3.2: Summary of ES46 Product Characteristics

CAT	Prime	TMC	TMR	SEC	SCRAP	DC	PC	TC	Contr.
WC_GB	0.79	0.13	0.05	0.00	0.03	0.14	0.34	1.48	0.02
WC_GC	0.79	0.02	0.19	0.00	0.00	0.11	0.18	1.29	0.21

From table 3.3.2 only two product lines are produced in this product quality:

- **Width ≥ 2000 and $4.5 < \text{Gauge} < 10$ mm (WC_GB)**

A healthy prime rate of 79% is obtained on this product. The bulk of the downgraded products are downgraded at TMC's, thus resulting in large cutback losses. The problem however, is that the scrap downgrade percentage is high at 3%. This results in large downgrade costs as well as well as large production time costs incurred due to the removal of scrap products. Also adding to the problem is the fact that this product is rolled in 7 passes and as such, requires longer production time per ton produced. The contribution margin of this product is at 0.02 pu. This product should not be rolled without a price premium, except if it is to attract larger orders for more profitable products.

- **Width ≥ 2000 and Gauge ≥ 10 mm (WC_GC)**

The prime rate of this product is also 79%. The difference is that scrap product production is non-existent and because of this, the downgrade costs are mainly incurred for cutback losses when the TMR's are reprocessed through the temper mill. This product is rolled in 5 passes and the total production time cost involved is also minimal. A very lucrative positive contribution margin of 0.21 pu is obtained with the production of this product. The production of this product should be seen as priority with marketing objectives put into place to try and stimulate demand.

- **ES46 performance overview**

This product quality constitutes 1.5% of the annual coil production. The first product considered has a very small positive contribution margin and should not be produced without price premiums. The second product line is indeed an attractive product line with high positive contributions of 0.21 pu. When considering the metallurgical composition of this product, it is noted that this product quality is one of the softer steel

products and as such leads to higher production yields through the mill. The two product lines offered in this product quality are both wide coils. Judging from the good contribution on the second product, it is predicted that the yields on narrower coils in this product quality will prove to be lucrative. It is important for the marketing department to evaluate the possibility of stimulating the demand for such products.

3.3.3. IL42

Table 3.3.3: Summary of IL42 Product Characteristics

CAT	Prime	TMC	TMR	SEC	SCRAP	DC	PC	TC	Contr.
WB_GB	0.85	0.10	0.03	0.01	0.01	0.13	0.22	1.35	0.15
WC_GC	0.89	0.01	0.01	0.06	0.03	0.16	0.27	1.43	0.07

- **1200 < Width < 2000 and 4.5mm ≤ Gauge ≤ 10 mm (WB_GB)**

The prime yield achieved with this product is high at 85%. This in conjunction with the low scrap production of 1% contributes to a relatively small downgrade cost. Due to the fact that scrap production is low and this product can be rolled in 5 passes the production time cost associated to the product is also low. A good positive contribution margin of 0.15 pu is achieved on the product.

- **Width ≥ 2000 and Gauge ≥ 10 mm (WC_GC)**

The high prime yield of 89% on this product is the main contributing factor towards the fair positive contribution margin of 0.07 pu. The relatively high scrap production of 3% penalises the product in regards with both downgrade cost and production time costs. Although not a very high positive contribution margin is obtained from this product it is a good product to produce without the necessity of a price premium.

- **IL42 performance overview**

The overall performance obtained on this product is good. This product attributes to 2.29% of the total annual coil production. Although a contribution of 0.07 pu is borderline in ensuring healthy company profitability, it is viable to produce products at this contribution margin. The yields obtained on this product are good and it is suggested that the present product line in this product quality should be expanded through marketing incentives.

3.3.4. NS09

Table 3.3.4: Summary of NS09 Product Characteristics

CAT	Prime	TMC	TMR	SEC	SCRAP	DC	PC	TC	Contr.
WA_GA	0.71	0.20	0.05	0.02	0.02	0.15	0.33	1.47	0.03
WA_GB	0.85	0.07	0.07	0.01	0.00	0.11	0.18	1.29	0.21
WA_GC	0.91	0.00	0.09	0.00	0.00	0.10	0.14	1.24	0.26
WB_GA	0.81	0.14	0.01	0.01	0.03	0.14	0.26	1.40	0.10
WB_GB	0.77	0.13	0.08	0.02	0.00	0.12	0.19	1.32	0.18

- **Width \leq 1200 and Gauge $<$ 4.5 mm (WA_GA)**

The prime yield achieved on this product is relatively low at 71%. The bulk of downgraded products are downgraded to TMC's. Although the scrap production is fair at 2%, the large percentage of coils downgraded to TMC causes large downgrade losses mainly because of cutbacks at the temper mill. The product achieves a positive contribution margin of only 0.03 pu. Although not negative this contribution is not large enough to contribute to good company profit. This product should either be offered with a price premium or accepted in order to secure large orders of more lucrative products.

- **Width \leq 1200 and 4.5mm \leq Gauge $<$ 10 mm (WA_GB)**

A good prime yield of 85% is obtained on this product. This fact in conjunction with the fact that virtually no scrap is produced from this product allows the product to achieve a good positive contribution of 0.21 pu. Marketing should try to increase the demand for this product even if it means offering the product at discounted prices.

- **Width \leq 1200 and Gauge \geq 10 mm (WA_GC)**

Achieving an excellent prime yield of 91% on this product together with the fact that virtually no scrap is generated contributes to an excellent product contribution margin of 0.26 pu. It should also be noted that this product is rolled in 3 passes thus further achieving lower costs for required production time. Marketing should desperately try and increase the demand for this product.

- **1200 $<$ Width $<$ 2000 and Gauge $<$ 4.5 mm (WB_GA)**

The good prime yield of 81% is the main reason for low downgrade costs. The scrap production in the region of 3% however penalises the product and keep the contribution margin at lower levels. The good positive contribution margin of 0.10 pu obtained on this product goes far in contributing to good profitability.

- **1200 $<$ Width $<$ 2000 and 4.5mm \leq Gauge $<$ 10 mm (WB_GB)**

Although the prime yield of this product is at 77%, its contribution is at a healthy 0.18 pu. Mainly due to the fact that the bulk of downgraded products are downgraded to TMC, with virtually non-existent scrap production. This product has a healthy contribution towards company profitability and should be promoted vigorously by marketing.

- **NS09 performance overview**

All the product lines in this product quality have positive contribution margins with few products that can be regarded as winners due to very high contribution margins achieved. When noting that this product quality accounts for 4.43% of annual coil production, it is clear that this product quality goes a long way in ensuring profitability.

3.3.5. NS30

Table 3.3.5: Summary of NS30 Product Characteristics

CAT	Prime	TMC	TMR	SEC	SCRAP	DC	PC	TC	Contr.
WA_GA	0.71	0.16	0.07	0.01	0.04	0.16	0.38	1.55	-0.05
WB_GA	0.68	0.20	0.09	0.01	0.03	0.14	0.26	1.40	0.10
WB_GB	0.70	0.14	0.14	0.01	0.01	0.13	0.22	1.35	0.15

- **Width \leq 1200 and 4.5mm \leq Gauge < 10 mm (WA_GB)**

The prime yield achieved on this product is only 71%. The main concern is that 4% of all products produced are downgraded to scrap. For this reason the downgrade cost and production time costs are high for the product. The contribution of the product is at a disappointing -0.05 pu. This product should either not be produced or it should be produced with a price premium.

- **1200 < Width < 2000 and Gauge < 4.5 mm (WB_GA)**

Although the prime yield is disappointing at only 68%, the contribution margin of this product is good at 0.10 pu. The main reason for this is that the scrap generation is at 3% with the bulk of the downgraded products downgraded to TMC. This product is playing an important role at contributing towards company profitability.

- **1200 < Width < 2000 and Gauge < 4.5 mm (WB_GB)**

The yield on this product is still disappointing at 70%. The reason why the contribution of this product is good at 0.15 pu is that only 1% of the product is downgraded to scrap. The contribution on this product is good and marketing should promote this product with customers.

- **NS30 performance overview**

The prime yields achieved on this product are not good. This is mainly because of the temperature characteristics of the product, posing serious problems at the laminar flow cooling stage of the production process. On the positive side the scrap production on this product is not too high and due to this the contribution on the latter two products is good. The first product evaluated, should only be produced if a price premium is charged. This product quality constitutes 11.99% of the annual coil production of which 82% is made up by the latter two products.

3.3.6. PT03

Table 3.3.6: Summary of PT03 Product Characteristics

CAT	Prime	TMC	TMR	SEC	SCRAP	DC	PC	TC	Contr.
WA_GA	0.89	0.07	0.02	0.01	0.02	0.12	0.30	1.42	0.08
WA_GB	0.93	0.04	0.01	0.00	0.01	0.11	0.22	1.34	0.16
WB_GA	0.80	0.14	0.02	0.01	0.04	0.15	0.29	1.44	0.06
WB_GB	0.78	0.10	0.07	0.02	0.04	0.16	0.30	1.46	0.04

- **Width \leq 1200 and Gauge $<$ 4.5 mm (WA_GA)**

The prime yield achieved on these products is exceptionally good at 89%. The scrap generated is fair at 2%. It should be noted that this product is rolled in 7 passes and this in conjunction with the 2% scrap generation is the reason behind the fact that a contribution margin of only 0.08 pu is obtained even with such a high prime yield.

- **Width \leq 1200 and 4.5mm \leq Gauge $<$ 10 mm (WA_GB)**

At a prime yield of 93% with only 1% scrap generated, this product is very attractive with a contribution margin of 0.16 pu. Marketing will do well in promoting this product with customers.

- **1200 $<$ Width $<$ 2000 and Gauge $<$ 4.5 mm (WB_GA)**

The prime yield on this product is good at 80%. The main factor in penalising this product is the high scrap generation of 4%. The contribution margin of this product is 0.06 pu. Although positive it is not large enough to contribute substantially to good company profitability. This product should only be produced if a price premium is charged or if it is to attract larger attractive orders.

- **1200 $<$ Width $<$ 2000 and 4.5mm \leq Gauge $<$ 10 mm (WB_GB)**

The prime rate of 78% is good to achieve on this product. The scrap generation of 4% is disappointing and constitutes the main culprit in undermining the contribution margin to achieve a contribution margin of only 0.04 pu. This product is not very attractive to produce and should only be produced in time periods when demand is low and volume important due to the fact that the demand for more lucrative products that is low.

- **PT03 performance overview**

Constituting 7.64% off the annual production of coil products, this product does play a valuable role in contributing to company profitability. Although not exceptionally high, the contribution of all the product lines of this product quality is positive and therefore contributes positively towards company profitability.

3.3.7. SS30

Table 3.3.7: Summary of SS30 Product Characteristics

CAT	Prime	TMC	TMR	SEC	SCRAP	DC	PC	TC	Contr.
WA_GA	0.39	0.21	0.23	0.03	0.14	0.30	0.70	2.00	-0.50
WA_GB	0.85	0.08	0.06	0.00	0.01	0.11	0.20	1.31	0.19
WA_GC	0.90	0.05	0.03	0.01	0.00	0.11	0.15	1.26	0.24
WB_GA	0.55	0.22	0.08	0.01	0.13	0.27	0.58	1.85	-0.35
WB_GB	0.71	0.19	0.08	0.01	0.02	0.14	0.24	1.38	0.12
WB_GC	0.76	0.09	0.12	0.03	0.00	0.13	0.14	1.26	0.24
WC_GB	0.69	0.18	0.09	0.01	0.03	0.15	0.35	1.50	0.00
WC_GC	0.79	0.05	0.10	0.05	0.01	0.15	0.21	1.36	0.14

- **Width \leq 1200 and Gauge $<$ 4.5 mm (WA_GA)**

The prime yield achieved on this product is poor at only 39%. This in conjunction with the excessively high scrap generation of 14% is the reason behind the terrible contribution margin of -0.5 pu. This is by far the worst performing product and should not be rolled at all in future. Not even with a high premium should this product be rolled, because when rolled, the mill is operating outside its normal operating parameters and the product will cause damage to the mill resulting in both equipment costs and lengthy delays. This product should be removed from the product catalogue of Highveld Steel.

- **Width \leq 1200 and 4.5mm \leq Gauge $<$ 10 mm (WA_GB)**

The prime yield achieved on this product is very good at 85%. Only 1% of products rolled are downgraded to scrap. The combination of the above is the reason why the contribution of the product is very good at 0.19 pu. This product is a good product to roll and should vigorously be promoted by marketing.

- **Width \leq 1200 and Gauge \geq 10 mm (WA_GC)**

With a prime yield of 90% and no scrap generation this product is very attractive with a contribution margin of 0.24 pu.

- **1200 $<$ Width $<$ 2000 and Gauge $<$ 4.5 mm (WB_GA)**

The prime yield on this product is only 55%. The scrap generation is unacceptable at 13%. This product, with its terrible contribution margin of -0.35 pu must not be rolled at all. This product is obviously beyond the specification of the steckel mill and will result in large indirect costs that will be incurred due to damage to machinery. It is clear that this product should be removed from the standard Highveld product catalogue.

- **1200 $<$ Width $<$ 2000 and 4.5mm \leq Gauge $<$ 10 mm (WB_GB)**

The yield on this product is fair at 71%, with the bulk of downgraded products downgraded to TMC. The product achieves a 0.12 pu contribution and therefore contributes to company profitability.

- **1200 < Width < 2000 and Gauge \geq 10 mm (WB_GC)**

At a prime yield of 76% with no scrap generation, this product is very attractive with a contribution margin of 0.24 pu. Marketing should promote the demand for this product.

- **Width \geq 2000 and 4.5mm \leq Gauge < 10 mm (WC_GB)**

The prime yield of this product is 69%, with scrap generation of 3%. Due to the poor prime yield and the large scrap generation this product's contribution margin is 0 pu. This product should only be produced if it is sold with a price premium, or to attract large attractive orders.

- **Width \geq 2000 and Gauge \geq 10 mm (WC_GC)**

The prime yield on this product is 79%, with 1% of scrap generation. At a contribution of 0.14 pu this product is making a good contribution towards company profitability.

3.3.7.9. SS30 performance overview

This product quality contributes to 8.61% of the annual coil production. Two products were identified of which production must be discontinued. Altogether these two products constitute a disappointing 17.99% of all SS30 coils produced (1.55% of total annual coil production). These products seriously impede company profitability and their production will have to be discontinued.

3.3.8. PM01

Table 3.3.8: Summary of PM01 Product Characteristics

CAT	Prime	TMC	TMR	SEC	SCRAP	DC	PC	TC	Contr.
WA_GA	0.78	0.13	0.06	0.01	0.02	0.14	0.32	1.46	0.04
WA_GB	0.90	0.06	0.03	0.00	0.01	0.11	0.20	1.31	0.19
WA_GC	0.94	0.02	0.02	0.01	0.01	0.11	0.15	1.26	0.24
WB_GA	0.81	0.13	0.04	0.00	0.02	0.13	0.24	1.36	0.14
WB_GB	0.82	0.13	0.03	0.00	0.02	0.13	0.24	1.37	0.13
WB_GC	0.85	0.08	0.05	0.00	0.01	0.12	0.18	1.30	0.20
WC_GB	0.69	0.19	0.06	0.01	0.05	0.17	0.39	1.56	-0.06
WC_GC	0.90	0.02	0.02	0.05	0.01	0.14	0.21	1.35	0.15

- **Width \leq 1200 and Gauge $<$ 4.5 mm (WA_GA)**

The prime yield achieved on this product is 78%. Only 2% of scrap is generated with the bulk of downgraded products, downgraded to TMC's and TMR's. This product is rolled in 7 passes. The contribution on the product is only 0.04 pu. This product should only be rolled if demand for other more profitable products is low or if it can secure a large order for other more profitable product lines.

- **Width \leq 1200 and 4.5mm \leq Gauge $<$ 10 mm (WA_GB)**

With a prime yield of 90% and 1% scrap generation, the contribution margin on this product is 0.19 pu. This product therefore contributes positively towards company profitability and its demand should be promoted by marketing.

- **Width \leq 1200 and Gauge \geq 10 mm (WA_GC):**

At an excellent prime yield of 94% and scrap generation of only 1% this product is extremely attractive to produce at a contribution margin of 0.24 pu.

- **1200 < Width < 2000 and Gauge < 4.5 mm (WB_GA)**

The prime yield achieved on this product is 81% with 2% of scrap generation. The contribution margin of the product is 0.14 pu and as such the product is attractive for production.

- **1200 < Width < 2000 and 4.5mm \leq Gauge < 10 mm (WB_GB)**

With a prime rate of 82% and scrap generation of 2%, the contribution of this product is 0.13 pu. This is a good product to produce and contributes well towards company profitability.

- **1200 < Width < 2000 and Gauge \geq 10 mm (WB_GC)**

The prime yield of 85% and scrap generation of only 1% is the reason behind the excellent contribution margin of the product of 0.20 pu. Marketing will do well in promoting this product.

- **Width \geq 2000 and 4.5mm \leq Gauge < 10 mm (WC_GB)**

Due to a low prime yield of 69% and large scrap generation of 5%, this product's contribution margin is -0.06 pu. This product line should either be discontinued or sold with a price premium.

- **Width \geq 2000 and Gauge \geq 10 mm (WC_GC)**

At a prime rate of 90% with only 1% scrap production, the contribution margin on the product is 0.15 pu. This product contributes positively to the profitability of the company.

- **PM01 performance overview**

Constituting 34.77% of the total annual coil production this product quality is very important to consider. All the products with the exception of one are produced with a positive contribution margin. It is important that marketing promote the more profitable products to improve company profitability. It is positive to see that the contribution margin on products in this category is on average good to very good.

3.3.9. UM19

Table 3.3.9: Summary of UM19 Product Characteristics

CAT	Prime	TMC	TMR	SEC	SCRAP	DC	PC	TC	Contr.
UM19:									
WA_GA	0.68	0.12	0.08	0.04	0.08	0.22	0.50	1.72	-0.22
WA_GB	0.84	0.08	0.07	0.00	0.00	0.11	0.19	1.30	0.20
WA_GC	0.90	0.03	0.03	0.03	0.01	0.12	0.16	1.28	0.22
WB_GA	0.73	0.18	0.09	0.00	0.00	0.11	0.18	1.29	0.21
WB_GB	0.70	0.19	0.07	0.01	0.04	0.16	0.31	1.47	0.03
WB_GC	0.78	0.13	0.04	0.03	0.03	0.15	0.22	1.37	0.13
WC_GB	0.68	0.19	0.08	0.01	0.04	0.16	0.38	1.55	-0.05
WC_GC	0.91	0.02	0.03	0.04	0.01	0.13	0.20	1.33	0.17

- **Width \leq 1200 and Gauge $<$ 4.5 mm (WA_GA)**

With a prime yield of 68% with 8 % scrap generation on this product it is clear that this product is not viable to produce. The contribution margin on this product is an unacceptable – 0.22 pu. This product can only be produced if a large price premium is charged.

- **Width \leq 1200 and 4.5mm \leq Gauge $<$ 10 mm (WA_GB)**

With a prime yield of 85 % with the bulk of losses attributed to downgrades to TMC and TMR's this product furnishes an impressive contribution margin of 0.20 pu.

- **Width \leq 1200 and Gauge \geq 10 mm (WA_GC)**

The prime yield on this product is 90 %. The contribution margin is 0.22 pu. This is a good product to produce and marketing should try to promote demand for it.

- **1200 $<$ Width $<$ 2000 and Gauge $<$ 4.5 mm (WB_GA)**

The prime yield on this product is only 70%, but with the bulk of losses downgraded to TMC's. For this reason the contribution margin on this product is high at 0.21pu.

- **1200 $<$ Width $<$ 2000 and 4.5mm \leq Gauge $<$ 10 mm (WB_GB)**

The prime yield on this product is disappointing at 70 %. The scrap production on these products is high at 4 %. The disappointing prime yield and high scrap generation is the main causes for the small contribution margin of only 0.03 pu. This contribution margin

is too small to make a valuable contribution to profitability and this product should only be produced if it will lead to the order of larger quantities of profitable products.

- **1200 < Width < 2000 and Gauge \geq 10 mm (WB_GC)**

This product is produced at a prime yield of 78% with scrap generation of 3%. The contribution margin on this product is 0.13 pu. This product has the potential to contribute to the profitability of the company.

- **Width \geq 2000 and 4.5mm \leq Gauge < 10 mm (WC_GB)**

With a prime yield of only 68 % and a scrap generation of 4 % it is understandable why the contribution margin on the product is -0.03 pu. This product will not contribute positively to the profitability of the company except if a price premium is charged on the product.

- **Width \geq 2000 and Gauge \geq 10 mm (WC_GC)**

The prime yield is 91 % and the scrap yield is only 1 %. The contribution margin is at 0.17 pu. The reason why this value is so low is mainly because of the large percentage of seconds generated.

- **UM19 performance overview**

The contribution of UM19 towards the annual product mix is 22.63 %. Most of the products categories generated in this quality have large contribution margins, with the exception of three products that were identified with sub-par contribution margins.

3.3.10. QC08

Table 3.3.10: Summary of UQ08 Product Characteristics

CAT	Prime	TMC	TMR	SEC	SCRAP	DC	PC	TC	Contr.
QC08:									
WA_GA	0.81	0.11	0.07	0.00	0.00	0.11	0.25	1.36	0.14
WA_GB	0.91	0.09	0.00	0.00	0.00	0.10	0.18	1.28	0.22
WB_GA	0.81	0.14	0.02	0.00	0.03	0.14	0.26	1.40	0.10
WB_GB	0.87	0.11	0.01	0.00	0.01	0.12	0.22	1.34	0.16

- **Width \leq 1200 and Gauge $<$ 4.5 mm (WA_GA)**

With a prime yield of 81 % and scrap generation of 0 %, the contribution margin is high at 0.14 pu.

- **Width \leq 1200 and 4.5mm \leq Gauge $<$ 10 mm (WA_GB)**

With a prime yield of 91 % it is understandable why the contribution margins is 0.22 pu. This is a good product to produce and marketing should do all in their power to promote demand for this product.

- **1200 $<$ Width $<$ 2000 and Gauge $<$ 4.5 mm (WB_GA)**

Although the prime yield is high at 81 %, the scrap generation is disappointing at 3 %. For this reason the contribution margin is only 0.10 pu. This contribution margin is not exceptionally good but has the potential to contribute substantially to company profitability.

- **1200 < Width < 2000 and 4.5mm ≤ Gauge < 10 mm (WB_GB)**

Due to a very good prime yield of 87% and a low scrap generation of 1%, the contribution margin is good at 0.14 pu.

- **UQ08 performance overview**

The product quality contributes to 5.14 % of the total annual coil production. When considering the contribution margin on the different product categories within this product quality it is important to note that all of them are high. This product therefore contributes substantially towards the profitability of the company.

3.4. Statistical analysis of contributions to profitability

From the analysis above, it is clear that the different products do indeed have different contribution margins. Four products were identified with contribution margins of less than -0.20 pu. These products should not be produced and eliminated from the product mix offered by Highveld Steel. Nine products were identified with contribution margins above 0.20 pu. These products play an important role in rendering Highveld Steel profitable. The marketing department should do everything in their power to promote the demand for these products.

To dig up a feeling for the overall performance of the strip mill regarding its product mix, it is important to evaluate the distribution of products in relation to contribution margin. From figure 3.4.1. it is important to note that most of the products produced have a positive contribution margin.

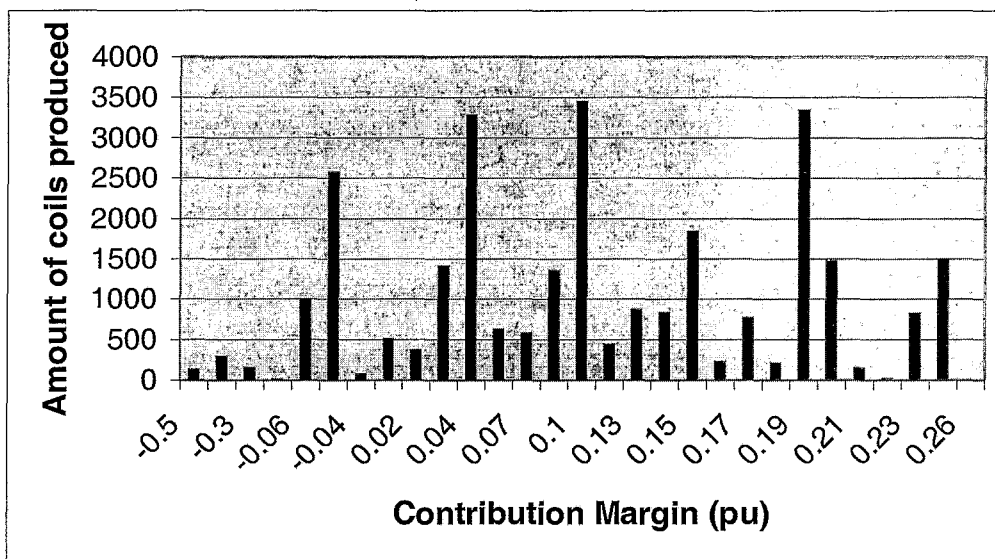


Figure 3.4.1. *Product mix contribution margin distribution.*

To make the information easier to interpret, the product mix will be split into five distinct product categories. These categories will be defined as follows:

- Category A** : Contribution margin ≥ 0.15 pu
- Category B** : 0.07 pu \leq Contribution margin < 0.15 pu
- Category C** : 0.0 pu \leq Contribution margin < 0.07 pu
- Category D** : -0.05 pu \leq Contribution margin < 0.0 pu
- Category E** : Contribution margin ≤ -0.05 pu

The percentage distribution of the product mix can then be summarised as:

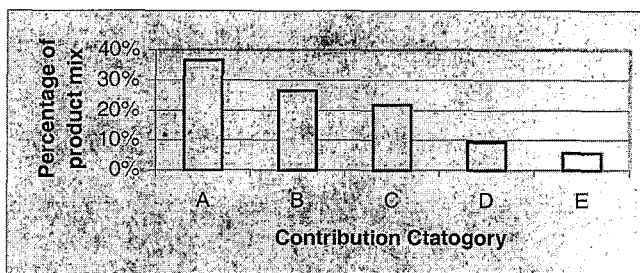


Figure 3.4.2: *Product Mix distribution according to category.*

From figure 3.4.2 the conclusion can be drawn that the largest percentage of products produced are those with higher contribution margins. This is a positive characteristic of the product mix and contributes well to the profitability of the company.

It is a concern to see that Category D and E products do form a substantial part of the product mix. These are the products that should not be produced except if a suitable price premium is charged on their production. In essence, the information above leads to the conclusion that 15,08% of the total coil production have the net effect of eroding company profitability. Not only do these products not lead to company profits but they erode the profit generated by other more profitable product categories.

3.5. Summary

After applying the model furnished above, it was clear that certain product categories produced by the strip mill erodes company profitability. This is clearly not conducive to ensuring operating efficiencies and proves that the product diversity strategy as presently applied at the strip mill needs serious re-consideration and improvements in order to effectively contribute to company profitability.

A clear distinction was made between product categories that contribute to company profitability and those that have negative contribution margins. This also enables the strip mill to estimate the opportunity costs incurred depending on the product produced.

CHAPTER 4

CONCLUSION & RECOMMENDATION

4.1. Introduction

With the contribution margin known for the different product categories, it is now possible to identify the sources of producing inefficiencies. From the previous chapter, it was clear that not all products contribute positively towards company profitability and that some product lines should be eliminated if strip mill's production is to be optimised effectively to furnish good returns.

From the results it is clear that the product diversity strategy is not effective because it allows for the production of products with contribution margins as low as -0.5 pu. From this it is clear that the product diversity strategy should be re-designed to include rules for the acceptance of product orders. Complicating the furnishing of these rules is the intricate complexities of customer relations that must not be influenced negatively, as far as possible. Good communication is an essential (Kichen, 1999:254) in ensuring that customers know that it is not financial viable for Highveld to produce certain products and that these product lines should either be discontinued or a price premium charged.

4.2 Conclusion

It is essential that high volume production companies focus on producing products that furnishes the best returns, thus effectively pushing for operating efficiencies (Tetzeli, 1993:1). It is important to understand that production capacity, in an environment of capital-intensive equipment, is limited and the optimisation of the usage of equipment is for this reason of utmost importance. The strip mill at Highveld Steel is one example of

one of these environments. To illustrate, let's assume that the mill can produce on average 1,400 tons of coiled products in 24 hrs.

Production time lost cannot be recovered, and this is especially important when considering the time value of money (Dury, 2001:246) and also that the costs involved with the production process in capital intensive processes is more dependent on processing time occupied than on output produced. When producing products with lower contribution margins, the annual return on investment of the mill will be limited due to operating inefficiencies. It is therefore, important to ensure that the limited production capacity is used effectively to produce products with the highest returns rather than wasting capacity on low return products.

When producing products with low returns, it is important to understand that there is a large opportunity cost (Drury, 2001:87) involved in producing these. For example, let's assume that two products A and B can be produced at a certain production facility. The return on product A is R100 and on product B it is R200. The company under consideration can produce 10 units per day of either products A or B or both. For each one of product A that is produced the company takes up its capacity to produce one single unit. It is true that product A does have a positive contribution margin, but its contribution margin is only half that of product B. The cost to produce product A does therefore also include the opportunity cost of producing product B rather than A that can furnish a further R100 contribution. Therefore by producing product A the financial benefits derived from producing product B are foregone or sacrificed, thus rendering an opportunity cost of R100 for every one unit of product A produced. If this is taken into account then it will be a bad strategic decision to produce any units of product A. If the contribution margin on the product produced is negative then it will be even more fatal to produce.

The problem with Highveld Steel's strip mill is that the order books are not always full enough to ensure that all the available production capacity of the strip mill is fully occupied. For this reason orders are generally accepted even if the products ordered are

difficult to produce. In chapter 3 it was proven beyond doubt that the strip mill produces some products that have negative contribution margins. These products were classified as product categories D and E and comprises of 15.08% of the total annual production of coiled products.

When weighting the contribution margins and production volume of these products the average contribution margin of these products (Category D and E) is -0.10 pu. It can therefore be concluded that on 15% of Highveld's production of coiled products it makes a loss of 0.10 pu, before fixed costs are assigned. The production of these products therefore decreases Highveld's coiled product's bottom line with 1,47 %. When calculating the average contribution of the total product mix (Category A-E) of the strip mill at Highveld steel, it amounts to 0.0906 pu. The total contribution of this product mix per annum therefore amounts to 10,390 pu when considering that 114,628 tons of coiled product is produced on average per annum.

If Highveld remove the products from categories D and E from its product catalogue then assuming that no orders are received to fill the freed production capacity, then the average contribution margin on the product mix will increase to 0.1243 pu. The total annual production will decrease with 15% to only 97,336 tons. The total contribution of the strip mill will then be 12,095 pu. A net increase in divisional contribution of 14% will therefore be furnished in this scenario.

Note that from the above it is clear that even though the total annual production volume is decreased the annual divisional contribution is increased. This proves the fatality of producing products with negative contribution margins. Not only do these products not furnish any profit, but they also increase the amount of profit that needs to be generated by the rest of the product mix in order to furnish reasonable divisional contribution.

If the marketing department is able to increase the demand for the more profitable products then the freed production capacity can be made up and the annual production of 114,628 tons can be produced at a contribution margin of 0.1243 pu. The total

contribution of the strip mill will then be 14,244 pu. The divisional contribution will under this scenario increase by 37 %.

From the above scenarios (Ungerer, Pretorius & Herholdt, 2002:57) it is clear that there is room for improvement in the strategic operation of the strip mill with the bulk of opportunity lying in concentrating on the production of products that is rolled well by the mill and the elimination of production runs of products not effectively produced by the mill. All of this boils down to the application of sound operating efficiency principles.

4.3. Recommendation

Again it is important to stress that the discontinuation of certain less profitable products will result in the loss of orders for more profitable products. Marketing should therefore work hard in trying to eliminate the orders on less profitable products without losing orders for more profitable products. Marketing should also promote the demand for more profitable products. To be able to make the correct strategic decisions it is important to furnish a model on when to accept and when to reject an order, when and how to charge an additional price premium on a product and when to promote product demand by means of financially viable product rebates.

When new orders are received it is normally received as a combination of different products. Using the information furnished in chapter 3 it is possible to predict the average contribution margin of any single order.

4.3.1. Order acceptance model

The normal procedure for ordering coil products is that customers approach Highveld Steel with a product inquiry on a range of different products and then receives back a reply on the product price and delivery date. It is therefore possible for Highveld to beforehand predict what products are going to be ordered and also in what quantity.

It will therefore be possible to calculate the average contribution value of each order weighted to the total volume ordered for each product. To keep the model easy to apply the price charged on all products should be the same when calculating the contribution margin. After the total contribution margin is calculated it can be decided whether the order will be financially viable or not.

In time periods characterised by a slow domestic economy any order received with a positive average contribution margin should be accepted without any investigation. This is because of the fact that any sale with a contribution margin that is positive will positively contribute towards company profitability (Drury, 2001:53). This principle should only be applied in times when coil demand is low and not when two different orders should be weighted up against each other, as is the case in high demand periods.

When the average order contribution margin is negative the year to date orders of the customer should be evaluated. In this case the average contribution margin on year to date (Last twelve months) customer orders received on the specific customer should be calculated, including the most recent product order inquiry. If the average contribution margin on the year to date orders is above 0.10 pu then the order should be accepted. If below 0.10 pu then it is important to assess the year to date contribution of the customer orders. If it is above 5 % of the total annual coil product return then the order should be accepted.

If none of the above requirements is satisfied then the low contribution margin products within the product order inquiry should be identified and the order must only be accepted with a price premium charged on these products with the size of the premium calculated to furnish a 0.10 pu order contribution margin. It should be explained to the customer that the bulk of products ordered by him is not profitable for Highveld Steel to produce and that Highveld must lift some form of premium on its price in order to be able to produce the products ordered.

It is also important that customers should be evaluated to determine their profitability and unprofitable customers should be clearly identified (Brown, 2000:132). If unprofitable customers are not satisfied with the price premium then they can take their unprofitable business to someone else. This may sound like turning away demand, but turning away unprofitable business is never foolish to do. It is like trying to buy a one dollar bill for two dollars.

In low demand periods the model above can be applied to strategically accept customer orders. In high demand periods different product orders received must be weighted up against each other and the most profitable ones accepted.

It is furthermore important for marketing to stimulate the demand for more profitable products. This can be done by offering certain products at a price rebate provided that certain conditions are met. Lets say for instance that a product order inquiry is received that adheres to the acceptance criteria stated above. Marketing should then accept the order, but it should also analyse the order further to identify products with high contribution margins that is ordered within the product inquiry. These products are the category A products. With the product order acceptance reply an additional offer can be submitted that states that if the customer double its order quantity on any one of these category A products he will receive a 5 % rebate on the price of that specific product.

Together with this a global rebate can be offered of 2.5 % on all products in category A. This should stimulate orders on the more profitable products.

It is important to understand that the demand for steel is of an inherent cyclic nature. The demand for steel is primarily determined by the strength of the domestic economy. When interest rates are low the domestic economy is in a state of growth and new projects are stimulated. Most of these projects needs steel for construction purposes and as a result the demand for coil steel products are also stimulated.

The exact economic state of the domestic economy cannot be accurately predicted for the future and therefore also not the steel demand. It is for this reason important that Highveld Steel utilise the model developed above to continuously monitor the contribution margin on coil products and then make marketing-, production- and other strategic decisions based on the model's outcome. Underlying these decisions should be that the production of the products with higher contribution margins should be maximised and the production of the less profitable products minimised as far as the market would allow.

It is also important in this regard to state that as the demand for steel products increase the price on steel products also increase, adhering to the supply-demand principles dictated by macro- and micro economic forces. (Smith, Dams, Mostert, Oosthuizen, Van Der Vyver & Van Gass, 1997:102) Product ranges that were deemed as unprofitable in this report may then indeed become profitable by resulting in positive contribution margins. The purpose of this report was therefore not to put hard- and fast rules on the table on what products to produce and what not, but rather to furnish a model on how to evaluate the real profitability of a certain product during a specific prevailing economic climate.

It should however be stressed that the sequence of relative product profitability as identified in this report will stay the same regardless of the economic climate. In other words category E products will not at any time in the future become category A products, but it might be possible that steel demand may foster positive contribution margins on both category A and E products. There will however always be the opportunity costs involved in producing products in category D and E rather than A-C and this should be carefully considered when deciding on which orders to accept and which to reject during high demand periods.

It is recommended that due to the unstable nature of the steel demand, the marketing criteria for accepting orders should be re-evaluated and re-designed on a monthly basis. This will ensure a good fit between strategic decisions and the market characteristics. It

is worth mentioning at this point in time that responsiveness of companies directly determined by flexibility, is a very important factor in determining a company's competitive stance in the global industry. It will for this reason not make strategic sense for Highveld to only rely on its product diversity strategy without taking into account the actual product contributions together with the market demand characteristics at any point in time.

4.4. Future Studies

The scope of this report only covered coiled products at Highveld Steel. The same principles developed in this report can be applied to evaluate the profitability of other products of Highveld Steel. These products include billets, blooms, structurals, plates, vanadium products and Ferro-alloys.

This report proved that not all products produced could necessarily be deemed as profitable and that it is important to identify lower earning products as well as products with negative contribution margins. It is also in this regard important that the model developed measure product profitability is applied by both marketing- and production management to furnish effective strategic decisions.

Only by applying the principles stated in this report would Highveld be able to ensure that sound operating efficiencies is put in place.

4.5. Summary

It was concluded that the product diversity strategy as presently applied by Highveld Steel is not effective in ensuring good operating efficiencies. This was established by noting that 15% of products produced by the strip mill is produced at contribution margins of below 0 pu. This despite of the fact that some of the other products produced furnishes contribution margins in excess of 0.20 pu.

Recommendations was made on how to improve this with the main emphasis on eliminating lower return products and fill the capacity by promoting higher return products. This can only be done with due regards to customer relations. It was also emphasised that the nature of market that Highveld is operating in, is characterised by its maturity as well as huge demand fluctuations.

It was further recommended that the model derived in this report is used to constantly re-evaluate and re-design the rules forming the basis of the product diversity strategy for coiled products produced at the strip mill. It was furthermore recommended that Highveld Steel should utilise the principles applied in this study to evaluate its strategies regarding other products produced by the company.

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