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PRODUCTIVITY MEASUREMENT IN MANUFACTURING

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FIGURES

ABSTRACT

Productivity measurement modelling cannot be the province of the expert only. Lower levels of management, and production foremen in particular, must become actively involved in the process.

Active involvement embraces more than just a basic knowledge of the different measurement models available. It requires understanding of the concepts involved, so as to enable participation in the development of measures pertinent to the everchanging priorities in an own manufacturing situation. For productivity to be improved, applied measurement must first succeed on the factory floor.

This dissertation attempts to explore productivity measurement theory and lifting out those aspects which are important to manufacturing operations. The discussion of theory culminates in a list of criteria which can be applied to the development of any productivity measurement system. All the key concepts are demonstrated by way of example.

Having established a theoretical base, the criteria are then applied to the development of three productivity measurement systems for a specific food manufacturing company.

The measurement methods relate to the Total Productivity Measurement, Industrial Engineering and Performance Matrix concepts - each applied to different organizational levels within the company.

The intent is not prove or demonstrate any relationship between productivity improvement and the introduction of measurement. It is the study of productivity measurement per se, which is at issue. Since introducing measurement however, there has been a noticable improvement in the effectiveness of certain sections within the organization. This matter is commented on.

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PART 1

The theory of productivity measurement as it would apply in a manufacturing environment.

CHAPTER 1

INTRODUCTION

1.1 OBJECTIVES

The productivity concept is something everybody understands. It is also something which many find difficult to measure and apply. Productivity proper, as theoretically defined, is a most difficult measure to apply in practice.

To overcome some of these difficulties, a multitude of performance measures can be introduced which are relatively simple to apply. On the strength of the results so obtained, certain assumptions can be made regarding productivity in the organization.

To improve productivity requires commitment from those seeking to benefit by it. Commitment can be achieved by understanding the dynamic character of productivity measurement. This understanding requires a knowledge of the basic measurement principles involved, the different techniques of measurement and some knowledge of the organization for which a system is to be developed.

The objective of this dissertation is twofold. Firstly, to present the theoretical basis for productivity measurement, the aim being to improve the operational manager's understanding of the productivity concept and its implementation. Secondly, to develop a productivity measurement framework for a food processing company.

1.2 STRUCTURE OF THE DISSERTATION

The dissertation is composed of two parts. Part one relates to the theory of productivity measurement. The aim as mentioned, is to establish a theoretical framework on which specific measurement models can be built. In part two, three measurement systems are developed for application in the target company.

In part one, chapter 2, the productivity concept, with specific reference to efficiency and effectiveness, is discussed. A concept, referred to as money-valued efficiency, is also introduced to be later applied in one of the measurement models in part two of the dissertation.

In chapter 3, under the heading of the productivity measurement concept, various issues are raised. One of these issues relates to the importance of the operational definition in a measurement situation. In the latter part of this chapter a distinction is drawn between various selected theoretical measurement models, which may possibly be of use in an industrial company.

Chapter 4 is dedicated to scaling. In the first half, the theoretical nature and principles for developing measurement scales are investigated. Thereafter constraints, as applicable to productivity measurement scaling, are highlighted and include the use of equivalents.

Chapter 5 is titled: "Principles of Productivity Measurement". The content essentially relates systems design to the concepts "output" and "input" with an in-depth discussion as to how these entities should be constituted. Special attention is given to the methods applied in calculating capital input.

Chapter 6 is in effect an introduction to part two of the dissertation. Although the discussion is based on the criteria which guide the choice of measurement models, the emphasis is on providing a practical method to prepare for measurement; i.e., when confronted by a situation where a measurement system has to be designed, how should the challenge be met ?

In chapter 7, the beginning of part two, a measurement model is developed and applied to the target company on the level of the total company. Data obtained from the company's financial statements is utilized for this purpose. Various pitfalls encountered during the system's development phase are also itemized and discussed.

In chapter 8 a measurement method is applied to lower levels of organizational aggregation. A specific work station in the target company is selected to illustrate the measurement method utilized.

In chapter 9 the system developed in the previous chapter is expanded to include measurement on a higher level of organizational aggregation. In the target company, section level (one level higher than the work station) measurement is seen as the key element to productivity improvement in the company. It is therefore important to develop a combined indicator of productivity in the various sections. This issue is addressed here.

Chapter 10 concludes the dissertation with comment regarding difficulties and successes experienced during the different development phases. Where applicable, recommendations have been made to improve the various systems and their application.

1.3 SCOPE AND LIMITATION OF THIS DOCUMENT

Although the theory contained in part one of the dissertation would be helpful to anyone wishing to apply measurement in an industrial setting, it is so structured as to fit the perceived needs of managers in the target company.

Notwithstanding frequent reference to "organizational levels" in the dissertation, measurement is applied to the so-called "unit of analysis". Each unit constitutes a system or "measurement packet". The measurement principles which guide systems development on each particular level in the organization tend to be similar - the only difference being the content. Therefore, where there are numerous similar units of analysis such as work stations, it is deemed sufficient to illustrate each method by way of one practical example only - as is done in part two of the dissertation. To do otherwise would only introduce new sets of data, without adding anything to the knowledge.

The development of the measurement system is ongoing and ever changing in content. Principle therefore, is the important issue. The rest is logic.

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CHAPTER 2

THE PRODUCTIVITY CONCEPT

2.1 INTRODUCTION

The central theme of economic science is the allocation of scarce resources. Economic principle dictates that man is in a continuous search for ways to obtain the greatest possible satisfaction of his needs with limited resources. To understand the productivity concept is to accept this principle.

The basic productivity concept is defined as "..the relationship of outputs to inputs". And that is all it is. Measuring productivity is not limited to the output/input ratio. In fact, various constraints may prohibit meaningful measurement using this format. The alternative is to measure identified factors which regulate output and/or input, and then to make assumptions as to their possible effect on the productivity ratio. "Constraints" refer to practical limitations in the measurement of the different variables in the productivity equation.

2.2 THE PRODUCTION PROBLEM

The productivity concept finds practical reason in production. Production is defined as " any process which converts or transforms a commodity or commodities into a different commodity" [Lancaster p. 59]. It is not only the making of physical things, but their transport, storage and selling, as well as the rendering of services.

All these activities lead to "added economic value" of commodities for which somebody in the system has to pay. A business undertaking therefore takes cognisance of the economic value issues, as part of the productivity measurement problem. To do this, assuming a given type and quantity of output, productivity can for instance be improved by utilizing less of any one physical input without increasing any other physical input. I.e., technical efficiency is improved. Or productivity may be improved by using less of one physical input and more, but not relatively more, of another physical input. This relativity is determined by attaching economic value to the various inputs. Technical efficiency is therefore not the only issue. Unit price and hence related total cost will dictate which input is more efficient.

Traditional productivity measurement methods concentrate on the efficient and effective utilization of resources [Sumanth p. 31] - which in a sense encompass both the quantitative and qualitative aspects demonstrated above. Given a strategic (and systems development) emphasis however, productivity measurement should be concerned with more than a static measure of resource input in relation to output. The factors which influence and direct efficiency and effectiveness should also be considered for measurement. How to measure these factors and relate their influence directly on productivity is a problem. Chapter 4 addresses this issue.

Firstly, in this chapter, the meanings of efficiency and effectiveness, as basic indicators of productivity are discussed.

2.3 TECHNICAL EFFICIENCY AND PRODUCTIVITY

An objective of production is to meet the demands of the market at the lowest possible cost. This can be interpreted to mean that all things being equal, production must endeavour to achieve a given physical output with the lowest possible physical input [Radel pp. 2-4]. The efficiency concept being input related, this in effect means improving the degree of technical efficiency with which resources are consumed.

Whereas productivity is defined as the ratio of output to input, <u>technical efficiency</u> is defined as a ratio between the expected consumption level of a physical resource(s), and the actual physical resource(s) consumed. To illustrate the difference between the concepts: if on a single resource input, the expected consumption is 5 physical units, and the actual consumption is also 5 units, then the state of efficiency is 1. If output in the productivity ratio is 5 units, then productivity is rated as 1. A state of inefficiency will exist if, on input, consumption increases to say 7 units. Assuming no increase in output, productivity is now rated 5/7 = 0.7. As efficiency decreases, so does productivity.

If production tons output is measured in terms of man-day input in a process where other resources are also involved (as there are bound to be), the measure being considered, is that of the productivity of labour. It is not a measure of the technical efficiency with which labour itself is being utilized, since the output is not the sole result of the labour input (see causality in chapter 3). Output is also influenced by other factors not related to the labour input. At best, the productivity ratio result will only be an indicator of the technical efficiency with which labour is applied.

2.4 MONEY-VALUED EFFICIENCY AND PRODUCTIVITY

In our economic system, production is organized within undertakings which compete in the market. An undertaking's objective in the long run is to optimize profits [Radel p. 4]. From an input perspective, this means controlling total cost.

The production unit will endeavour to realise the given physical output at the lowest possible total cost, whilst maintaining quality standards. Price (cost) implies a wider definition of efficiency. (It also implies that there are at least two operational definitions for the productivity concept).

Money-valued efficiency can be defined as a ratio between the intended total cost of a resource and the actual total cost incurred.

Suboptimization in the use of resources (technical efficiency) may result because of price considerations. To illustrate the principles involved: In figure 2.1, output can be defined as quantity x unit price, say 12 tons x R200 = R2400, and input as quantity x unit price, say 12 tons x R60 = R720. The productivity rating on the technical approach is 12/12 = 1. On the money-valued approach, productivity is rated R2400/R720 = 3.3. Assume that the unit price of the input decreases to R30. Technical efficiency will remain the same, but money-valued efficiency will improve (R720/R360) by 100%. If the money valued scale is accepted, the productivity will also inprove by 100%.

Difficulties with the money-valued approach are that if the different variables (quantity and unit price) are not separated at data source, it is difficult to determine the cause of a change in productivity of the money-valued kind.

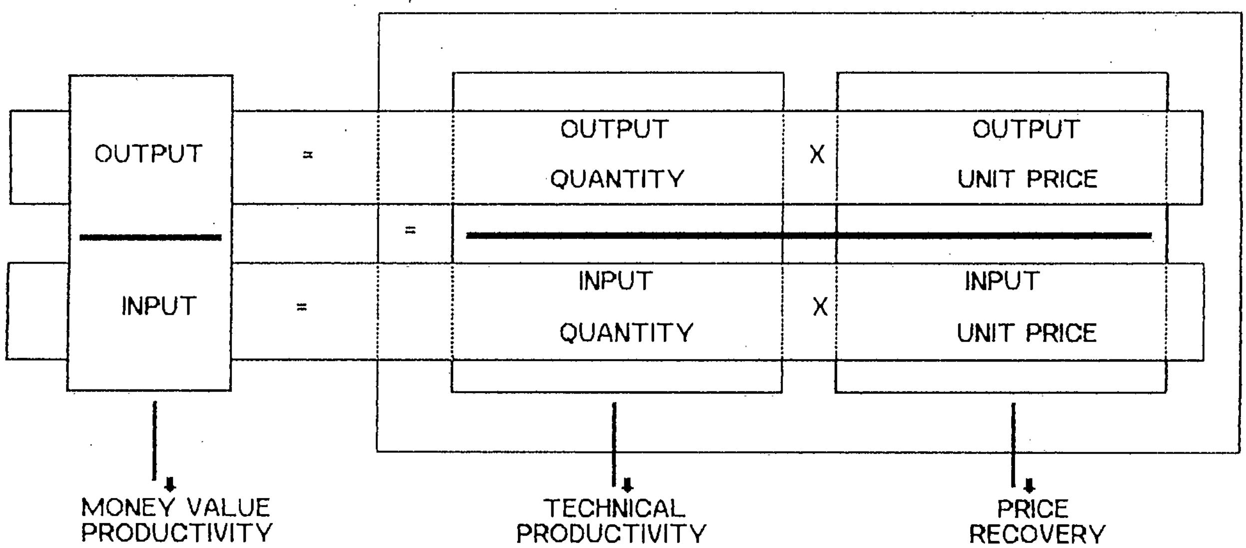

Figure 2.1: Classifying Technical Efficiency and Money-valued Efficiency in the Productivity Equation.

With the single labour resource example used in para 2.3, the productivity of labour, i.e., tons output/(man-days x unit price), now becomes a measure (indicator) of the degree of money-valued efficiency with which labour is applied.

The professed benefit of making use of the money-valued efficiency and productivity concepts is that productivity can be directly related to profit in an undertaking, as does the Total Productivity Measurement Model of the American Productivity Center (REALST MODEL). [Mason pp. 14-16]. Refer to figure 2.2 which is self-explanatory.

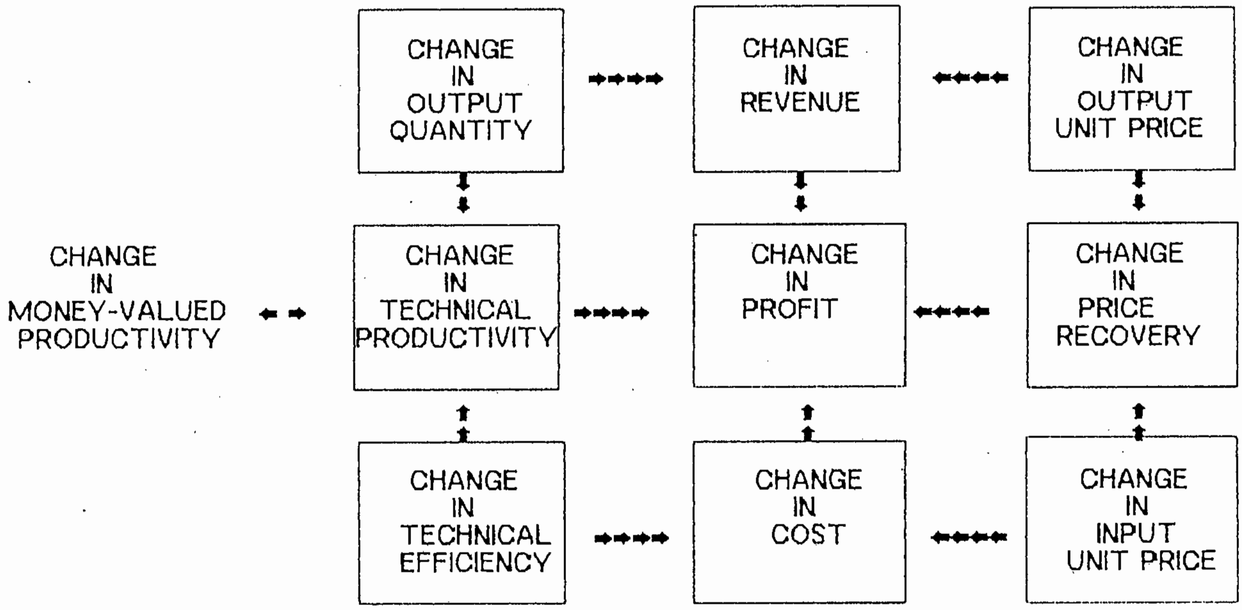

Figure 2.2: Money-Valued Productivity and Profit (REALST MODEL). Adapted from Parsons J., Productivity Profits and Prices. National Productivity Institute, Pretoria, 1984, p. 6.

2.5 EFFECTIVENESS AND PRODUCTIVITY

In theory, an undertaking will negotiate lowest unit cost prices for the different resource inputs, assuming acceptable quality. If not done, potential technical efficiency gains would be squandered only to the benefit of the supplier. In the same vein, the undertaking will not necessarily pass on technical efficiency gains to the customer in the form of lower selling prices. Convincing the customer to pay more (and thus add more value to the undertaking's profits) can be an indication of the effectiveness with which an undertaking conducts its business. This in turn is an indication of productivity in a subjective sort of way.

It is stated that effectiveness as an indicator of productivity is output orientated, as described above. But, there seems to be no universal agreement to what the term effectiveness means in either a theoretical or a practical sense. How it is defined, reflects adherence to one of two general approaches, namely the goal approach and the systems approach [Gibson p. 35].

The goal approach is akin to the method of management by objectives. The degree of accomplishment indicates the degree of effectiveness. Not only is output an entity to be measured, so too is input. Any other factor which is thought to indirectly influence productivity may also be isolated and targeted for effectiveness measurement. In each case, the level of performance to be accomplished will depend on the perception that the people setting the objectives have of the factor's impact on productivity - without their really knowing the magnitude of the influence.

Within the context of the goal approach, there are basically two criteria by which effectiveness can be measured. These criteria refer specifically to the variables contained in a productivity ratio;

1. <u>Production</u>: can be either quantitative or qualitative output. It includes performance measures such as units produced, rand sales, clients visited, and so forth (compared to a target of course !).

2. Efficiency: Input measurement relating to either time, physical quantities or monetary value. Example: output expected to be delivered per hour divided by actual output delivered per hour - say for a machine where output translates into input, etc. Different writers attach the same meaning to the efficiency and productivity concepts. Productivity as explained, differs from efficiency. An effectiveness measure of productivity can include a string of ratios such as units produced/labour hours utilized, km/litres of fuel, etc.

In contrast to the goal approach, the systems approach centres on people's behaviour (be it an individual worker, manager or group) as being the motivating factor to effectiveness. To cite an example: The "inputs" of behaviour are "causes" that arise from the work-place. The cause can be a directive from a manager to a worker, or group of workers, to perform a certain task. The input is then acted upon by the individual's (or group's) mental and psychological processes to produce a certain outcome. The outcome preferred is compliance with the directive, but depending on the state of the individual's processes, the outcome could be non-compliance.

The goal and systems approach differ in the sense that the former is concerned with intangible (and sometimes undefined) factors which influence the attainment of a goal.

Three criteria are cited against which effectiveness (of intangibles) can be measured;

1. Satisfaction: The degree of success in meeting the psychological needs of stakeholders in the organization, be they employees, customers, suppliers or shareholders. Only those "satisfaction factors" which promote productivity or efficiency are of interest. Quality of work life is an example of a "satisfaction" factor.
2. Adaptiveness: The extent to which the organization can and does respond to internal and external changes. An unacceptable level of work stoppages on a production line may indicate an inability of the firm to adapt.
5. Development: The ability of the organization to increase its capacity to deal with environmental demands. Training is an example.

Effectiveness as a concept, stands apart from the efficiency concept. For practical measurement purposes, the attainment of an effectiveness level should be based on (stated) expected targets. The absence of objectives would mean that effectiveness cannot be measured.

2.6 CONCLUSION

Productivity is not a measure of either efficiency or effectiveness, but rather the result of both. Productivity as a measure, can be seen to indicate a state of efficiency and/or effectiveness - just as the efficiency and/or effectiveness measure can be seen to indicate a state of productivity. As will be seen in chapter 3, this is also true for the measurement of any other factor which has either a direct or an indirect influence on the productivity ratio.

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CHAPTER 3

THE PRODUCTIVITY MEASUREMENT CONCEPT

3.1 INTRODUCTION

Contemporary writers on industrial productivity measurement are moving away from the traditional notion that productivity is to be expressed only in terms of either technical efficiency, or the physical output over physical input ratio. This development derives, in the first instance, from the difficulties being experienced in bringing together a reliable data base on a consistent basis, for comparatative measurement. Secondly, as productivity measurement moves out of the manufacturing environment, other factor relationships (involving mainly intangibles) are being evolved which have proved to affect overall business performance. The emphasis is quite clearly toward the measurement of so-called productivity indicators or key productivity factors.

Ideally, a productivity measure should present a single quantitative result, indicating either a deterioration or an improvement in productivity. To achieve this, different factor scales have to be combined into one common measure.

To evaluate the risks involved in developing a measurement system requires an understanding of current productivity measurement trends and the concept of scaling. Trends are discussed in this chapter and scaling in chapter 4.

3.2 CAUSALITY AND PRODUCTIVITY MEASUREMENT

It is common practice to measure productivity performance in terms of some resource or other. Inevitably, the question is raised as to how much causal relationship there is between the resource (input) in question and output, and between resources and other societal variables. There is obviously interaction. Mills [p. 503] makes the point: "In general....it is most useful to measure output with reference to the input of human effort (or any other resource)... But we must recognise that the effectiveness of this effort varies not only with the intensity and skill of the human factor, but also with the number, quality of tools employed, the amount of power utilized, the nature of the productive organization, and other features of the productive process." He conludes: "Causality may be shared in many ways not necessarily observable from productivity ratios."

Illustrated above is a basic feature of the productivity (partial) ratio. The measured change of the ratio does not necessarily represent an improvement in efficiency of the specific resource. The change is a function of the combined effect of many factors. It is therefore advisable to obtain a "total" measure which includes all input quantities combined into a single denominator. If then, an increase (or decrease) of one input impacts negatively (or positively) on any other variable in the equation, this will be balanced out in the single indicator result.

3.3 PARTIAL AND TOTAL MEASUREMENT

The productivity of a single resource is referred to as a Partial Productivity Measurement. If by estimation, all the so-called production factors (labour, capital, materials and intermediate resources) are included in the measure (relative to an output), it is traditionally called Total Productivity Measurement. This terminology is somewhat ambiguous. Not all possible inputs and outputs can ever be represented in the productivity equation. It is only "total" in terms of a specific operational definition (see below). A more suitable term to describe the "total" concept is multi-factor measurement, with the operational definition describing just how inclusive the concept is.

The productivity measure is a relative concept in terms of the output/input ratio. Productivity cannot be taken to mean an absolute quantity. It is a meaningless measure if the result is not compared with the productivity performance of either: (1) a comparable period or, (2) another comparable production unit or, (3) with a scientifically determined standard.

There are, as mentioned, also other indicator measures of productivity - commonly called "surrogate" measures. Any factor having an influence on productivity may be measured. Examples of such factors are sales levels, be they physical quantities or total monetary sales value. Or it may be the level of absenteeism. Or the hygiene in a factory. There are many considered factors. All these "loose" factors can be combined into a performance matrix in which is derived a single dimensionless number as measure of performance or "total indicator of productivity". A practical example utilizing this method of measurement is illustrated in chapter 9.

3.4 OPERATIONAL DEFINITIONS

3.4.1 Classification of Variables

Distinguishing between the theoretical definition of the productivity concept presented, and the operational definition required, is not always emphasized in literature. The latter has to be developed, and will differ in scope, content and construction in each particular measurement situation [Lundberg pp. 58-63]. In practice productivity measurement is built on the operational concept.

Normally the theoretical definition of productivity is presented in terms of other concepts which are supposedly already understood - such as "output" and "input". Both these concepts may have many meanings, depending on the perspective, which will include such considerations as the availability of data, purpose of the measure and even the audience. The practical difficulties of productivity measurement system design, as it relates to the operational definition, revolve around three decidable issues:

1. Identification: of the variables which constitute output and input. For example, an operational definition for output could be based on physical product units sold, together with utilities embodied in the sale, a utility being something such as "service level". To sensibly analyse the results of such a combined concept, requires a precise definition of the class of product. For the qualitative variable, a detailed description or instruction for collecting and recording data is necessary.

   Although the above is a somewhat exaggerated example of an operational definition for "output", the process is not much easier when only quantitative variables on recognised scales (tons, man-days, etc.) are involved. To overcome the difficulties of scale combination, use is made of a common denominating scale such as a monetary value scale (see below).

2. Scaling: All the identified variables have to be scored, each on a different scale.

3. Combining: The results obtained on each scale then have to be combined on a single scale if the intention is to present an integrated output measure.

The same principles would also apply in the case of input.

3.4.2 Ambiguities

3.4.2.1 Reliability

An operational definition can be considered to be a detailed set of instructions on how to classify the primary variables (outputs and inputs) unambiguously. This statement has two meanings. For a quantitative variable it means selecting data categories. What for example is meant by "units sold" - cash sales and/or credit sales ? For a qualitative variable it means developing a new scale of measurement and tying in value readings (see chapter 4). There may be several operational definitions (different rating forms), which have equal status, and are being used, but with no agreement as to preference. Each one may be valid in its own right, but uncompatible for comparison. Whatever the case, each procedure must be sufficiently precise, so that any other person using it can achieve the same results. It makes for a reliable measure.

3.4.2.2 Validity

When defining data into an operational format, the risk exists that theoretical concept validity may be destroyed. A question always arises as to whether an operational definition presented, really measures that which was intended by the theoretical definition. It is argued [Northrop pp. 85-88] that there is ultimately no method of associating the two kinds of definitions other than by convention or common agreement. The perceived confusion that surrounds productivity measurement is a case in point. For example, who is to say that the money-valued productivity concept, as explained within the context of activities conducted by a business undertaking (chapter 2), is not valid ? There are most certainly many economists (macro-economics) who will frown on such interpretation. It is said that such practice is inflationary and to the detriment of living standards. From a macro-economic perspective it is certainly true, but not so from the vantage point of the single business undertaking. Society - i.e. the political and economic systems - should carry the responsibility for inflation. This is the developmental nature of productivity measurement.

3.5 APPROACHES TO PRODUCTIVITY MEASUREMENT

Different approaches, each with different models are presented in literature as guideline examples for measuring productivity in manufacturing undertakings. In consideration of the management task and the specific objective for which a measured result is to be used, certain approaches may be discarded as inappropriate. Even then, the models which remain, individually, cannot be presented as a definitive solution to the productivity measurement challenge in the business undertaking (and more specifically in manufacturing).

3.5.1 Measurement Models

How productivity should best be measured in manufacturing is still an open debate. The many measurement models developed over the years have obviously improved the situation, but at the same time, confused manufacturing management. The manufacturing company's dilemma stems, so it would seem, partly from an inability to discriminate between the different approaches available, and to extract that which is pertinent to its own situation. The different approaches with comment are presented in summarized form:

3.5.1.1 <u>The Index Approach</u>: also referred to as the "macro-economic-orientated" approach, is associated with economists using measurement conventions adopted at macro- economic level. This approach can also be considered to be "accounting system-orientated", in so far that it relies on existing financial accounting data as the basis for calculation. It utilizes the classical productivity ratio to measure productivity gains and losses. In all the models under this approach the so-called "constant monetary value rule" applies. This means that physical quantities for input and output variables are derived from monetary values reported on the financial statements. To do this, current monetary values normally have to be deflated.

Important models presented under this approach are those of:

a) Kendrick and Creamer who developed the concepts "Total Productivity", and "Partial Productivity". The measured result in this model (a few models actually) is derived from financial statement monetary values by way of base year constant unit pricing. The technical dimension of productivity is at issue. Except for intermediate inputs (see chapter 5) which are omitted from the model, the traditional resources (labour, capital and materials) are thus featured.

b) Craig and Harris who refined the concepts of output and input by including all cost-based inputs and exploiting the concept of equivalent monetary value. A comparison of ratio results over time is made by utilizing price indices to achieve constant monetary value in succeeding periods.

c) The American Productivity Center Model which makes use of unit monetary value on both the output and input side, which as an output/input ratio is separately defined as the so-called price recovery factor. This "factor" is attached to the technical productivity ratio which exhibits physical output/input quantities. From the combination of these two elements, technical productivity is related to profitability (see adapted REALST MODEL in chapter 2).

   Theoretically this is an ideal "total" measurement model. Unfortunately the results become less reliable and application more difficult as more input elements are included in the equation.

This approach is also supported by the National Productivity Institute of South Africa.
[refer Productivity SA, vol 14, no 1, Feb. 1988 & vol 13, no 3, June 1987]

d) <u>The Davis Model of Total Factor Productivity Measurement</u> which adjusts output in the standard ratio calculation to represent the so-called value-added principle.
This requires further explanation. In partial productivity measurement as per any of the index approach methods (which is monetary scale based - see above), it is considered necessary to adjust output. The total output value is adjusted downwards by the combined value of all those inputs not featured in the partial measurement.
The principal argument is that total income (output) of an undertaking (or of a commodity, department etc.) is a function of the total cost (inputs) plus mark-up. That is, the cost of materials, labour, allocated capital depreciation, overhead and profit are taken into account.
The concept is illustrated in table 3.1:

Assume that the output and input values for two periods are as indicated. In period 2 the cost price of the raw material, drops from R100/ton to R50/ton. The total output value in period 2 is affected by this decrease in input - because it is assumed that the mark-up (or profit) will be maintained whilst lowering selling prices. All other input costs remain the same in period 1.

Although labour is still delivering the same output in physical terms, the monetory scale indicates a substantial decline in labour productivity. Subtracting the two raw material values from the respective total values, R23800 changes to R3800, and R13800 to R3800.

		PERIOD 1	PERIOD 2
		TOTAL VALUE (CURRENT PRICES)	TOTAL VALUE (CURRENT PRICES)
INPUT:	Raw Materials	R20000	R10000
	Labour	R 800	R 800
	Depreciation + Overheads	R 1000	R 1000
	Mark-Up	R 2000	R 2000
OUTPUT:	Income	R23800	*R13800
PARTIAL PRODUCTIVITY RATIO (LABOUR); UNADJUSTED OUTPUT VALUE		23800/800 = 30	13800/800 = 17
PARTIAL PRODUCTIVITY RATIO (LABOUR); ADJUSTED OUTPUT VALUE		3800/800 = 5	3800/800 = 5

*Due to reduction in unit selling prices

Table 3.1 : Value Added Concept applied to Partial Productivity Measurement

On recalculating labour productivity with the adjusted monetary figures, the ratios now reflect the figure 38 instead of 238 for the first period, and 38 instead of 138 for the second period. This is more representative of the actual facts.

Had the change in raw materials gone to profit (as it is bound to), then subtracting this from output, will serve no purpose for measuring partial productivity. As such the value-added concept is rather outdated for application in a micro-economic or industrial setting.

The value-added concept should not be confused with causality. Its application does not cancel the effects on productivity of other factors, already gained or lost.

e) Sumanth presents a model emphasizing the product as a unit of analysis (as opposed to the production process in the other models). He directly relates the separate partial productivities which are relatively easy to determine, to the total productivity measurement.

A noticeable difficulty with all these index models is the different definitions which are given to capital input. There seems to be no agreement on how this should be measured. Neither does any of the models present any credible argument as to what the capital input format should be (see chapter 5 for methods to calculate capital input).

The word "index approach" should not be confused with the concept of indexing. Other approaches may, and do, make use of the indexing concept.

3.5.1.2 The Utility Approach: This approach supports the "performance indicators" or "surrogate measures" concept. Measures vary from being a single operational ratio through to a combination of ratios combined in the so-called Objectives Matrix Model [Riggs & Felix pp. 82-92].

The pretext for using this approach is that management assumes "to know" which factors are important to productivity improvement. With this approach the "cause" rather than the "effect" for productivity movement, as perceived by management, is addressed (see chapter 9).

3.5.1.3 <u>The Industrial Engineering Approach</u>: In this approach time study data is used to determine a measure for output. Terms such as work study and work content are synonymous with this approach. Although there is one example [Greenberg p. 22] where total plant level measurement is attempted with this approach, it is applied most extensively on work station level. The emphasis is on time standards, i.e. measuring the output of a production line, a team or an individual worker in terms of time. The level of productivity is taken to be the calculated variance from a predetermined standard. A benefit of this approach is that it can isolate and report the cause of a deviation in efficiency.

3.5.1.4 <u>The Financial-Ratios Approach</u>: Within the context of company productivity measurement there is still argument whether profit constitutes output (it might be so for the investor). Ratios associated with this approach are inventory turn, debtor days, etc.. At best these and other similar financial ratios can be classed as effectiveness performance indicators.

3.5.1.5 <u>Unit Costing Approach</u>: This approach is conceptually no different from the industrial engineering approach, except that by making use of standard costing methods, a monetary-valued standard, instead of a time standard is used to compare efficiency.

3.5.1.6 <u>The Production Function Approach:</u> This is an area of study not considered practical for use in the manufacturing environment. It is used more in economic studies where some general mathematical model is developed for output as a function of input factors. This is not to be confused with symbolic expressions utilized in the other measurement models (such as those of Sumanth) to express certain relationships.

Although not covering all the existing approaches to productivity measurement, the above-mentioned models constitute what is believed to be the major categories applicable to manufacturing. Scientific and technical journals contain many derivatives based on the above approaches. Examples in these journals are situation specific, and deviate from any one of the above models only in the manner in which the operational definitions are presented.

3.6 CONCLUSION

Operational management often has to improvise for lack of data, and in the process omit essential features required to maintain theoretical definition validity. It is for this reason important to distinguish, from the outset, the different dimensions of productivity measurement, and to apply these in a rational way to each appropriate operation.

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CHAPTER 4

SCALING

4.1 INTRODUCTION

A productivity variable is normally described by an observable set of characteristics. A characteristic may be either a quantity or a quality. The variable value therefore, may be either quantitative or qualitative.

Numbers are assigned to each of the characteristics according to certain rules - meaning some consistent, logical and valid matching process between the characteristic and some scale. To do this, either an existing scale is used, or, as is necessary when measuring qualitative productivity factors, new scales have to be created.

In this chapter the theoretical nature and principles for the development of measurement scales are investigated. It is fundamental to understanding the limitations which may apply when developing any measurement system.

4.2 LEVELS OF MEASUREMENT

The measurement concept relates to certain categorization procedures or levels. Particular mathematical operations and/or different analytical (statistical) techniques can, where appropriate, be performed only at the scale level on which observations are made. The principles relating to scaling are summarised below. There are four scale categories: nominal, ordinal, interval, and ratio [Krantz chap 1-3][Senders chap 2][Blalock chap 1].

4.2.1 Nominal Scales

Many qualitative factors (variables) which affect productivity have no natural measures (e.g., how is the quality of work life measured ?). New measures have to be developed. Such a process starts at the nominal scale level, where variables are classified with respect to certain characteristics. Categories are thus created, (e.g., something is "good" or "bad."). The aim is to create categories that are as homogeneous as possible compared with differences between categories. As long as the categories are exhaustive (include all cases) and mutually exclusive (nonoverlapping), minimal conditions exist which is necessary for the application of statistical procedures. This is the lowest level of measurement. No attempt is made to size the categories or to make comparisons in a measurement sense.

Numbers may be arbitrary used to label the different categories, but they cannot be used for normal arithmetical operations (addition, subtraction, etc.).

The importance of an operational definition (of performance) as discussed in the previous chapter is clearly demonstrated. It is not likely that any two people, let alone two undertakings, will support the same operational definition describing a certain productivity variable. For instance, a "good" quality of work life in one undertaking will differ considerably from a "good" life in another. The characteristics describing "good" must be unambiguous. More so, if frequent measurement is to be made over time using the same scale.

4.2.2 Ordinal Scales

Often, a new scale can be created on which variables can be grouped and ordered. For example, two departments in an undertaking may wish to be compared as to their overall output. "Output" in this case is undefined in the sense that several unlike characteristics are grouped subjectively to represent the output concept. A scale can be set up on which 4 is 'excellent', 3 is 'good', 2 is 'fair' and 1 is 'poor'. Each number identifies a different performance category or level of performance. A scale value of 4 would indicate a higher level of performance than a value of 3, and so on. On the scale "4>3","3>2" and "2>1". But the intervals between the units are not equal and the difference in performance between, say a "good" and "fair" performance in the one department is probably not the same as the difference in between a "fair" and "poor" performance in the other department. Because of the interval inequality, the basic mathematical operations of subtraction, addition, multiplication and division are once again not permissible.

A number of tehniques are used to develop an ordinal scale for qualitative factors. The Nominal Group Technique and the Delphi Method are mentioned in literature. [Sink chap 4].

4.2.3 Interval Scales

For productivity analysis, the preferred lowest level of measurement is a physical unit of measurement agreed upon as a common standard which is replicable. In other words, a unit of measurement in which the interval differences are constant throughout the scale.
An interval scale provides a relative measure of magnitude. A drawback is that its zero-point is arbitrarily chosen. For this reason a person cannot say that 70 degrees Farenheit is twice as hot as 35 degrees Farenheit. The difference between these temperatures is however the same as that between 105 and 70 degrees Farenheit.

Riggs & West [pp. 484-290] mention various procedures designed to yield interval scales for qualitative productivity variables. The first method is based on a standardized rating form. Depending on the variable being measured, attributes are attached to a numbered scale describing each level of performance as a different standard. Resulting values are collectively taken as a representative measure of performance (as indicator of productivity).

A more reliable procedure, designed to yield an interval scale is based on utility theory. Used extensively in performance measurement, it rates qualitative and quantitative variables together by making use of so-called dimensionless numbers. For each variable an upper and lower limit is fixed. For a qualitative variable it is done by visualizing the perfect outcome as 10, and the worst possible outcome as zero. Consider factory hygiene. To rate this variable one can use a role model of the "cleanest factory ever seen". Such a subjective standard would rate 10. The dirtiest would rate a zero. Preferably each numbered level will list a number of attributes so as to ensure consistency of measure.

To rate a quantitative variable on a dimensionless scale a similar procedure is followed. Rejects for instance can be rated by scaling the lowest reject level ever recorded as 10. A zero number is obtained by using the highest level ever recorded. The intervals between 0 and 10 can be divided on a proportional basis. An example illustrating this method is discussed in chapter 9.

The benefit of making use of these so-called dimensionless numbers (or scales) is that variables (or criteria) may be directly compared. The numerical reading obtained for each variable can be added to reflect a single indicator of performance. In productivity measurement this method of combining variables goes under the names Multicriteria Performance/Productivity Measurement Technique and Objectives Matrix Procedure.

4.2.4 Ratio Scales

A ratio scale is an interval scale with an absolute-zero point. The number "0" represents complete absence of the characteristic being measured. On this level all mathematical operations are allowable. [Evart pp. 12-14]. An example of a ratio scale is the rands-and-cents scale for measuring constant monetory value. Mass and distance are also ratio scales. Although the ratio scale is a "perfect" scale, its use in productivity measurement is limited in the sense that different ratio scales are not necessarily compatible. How for instance are man-hours added to tons of raw material? It could be done by making use of a third common denominating scale - if one is available.

4.3 SCALING CONSTRAINTS

Where certain outputs or inputs are valued on a physical scale (man-days, machine-hours, tons of material, etc.), the different scales will be incompatible for combined productivity measurement.

4.3.1 The Principle of Equivalents

To overcome the problem of incompatibility any one ratio scale common to all the different physical scales can be utilized to obtain equivalence. Normally a monetary scale is used. This creates a problem in that the monetary scale is considered value variable over time, which makes it an interval scale, unsuitable for maintaining equivalence.

If money-valued productivity is being measured the current value monetary scale is adequate. Technical productivity however is based on physical quantities, which means that, given a monetary value, physical value has to be derived.

4.3.2 Constant Monetary Value - derived physical value

As per the REALST model illustrated in chapter 2, if unit prices rise, total value will rise even if nothing else changes. Technical productivity indices will show an unreal increase unrelated to the physical dimension if the total monetary values are used in deriving physical value. This problem is demonstratred in table 4.1:

Comparing the productivity ratios developed on the monetary scale over the two periods 238 (11900/50) and 404 (20200/50), and those on the physical scales 2 (100/50) and 2 (100/50), the bias using the monetary scale values can be considerable. Total output above is R11900 (100 x R119) for the base period, and R20200 (100x R200) for period 2. To achieve an equivalent value on output in the second period, physical output (100) is multiplied by the unit price of the base period (R119). The example also demonstrates the principle of "value weighing".

	PERIOD 1	PERIOD 2	
PHYSICAL TONS OUTPUT	100	100	
UNIT SELLING PRICE	R 119	R 200	
TOTAL MONETARY VALUED OUTPUT	R11900	R20200	
PHYSICAL LABOUR INPUT	50	50	
	RATIO	RATIO	INDEX
PARTIAL PRODUCTIVITY -ON MONETARY SCALE - ON PHYSICAL SCALE	 11900/50 100/50	 20200/50 100/50	 170 100

Table 4.1.: Distortion deriving Physical Value from Monetary Value

In practice the manner in which data is presented, is somewhat different. Unit prices are not always separately available. As a result, the method of weighing to achieve constant monetary value cannot be utilized. The alternative is to apply total monetary value deflation. To do this, the company must have a price index available which reflects the price changes of its mix of outputs and inputs. National indices, such as the Consumer Price Index will probably not be suitable for this purpose. The procedure is to select a base year and to convert the actual rand values in subsequent years to the base year equivalent by applying the appropriate price deflator.

Even if the price indices used, are assumed to be an accurate representation of rising unit prices, it cannot be claimed that all the bias and distortion are so removed and not transferred to the derived "physical" values. It is quite possible for a price change to have taken place twice during one period. If that period's "average" price is not adjusted, it will cause a distortion to the derived physical value. A similar problem is caused when new products are introduced or old ones removed from the market during subsequent periods, or if the output product mix and/or input resource mix change between periods.

Interpretation of the productivity results based on derived "physical" values should be approached with caution.

4.4 CONCLUSION

To be credible, measured results must be reliable and the method consistent. In terms of scaling, the question may well be asked, how is it decided what level of measurement is legitimate? The answer is not quite so obvious. Many qualitative factors professed to affect productivity are these days being targeted for measurement. Because of scaling limitations these qualitative input variables cannot be directly tied to output in a measurement sense, i.e. in a single equation.

To overcome this problem there are three practical remedies. Making use of the ratio format, one must either break down the index into separate dimensions of partial productivity so as to admit ratio level of measurement, or "force" an interval scale on the data by making decisions on the relative weightings of each dimension and the equivalence involved.

A second alternative is to make use of so-called formal indicators of productivity, i.e. measuring for efficiency and effectiveness on a partial basis.

A third remedy is to combine different indicators ("surrogate" measures), using dimensionless numbers in a matrix. The result so obtained, is a performance measure from which certain assumptions can be made as regards productive behaviour.

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CHAPTER 5

PRINCIPLES OF PRODUCTIVITY MEASUREMENT

5.1 INTRODUCTION

An undertaking (company) is a unique organizational system comprising many interrelated subsystems. In terms of production such a system uses labour, capital, materials and/or other inputs to produce or add value to output. [Gallop pp. 35].

Each subsystem is a complete system in its own right. The definition (scope) of the system will delineate its output and input. A system may refer to the total company, a manufacturing plant, a production line, a work group, a work station or an individual. Or it may be one of many functional departments such as engineering, marketing and so forth, or a combination of any of the above and some more. The subsystem concept is an ideal tool to structure clear-cut measurement packages, since by definition: ".. a system is nothing more than a collection of components (inputs) interacting as a process to achieve a specified objective (output).." [Bedworth pp. 14-19]. The relationship of these elements is depicted in figure 5.1.

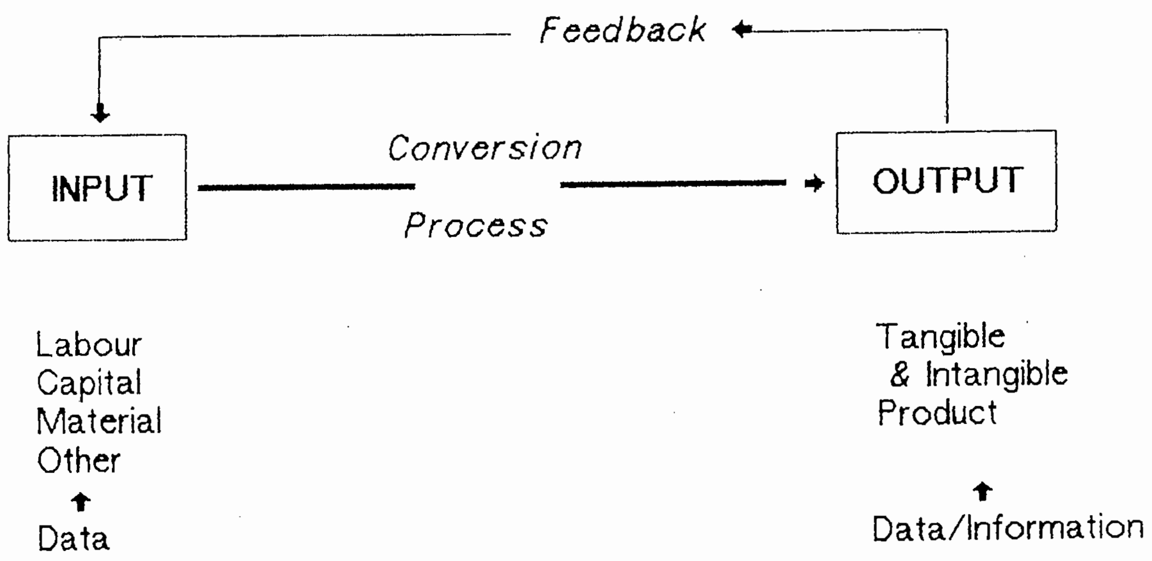

Figure 5.1 : Elementary Systems Model

Inferred by definition is that the boundaries of a system enclose all components which directly interact. These may include outputs from other systems which become an input to the target system. [Matthews pp.57-69].

Theoretically, any of the productivity measurement approaches (methods) mentioned in chapter 3, can be applied within any systems combination mentioned above. Depending on the specific measurement objective, a comprehensive measurement system can be of a "coupled" or "de-coupled" design nature. This enables independent and overlapping measurement (more than one method) to be applied. Figure 5.2 depicts what is meant by "overlapping".

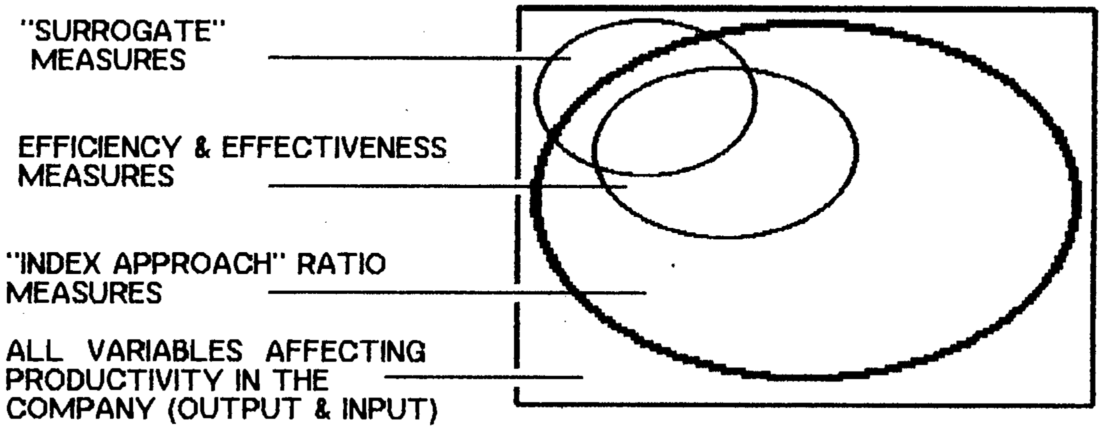

Figure 5.2 : Venn-diagram; Measurement Techniques (Approaches) Overlaps

5.2 ORGANIZATIONAL STRUCTURING

The wider the scope of the system's definition, i.e. the higher the degree of organizational aggregation, the more likely it will be that output and input data will be available in monetary value only. Lower down, on work station level for instance, reliable direct physical and time measurement is more readily attainable.

For this reason only three measurement approaches are practical: index, industrial engineering and "surrogate" measures.

The theory of multi-factor (total) productivity measurement (Index approach) on the level of the company is well developed. There are various risks to the application, not the least of which is data reliability. In this regard the financial recording and reporting system plays a crucial role.

Work station or production process data recording and reporting for productivity measurement is not as a rule a financial function. Independent time standard or physical unit measures are utilized to determine the degree of technical efficiency for each subsystem.

There are many other organizational levels (or subsystems) to be considered for measurement. A host of surrogate measures, operational ratios and the like, which serve as "indicators" of productivity can be applied. All the measures mentioned are considered complementary. Used in parallel combination, they will diminish the problems commonly associated with productivity measurement (for "problems" see chapter 6).

5.3 THE OUTPUT CONCEPT

5.3.1 Total Output - For the "Total Company" Level of Measurement

The system or unit of analysis here is the total company. Output can be defined in either a technical or money-valued sense. Normally, output is taken to mean a tangible or physical commodity. Hence it has to be decided whether the operational definition of output must be based on sales or production. [Siegel p. 16]. Writers differ on the concept definition of output. Physical output is not the only issue, they say. "...Productivity growth is a measure of economic performance.." [Gollop p.57].

These sentiments are also expressed by Takeuchi [p. 53]:

> "A production-orientated concept of output poses several problems, even for the manufacturer. Take the manufacturer of a television set as an example. What comes out of the factory may be a tangible product, but certain services are added to the factory output in the form of packaging, warranty, customer instructions, financing, delivery arrangements, and so forth. These services are additional values embodied in the product......to say that the manufacturer's output consists solely of tangible products is, therefore, too simplistic...".

The same theme or line of reasoning is of late being expressed in technical literature related to marketing. (See Appendix A - Brands are Assets).

An interpretation of the views of people like Takeuchi, is that intangibles should be measured as monetary "value added" in addition to the tangible (physical) value of output. How this "added value" concept is to be handled in terms of measurement, is unclear. To accommodate the concept, an argument can be made for money-valued productivity. A practical measurement method regarding this issue is demostrated in chapter 7.

5.3.2 Subsystem Output - Operational Production Units

Operationally, subsystems can be either vertically or horizontally integrated into the total company system. The operational unit can be a system in its own right. If a operational unit (a work station, a production process, a manufacturing plant, or whatever) produces a physical product (final or intermediate), the output definition can be defined according to the guidelines mentioned above. Data will probably be available in physical format i.e. kilograms, number of packages etc., and need not be derived from a monetary scale.

5.3.3 Output - The Utilization Concept

Utilization is defined as the degree to which the resources committed to a process are actually converted into output. The concept is rooted in work study and can be applied to any physical resource being utilized. As appropriate, utilization can be accurately measured in terms of time or quantity. It is an indicator of efficiency.

The concept is illustrated by way of example as follows:

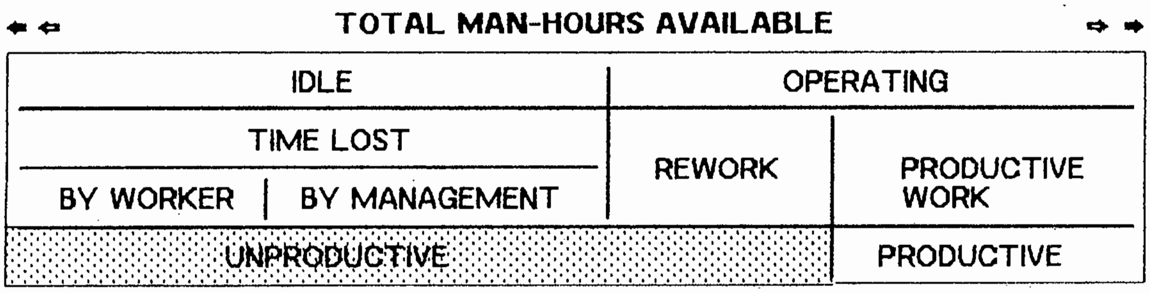

Figure 5.3 : Composition of Labour Time
Adapted from Humprey & Halse p. 19 and
Van Niekerk p. 22

As per figure 5.3, "total man-hours available" is the official working time for which the employees are paid. It can also be taken to be the total time allowed for a job. The total period can be broken down into time spent idle and time spent at work. Idle time is made up of time lost by workers themselves or by management. Extra work is defined as rework and/or other unnecessary work done by the worker. The balance of the time is used for productive work. Efficiency is calculated as productive time over total man-hours available.

Making use of this technique requires that a theoretical "output" standard be established. Actual output achieved is compared to standard, and efficiency calculated. This concept is more fully illustrated by way of a practical example in chapter 8.

5.4 THE INPUT CONCEPT

An input can be described as any factor which affects a related output. The operational definition should indicate whether a specific variable be classified as an output or input. Example: product quality can be seen to be an input to sales. It can also be seen to be an output if, for instance, the input is training, undertaken to improve workmanship.

Instead of trying to fit "product quality" into the productivity ratio, it can be measured separately as an independent entity ("surrogate" measure). In other words, it is measured either as an input or an output. From the singular result obtained, conclusions can be made in terms of its effect on productiveness. If quality deteriorates on whatever scale measured, it can be assumed that productivity will also deteriorate. This assumption is amply supported by research results.

Referring specifically to the "total company" level of measurement, an input can be brought directly into the productivity equation by way of the financial statements. Inclusion will of course depend on the ability to identify and scale the input variable. Using the index method, input types are normally classified under the headings: labour, capital, material and intermediate. Intermediate inputs are other cost items, not included in the other categories, where "cost" has the same meaning as in the income statement.

5.4.1 Labour input

The physical measure of labour is man-hours. Depending on the operational definition, labour can be the man-hours expended by all people engaged in the production of an output, without differentiation as to the different classes of labour, i.e. one man-hour of unskilled labour has the same value as one man-hour of skilled labour. Provided there are no major proportional changes in the labour mix between measured periods, such a measure is considered adequate. The ideal preferred, considering economic interest, is to weigh the hours according to some pattern of labour composition, be it by skill, compensation or other factor. The choice as to how to categorize labour input is left to the individual undertaking. There is no prescription except for consistency of application.

5.4.2 Capital Input

Capital input rates as the most controversial aspect of productivity measurement on the level of the company. The "quantity" of capital is not so intuitively obvious a notion as the "quantity" of labour [Siegel p. 19]. Capital can be theoretically defined in many ways. Useful though, is to divide total capital (as per balance sheet) into fixed and working capital. Given this classification, fixed capital is the category of greatest interest.

Fixed capital comprises elements such as equipment, machinery, buildings and land. Literature makes mention of four basic methods to measure this input. [Riggs & Felix pp.71-73]:

5.4.2.1 Depreciation value method

Depreciated book value is taken as an approximation of fixed capital consumed. It is estimated directly from the accounting records. For consecutive period measurement, input is taken to be the monetary depreciation charges. Since the depreciation values are normally arrived at only after due consideration of tax benefit write-offs in the first year of operation, the reliability of the concept is suspect. The inflation factor impact is as a rule not considered when deriving "physical" input [Sumanth p. 161]

5.4.2.2 Lease value method

The rental price or lease value approach visualizes capital assets as being leased [Graig & Harris p. 24]. To calculate usage values, current purchase prices are deflated to base year values. The base year value is then multiplied by an annuity factor, set to recover the invested capital over the expected life of the asset and the desired return (for the imaginary lessor). This rental cost is then the input value for the year.

Example:If the real-rand value of a machine is R50000, its life 6 years and the expected rate of return 20% , then the annual "rental" cost (input) is calculated as:

Value of fixed capital input for company = Sum of annuity values for each asset, calculated on base year cost, productive life, and cost of capital.

= R50000 x capital recovery factor 20% over 6 years.

= R50000 x 0.30071.

= R15035.

5.4.2.3 Annual cost method

Similar to the lease value method, a "consumption" plus return on capital percentage is charged against real-rand capital stock to obtain annual capital input. The "consumption" rate is determined by estimating the useful, and not book life of an asset. If the useful life is estimated at 6 years for instance, an asset will loose 16.7% of its value annually, which is then the "depreciation" rate. In addition a return rate of 20% can be allowed, depending on the average estimated cost of capital. Annual capital input is calculated by multiplying the real-rand gross investment by 36.7 percent.

Example:

Value of fixed capital input in company	=	Depreciated value of asset x (depreciation rate + return rate).
	=	R50000 x (0.167 + 0.20).
	=	R18350.

Additions to fixed capital, where the scope of measurement is wider than just one asset as in the example, will be deflated with an appropriate price index to a base year value.

5.4.2.4 Perpetual Capital Inventory method

Not tied to the financial accounts, a separate control is introduced for capital asset inventory values. An asset's annual consumption is estimated to establish a schedule of depreciation based on actual use, not tax life. The estimated consumption can be calculated as a fixed amount by dividing purchase value, deflated to base year value, by the estimated actual life. Each year the portion of an asset's worth that is "consumed", is then dropped from an updated inventory. For instance, if the estimated useful life of an asset worth R50000 in the base period is 6 years, then consumption is R8333 per year:

Value of fixed Capital input = Gross value inventory in base period - updated capital inventory value.

Where updated inventory value is: Gross value base period - consumption in previous periods, and

therefore, inventory end year 1 = R50000 - R8333 = R47667.

year 2 = R50000 - R16666 = R33334.

and so forth.

Other parameters can be used to estimate "comsumption". If it is estimated that the machine may be utilized less later in its useful life, or require more maintenance, consumption values can be loaded in the earlier periods.

5.4.2.5 Concluding Remarks on Capital Input

It should be remembered that the input element of the productivity ratio referred to, is supposed to be measured in physical units. Given the difficulties, should capital really be considered for inclusion in the productivity equation? Most examples using index models either ignore capital as an input, or apply methods of measurement which seem to be of little assistance to operational management.
Nevertheless, the following measurement method is suggested:
Working capital may be captured in the income statement as the interest payable on net working capital. If interest is received, it becomes an output or "positive" input. Different interest rates can be categorized as input sub-categories of

working capital. Physical value can be derived on a deflated monetary-value basis. In other words, the amount of money value received in interest is deflated to base year value.

For fixed capital, alternative methods to those mentioned above, are difficult to develop and introduce, given that the company's accounting practices normally force the issue. Each of the methods presented, carries risks. Since all the methods go out from a recorded rand-value base, some methods may overstate value if the derived "physical" write-off is too large too soon, or understate value if straight financial depreciation methods are used to value capital usage. However, fixed capital can be considered in use twenty-four hours a day. Input can be calculated using this basis which is more or less the same as that for the depreciation method. Input is "uncontrollable" once the company has committed itself. In a sense the level of capital productivity will depend on market sales demand and not on how production conducts its operation.

On lower levels of aggregation, fixed capital input can be measured in terms of machine hours or utilization, separate from financial considerations.

5.4.3 MATERIALS AND INTERMEDIATE INPUT

All other inputs besides labour and capital are classified as either materials (raw materials and packaging) or intermediate goods and services. The latter being things consumed in the process of producing output. Included are energy, operating supplies, and other purchased services.

Goods purchased into stock can in most cases be accurately adjusted to show actual physical usage. The other money-valued inputs are deflated to base year prices so as to derive an imaginary physical value.

5.5 CONCLUSION

Except for the productivity ratio concept, there are no other fixed principles. Inclusion of a variable in the equation will depend on the operational definition and the ability to scale such variable. The traditional format (index approach) of productivity measurement has many practical limitations. For this reason "surrogate" measures are utilized provided that there is an obvious and predictable relationship between the behaviour of the surrogate measure and productivity.

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CHAPTER 6

PRACTICAL PREPARATION FOR MEASUREMENT

6.1 INTRODUCTION

For each situation, a measurement system has to be built up from scratch. The theoretical models presented in literature serve only as conceptual frameworks around which particular practical measurement instruments are built to suit local conditions. Operationally defined concepts will differ in each particular instance. The need for direction as to where one should start with the measurement process, is seen to be a problem.

6.2 CHOOSING THE CORRECT APPROACH

The ultimate measure of a system's success will be whether it achieves the objectives for which it was developed. Certain criteria are common to choosing an appropriate productivity measurement approach and identifying individual measures [Seung-il et al. pp. 555-560]. In this chapter these criteria are identified and discussed. This is in preparation for the design and development, in part 2 of this dissertation, of a measurement system for the target company. [Weiss pp. 11-16][Guion pp. 37-38][Kerlinger pp. 71-75]. These criteria are:

Criterion 1. Unit of analysis: To refer to "levels in the organization" as being the focus of measurement can be confusing. Measurement should be applied to a "unit of analysis" instead. The idea is to divide the company into independent "measurement packets". There are potentially as many units of analysis as there are activities in the company. Only certain organizational units though, are targeted for measurement. In the target company these units are:

1) The total company (as one system)
2) Sections (or work station groupings) within the different responsibility centres
3) Individual work stations. (See Appendix C for the organizational chart)

The definition of each unit may be narrow or wide, i.e. starting from an individual person or one machine and progressing up to the whole company. Whatever the choice, the unit should fit in with the formal organizational structure, i.e. clarity as to accountability.

Criterion 2. Purpose of measure: in terms of what management wants to achieve. Are the measurements to be improvement (show "cause") or control (show "effect") orientated? For each unit of analysis, specific objectives should focus the direction that measurement should take. Examples of such objectives are:

- to serve as psychological stimulus toward better performance by management, supervisors and/or workers.
- to determine which major factors in the organization (system) influence productivity.
- to assist proper planning and business forecasting.
- to appraise, by means of before-and-after productivity comparisons, the efficiency of remedial actions.
- to establish realistic hiring and training schedules.
- to improve work routine and plant layout.
- to improve timing on equipment and process change decisions.
- to assist buy or make decisions.
- to detect changes in output in respect of alternative inputs, in order to correct undesirable action, and to exploit desirable methods and techniques.
- to control the extent to which individuals, work groups and, in general, operational units are efficient and/or effective.
- to adjust operational work loads.
- to control costs by means of targets for reject production and for unit requirement of labour, capital, energy and materials.
- to facilitate wage and bonus payments.
- to direct budgeting.

[Van Niekerk p. 13. Also Siegel p. 35]

The list is not exhaustive, but illustrates the point that situational needs will differ.

For the target company there is an overriding goal: The system must, as part of total company strategy, facilitate and strengthen a movement toward a decentralization of tactical decision making to the middle and lower management levels in the organization. (See internal report in Appendix B.)

Operationally, the underlying goal to be striven for through measurement on the level of the total company, is that it will afford a measure of control. On a section level, the goal is to promote team work. On work station level it is to promote worker motivation. Hard objectives, specific to each unit of analysis for which measures are developed, are given in part 2.

Criterion 3. Type of Data: This criterion has two sides. Firstly, how detailed is the existing data base, and does it tie in with the units of analysis targeted for measurement? Secondly, what detail is required, and on which scale is it to be measured?

In the target firm, a two-tier information system is maintained. The first tier comprises the normal integrated finanacial or management accounting system, consisting of a balance sheet and income statement. The income statement is of a mixed classification with some elements of a trading statement and manufacturing statement for the firm as a whole, as well as information in the form of manufacturing statements for three production departments (called responsibility centres). Costs are debited or allocated directly to all the responsibility centres. The format is scheduled in Appendix D.

Second-tier data originates in the manufacturing department, and is generated in the work stations by means of production control charts. The system contains mainly non-monetary machine utilization and other data for the exclusive use of the manufacturing department. Labour time measurement is determined by incorporating data taken off the clock cards located in each reponsibility centre. The clock card system is administered by the personnel department who supplies information to both the financial department and manufacturing operations for further manipulation.

Criterion 4. Concentration: refers to the degree to which the measurement administration is to be centralized or decentralized. The organizational structure has to be considered.

Notwithstanding the organizational structure, the reliability of measure is most important. Reliability is the extent to which repeated measurement produces the same result. Errors in the measurement process should either be consistent over time or minimized. A measurement process can have the following types of error:

1) Variable scaling: which refers to the inherent qualities of the scale itself. Utilizing a nominal or interval scale for instance can cause difficulties. Error can be minimized by ensuring thorough operational definition of concepts, write-up and scoring.

2) Omissions: are a function of operating procedures error. In the case of the total productivity measurement model in chapter 7 for instance, reliability will depend on the quality of data supply from the financial function. Consequently this model is best administered on a centralized basis. Omission and incorrect recording can, on work station level, also be a problem. Data recording forms design should enable easy write-up.

3) Misclassification: is when certain entities are incorrectly allocated or omitted. For instance, where an input is recorded under a resource heading not intended.

Criterion 5. Time Frame: has to do with the time scale of system introduction and operation. Performance measures ("surrogate measures") can be introduced reasonably early. The data required can normally be generated on a routine basis on work station level. The nature of such measures are mostly non-financial. Real productivity measures (output/input) on the other hand, require a very high level of commitment and cooperation from all the people in the organization to be effective. This process is time consuming.

In the target company the measurement needs fall within both categories.

Criterion 6. Comprehension Level: refers to the user profile, i.e. the audience for whose use the results are intended. Whatever the measure, the content must be comprehensible to the users. Given the need for worker participation in the decision making process (identified as specific objective in chapter 8 on work station level measurement), certain reporting difficulties have to be overcome. Abstract ratio manipulations are not suited to shop-floor understanding and discussion. A rule is to present results as simplistically and graphically as possible.

Criterion 7. Reporting Time cycle: refers to how often result reports should be made available - daily, weekly, monthly or yearly. With productivity or performance measurement, feedback time is of the essence.
Financial function based measurement systems normally lack time versatility. Administratively, data should be manipulated as near as possible to the source so as to limit information feedback time.

Criterion 8. Performance Criteria: To manage productivity effectively, the array of measures should also include key factors which affect productivity. In addition to the productivity ratio and measures of efficiency and effectiveness, there are "key productivity factors" [Geyser pp. 7-17], which unconciously affect productivity. Examples are factors such as absenteeism, quality, working conditions, etc. Each unit of analysis will have a unique set of factors to consider.

Criterion 9. <u>Single Indicator</u>: For each unit of analysis, the measurement system must allow for the different individual measures to be combined into a single numerical indicator of productivity or performance. Only the Total Productivity Measurement Method (Index) is capable of measuring productivity proper, where all the partial productivities can either be reflected separately or combined into a single indicator. The results of all the other measurement methods such as the Industrial Engineering method and other "surrogate measures" are "factor" measuring devices. The numerical results obtained are indicators of productivity. By making use of the Matrix Method, the results can also be presented as a single indicator.

Criterion 10. <u>Controllability</u>: The activities measured should be controllable by the responsible person. For example, the measure of machine efficiency is not necessarily a reflection of the efficiency of the labour resource operating the machine.

Criterion 11. <u>Inclusiveness</u>: The numerical results of productivity measurement obtained should ideally include all the measurable variables associated with the cause of performance. However, the measures decided upon will depend on many operational considerations. The systems design therefore, should be concerned with supplying answers only to what is required. In productivity measurement there is more than one way of measuring what is essentially the same thing. If a so-called surrogate measure will suffice, then it can be used instead of the more complex measure. The problem with surrogate measures though, is that they fragment the measuring process. The system is therefore not integrated to the point where a "total effect" reading can be made. Consequently, a person is not always certain what effect improvement in one area has on the productivity in another.

Criterion 12. Quantifiability: This criterion refers to the ability to identify and scale the factors which affect productivity. It may also refer to the combining of different scales. Much of this issue is covered in chapter 3 and requires no further comment.

Criterion 13. Validity of Measure: Finally, but perhaps the most important, is the issue of validity. It refers to the extent which the formulated measure is measuring that which it is supposed to do. When the physical output over physical input is presented, there can be no controversy. If the operational definition calls for physical value to be derived from a given monetary value, there still can be no controversy. If efficiency is being measured, its linear relationship to productivity is also normally accepted. The problem arises when a surrogate measure is taken as an indicator of productivity, as the conclusions can be disputed. It is up to management to evaluate the importance to productivity of such a measure. Operationally, the only logical way to justify a surrogate measure, is to treat it as a measure of effectiveness.

6.3 CONCLUSION

Each measurement situation has its own idiosyncrasies. The criteria however, reflect common issues which have to be considered before embarking on productivity systems development.

Given the units of analysis selected and the theoretical characteristics of the different models discussed thus far, three models will be developed namely:

1) the Total Productivity Measurement Method (Index) for the company as a whole

2) a Dimensionless Number Matrix which combines various surrogate measures of performance for different sections,and

3) the Industrial Engineering Approach to measure efficiencies and effectiveness within the work stations.

*

PART 2

Productivity measurement models for a manufacturing company.

The target company is involved in the milling, packing and marketing of grain products.

CHAPTER 7

PRODUCTIVITY MEASUREMENT ON TOTAL COMPANY LEVEL

7.1 INTRODUCTION

In the target company the only re-occurring and consistent source of data which relates total income (output) to total cost (input), and from which can be developed a total company productivity measurement model, is the financial statements.

The ideal data format and detail required, were presented in figure 2.1 (REALST), chapter 2. Depending on the available data detail, several variants of the total productivity measurement method (or index model) may be applied. Application in a practical sense, is guided by a specific operational definition of the productivity concept. Whether total monetary values are utilized to derive physical outputs and inputs, or monetary value is to be included in the productivity concept - by implication the issues of reliability and validaty will feature prominently.

7.2 SPECIFIC PRODUCTIVITY MEASUREMENT OBJECTIVES

Specific objectives relating to productivity on company level measurement are the following:

1. To provide an analytical productivity audit of company performance.
2. To facilitate productivity control of non-physical transactions (functional services).
3. To assist with the setting of productivity objectives for planning purposes in terms of money-valued efficiency and effectiveness.

The use of the information emanating from the model, is primarily to aid top management in operational decision making.

7.3 THE TARGET COMPANY INCOME STATEMENT FORMAT

Income statements for two periods of a food manufacturing enterprise are presented in the Appendix section. In Appendix D, the statement for April (period 1) is presented, and in Appendix E, the statement for May (period 2).

Apart from the total monetary value being stated, the statements include a horizontal classification which breaks down the total monetary value for allocation to the various middle management responsibility centres. The column classification does not necessarily signify importance within the organization's authoritative hierarchy. See the organizational chart in Appendix C.

7.4 INCOME STATEMENT ISSUES

On company level performance measurement, the operational definitions of both the productivity concept and other productivity variables will be decisively influenced by the financial data presented.

The reliability of data taken from financial statements should as a rule be questioned. What is seen as perfectly correct procedures in financial measurement, may not be acceptable for productivity measurement. Agreement has to be reached on the manner and consistency of financial reporting practice. Areas of concern may relate to the following:

1) Consistency: as to book entry. If the purchase of a resource is booked in a period other than the one intended, this may reflect as an unrealistic decrease or increase of productivity in a particular period. Also consistency as to the allocation of costs and income to the same accounts over time.
2) Stock taking: The level of accuracy which, apart from the count, involves issues such as classification and relationship between the costing (FIFO, etc.) and stock turn on raw materials and packaging materials.

3) Profit Provision: These exist in most industrial organizations. If profit provisions are debited between periods to any account in an inconsistent manner (i.e. not declared to users of productivity information), it will render productivity measurements unreliable. As this is a major distortion factor if not handled correctly, it is essential to get agreement from the financial functionaries that profit provisions be debited to one account consistently. Normal operating provisions, i.e. late receipts of invoices, etc., should be handled in a manner which contributes to consistency, as in point 1 above.

4) Pricing policy: On the output side, selling price lists of the target company are adjusted only once per year. Price levels are traded off from the list price and recorded separately as either promotions or discounts, whichever is applicable. This practice simplifies productivity measurement since the unit price element can be considered stable on the output side, with discount being treated as an input in the same way as raw materials for instance.

The measurement model to be developed, utilizes indices to indicate either an increase or decrease in productivity. To illustrate the adopted principles on which measurement is based, only two measurement periods, or two consecutive months, were chosen for demonstration.

Money values are not adjusted for time elapse. For each accounting entry the responsibility centres are totalled to column 11. (See Apendix D & E). Vertically, income and costs are classified in typical financial manner. Additional information, not normally included in an income statement, is for an inventory adjustment of finished products, which reflects production (line 2) as opposed to sales (line 1).

The terminology "variable expenses" and "fixed expenses" (on lines 14 and 25), may confuse as it is not meant to describe literally the characteristics of the costs. The "fixed expenses" are not in all cases fixed. A more appropriate description would be "overhead expenses". Interpretation of the rest of the information contained in the two income statements is conventional.

7.5 A PRODUCTIVITY STATEMENT FOR THE TARGET COMPANY

Once the issues regarding financial write-up have been resolved, a specific productivity statement format has to be drawn up. The process involves editing out certain financial elements not required in terms of a specific productivity measurement objective.

7.5.1 Editing Data

The editing task involves making a decision as to which output (income) or input (cost) elements are to be included in the productivity statement. Measuring total productivity does not mean having to measure each variable or factor. The contribution of an omitted input component, if included in the income statement, but not the productivity statement, is automatically captured in the equation through the principle of causality. A variable consciously omitted from the productivity statement, need not invalidate the measured result in so far as other inputs are concerned. A practical example of omittance, in a multi-factor (total) measurement type system, being reportedly successfully applied, is that of ESCOM [Cooper pp. 12-17]. In their model only key, physical measurable input factors are taken into the equation. A prerequisite for omitting an element is that the same condition be maintained in subsequent productivity statements (consistency over time).

For the target company, all income statement items are included in the productivity statement so as to relate profit to the performance of the different input elements.

7.5.2 Format Design

With editing complete, the remaining elements are rearranged to bring together the different output (income) elements and then the input (cost) elements into chosen categories. If a traditional category mode is implemented, input can be divided into the four resource categories already mentioned.

The statement format chosen for the target company is represented in tables 7.5 through to 7.14 in Appendix F. Normally the tables are combined into one statement. For purposes of discussion however, the different categories are presented separately.

The basis for the input group classification used here, rests on careful discussion with senior management as to the preferred combination of elements. The intention is to bring together input elements more or less similar in nature, and to group together resource input elements which correspond to the managerial responsibilities of different members of senior management (the document being intended for use at top management level only).

Table 7.5: includes all the elements of output which, referring to column 2, are the monetary value of production of the three responsibility centres responsible for the total physical production. On a month to month basis, production output is considered more closely tied to input than is sales output. Some proportion of sales is drawn from inventories from a previous period's production input.

Table 7.6: includes all the elements considered to be related to the labour input.

Table 7.7: represents elements related to the raw material and packaging material input.

Table 7.8: includes depreciation and interest, representing capital input. As was indicated in chapter 5, there is little guidance or agreement as to how capital input should be calculated.

In this model, fixed capital usage is taken to be the recorded depreciation. Working capital (net) usage is interest paid. Both these resources are treated no differently from any of the other inputs. If, because of financial (tax) considerations, more fixed value is written off in one period than in another, then a higher depreciation value is taken as an increased input. The same principle applies in the case of interest. Interest is seen as a service input consumed by the company.

Rather than capitalize a fixed asset and depreciate, the company may decide to write off the amount of purchase to operational expense. Because this model includes all inputs (which are financially recorded), it means that a write-off will be captured somewhere in one of the other input categories. Should write-offs occur to, say, the factory maintenance account, then it is suggested that a "non operational" maintenance account be opened for such purposes. This entry can be classed with the capital elements in the productivity statement so as to reflect the trade-off. This is one of the issues whose handling is to be decided beforehand.

Tables 7.9 to 7.13: Traditionally, all elements which are not at home in either the labour, materials or capital categories are grouped as so-called intermediate inputs. In this model four sub-categories have been chosen on the basis of top managerial responsibility. The categories are: materials handling, marketing support services, production support services and administration support services.

Table 7.14: contains the various column totals of the productivity statement.

Profit provision is grouped with the profit entry on line 90 (table 7.14) of the productivity statement. This provision is not considered to be either an input or an output. As with profit, it is the result of the overall company activity and is considered an output of another unit of analysis (shareholders). If at a later stage it is decided to bring the provision back into the operational accounts to cover a real expense, then only will it feature in the company's productivity equation. While a provision is being entertained, its effect on total productivity is theoretically channelled through the interest input. The provision entry is a credit balance on the balance sheet which affects working capital and therefore interest (the interest charge is captured on the income statement).

7.6 THE PRODUCTIVITY CONCEPT OPERATIONALLY DEFINED

The write-up conventions and design decisions stated above, are part of the operational definition. The formulation of the productivity concept in this model corresponds to the money-valued productivity concept argued in chapter 2. The concept combines both the physical and monetary values into a single indicator of performance in an effort to answer to the measurement objectives stated in para. 7.2.

An overview of the concept calculations are: Recorded output tonnage in the base period is taken to be the physical component for both output and input. By dividing this quantity into the total monetary value of any line item on the productivity statement a "unit price" per ton is extracted for each item. The unit price as per line item is transferred as a constant to all succeeding periods. Making use of the constant "unit price" and total monetary value, an "imaginary" physical value is derived for each subsequent period. A detailed explanation follows.

7.7 CALCULATIONS

Refer to the productivity statement in appendix F.

7.7.1 Calculating output

The output calculations for period 1 (April) in table 7.5 are reflected in columns 2, 3 & 4, and for period 2 (May) in columns 5, 6 & 7.

1	2	3	4	5	6	7	8	9	
TOTAL OUTPUT	April Current Total Value	April Tons	April Derivrd Unit Price	May Current Total Value	May Equiva. Tons	May Constant Unit Price (Rand)	PRODUCTIVITY Index	Profit Movement	Line Ref.
Product Group 1	4767658	1859	2564.64	4649648					1
Product Group 2	2260224	2616	864.00	1895730					2
Product Group 3	1026207	1253	819.00	1110770					3
Total output	8054089	5728	1406.09	7656148	5445	1406.09			4
					5431	1409.71 --Actual May Month			

Table 7.5: Extract from Productivity Statement: Total Output.
(see Appendix F)

The total monetary value of physical production of the three product groups (col. 2, lines 1, 2 & 3) is derived by adjusting gross sales value by finished goods inventory; that is, gross sales minus opening stock plus closing stock. Tons of goods produced (col. 3, lines 1, 2 & 3), are calculated in a similar manner.

For April, which is the base period, total output value (R8054089 in col. 2, line 4) is the sum of the total outputs (gross production) of all three product groups. Total physical output quantity is represented by the total tonnage (5728 tons in col. 3, line 4). Total average unit price (R1406.09 in col. 4, line 4), is derived by dividing the total tonnage quantity into total monetary value, i.e. R8054089/5728 = R1406.09.

Total output for period 2 (May) is calculated by taking unit price to be the same as for April, i.e. R1406.09. By dividing R1406.09 into the total production revenue (R7656148 in col. 5, line 4) of May, an equivalent tonnage (5445 tons in col. 6, line 4) is derived.

Price adjustments are made annually at the beginning of October. Equivalent output therefore, in this case more or less equals real physical output. The difference between the derived "imaginary" or equivalent, and real total average physical output (see col. 6, line 4 and below line 4), can be ascribed to a slight product mix change from one month to the next. Referring to the production output data of the three product groups listed in Appendix G, it is noted that over a period of a year, output of the three groups remained more or less proportionally stable. This obviously minimizes distortion when including input quantities into the productivity equation, i.e. working with the total average output as opposed to the individual outputs. Total "imaginary" output as defined in period 2, thus carries a slight bias due almost totally to product mix change.

7.7.2 Calculating Input

7.7.2.1 Deriving Input Quantities for Period 1

In table 7.6, column 2 reflects the total monetary cost values for each labour input as transferred and edited from the April income statement (base period).

1	2	3	4	5	6	7	8	9	
LABOUR INPUT	April Current Total Value	April Tons	April Derivrd Unit Price	May Current Total Value	May Equiva. Tons	May Constant Unit Price	PRODUCTIVITY Index	Profit Movement	Line Ref.
Salaries	R241,166	5728	R42.10	R234,029	5559	R42.10	98	(R4,779)	5
Wages	R280,194	5728	R48.92	R261,987	5355	R48.92	102	R4,363	6
Motor Cars	R16,615	5728	R2.90	R16,242	5601	R2.90	97	(R448)	7
Staff costs	R104,272	5728	R18.20	R95,731	5260	R18.20	104	R3,389	8
Staff recruite	R215	5728	R0.04	R0	0	R0.04		R204	9
Staff training	R15,733	5728	R2.75	R5,432	1975	R2.75	276	R9,524	10
Prot. Cloth.	R3,121	5728	R0.54	R2,865	5306	R0.54	103	R102	11
Canteen	R3,256	5728	R0.57	R2,134	3744	R0.57	145	R961	12
LABOUR	R664,572	45824	R14.50	R618,420	42650	R14.50	102	R13,316	13

Table 7.6: Extract from Productivity Statement: Labour input.
(see Appendix F)

In column 3, an imaginary physical input quantity for period 1 is derived. All the input elements, no matter their particular physical scale (defined or undefined) are converted to a scale equal (individually) to the total output tonnage of period 1.

The physical quantity for salaries in period 1 (col. 3, line 5) for example is taken to be 5728 "imaginary" physical units. The argument is that for the base period, to deliver an output of 5728 physical units, it requires an input of 5728 imaginary physical salary units. The average unit cost price for salaries is derived by dividing the imaginary units into total cost, i.e. R241166/5728 = R42.10. The same calculation principles apply to other inputs in period 1.

7.7.2.2 Deriving Equivalent Input Quantities for Period 2

Again using the salary input to illustrate: The average unit cost price from period 1 (R42.10) is tranferred to period 2 (col. 7, line 5). By dividing the average unit cost price into the total cost (col. 5, line 5), an equivalent or "imaginary" input quantity (5559 in col. 6, line 5) is derived for period 2.

As the formulation in period 2 stands, some monetary value (unit cost price change) may possibly have been translated into the "imaginary" physical scale if real (but unknown) unit prices have changed. This means that the difference between the "imaginary" quantity in period 1 (5728) and period 2 (5559) is a function of more physical units having been consumed, as well as possibly a change in unit price being translated into the 5559 in period 2. These arguments essentially reflect the difference between "physical" quantity in this model and other models.

If the intention is to obtain equivalence in the sense of derived real physical quantities, the total monetary value first has to be deflated with the appropriate price index.

7.7.3 Calculating the Productivity Index

Given the productivity statement format, productivity as operationally defined, can be calculated on three multi-factor levels of input aggregation: The first is on a single account level, i.e. salaries, protective clothing etc. The second is on a grouped basis, i.e. labour input, capital input, production support services etc. The third is on an all factor "total" input basis.

Notwithstanding the level of aggregation, the formula for calculating productivity is the same in each case. The results of the two periods' productivity ratios are not included in the productivity statement. These calculations are done automatically to culminate as a period change index in column 8. Each index (per input category) is calculated by first determining the productivity ratio of period 1, and then dividing that into the productivity ratio of period 2. To illustrate, using the packing materials input element on line 18 of table 7.7:

1	2	3	4	5	6	7	8	9	
MATERIALS INPUT	April Current Total Value	April Tons	April Derivrd Unit Price	May Current Total Value	May Equiva. Tons	May Constant Unit Price	PRODUCTIVITY Index	Profit Movement	Line Ref.
Raw Materials	R3,818,548	5728	R666.65	R3,630,982	5447	R666.65	100	(R1,103)	15
Railage IN	R209,602	5728	R36.59	R212,642	5811	R36.59	94	(R13,396)	16
									17
Packaging	R789,747	5728	R137.87	R771,993	5599	R137.87	97	(R21,266)	18
									19
Insurance	R6,547	5728	R1.14	R6,929	6078	R1.14	90	(R705)	20
Storage Premium	R261,454	5728	R45.64	R263,219	5767	R45.64	94	(R14,683)	21
MATERIALS	R5,085,898	28640	R177.58	R4,885,765	27513	R177.58	99	(R51,154)	22

Table 7.7: Extract from Productivity Statement: Materials Input.
(see Appendix F)

1. Productivity ratio period 1:

   = (total physical output)/(imaginary input)

   = (col. 3, line 4)/(col. 3, line 18)

   = 5728/5728

   = 1

2. Productivity ratio period 2:

   = (total equivalent output)/(equivalent input)

   = (col. 6, line 4)/(col. 6, line 18)

   = 5445/5599

   = 0,97

3. productivity index for packing material:

   = period 2 ratio/period 1 ratio

   = 0.97/1

   = 0.97

Calculating the partial productivity for an input group such as materials for instance, the same procedure is followed as above. Referring to table 7.7, the productivity index for materials is .99 or 99 (col. 9,line 22), meaning a deterioration of 1% in productivity for that particular group. The rest of the index readings are self-explanatory. Total productivity for the company improved by 1% as reflected in column 8,line 88 - See Appendix F.

7.7.4 Introducing New Input Components

As the model stands, a debit balance in the income statement of any subsequent period will automatically be taken up in the productivity statement. The more detailed the account classification in the base period, the less is the risk of a misallocation of input elements in succeeding periods. It is possible to create a new account (or input) heading, representing an input of a kind not reflected in the base period, in a subsequent period. The total monetary value of such an entry can be reflected in column 5 in the normal manner, without a unit cost price being stated or equivalent quantity calculated. No element index calculation is done (since it has no base period comparison). The total monetary value will nevertheless be taken into the group total (labour, materials etc.). The group's average unit price, to which the new entry is allocated will remain unchanged. The reason for this is to determine the money-valued productivity shift relative to the base period of the resource grouping being measured. The same principle applies in the case of a cost element having been separately debited in the base period, and now reflecting a nil balance in a subsequent period.

7.7.5 Profit Movement

Column 9 is an indicator of the change in profit for period 2 brought about by the change in productivity for each line item.
For example, the decrease in productivity of 2% on salaries (line 6 in table 7.6) sacrificed R4779 in profits for period 2. The loss or gain on each line is calculated as follows:

Change in profit = (Qty. change in output - Qty change in input) x total cost period 1
=(col 6, line 4)/(col 3, line 4)-(col 6, line 5)/(col 3, line5) x (col 2, line 5)
= ((5445/5728)-(5559/5728))(241166)
= R4779

Note that the profit on the income statement and the profit on the productivity statement differ to the extent that the latter is based on production figures and not sales.

7.8 INTERPRETING THE RESULTS

7.8.1 A General intepretation

The logic for calculating "imaginary" equivalent quantities in period 2 is sound if the nature of the content is known to the person doing the analysis. Since output for the two periods have remained more or less the same, a shift in the productivity index is to be interpreted as: either a change in technical efficiency and/or a shift in current unit cost price and/or a shift in the input mix (per line item).

7.8.2 Interpretation in terms of objectives

7.8.2.1 "Provide an analytical productivity audit of company performance", was the first objective to be achieved. The operational definition of the productivity concept has been established as being of a money-valued dimension. An improvement in the index indicates that, given the three possible reasons for a shift in productivity (see above), a positive combined result, i.e. the trade-off, was positive in terms of what management paid for and how it applied the resource. By including more input elements into the same equation, the trade-off among the input elements as a combined measure is also displayed.

For the month of May (period 2), it was independently established that there are twenty seven elements of which the respective unit input prices did not change. In monetary terms this represents an amount of R6703688 (May) or 97% of all input. In other words, for virtually 100% of the inputs the money-valued productivity index and the physical productivity index are the same concept. By "no input unit price change", is meant that, had the same input purchased in May been bought in April, the price would have been the same. The values in column 6 can therefore be seen to represent real physical quantities in instances similar to the above. However, such interpretation should be cautiously considered since the "input mix" factor is still present and can, depending on the output product mix, vary to such an extent as to render such a supposition invalid.

7.8.2.2 "Facilitate productivity control of non-physical transactions" was the second objective to be achieved. Services are in many instances supplied to the company on a quoted price basis where it is difficult to determine the true value of such service to the company. Say, for example an additional fork lift has to be hired in period 2 (line 33). Various input-output combinations may result (nine in fact), of which only two are discussed to demonstrate the analytical approach:

1) an increase in input with no increase in output. In this example using period 2 as being some future period, it means that a R1000 hire cost would increase input by 581 equivalent units. Given an estimate of 5445 equivalent output units, productivity of the resource may deteriorate

by 9% (5445/581) compared to the base period. In terms of total productivity, the hire contract can affect productivity by 43 (R1000/R22.98 on line 88) equivalent units. This represents an estimated 0,01% deterioration in total productivity, i.e. (equivalent output est./43)/((col. 3, line 4)/(col. 3, line 88)), which is (5445/43)/(5728/315040) or (0.0181/126.6) which equals 0,01%.

2) an increase in fork lift input, with a decrease in other inputs, but with no change in output. Assume wages (line 6) can be decreased by R1500 as a result of the fork lift hire. In terms of the fork lift an equivalent value of 291 (R1500/R1.72)-(R1000/R1.72) or (872 - 581) units will be saved. In other words, total productivity can improve by 0,007% (same calculation method as in 1 above).

The same principles apply to less tangible services which can be made "physical" by way of the methods already described. When a service is used for the first time (no base period reference), the total cost can be included with an existing input component of nearest function. Unit cost price is not affected and the result of the additional input will translate into an equivalent quantity for the current period.

7.8.2.3 "Assist with the setting of productivity objectives in terms of money-valued efficiency and effectiveness" was the third objective. In terms of each line item input, a productivity objective can be set by adjusting the equivalent value in column 6 for expected price inflation to be offset by expected technical efficiencies, or whatever other condition is expected. The manager responsible for a specific group of inputs thus has a flexible choice for achieving the stated objective. The input objective should obviously be set relative to the same period's output as well as the base period's productivity. The input objective therefore is not a static number, but will have to fluctuate. In fact, the index percentage increase or decrease will be the objective. Expected fluctuation in utilization, as determined by output, will need to be taken into consideration when determining the equivalent input quantities. If physical output is cyclical, and monthly productivity comparisons are made, it might be wise to introduce a moving base period arrangement, whereby the current period measurement is compared to a base period, one year previously, i.e. May 1990 (base), May 1991 (current).

7.9 CONCLUSION

The validity of the operational concept definition can be argued. By applying deflation techniques to stabilise monetary value, technical productivity can be derived. If done, the question then is: How accurate is the result?

The aim is not to detail the causes of a shift in productivity. No generalist model on this level of measurement can do that. The aim is to monitor the effects or performance of activities in the company - in terms of the output/input concept.

CHAPTER 8

PRODUCTIVITY MEASUREMENT ON WORK STATION LEVEL

8.1 INTRODUCTION

The need for performance measurement on a work station and section level in the company was prompted by problems experienced on an industrial relations front. A major issue was worker (and management) motivation and commitment. A strategic decision was taken to improve the organizational structure by delineating more clearly areas of accountability and tactical operational decision making; thus repositioning the foreman into a strong leadership role.

To support the strategic endeavour, which admits controlled worker participation, the mechanics of the measurement system had to facilitate accurate and speedy performance information feedback. The project included the establishment of physical facilities to promote a team spirit in each section. Several "libraries" (group meeting areas) were established in the various sections to assist formal communication on tactical operational planning and measured performance feedback.

Measuring productivity on lower levels in the organizational structure as presented, can basically follow two routes: The industrial engineering approach, whereby the efficiency of each resource utilized, is measured. Or the "performance indicator" approach, which measures the performance of identified productivity factors, i.e. effectiveness.

This chapter reflects the broad framework and examples of how the measurement challenge was handled on a section and work station level.

8.2 APPLYING THE MODEL DEVELOPMENT CRITERIA

Developing a measurement system starts off by drawing up a measurement profile fact sheet, based on the criteria stated in chapter 6. If, for whatever reason or constraint, measurement on a lowest level of aggregation (work station) is found to be impractical, the level of aggregation can be moved up. Figure 8.1 reflects the different levels of recognised organizational aggregration.

8.2.1 Setting up a Measurement Profile Fact Sheet

Any suitable visual format can be selected for the fact sheet. It should nevertheless contain at least three broad categories of information: Firstly, information relating to the situational conditions within the unit of analysis selected. Secondly, existing constraints relative to each condition identified. And thirdly, possible solutions to the constraints.

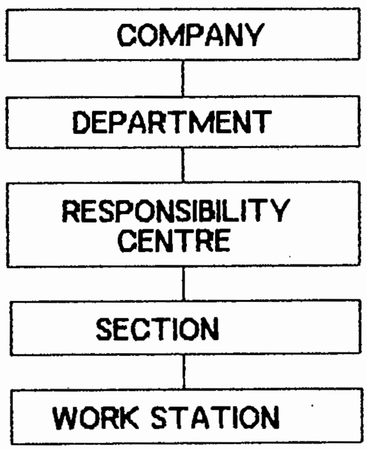

Figure 8.1.: Levels of Recognised Organizational Aggregation in the Target Company

Situational Conditions: Having identified the unit of analysis, the first step is to connect all the relevant subsystems to the unit of analysis. A second step is to stipulate the purpose of the measurement as it relates to the unit of analysis. The third step is to define and list the performance criteria considered appropriate and necessary to serve the purpose of measurement. Fourthly, establish the availability of the type of data required, for the unit of analysis, as well as on lower subsystem level. Step five is to determine the availability and reporting cycle of each data (and/or information) type, i.e. daily, weekly and/or monthly. Step six is to determine feasibility and preference to integrating the system to a higher level of organizational aggregation. At this stage it also has to be decided whether the measurement system can be internally managed or if outside administrative resources would be required. Step seven is to define, precisely, the user profile. The final step is to identify possible measurement modelling approaches, i.e. index, objectives matrix, industrial engineering, or any other.

Since the criteria are interdependent, step selection need not necessarily follow the same sequence as above.

Constraints: A constraint may be identified in any of the criterion areas stipulated above. For example: The user profile may indicate illiteracy in a certain section, which means that pictorial reporting of results may have to be considered to improve comprehensibility. It may also mean that meter reading instead of data "write up" is required for data collection at work station level; or that a specific training program should first be instituted. A constraint will be relative and situational, applicable only to the specific unit of analysis.

Solutions: They may be long term and/or short term and of a nature not foreseen when the intention to measure was first mooted. The process of scheduling longer term solutions is best handled by phasing objectives. For immediate action, the focus should be on aspects pertaining to the "ability to measure". The approach should be positive and energetic with a view to start the measurement process without delay. A compromise situation will most probably arise, given the totality of constraints. In such situations the versatility of the measurement system, becomes all important.

It should be obvious that every individually identified unit of analysis will have its "own" profile. For each a fact sheet can be drawn up.

In the work that follows the packaging section of the responsibility centre (product group 1) containing work stations 33, 34 and 35 (see Appendix C), will be used to illustrate the measurement techniques and principles utilized on this level of organizational aggregation in the company.

8.3 MODELLING THE WORK STUDY APPROACH

Two of the work stations (33 & 34) covered by the intended measurement, each consists of a series of machines in a continuous flow production mode. Each series, with five operators/workers on each process, is defined as a work station. The third work station (35) also consists of a series of interconnected machines, but the process is utilized intermittently on a batch production basis. One foreman oversees all three stations. Another seven workers service all the machines with packaging material handling, palletizing packed product, general cleaning and relief duties. Although activity-wise, each bank of machines (work station) operates independently, 33 & 34 feed on raw material off the same process further up the line (another section with its own foreman). Work station 35 is connected to yet another process and packs a variety of derivative products. All the processes are machine driven, but under operator control. Work in progress can be stored either immediately before or after each of the processes mentioned.

8.3.1 Theoretical framework for measurement

Applying the so-called industrial engineering approach of productivity measurement, involves work study techniques to establish work standards. Supportive to the concept of work study are the techniques of method study and work measurement. The former is aimed at the development and application of more efficient methods to ensure optimal utilization of resources. The latter is aimed at establishing time standards against which the performance of work can be measured.

The interest here is not method study. Method study comes into its own during productivity improvement and operator training. These needs will be identified by the measurement process.

Work measurement can be direct or indirect. Direct measurement consists of stop watch measurement and activity sampling. Indirect work measurement can be an estimate and/or acceptance of standards supplied by someone else, such as the supplier of a machine. The establishment of work standards can be taken in a wider context than that of quantitative standards, to include financial standards which bring the process into the sphere of a standard costing system. Figure 8.2 clarifies:

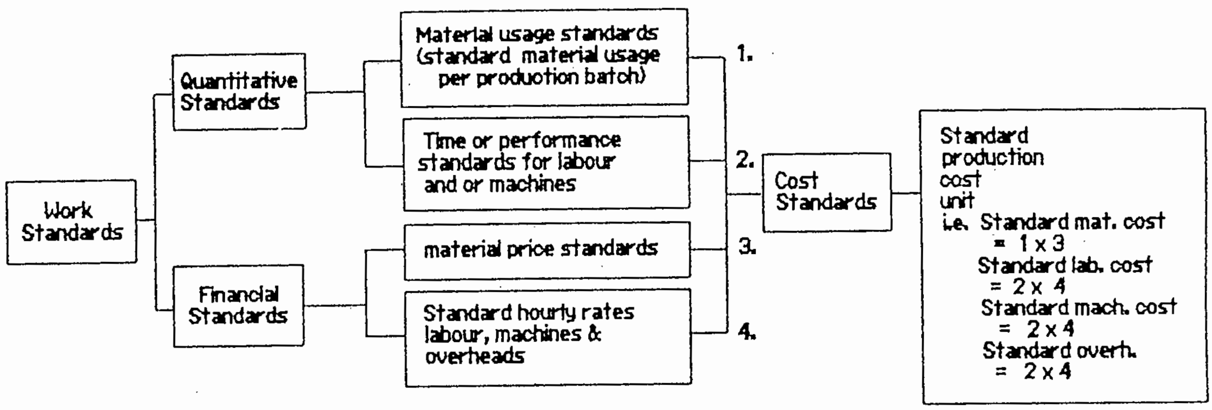

Figure 8.2. : Diagrammatic representation of standards determined in the production department and how they are utilized in the calculation of standard unit costs.
Source: De Bruin, J.W.A. S.A Chartered Accountant p. 140

Work station performance is measured in terms of machine efficiency and process effectiveness based on quantitative standards (see figures 8.4 & 8.5).

8.3.2 Situational Examples

All the examples relate to work station 33, but the same principles apply to the other work stations (manufacturing).

8.3.2.1 Machine Efficiency (work station 33)

The first performance measure is machine efficiency. Efficiency is derived from the utilization concept.

8.3.2.1.1 Machine Utilization - Data collection

The recording of production data originates in the work station and is done on a continuous basis throughout the working day. See production control chart in figure 8.3.

Data is recorded in the following categories:

Production start and stop times: The period in between is seen as time "in control" of the operator. Start and stop times are determined by shift management.

Units produced: are meter measured, whereby the finished products (in retail units of 500gm) coming off the production line is recorded. These quantities are translated into wholesale pack sizes and reconciled with receipts in the warehouse (the next process or work station).

WORKSTATION I.D.: 33

DAILY WORKSTATION PRODUCTION RECORD DAY: MON DATE: 13.9.90

TIME	WRITE TIME	TICKET /COUNTER NUMBER	WEIGHTS 1	2	3	4	5	6	DOWNTIME
STOP									
5.00									
4.30									
4.00	4.00	SHIFT END							
3.30	3.30	CLEANING							15 m. CLEANING
3.00	3.15	45760	505	506	506	504	505	505	
2.30		38120	498	499	499	503	503	503	
2.00		34780	503	504	504	505	505	503	
1.30		31320	504	504	505	498	499	498	
1.00		30920	489	489	493	494	502	504	30 m. LUNCH
12.30		26420	503	504	504	505	510	511	
NOON	12.10	23120	506	506	501	503	503	504	
11.30		20430	510	502	502	503	504	505	
11.00		17210	496	503	503	503	504	504	
10.30		15810	495	503	503	506	506	505	
10.00		15810	503	501	504	507	498	498	30 m. TEA
9.30		13210	500	504	502	502	502	502	
9.00		10150	503	501	503	504	504	504	
8.30		7839	501	500	502	501	502	503	6 m. CARTONER
8.00		5600	500	502	500	501	501	502	
7:30		2100	501	503	500	501	502	501	5 m. INNER SETTING
START	7.00	0		DATE CODE:		96			

PRODUCT DESCRIPTION	OPENING STOCK	WHOLESALE UNITS TICKET/METER	"AFTER - METER LOADING	"AFTER - METER REJECTS	CLOSING STOCK	TRANSFER TO WAREHOUSE
WHOLESALE	CASES	CASES	N/CASES	N/CASES	CASES	CASES
24 x 500g	4	0	1906	107 UN.	0	1906
				4 CASES		

PACKING MATERIAL LOSSES

0	SACHETS Kg
3.75	INNERS Kg
13	OUTER CASES

TIME SUMMARY

	MINUTES
PAID TIME	540
TOTAL D/ TIME	95
MANAGER TIME	30
PAID REST	15
MACHINE	20

Completed by: [signature] Date: 13.9.90 Time: 5.10

Figure 8.3.: Production Control Chart

Quality check weights: Sample weights are recorded on a continuous sample basis.

Downtime: Any "stoppage" on the packing line lasting longer than 4 minutes is recorded together with reasons by the operators. If the work station is non-operational for the day, this is recorded as being due to manager's scheduling. See figure 8.3. For normal stoppages, a timer sets off a warning hooter after 4 minutes of stoppage on the production line. The reasons for downtime are recorded on the production chart and summarised in the right-hand bottom corner. Any downtime not recorded, will automatically be captured in the efficiency calculation.

8.3.2.1.2 Operational Definitions - Standard Output and Actual output

Refer to figure 8.4, which summarizes the elements to be discussed. Also see in Appendix H an example of an actual report relating to the efficiency calculations of all the packing operations (work stations) in the company.

The standard output levels of each work station is formulated to suit the circumstances. For work station 33 there are two standard output definitions. The one refers to the output to be accounted for by the operators on the work station, i.e. time between the shift start and stop times as determined by the manager. The other definition is for those periods of the available total time (i.e. time paid for in terms of shift wages), not utilized by the operators due to instruction from the manager.

Total machine capacity available: is the total potential standard output. It is the paid time of the shift, converted to physical capacity, multiplied by 80% of the maximum potential throughput capacity of the slowest machine on the line. "Maximum potential" is the manufacturer's specification. Normal paid time is a standard nine hours per day. Overtime hours, if paid for, are included in the standard output definition. The departmental manager is accountable for recording this time.
In the example (figure 8.4), total standard output is calculated as 540 minutes multiplied by 140 units/minute, multiplied by a machine rating factor 0.80; giving total standard output as 60480 retail units per (this) working day for the work station.

Machine capacity to the operator: is the capacity available to the operator. It is the time between the shift start and shift stop. If the foreman or manager instructs the operator to stop earlier in the day, for the labour to be utilized elsewhere, the time (in equivalent physical units) is subtracted from the total capacity available to calculate "machine capacity to operator", or capacity available to the operators. In the example, operator's capacity available is calculated as 60480 - 3360 = 57120 units. The manager instructed the operation to be stopped 30 minutes before full time, resulting in a loss of capacity of 30 x 140 x 0.80 = 3360 units.

Total machine capacity utilized: This is recorded from the production control chart (diagram 8.3) as 45760 units minus the rejects of 107 units. Therefore actual output is 45653 units.

From the production chart, time losses are converted into equivalent units. The foreman of the section then summarizes the time losses on the production chart. The chart is delivered to the production planning clerk who enters the data on computer to print a report as in Appendix H. The time losses are calculated as follows (refer to figure 8.4):

Calculated total capacity losses: This is the difference between total capacity available and total capacity utilized, that is, 60480 - 45653 = 14827.

To manager's scheduling: is the recorded equivalent capacity lost through instruction from the manager or foreman to halt production 30 minutes before standard paid time, i.e. 30 x 140 x 0.80 = 3360, as per the control chart.

To operators' handling: is the total time in equivalent units, lost by the operator(s). This is calculated by subtracting the manager's scheduling loss from the total calculated capacity losses as defined above. The 11467 units are made up as follows - from the control chart:

Operator losses:

Rejects = 107 units.

Rest period = 30 minutes x 140 x 0.80 = 3360. This period is automatically subtracted as a loss. If the personnel on the work station are able to find an innovative way to stagger their lunch break, this time may be scored to improve their efficiency.
Cleaning period = 15 minutes x 140 x 0.80 = 1680. These are units lost through stopping to clean the machine line.
Machine idle periods = 20 minutes x 140 x 0.80 = 2240. These are attributable to machine stoppages (longer than 4 minutes per incident).

The total "operator" stoppages on the line as recorded on the production chart add up to 7389 equivalent units lost. The check balance under the heading "to operator's handling" gives 11467 units. This means that 4080 units were not declared on the control chart by the operator. This amount is added in under "undeclared operator loss" to balance the efficiency statement.

Material waste: to inner packaging and outer cartons is not part of the machine efficiency calculation. Although included as part of the data gathering on the production control chart, it is an indicator of processing efficiency (in terms of material losses). The percentage loss recorded for both the inners and outers is based on the "total machine capacity utilized", i.e 45760 units. Inners are recorded in kilogram mass and converted in the computer program (Appendix H) to retail units. For the outer carton calculations the 45760 is converted into outer units as per the production chart which gives a base of 1906 cartons.

Efficiency Reading Work station No. 33

	Base units	Percentage
Total machine capacity available:	60480	100.00 %
Total machine capacity utilized:	45653	75.48 %
Calculated total capacity losses:	14827	24.52 %
To manager's scheduling:	3360	5.56 %
To operator's handling:	11467	18.96 %
Machine capacity to operator:	57120	100.00 %
Operator losses; Total:	11467	20.00 %
Rejects:	107	0.19 %
Rest:	3360	5.88 %
Cleaning:	1680	2.94 %
Machine:	2240	3.92 %
Undeclared operator loss:	4080	7.14 %
Operator's capacity utilized:	45653	79.92 %
Material Waste -Inners:	112	0.24 %
-Outers:	13	0.07 %

Figure 8.4: Efficiency calculation example

8.3.2.1.3 Efficiency Operationally Defined.

In terms of overall machine (and labour) efficiency on this particular work station, the efficiency reading is 75.48% - refer to right-hand column in figure 8.4. Given the stated objective, namely worker commitment this is not considered the most important indicator. The efficiency reading that the operators will be watching is 79.92% as indicated under the "operator's capacity utilized" heading. This they can control.

The format of machine utilization reporting as used here closely matches the engineering format or work study approach demonstrated in chapter 5.

8.3.2.2 Work station Effectiveness

Effectiveness standards relating to different performance factors have been adopted. For this work station it is agreed that:

Cleaning time should not exceed an equivalent output of more than 5% of "operator's capacity available", i.e. paid time minus manager scheduled time multiplied by the output rate per minute multiplied by the machine rate setting factor. For the particular production day, the target is calculated as: (540 - 30) x 140 x 0.80 x 0.05 = 2856 equivalent units.

Machine, Undeclared & Operator Rest Losses should not exceed 10% of "total capacity utilized", i.e. 45653 x 0.10 = 4565 equivalent units.

Rejects should not exceed 0.8% of total units processed ("total capacity utilized"), i.e. 45653 x 0.008 = 365. Packaging Wastage should not exceed 0.5 % of total processed on inners ("total capacity utilized"), i.e. 45653 x 0.005 = 228 equivalent units, and 0.2% on outer cartons, i.e. 1906 x 0.002 = 4 equivalent units.

Figure 8.5 summarizes the equivalent target unit comparisons with the actual levels recorded. Appendix I contains the actual weekly effectiveness report (derived from the weekly efficiency report - Appendix H) presented as feedback to the work station.

Effectiveness Reading Work station No. 33

	Target	Actual	Better/(worse)
Cleaning	2856	1680	1176
Machine/Undecl/Rest	4565	9680	(5115)
Rejects	365	107	258
Wastage inners (packaging)	228	112	116
Wastage outers (packaging)	4	13	(9)
Total Team Effectiveness	8018	11592	(3574)(44.5%)

Figure 8.5: Effectiveness calculation example

According to the example, the actual total effectiveness losses exceed the target by 3574 equivalent units. That is, effectiveness is running 44.5% below target.

In line with the goal expressed at the beginning, regarding formal communication and feedback, the efficiency and effectiveness results are graphed for discussion and display in the library area on a daily basis.

8.3.3 Materials Utilization

Two major categories of material are involved, namely processed raw material and packaging. As already stated, it is difficult to record raw material yield on a daily basis according to the above method, given the nature of raw material and the vast bulk amounts in process at any given time. Raw material stock is taken at the end of each month and usage calculated for financial purposes. Incidentally, this information indicates satisfactory yield which diminishes the need for daily or even weekly measurement. Should monthly measurement reveal a deterioration, a higher frequency could be reinstated.

Packaging material wastage is recorded on the production control chart for which a target is set to measure effectiveness. Physical inventory checks are taken weekly for purposes related to the master production schedule. The fact that suppliers of packaging material have agreed to credit all packaging wastage in full, has resulted in this element carrying a low priority in measurement. The measurements taken on a work station level are considered adequate for motivational purposes.

8.4 CONCLUSION

The company has identified 53 work stations in the manufacturing department. In certain instances, such as factory maintenance, a work station may consist of a team of two people - the artisan and his assistant. In another, it consists of one operator and an integrated bank of 30 machines. In each instance the same industrial engineering measurement approach principles, relating to efficiency and effectiveness, are being progressively instituted and applied. All measurements are of a quantitative nature. In keeping with the measurement objective stated at the beginning of this chapter (worker motivation and commitment), any activity which cannot be reported on, on at least a weekly basis, is not taken up into work station measurement.

The efficiency with which any resource in any work station is being utilized, can potentially be measured. Where it is not feasibly practical to measure efficiency, the focus can be on effectiveness. Alternatively the work station can be incorporated into a larger unit of analysis where other forms of productivity measurement are possible.

*

CHAPTER 9

PERFORMANCE MEASUREMENT ON SECTION LEVEL

9.1 INTRODUCTION

Comprehensive and independent work station measurement is not always feasible. Without losing sight of the measurement objectives, the unit of analysis then needs to be expanded to include more than one work station. That is, the unit of analysis has to be redefined. In terms of the organizational structure, it means one step up to section level.

Circumstances will dictate which resource measures are better suited to section level measurement as opposed to measurement on work station level. Refer to the criteria in chapter 6.

This chapter is an extension of chapter 8. The principles regarding section level measurement as applied in the target firm are explained. The focus is firstly on labour productivity measurement. Thereafter application of the Objectives Matrix Measurement Method is demonstrated.

9.2 LABOUR UTILIZATION

From the productivity statement presented in Appendix F, it can be seen that labour is a major expense. Notwithstanding its importance, it is not feasible to measure labour utilization on work station level. Labour mobility between work stations in each responsibility centre is one reason for this constraint. On section level however, it is possible to isolate and measure three dimensions of productivity on labour.

Of the three dimensions of measurement, two are based on the Industrial Engineering Approach. The other one is a partial productivity measurement, based on the Index Approach.

Figure 9.1 is an extract from Appendix J. The latter is the actual complete labour productivity report, published weekly in the company. The table's content is utilized to explain the measurement concepts involved. The data relates to the packing section (section No. 12) of Product Group No. 1. - a responsibility centre identified in the organizational chart.

9.2.1 Industrial Engineering Approach - Time Standard.

A weekly standard (quota) of total work hours required is

RESPONS.CENTRE:	Product Grp.1	Line Ref.
SECTION:	Packing Section	
Hours Normal	1690	1
Worked Overtime	22	2
Total	1712	3
Equivalent Man-week	37	4
Value Normal	R8,230	5
Paid Overtime	R142	6
Bonus		7
Misc.		8
Company Contrib.	R1,646	9
Sick leave	R75	10
Annual Leave	R672	11
Total	R10,765	12
Casual Hours	34	13
Equivalent Man-week	1	14
Casual Value	170	15
All Man-week	38	16
All Value	R10,935	17
Man-week Index	0.90	18
Value Index	0.99	19
Output - Tons	432	20
Output/Man-week	11	21
Cost:R/ton	R25.31	22
Absentee Rate	0.59%	23

Figure 9.1 : Labour Productivity Report.

(Extract see APPENDIX J)

allotted to each section. This quota is determined as part of the annual budget exercise. Labour hours allotted are taken to be constant through the year, the logic being that machine capacity is able to handle seasonality. Should the machines be under utilized, the labour cost remains constant. Given the methods to be applied in measuring productivity, the hour allotment issue is relatively unimportant. Nevertheless, for each section a weekly, man-day and monetary value quota is set. The first week then serves as base period standard.

Standard output: A total of 1940 (not shown on report) man-hours were allocated in the packing section. This includes overtime hours. The total hours have the same meaning as "total man hours available", demonstrated in Figure 5.3, chapter 5.

Actual Output: Is taken from the clock cards through a computerized program for each department. Actual hours include:

-Ordinary time worked by permanent employees (1690 hours line 1), plus

-Overtime worked by permanent employees (22 hours line 2), plus

-Casual labour (34 hours line 13)

Movement of permanent employees between sections and departments are accounted for by means of a system called "the green card". A Foreman is permitted "to sell" labour on a day to day basis to another foreman (in another section) on condition that the "buyer's" section is debited with the hours.

Efficiency is calculated as:

Efficiency (utilization) reading

Section No. 12

		Hours	Percentage
Standard Output available		1940	100.00 %
Actual Output utilized		1746	90.00 %
	Difference	194	10.00 %

Efficiency for the week improved by 10.00% as reflected by the man-day index reporting of 0.90 on line 18 in figure 9.1. No effectiveness target is set in this dimension.

9.2.2 Industrial Engineering Approach - Economic Standard.

In this dimension the scope of output measurement is expanded to include the monetary value of elements not captured in the time dimension.

Standard Output: The economic value of each unit of labour includes all costs connected to each head count. That is, ordinary hours multiplied by the specific estimated wage rate plus overtime plus bonusses (pre-determined) plus so-called company contributions (pension fund, etc.) plus an annual leave provision. There is no provision for sick leave. The total monetary amount for section 12 is given as R11045 - hidden and not reflected in the report.

Actual Output: The following is recorded:

-monetary-valued ordinary hours payment to permanent employees (R8230 on line 5)

-monetary-valued overtime for permanent employees (R142 on line 6)

-annual leave pay (R672 on line 11)

-all bonusses and employer contributions (R1646 on lines 7 to 9)

-all sick pay (R75 on line 10)

-Payments to casuals (R170 on line 15)

According to the report:

Economic Efficiency (utilization) reading

Section No. 12

	Value	Percentage
Standard economic output available:	R11045	100.00 %
Total economic output utilized:	R10935	99.00 %
Recorded economic gain:	R 110	0.99 %
Sick Leave:	R 75	0.67 %
Undeclared:	R 35	0.33 %

Economic Efficiency as recorded, is running at 1% better than the "break-even" standard in the report, i.e efficiency reported on line 19 of figure 9.1 has improved by 1.00% this week compared to the standard. No effectiveness standard is set in this dimension.

9.2.3 Index Approach - Partial Productivity measurement

Physical output of the section is recorded in the conventional manner, i.e. the throughput of physical material handled during the week. Partial input is recorded as either the man-hours committed to the process in the section, or as the monetary-valued input for the same week.

Referring to line 20 of figure 9.1, output for section 12 is recorded as 432 tons. To calculate efficiency:

<u>Technical Efficiency</u> = Output/Physical Input (average man-days/week).

= contents line 20/contents line16

= 432/38

= 11 which is the productivity ratio.

The result may be indexed on a base period. In practice, each week's ratio is calculated by the section foreman. The result is then graphed (for 52 weeks) in the library area of each section.

<u>Economic efficiency</u> can be calculated in a similar manner to technical efficiency. An operational ratio of total cost input/tons output (line 22) was found to be better understood by the workers, and is utilized as an "indicator" measure of economic efficiency - as defined in chapter 2.

In Appendix J it should be noted that output quantities are recorded in each section, except for sections in the engineering maintenance function. A totally separate computerized measurement system, has been introduced in this section. Time standards are set for each job, based on information on the job request card. An estimate of job duration is done by the responsible foreman. Actual time then taken by the tradesman to complete the job is noted and compared with the estimate so as to achieve an efficiency reading. The time noted by the tradesman is reconciled with the time recorded on his weekly wages clock card.

9.3 MODELLING THE MATRIX APPROACH

In the company most of the productivity management focus is on the different sections. It is felt that failure to secure a sound productivity management practice on this level, will negate any desired improvement anywhere else in the company. The improvement process is dynamic. Should the objectives change, the measurements should be reformulated where necessary.
To accomodate this very important requirement, the "Objectives Matrix" method promoted by Riggs and Felix [1983, pp. 222-234], is utilized. The method is versatile enough to accommodate any productivity measure or factor (quantitative or qualitative). Furthermore it combines all into one single indicator of performance. These include measures taken on work station level.

The packing section (no. 12) of Product Group No. 1, as a responsibility centre, is again used to illustrate the various principles related to the developing of the matrix method of measurement. The selection of specific performance criteria is done in collaboration with the staff in the

LINE REF. PERFORMANCE MATRIX SECTION NO: 12 WEEK NO: 13

LINE REF.		1	2	3	4	5	6	7	8	9
1.	PERFORMANCE CRITERIA	WEEKLY EFFICIENCY 33.	WEEKLY EFFICIENCY 34	WEEKLY EFFICIENCY 35.	WEEKLY EFFECTIVE-NESS 33	WEEKLY EFFECTIVE-NESS 34	WEEKLY EFFECTIVE-NESS 35	LABOUR PRODUC-TIVITY	HYGIENE AUDIT	
2.	MEASUREMENT RATIO	SEE LOTUS 12/2. OPERATORS EFFICIENCY	SEE LOTUS 12/2 OPERATORS EFFICIENCY	SEE LOTUS 12/2 OPERATORS EFFICIENCY	WEEKLY REPORT	WEEKLY REPORT	WEEKLY REPORT	OUTPUT / MANWEEK	HYGIENE REPORT	
3.	ACTUAL MEASUREMENT	% 80,5	% 85,8	% 72,1	% 5,4	% 16,7	% 13,4	11	% 72	
4.	10	≥92	≥92	≥85	≥21	≥26	≥26	≥17	≥98	
5.	9	89-91	89-91	81-84	21-25	21-25	21-25	15.5-16	90-97	
6.	8	87-88	87-88	77-80	16-20	16-20	16-20	14.5-15	83-89	
7.	PERFOREMANCE 7	85-86	85-86	73-76	11-15	11-15	11-15	13.5-14	76-82	
8.	6	83-84	83-84	69-72	6-10	6-10	6-10	12.5-13	68-75	
9.	SCORE ⇨⇨ 5	81-82	81-82	65-68	1-5	1-5	1-5	11.5-12	61-67	
10.	4	71-80	76-80	54-64	(1)-0	(1)-0	(1)-0	10.5-11	52-60	
11.	3	61-70	71-75	46-53	(7)-(2)	(7)-(2)	(7)-(2)	9.5-10	45-51	
12.	2	51-60	66-70	38-45	(13)-(8)	(13)-(8)	(13)-(8)	8.5-9	38-44	
13.	1	41-50	61-65	31-37	(19)-(14)	(19)-(14)	(19)-(14)	7.5-8	31-37	
14.	0	≤40	≤60	≤30	≤(20)	≤(20)	≤(20)	≤7	≤30	
15.	EQUIVALENT SCORE multiply	5	7	6	5	8	7	4	6	
16.	MANAGERS WEIGHTS	16	16	15	9	17	9	8	10	
17.	INDIVIDUAL PERFORMANCE INDICATORS	80	112	90	45	136	63	32	60	

18. CURRENT TOTAL PERFORMANCE INDICATOR 618

RESPONSIBILITY CENTRE NAME: PACKING PRODUCT No 1 COMPLETED BY: [signature]
DATE: ....

Figure 9.2.: Performance Matrix (example)

various sections. An example of a completed performance matrix is given in figure 9.2. It is used in the explanation of the steps to be followed when developing a matrix set-up.

9.3.1 Steps in Drawing Up a Matrix

9.3.1.1 Selecting Performance Criteria (line ref. 1): The productivity measurment fact sheet mentioned in chapter 7 will indicate which performance criteria can be accommodated in each section and work station - based on data availability and other practicalities. The range of criteria applied is further expanded in consultation with each section team. Criteria selected for the section team under discussion are:

1. Weekly efficiency rating: work stations 33, 34, 35.
2. Weekly effectiveness rating: work stations 33, 34, 35.
3. Section labour productivity.
4. Hygiene audit count.

For 1 & 2 above, see Appendix H and Appendix I respectively.

The basis for selecting certain criteria, apart from reliable data sourcing, is to select factors which are perceived to have the greatest influence on a section's productivity, or which is considered to be a problem issue. The factors chosen, must relate to activities controllable by the team. No more than seven performance criteria are permitted so as not to confuse, and to achieve some degree of focus on the important issues. The foreman of each section is responsible for writing up and graphing the results in the library area at stipulated times.

Note: The "hygiene audit count" listed above and not yet explained, is based on a hygiene inspection carried out each month by two foremen from another section together with the operational director of the company. A questionnaire listing 100 inspection points is judged for cleanliness on a 1-6 item scale. The score of all inspection points are totalled to give a mark out of 600.

9.3.1.2 Determining the Measurement Format for Each Performance Criterion (line ref. 2): A criterion may be recorded as a physical quantity , a ratio or a percentage. The scale level should not be below interval classification.

9.3.1.3 Establishing Performance Scales (line ref. 4 to 14): In the matrix itself, a utility performance scale (also termed a dimensionless scale) is introduced which runs from 0 to 10, thus giving eleven levels of accomplishment for each criterion. All possible results to be expected from each criterion are allocated into each column in the body of the utility scale level, on the following basis:

Utility scale level 0 should be the lowest expected result possible for the criterion on the actual measurement scale in use.

Utility scale level 4 is taken to be the operating results that represent the current average performance for each criterion.

Utility scale 10 should be a realistic estimate of a challenging result that can be attained over the next two years, given the same resource base for each criterion.

The intervals are developed on a linear scale in the following manner (Refer to the work station no.33's "machine efficiency ratio" performance criterion in Figure 9.2.):
The highest expected result is given as 92%. This is entered opposite the matrix utility scale level 10.
The average performance of (more or less) 79% is entered opposite the matrix utility scale level 4.

To calculate the interval spacings between levels 10 and 4, the difference 92 - 79 = 13 is calculated and divided by the 6 steps between 10 and 4 to give the interval range for each step 13/6 = 2.2 (approximately 2). In setting the minimum and maximum reading on each level, the readings should be mutually exclusive.

The lowest expected result is given as 40%. This is entered opposite the matrix utility scale level 0. To calculate the interval spacing between levels 4 and 0, the difference 79 - 40 = 39 is divided by the 4 steps between 4 and 0 to yield an interval range of 39/4 = 9,8 (approximately 10).

9.3.1.4 <u>Departmental Manager's Rating</u> (line ref. 16).
Management is responsible for assigning an importance weighting to each criterion. Through this exercise, management emphasizes which criteria are more important than others. To apply weighting, a 100 points are distributed between the listed criteria of the section. In figure 9.2 the departmental manager has decided to apply the weights as indicated.

With the completion of this step all the groundwork has been done. The steps that follow have to do with entering actual performance results and calculating a single performance value.

9.3.1.5 <u>Recording Actual Performance</u> (line ref. 3). The actual performance for each performance criterion is entered at the top of the matrix as indicated. In the example (Figure 9.2), data has been taken from the weekly reports in the Appendix section. See pages 168 for efficiency, 170 for effectiveness and 172 for labour productivity.

9.3.1.6 <u>Reading the Utility Scale Score</u> (line ref. 15). Actual performance is slotted in the appropriate interval and the equivalent utility scale score identified for placement at the bottom of the matrix under the criterion column. For the "work station 33" the utility scale reading on operator's efficiency is 5.

9.3.1.7 <u>Determine Performance Indicator</u> (line ref. 17). For each criterion the manager's weight (line 16) is multiplied by the utility scale score (line 15) to get the weighted performance value (line 17) for each criterion. All the performance scores are totalled to give a single "dimensionless" performance indicator for the section on line 18. This indicator (618

) is graphed in the library area.

9.4 SPECIFIC PRODUCT QUALITY

Specific quality standards, which have to be monitored by the operators, are stipulated for each work station. In theory the degree of conformance to these standards is taken to be one of many indicators of the level of effectiveness of the work station. In work station No.33, conformance to quality standards will be under control, if the daily average pack mass does not deviate more than 1% from the standard mass (500gm). Mass is monitored on a continuous sample basis from the production control chart. The workers are presently going through a learning process. More sophisticated statistical methods based on quality control charting are being maintained in other work stations where process control is more important than in the packing sections. In the packing sections, the scope of quality factors will be extended as circumstances allow. The work station's daily average packet mass is recorded separately in graph format in the library area.

9.5 CONCLUSION

In the target company the manufacturing department has seven responsibility centres. The responsibility centres in turn consist of seventeen sections altogether. It is therefore important that within each section, data is collected with the active participation of the foremen and of the workers themselves. Feedback of results on an routine basis is most important. To this end a dedicated administrative person (on computer) assists to speed data manipulation and reporting.

In introducing the system as set out above, it was found that interest from the side of the workers was best maintained if reporting was regular and consistent. A weekly time frame, as opposed to daily reporting was also found to be more beneficial. The fact that workers have indicated that they prefer a formal feedback before commencing the following period's work, is taken to indicate heightened interest and commitment to the job.

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CHAPTER 10

CONCLUSION - COMMENT AND RECOMMENDATIONS

10.1 INTRODUCTION

The introduction of a measurement system can be harmful to the morale in a company. A system's design should fit the organizational structure of the company. If it does fit, and if the structure is practical, people will perform. The nature of the structure is important and should be in harmony with the style of management in the company.

Measurement is only one of many factors contributing to productivity in the company. Its role should be to focus people's attention on those activities which contribute to productivity improvement. If its application is so intended, measurement becomes a strategic issue. It is within this context, that the benefits which have been derived by the introduction of the specific measurement systems, are commented on below.

10.2 IMPEDIMENTS TO DETERMINING MEASUREMENT BENEFITS

A year prior to measurement, the manufacturing organization was restructured to its present form. Coupled with this, tactical decision making responsibility was encouraged on the lower levels of management. Tactical decisions were to be based on the dictates of a simple, but effective production planning system.

During that same year, the company recorded a 54% increase in profit before tax, thereby reversing a downward trend evident over the previous three years.

One outstanding reason for the downward trend in previous years was that, notwithstanding adequate capacity, production was unable to cope with peak season demand. The production/delivery lag was 6 weeks. Within two months of restructuring, this time was reduced to 13 days. Since introducing productivity measurement this time was further reduced to the current position of 5 days, i.e. delivery to any depot in the Republic within 5 days of receiving the order.

Many other aspects of productivity have also improved since measurement was introduced nine months ago. It is however difficult to say exactly how much of the improvement was due to measurement alone.

The measurement system is not as yet fully established in all the responsibility centres. Some sections still have to establish library areas for instance. Performance measures have been introduced in all the responsibility centres, but are not yet summarized in a matrix for regular feedback to the work force in all the sections.

10.3 TOTAL PRODUCTIVITY MEASUREMENT - CURRENT SITUATION

From a usage perspective, the Total Measurement Model has not been successfully introduced. The potential users are still inclined to fall back on the financial statements for discussion and decision making. There are apparently three reasons for this:

1) The financial statements compare actual performance to current budget and to those of previous years. The productivity statement does not carry this information.
2) Top management is more comfortable with the financial concepts and ratios in dealing with their peers.
3) The introduction of productivity statements has led to the financial function drastically improving the reliability of financial reporting. Committed and outstanding cost concepts have now been pinned down to such an extent that new operating procedures and financial systems operation have been introduced to accurately determine actual costs. The "provisions" reporting principles promoted in the productivity statement have also been adopted in financial reports.

To date the productivity statement has been written up independently. Given the size of the company, the next step should be to integrate the system with the financial one through automatic computer manipulation. Automation will ensure the effortless building of an historical data base for forecasting and planning purposes.

10.4 IMPROVEMENTS IN MANUFACTURING

Since introducing measurement, performance indicators have recorded a gradual improvement in efficiencies. At the same time middle and lower management have reacted positively, improving other aspects of operations.

10.4.1 Efficiency

In every work station, without exception, "operator's capacity utilized" (see diagram 8.5) has improved since April 1990. On work station no. 33 for instance, the efficiency reading which started at 69% , currently (September) stands at 89%. Capacity lost as a result of "manager's scheduling" at first decreased. As demand levelled off toward the end of the peak season, it increased again. This trend is interpreted as meaning that the same physical production is being attained in less time, leaving spare time. The assumption is supported by the improved results on "operator's capacity utilized"; i.e. "manager's sheduling" has improved, and the increase is not a result of poor planning - on the contrary.

The results of the productivity measurements taken from the schedules such as the one presented in Appendix J, indicate no noticable change in labour productivity. This result does not mean that labour productivity is stagnant. The problem is that the operational definition of output is incomplete. It only covers physical output with respect to work station production. The labour is obviously at times being utilized on other jobs (see "managers scheduling") of which the output cannot be recorded, such as housekeeping chores.

The kind of information obtained from the measurements no doubt gives the answers required and which is understood by lower management. The application of graphics adequately reflects trends which are understood by the majority in the work force.

10.4.2 Other Benefits

There has been changes in management practice and worker attitudes which can be ascribed to measurement. The activities noted below are all connected to measurement in some way:

1) Whereas managers were office bound before, they are now spending much more time on the factory floor.

Consequently, processes which have been in operation for many years are being simplified. So far this year more than 75 tons of redundant equipment have been removed from the factory floor to storage. Middle and lower management are making time available to take an active lead in getting things done. Examples are the spray painting of older machines, obtaining outside quotes to refurbish certain machines, etc. This is being done within the parameters of their budgets.

2) Factory floor space has increased by approxmately 10% as a result of the actions taken above. This means easier cleaning and higher scores on the hygiene audit.

3) In the past, operators were not inclined to do any maintenance on their machines. That situation has also changed completely. In the one packing section, for instance, a small "workshop" area has been set aside for certain machine spares and tools to be kept. This has resulted in less machine downtime and improved "operator's capacity utilized".

4) Workers are much more willing to do different jobs. Not so long ago it was considered "worker exploitation" if a worker was asked to do another job. There is a much higher incidence of "green card hiring". The sections "hiring out" labour are gaining through man-hour savings, which is reported on the labour productivity schedule (Appendix J).

5) Materials management has improved. Whereas packing material shortages was a constant problem two years ago it is unheard of today. The packing material stock holding in terms of mass, has on a monthly basis decreased by 7%, compared to the previous year.

6) Over the past 18 months, manpower headcount in the manufacturing department has been reduced by 13%. During the same period absenteeism has dropped from 6% to 4%.

7) There is a greater willingness on the side of production staff to try new ideas. During the past seven years the company has only launhced 2 minor new products, which was done in 1989. Now, two major launches are planned for 1991. Production management apparently feel more comfortable and in control of their situation, given the performance measures introduced.

10.5 RECOMMENDATIONS

The introduction of the total productivity measurement system was premature. The fact that many of the recommendations suggested under "income statement issues", discussed in chapter 7, have been adopted by the company, is seen as a step closer to acceptance of the productivity statement concept.

In retrospect however, the total measurement system should only have been introduced <u>after</u> the successful introduction of the matrix system in the manufacturing department. The benefits obtained from such a system are immediate, and they open the way for acceptance of the much more involved and difficult task of total productivity measurement. If the exercise had to be repeated, total measurement would be targeted at responsibility centre level, with the emphasis on partial measurement with the objective to improve operational decision making through improved control. Thereafter the system can be expanded into other areas to include the whole company.

With regard to the measurement system introduced on section and work station level, the results thus far have surpassed all expectations. It is too early to recommend any changes to the system, except to say that in the introductory phase, section management requires a lot of moral support from top management until the whole process of information collection and feedback has become routine.

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APPENDIX A

'BRANDS ARE ASSETS'

Research Digest

Keeping You In Touch with Research

August 1990

The Smarter Generation

The challenging, changing, dynamic, turbulent, sometimes bewildering marketing world makes us uneasy, uncomfortable, even confused. Some say we should get back to basics. Not to old basics. We need to identify and practice new basics.

Market globalisation, agency concentration and retail polarisation have changed the marketing landscape. When the market changes, marketing must change. The consumer is the ultimate arbiter of success. The new consumer is more sophisticated, more sensitive, more selective, and more sceptical than ever before.

For the first time in the history of the world, 50% of the world's school-age population is enrolled in school. For the first time in history, half the children of the world have the opportunity to learn the basic skills for turning darkness into light. But, education is more than just schooling. When school ends, homework ends and learning begins. This generation has access to, and is exposed to, more information about everything. They hear more, see more, experience more than ever before. Increased education and increased access to information are basic, fundamental, pervasive developments affecting society, politics, and business worldwide.

Smarter people live smarter. As education goes up, the percentage of working women goes up. Smarter women work for a raise in pay and also for a raise in praise.

As education goes up, family size goes down. As education goes up, occupational status changes from industrial to service, from lifting things to thinking things, from muscle to mental, from pushing steel to pushing pencils.

Smarter people live smarter and longer. They want to live better. They are more self conscious and more conscious of their physical selves. The Smarter Generation has a passion for fitness. They want to feel good and look good. They are health conscious. They are fitness conscious.

They don't want status symbols that say what snobs they are. They want those that say how smart they are. To the Smarter Generation,

BRANDS ARE ASSETS

This issue of Research Digest is based on Larry Light's speech at the sixth annual Reader's Digest Marketing Seminar in Canada.

Larry Light, President & CEO, Arcature Corporation, Stamford, Connecticut, is a PhD whose strategic planning and marketing management abilities have won him an international reputation in business and in academia.

"smart" isn't an IQ score, it is an attitude. To be smart means to be alert, resourceful, ingenious, intelligent, knowledgeable, bright, competent, clever, amusing, witty, wise, stylish, elegant, exclusive, fashionable, chic, trendy, scintillating, bold. The Smarter Generation wants to eat smarter, look smarter, feel smarter, live smarter, and buy smarter.

We have a more informed, more sceptical, more selective, more sophisticated, more sensitive, more questioning, more demanding, Smarter Generation of consumers than ever before. This is the Age of the Smarter Generation. Smarter people buy smarter. Smarter people value quality. They value money. They also value time.

To the Smarter Generation, time is as precious as money. Instead of spending time to save money, they will spend money to save time. It is not only how much time you spend, but how you spend your time that matters. Convenience used to be a reason why a product or service was cheaper. Today convenience makes it better. People actually prefer self-service. More and more people prefer the convenience of cash machines to waiting in line at so-called full-service tellers. At petrol stations, an increasing percentage of people say they prefer self-service. They will pay a premium to shop at convenience stores.

The Smarter Generation values quality, money, and time. That's why they value brands. They value brands because brands add value. Brands add value by promising a quality experience for your money and time.

The idea that brands add value to a product goes back to the dawn of marketing. In medieval times, a tradesman put a mark on his wares . . e.g. pewter, gold, silver, cloth. Since it was the mark of the tradesman, it came to be known as a trademark. The trademark was recognised as a very valuable asset.

Brands are Assets

Brands are assets. They are more than trademarks. They are *trustmarks*. A trusted brand is a genuine asset. When people purchase computers for their company, the trustmark IBM has a definite advantage. An executive knows that an IBM computer will be well made and well serviced. He also knows that he won't get fired for buying IBM. IBM doesn't stand for International Business Machines. IBM is a trustmark. It stands for "I Believe in this Machine".

"Goodwill" is defined as the financial value of the reputation a company has with its customers. That is what branding is all about . . . a reputation that a product/service/ company has with its customers. According to the accountants, however, the only way a company can recognise their years of investment in brand building is to sell the company. This policy encourages buying and selling rather than investing in brands.

Many executives are nervous about brands, too. To them, if you can't measure something, it doesn't exist. It's hard to measure feelings. It is hard to quantify desires, dreams, cares, concerns, ambitions, affection, loyalty, love. But, feelings do exist. Every customer comes with a brain and a heart. Brands appeal to both. A brand is more than a product. To product function, a brand adds feeling. To product performance, a brand adds personality. The role of advertising is to make a product into a brand. Brands are worth more than products. Brands are valuable assets.

Some critics argue that a reason for not treating brands as assets is the concern that the life of a brand might be limited. This makes no sense. The life of a brand is one of the few potentially unlimited assets of the company. Brand assets are enduring assets. *Brands outlive products*. For example, Mercedes has long ago outlived the original factories and the original employees.

This point of view is recognised in law. The law tells us that of the three forms of intellectual property, patents must expire. Copyrights expire. Only a trademark can be owned forever.

The Law of Dominance

All this emphasis on brands is very good. It forces us to focus on the true enduring assets of a company, the brand assets. And dominant brands are the best assets.

We conducted a special study of the return on investment (pre-interest, pre-tax) vs. market rank for 2746 businesses in the renowned PIMS data base. We found a clear relationship between market rank and profitability.

Here is the evidence:

MARKET RANK VS. ROI

RANK	ROI
1	31
2	21
3	16
4+	12

Businesses with a market rank of 1 average an ROI of 31 percent. Those with a market rank of 4 or worse deliver an ROI of only 12 percent. Market leaders are about two and a half times as profitable as those businesses which rank 4+. A 4+ business isn't really a viable business; it is an unprofitable hobby.

The pattern is consistent and clear. We call this pattern the Law of Dominance. One is wonderful. Two can be terrific. Three is often threatened. And four is usually fatal.

We recognise, however, that all leaders are not the same. There are dominators and there are marginal leaders. A market "dominator" is defined as a business with sales volume at least 1.5 times its nearest competitor. The remainder of number 1 businesses are defined as "marginal leaders".

MARKET RANK VS ROI

RANK	ROI
Leaders	
Dominator	34
Marginal Leader	26
Competitors	
Competitor 2	21
Competitor 3	16
Followers	12

Market rank is a critical determinant of business performance. A market dominator is 52% more profitable than its nearest competitor (Competitor 2) and is three times as profitable as the market followers.

The battle for brand dominance is not an ego trip. It is good business sense. Dominant brands are the most profitable assets.

Beware of those who say "This market is so large we can have a small share and still succeed". Wrong! This kind of advice is misleading, misguided, mistaken mismarketing.

Market size is not the issue. In a big market or in a small market, leaders thrive, while followers struggle to survive. Concentrate your resources on clearly defined markets in which you can become and stay a leader. It is more profitable to be a niche-picking leader than to enter a big market and be a follower. Be a giant. Be a giant killer. Be a niche-picking dominator. Big market or small market, aim to dominate or expect to die.

How to Build Brand Assets

What factors are associated with market rank? We studied over 25 strategic factors. Here are two important factors associated with leadership.

1. Quality is Critical

Market leaders are distinguished by superior quality relative to competition. Products marketed by dominators are rated 14% better than competitive alternatives. Followers, on the other hand, market products which are 3,1% worse than competitors' products. Dominators sell on quality, while followers attempt to compete on price.

MARKET RANK	INDEX OF RELATIVE QUALITY
Dominators	+14
Marginal Leaders	+6
Rank Two	+0,3
Rank Three	-2,7
Followers	-3,1

Quality brands are more than just quality products. To be a quality brand, everything associated with the brand must be quality. You cannot sell quality except in a consistent quality manner.

But, the bean counters have a passion for productivity. They focus only on cost cutting. They focus only on efficiency instead of on effectiveness. They look at advertising in terms of what it costs instead of what it is worth. They focus only on how to do something cheaper instead of how to do it better. They encourage a strategy destined to build market followers, not market dominators.

To build an enduring, dominant, profitable brand asset, quality products must be supported by quality marketing. Improving quality increases the odds of leadership. Supporting a quality product with increased advertising weight significantly improves those odds. A brand is a total experience which includes everything associated with the product . . . consideration, purchase, use and repurchase. A brand experience includes display, promotion, packaging, public relations, advertising, etc. What is the use of making a high quality product and then marketing it in a low quality manner?

2. The Marketing Mix Matters

There is a furious battle raging in marketing. A battle between the proponents of advertising vs. the proponents of promotion. The extremes are, of course, wrong. There is a place for both advertising and promotion. Spend 100% on promotion and you build volume but not loyalty. Spend 100% on advertising and you build loyalty but insufficient volume to be a market leader. You need both advertising and promotion to be an enduring market dominator. It is not only how much you spend, but how you spend it that matters.

Our evidence in unequivocal. Compared to the average, dominators spend **20% *more*** of their budget on advertising. Followers spend *11% less* than the average on advertising. The key is to get the balance right. While dominators spend half of their budget on advertising, followers spend two out of three dollars on promotion. Spend two thirds of the advertising and promotion budget on price rather than on brand qualities and you are selling products, not marketing brands. Instead of emphasising how good a brand is, we are stressing how cheap it is.

There is an important place for both advertising and promotion. Promotion builds volume. Advertising builds loyalty. You need product volume to be a dominator. You need brand loyalty to be a profitable dominator.

Brand loyalty is key to profitability. There is no such thing as *product loyalty*. There is only *brand loyalty*. We cannot build long-term brand loyalty by excessive emphasis on short-term bribes. The excessive use of dealing and promotion debilitates, debases, and potentially destroys brand assets.

If these trends continue, everybody loses. The manufacturer loses brand loyalty. The retailer loses quality brands to sell. And the consumer loses quality brands to buy.

Marketing policies which destroy rather than strengthen brand assets are wrong!

How do you build enduring, dominant, profitable brand assets?

1. Quality is critical. Be excellent. Good enough is not good enough. A quality brand is more than quality product performance. A quality brand is a total quality experience . . . a quality product presented and experienced in a quality manner.

2. Differentiate your brand. Identify a relevant consumer want. Carve out a special niche. As one philosopher pointed out — you can't be excellent; you must be excellent at something. Identify the something special which differentiates your brand. Don't try to appeal to everyone. Be very special to someone special.

3. Aim to dominate. Play to win or don't play. Be a leader in everything you do. To reach the top of the market, be top of mind. Dominate in media, display, promotion, etc. Consumers trust leaders. Big market or small market, aim to dominate. To dominate, you must concentrate. Concentrate your resources. Diffusion leads to dilution. Concentrate your resources on a niche you can dominate.

The Financial Value of Brand Assets

Success in the future will depend not on the factories you own, but on the markets you own. The only way to own a market is via branding. What is the financial value of a differentiated, quality, dominant brand asset? While it is difficult to quantify the specific contribution of each input into a brand's reputation, it is possible to quantify the total value of the brand asset itself. We must remember to avoid "perfection paralysis". Because something is hard to measure perfectly, that does not mean we shouldn't try to measure it at all.

What is a brand asset? A brand asset is a result of:

1. how the market *rates* your brand in use;
2. how the market *differentiates* your brand from competition;
3. how the market *ranks* your brand in sales.

We computed what we term "market asset value" or "MAV". MAV is defined as the combination of three quantitative measures : (1) Market quality, (2) Market differentiation, and (3) Market rank. We correlated our measure of a business's market asset value with the "investment multiple" associated with a business (defined as stock market value vs. book value).

Result? Businesses with a high MAV have an investment multiple that is over 225% greater than businesses with a low MAV. A business with high quality, market differentiated, market dominant brands is worth over twice as much to the financial community. Investors will pay a premium over book value because they value premium quality, highly differentiated, market dominant brands.

Nestle didn't pay 25 times earnings for Rowntree's factories. They bought Rowntree's differentiated, quality, dominant brands. Companies and investors recognise that a company's most valuable assets are its brand assets. And the best assets are differentiated, quality, dominant brand assets.

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The Smarter Generation wants Brands

The Smarter Generation respects and trusts leaders. They will pay a premium price for leading brands. The business and financial communities increasingly recognise that a company's most valuable assets are its brand assets. And the most valuable brand assets are high quality, market differentiated, market dominant brand assets. Consumers value quality, differentiated, dominant brands . . . and the financial community values companies that market those brands.

An advertising agency is really a manufacturing company. Clients manufacture products. Agencies manufacture brands. The agency's manufacturing plant is in the consumer's mind. The manufacturing process is marketing. Marketing, particularly advertising, creates a brand which is worth more to the consumer than the product itself. Consumers will pay more for brands than for products.

Strong brand assets are good for business. Strong brand assets are good for consumers. Strong brands are a trust assurance policy for the consumer. Strong brand assets are good marketing policy and good public policy.

We live branded lives. We drive branded cars. We eat at branded restaurants. We use branded credit cards. We wear branded clothes. Our children attend branded schools. We live in branded cities where we have jobs in branded companies. We take branded planes to branded vacation destinations. We live branded lives. And branded lives are better lives.

The Smarter Generation is on our side. They are telling us that brand loyalty is not bought through bribes, it is earned through trust. The Smarter Generation trusts leaders. They tell us they want quality, they want value, and they value time as well as money. They will pay a premium price for differentiated, quality, dominant brands. They tell us they want a quality total brand experience supported by quality marketing, communicated in a quality manner. They will pay more for brands than for products. They will pay more for premium quality, market differentiated, market dominant brands. They want *trustmarks*, not mere trademarks. They want what marketers want to provide.

To our Readers

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APPENDIX B

INTERNAL REPORT

Refer to p. 60. Two relevant issues are discussed:

- Management Planning and Control
- Operational Control

The aims as set out in this report can only be achieved through specific productivity (or performance) measurement.

EXECUTIVE ROLES AND OBJECTIVE SETTING

1. Organisational Needs

Modern organisations are large and complex. Because they have become so it has been necessary to delegate the responsibility of managing their component parts to an ever-increasing hierarchy of managers.

This hierarchy of managers, through the organisational design and the network of planning, control and information systems within which they function, forms the infrastructure of the modern organisation. Together they form a gestalt and, under the influence of the chief executive, give the organisation its character, style and personality.

There is, however, an order in this infrastructure which allows one to generalise about the roles of managers at the various hierarchical levels.

In this section:

- The need for organisational effectiveness and efficiency is explored.

- Strategic planning and management (business) planning and control that reflect effectiveness, operational control that reflects efficiency, are defined.

- Delegation and its effect on managerial roles are examined.

- Finally, a model indicating the degree to which a particular manager, at a particular level in a managerial hierarchy, should be involved in strategic planning, management planning and control and operational control is developed.

This model has been termed the normative management structure and is compared to what can be termed an empirical management structure which indicates that managers in most organisations are overly involved in operational control and that, in comparison with the normative model, too little innovative planning is undertaken.

It is also indicated that, if organisations are to move from the empirical model to the normative model, managerial key performance areas need to be identified, the flow of redundant operational control information needs to be eliminated, and a proper management control system to trigger dynamic continuous replanning needs to be developed.

An organisation needs to be both effective and efficient to survive and grow. It needs to be effective in the sense that its interaction with its environment leads to profitable growth. This requires continuous entrepreneurial action in.

- The development and selection of a grand strategy for growth and survival. This includes the setting of various kinds of objectives and policies and the specification of strategic guidelines that are essential to give direction to the various planning processes in organisation.

- The choice of products and markets to ensure that they fulfil a need in society. this involves both formal and informal market research and the development of new products and markets to keep pace with the changing demands of society on the one hand, and to keep ahead of competition on the other.

- The development and maintenance of a competitive strategy to create and stimulate demand, to ensure material and financial resources and to increase market share. This includes the dynamic use of marketing tools in the light of changing patterns of demand, substitutes and new entrances to the market.

- The choice and source of raw materials in manufacturing organisations and suppliers in merchandising organisations appropriate to its competitive strategy.

- The application of innovations developed within as well as outside of the organisation to the manufacturing and other functional processes of the firm.

- The selection and development of human resources to improve productivity and managerial efficiency. Use of these resources through improved relationships to carry out tasks operationally.

The effectiveness of action in these areas is reflected in an organisation's ability to anticipate changes in the environment and to develop competitive strategies in advance of such changes and thus to always be in a position to grow profitably in the changing world of tomorrow. It is also relected in an organisation's ability to react quickly and efficiently to those unanticipated changes with which competitors, governments and labour unions like to confront the organisation.

The group of managers who are primarily responsible for effectiveness are the entrepreneurs of change agents - short, the thinkers - in the organisation. They interact with an ever-changing dynamic environments and therefore function in an open system. They are to be found in the higher echelons of management.

An organisation also needs to be efficient in the sense that the numerous tasks that are carried out internally in the organisation should be performed at a level considered to be acceptable. An organisation therefore should see to:

- The development of standards of acceptable performance. These standards can be developed historically or scientifically by using work study or industrial engineering techniques. Examples of efficiency standards are man-hours per unit of product, machine-hours per unit of product, material per unit of product, machine downtime, productive time ratios, minimum/maximum invetory levels, percentage rejects per volume of output, salesman calls per day, average sales per call, contribution per salesman, cost per kilometre, billings per clerk, and many others.

- The development of rules and procedures that prescribe the preferred manner in which things are to be done in the organisation, as well as a means of monitoring the application of these rules.

- The development of a culture of discipline within the organisation which involves the development of control systems to monitor the efficient performance of tasks, together with a mechanism to ensure that corrective action is initiated when variances from the standards exceed acceptable levels.

Efficiency here is reflected in an organisation's ability to perform according to the stated standards and to generate corrective action whenever there are unacceptable deviations. It is also reflected in its ability to continuously improve productivity along the learning curve as opposed to productivity improvements that are the result of specific plans and programmes aimed at changing the composition of resources used in any particular situation.

The group of managers who are primarily responsible for efficiency is much larger than the group primarily responsible for effectiveness. They are the administrators and supervisors in an organisation and tend to operate in an evironment which is to a large extent buffered from the uncertainties of the external environment; they thus function in a relatively closed system (or, more correctly, a less open system) than the entrepreneurs and change agents responsible for effectiveness. They are to be found in the lower echelons of management.

Thus, if an organisation is to survive and grow profitably, it must be both effective and efficient, with the higher levels of management primarily involved in effectiveness and the lower levels of management primarily involved in efficiency.

2. Strategic Planning, Management Planning & Control & Operational Control.

A more explicit way of specifying an organisation's need for both effectiveness and efficiency is to do so in terms of the planning and control activities it has to undertake. These are:

- Strategic planning
- Management planning and control
- Operational or technical control

Strategic planning and management (business) planning and control are primarily aimed at ensuring effectiveness while operational control is aimed at ensuring efficiency.

Strategic planning is the process of deciding on the mission and objectives of the organisation, on the resources to be used in attaining these objectives and on the strategic guidelines and policies that are to guide and govern the management or business planning process. It therefore involves -

- deciding on the mission of the organisation and thus what kind of business or businesses the organisation wants to be involved in,

- specifying the objectives of the organisation and also any changes in these objectives,

- the allocation of resources, and

- the specification of strategic guidelines and policies that are required to give direction to the management or business planning process.

Management (business) planning and control is the process of ensuring that resources are obtained and used effectively in the accomplishment of the organisation's objectives. It therefore involves -

- the development of plans for the effective acquisition of resources, and

- the development of plans and action programmes relating to the effective utilisation of these resources in the areas of administration, marketing, manufacture, inventory holding, research and development, and in any other area in the organisation in which resources are used.

The plans and action programmes are all aimed at the accomplishment of the organisation's objectives in a continuously changing and uncertain environment and are often bound by the strategic guidelines and policies resulting from the strategic planning process.

It is clear that many more managers are involved in management planning and control than in strategic planning.

Operational or technical control is the process of ensuring that specific tasks are carried out effeciently. This involves:

- a clear specification of the task to be performed as well as procedures for performing it;

- the specification of efficiency standards;

- the measurement of actual performance

- the identification of variances from the efficiency standard; and

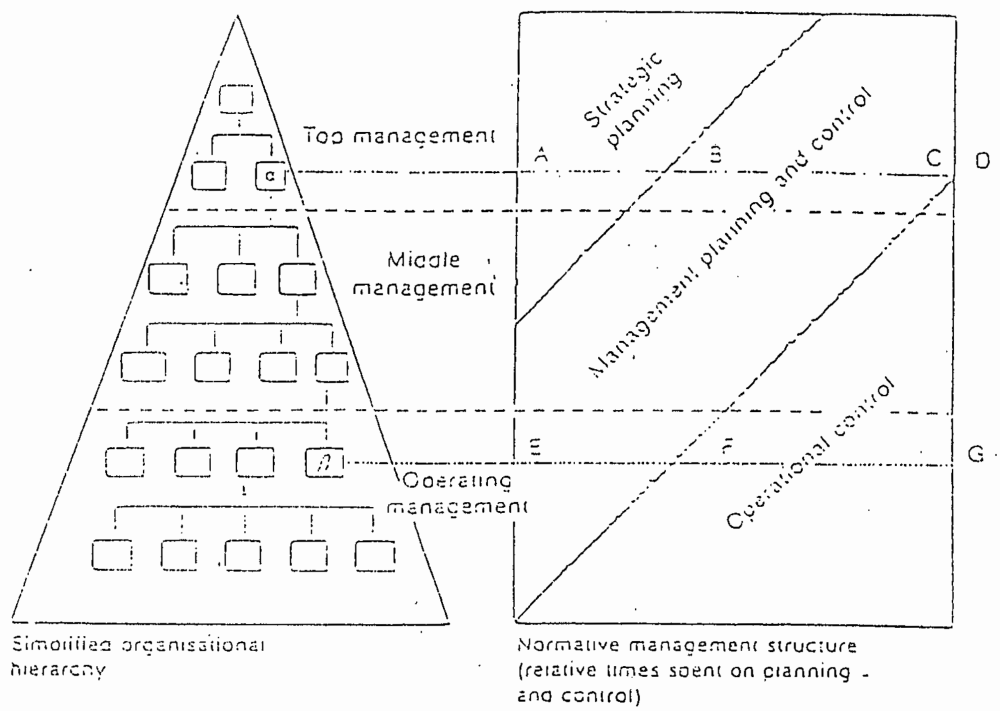
- the initiation of corrective action.

Operational control therefore involves the creation of a whole network of efficiency standards and operational control systems within the technical and administrative core of the organisation. In comparison with the strategic and management planning and control processes, it involves many more managers at supervisory level where physical tasks are performed.

The characteristics of the foregoing planning and control processes are summarised below.

Characteristic	Strategic Planning	Management Planning and control	Operational control
Focus	One aspect at a time.	Whole operation	Single task or transaction
Persons primarily involved	Top management and staff	Line managers	Supervisory management
Process	Emphasis on planning	Control through replanning	Control through corrective action
Mental activity	Creative and analytical; political and negotiated	Creative, judgemental persuasive	Following of instructions and reliance on rules
Time horizon	Tends to be long	Medium (annual, year end)	Short (day-to day)
Degree of structure	Unstructured and Irregular projects	Structured and rhythmic	Highly structured
Nature of information	Tailored for problem external, inaccurate, futuristics, highly uncertain	Integrated, financial futuristic forecasts, more accurate	Tailor-made to operations, historic, accurate

Figure 1. Normative management structure



Normative management theory emphasises that top management should be heavily involved in strategic planning and supervisory or operating management heavily involved in operational or technical control. The role of middle management is less clearly defined in normative theory, but one would intuitively expect them to be fairly heavily involved in management planning and control, that is to say the effective acquisition and utilisation of resources in a dynamic and ever-changing environment, and only marginally involved in strategic planning on the one hand and operational control on the other.

The principles of delegation tend to modify the foregoing statement slightly insasmuch as the accountability of managers for the performance of subordinates inevitably involves them in the planning and control activities that have been delegated to those subordinates. Top management thus become more heavily involved in management planning and control and even in highly exceptional cases in operational control than is, according to normative theory, necessary.

It would therefore seem that -

- top management should be heavily involved in strategic planning as well as in management planning and control, but only in highly exceptional cases in operational control;

- middle management should be heavily involved in management planning and control but also in operational control, and to a lesser degree in strategic planning; and

- operational management should be heavily involved in operational control, to a much smaller degree in management planning and control, and not involved in strategic planning at all.

3. The Normativ Management Structure

Assuming that the foregoing statements correctly reflect the planning and control responsibilities of line management at the various managerial levels, it is possible to develop a normative management structure in the manner illustrated in figure 1. The managerial pyramid at the gross level distinguishes between top, middle and operating management and, within that, at a more detailed level, the organisation chart illustrates the specific levels of management and their relationship to the normative management structure.

The levels of management are indicated by the vertical axis and the relative average time spent on the various planning and control activities within an average year by the horizontal axis. A horizontal cut across the normative management structure at any hierarchical level will illustrate what planning and control activities a manager at that particular level, normatively speaking, should be involved in.

The horizontal cut will also indicate, approximately, the relative proportions of time spent on planning and control of the three types, and thus in which of these areas the manager uniquely contributes to the achievement of organisational objectives. This is due to the fact that the mangement structure, although illustrated abstractly, highlights managerial involvement in the various planning and control activities at the different managerial levels, relative to one another. As already stated, this division refers only to time spent on planning and control, and not to total working time, for the manager will typically also spend time on other activities such as interaction with subordinates, peers and supervisors; thus on activating functions as well as in operating or the doing activities, which do not fall under planning and control.

With reference to figure 1.2, manager A would spend approximately AB/AD% of his planning and control time on strategic planning, BC/AD% on management planning and control and CD/AD% on operational control. Likewise manager B would spend EF/EG% of his planning and control time on mangement planning and control and FG/EG% on operational control.

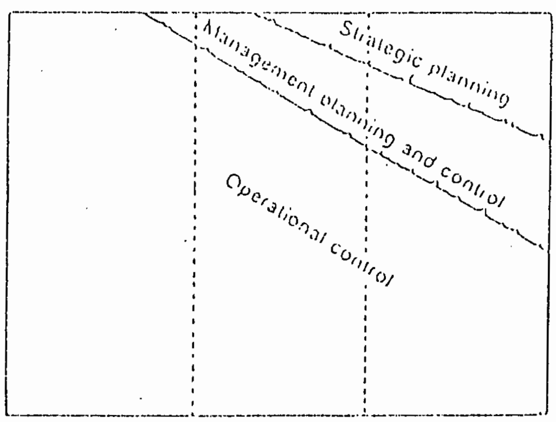
It should be stressed that an unwarranted degree of precision should not be read into or attached to the normative management structure model; this model is merely an approximation and is intended to serve as a guideline for managerial roles in a management hierarchy.

4. Traditional SA Management/Emoirical Management Structure

Empirical research and the subsequent wide application of the key performance area analysis technique has indicated that actual management practice regarding planning and control. together with the management structures that come into being as a result thereof, deviate significantly from the normative structure described in the foregoing section.

Both research and key performance area analysis indicate a very high degree of involvement on the part of both top and middle management in operational control in the real-life situation, relative to the normative situation. This over-involvement in operational control has a marked effect on the management structure which reflects the planning and control activities in which management at the various organisational levels are involved. In figure 2 the management structure reflecting the real-life situation, which has been termed the empirical management structure, is illustrated abstractly and compared with the normative management structure.

Traditional SA Management or Empirical Management Structure



There are a number of reasons for the empirical type management structure in organisations. The following would appear to be the most important:

a) The extremely high degree of uncertainty which exists amongs individual managers as to what exactly their roles in the organisation are. This uncertainty relates to a particular manager's unique contribution in the organisation. The result is that he tends to be heavily involved in the management of responsibilities that have been delegated to subordinates who in turn tend to deal with efficiency and thus operational control. This uncertainty seems to be prevalent at all levels of management.

b) The high level of sophistication to which operational control systems dealing with efficiency have been developed. Systems that measure production throughout, plant utilisation, labour productivity, maintenance efficiency, distribution, efficiency, backorder processing, inventory control, process control and many others, have been well developed. Most of these systems are computerised with the result that stacks of information or data are provided to which managers at all levels seem to feel a need to react. All these systems deal with efficiency and thus operational control and the sheer volume of reports result in an over-involvement by all levels of management in operational control.

c) The lack of replanning systems of a formal nature or more specifically a management control system to serve as a trigger for both management planning and control, and strategic planning. The budget variance reporting system, which is the major information system with which top and middle management interact, <u>traditionally emphasises historical performance</u> with variances. It tends to suggest corrective action which is more often than not <u>simply impossible</u> because of a changed environment. In these cases an explanation of the variance is all that is required. What is more, <u>favourable variances</u> are often <u>considered</u> to reflect satisfactory performance while this may, <u>in fact, not be the case</u>.

d) Finally, there seems to be a number of less important reasons for the evolution of an empirical type management structure, such as -

- the inability of managers to move from functional or specialist management to general management;

- the inability to delegate;

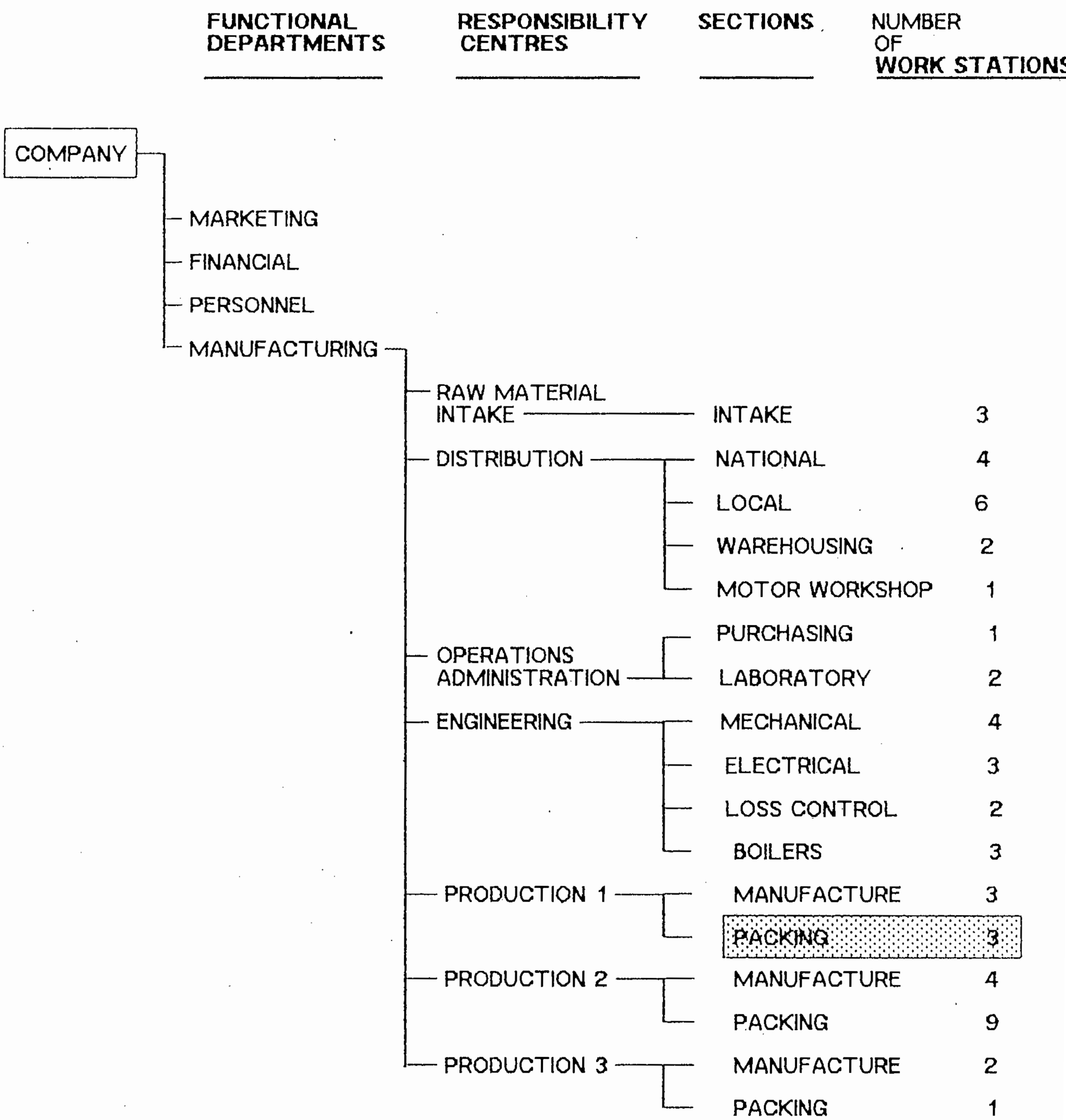
- the tendency, on promotion, to drag the old job along; and

- the Peter principle of promotion to a level of incompetence.

APPENDIX C

ORGANIZATIONAL CHART

ORGANIZATIONAL CHART



NOTE: WORK STATIONS No's 33, 34, 35 and SECTION No 12 situated in shaded area.

APPENDIX D

INCOME STATEMENT - APRIL PERIOD 1

RESPONSIBILITY CENTRES

INCOME STATEMENT (Rand)	1	2	3	4	5	6	7	8	9	10	11	
Month: APRIL	Raw Material Intake	Distri- -bution	Enginee- -ring	Manufac- -turing Admin.	Marke- -ting	Person- -nel	Finan- -cial	Product Group 1	Product Group 2	Product Group 3	Total	Line Ref.
Sales volume(tons)								1964	2600	1396	5960	1
Production volume(tons)								1859	2616	1253	5728	2
Gross Revenue								4856554	2255847	1165979	8278380	3
Inventory Adjustment								4767658	2260224	1026207	8054089	4
Sales Returns								29299	1873	6874	38046	5
Promotions								21324	0	7654	28978	6
Net Revenue								4805931	2253974	1151451	8211356	7
Cost of Sales:												
Raw Materials								2002416	1354339	461793	3818548	8
Packaging								715148	0	74599	789747	9
Railage In								73456	78910	57236	209602	10
Insurance								2226	900	3421	6547	11
Storage Premiums								12000	249454	0	261454	12
Total								2805246	1683603	597049	5085898	13
Gross Margin								2000685	570371	554402	3125458	14
Variable Costs :												
Commission Paid								13654	0	8753	22407	15
Promotions								0		0	0	16
Discount allowed								179285	67675	162321	409281	17
Royalties Paid								500	0	0	500	18
Railage Out								80631		22066	102697	19
Shipping Cost								14987		3000	17987	20
Vehicle Hire								3098		2104	5202	21
Road Transport								86049		25814	111863	22
Total								378204	67675	224058	669937	23
Gross Contribution								1622481	502696	330344	2455521	24
Overhead Exp.(see Table 7.2	62116	98526	162415	42402	353835	31580	283860	218773	160604	138700	1552810	25
Profit before Interest/tax											902711	26
Interest											13254	27
Profit before Tax (PBT)											889457	28

Table 7.1: Income Statement for month April

Responsibility Centres

OVERHEAD EXPENSES (Rand) SUMMARY	1	2	3	4	5	6	7	8	9	10	11	
Month: APRIL	Raw Material Intake	Distri--bution	Enginee-ring	Manufac--turing Admin.	Marke--ting	Person--nel	Finan--cial	Product Group 1	Product Group 2	Product Group 3	Total	Line Ref.
Fixed Expenses:												
Assessment Rates							14532	0	0	0	14532	1
Audit Fees							2399	0	0	0	2399	2
Bad Debts							3986	0	0	0	3986	3
Bank Charges							1432	0	0	0	1432	4
Canteen						3256		0	0	0	3256	5
Cleaning		1832						2343	1234	2132	7541	6
Computer Expenses							7645				7645	7
Depreciation	7654	21342	3212	5432				81234	120343	43043	282260	8
Donations					341						341	9
Fines & Penalties							30				30	10
Forklift Expenses	1051	3432						2132	0	3241	9856	11
General Expenses							1325	0	0		1325	12
Insurance							45324				45324	13
Laboratory Expenses				4432							4432	14
Launch Costs											0	15
Legal							1743				1743	16
Licences							432				432	17
Marketing Expenses					160675						160675	18
Merchandising Expenses					2178						2178	19
Factory Expenses	231							432	124	765	1552	20
Motor Car Expenses		856	876	1500	8765	843	1345	876	678	876	16615	21
Postage							563				563	22
Power: Coal			19765								19765	23
Power: Electricity			54654								54654	24
Printing & Stationery							6754				6754	25
Property Maintenance			23					3215	1101	2784	7123	26
Protective Clothing						3121					3121	27
Profit Provision							150000				150000	28
Regional Service Levies							3893				3893	29
Factory Maintenance	4453	1283	5643					19645	4452	17400	52876	30
Research & Development				4213	919						5132	31
Salaries	4234	9876	14332	15433	123456	6654	32541	22343	4532	7765	241166	32
Security				7124							7124	33
Staff Costs	5890	11541	12433	3087	28814	1331	6508	18038	5292	11339	104272	34
Staff Recruitment						215					215	35
Staff Training						15733					15733	36
Sterilization	986							435	643	134	2198	27
Telephone Services	313	537	231	160	4321	196	2754	234	278	289	9313	38
Transport Vehicle Cost	12087										12087	29
Travel & Ent: Local				1021	3753	231	654				5659	40
Travel & Ent: Overseas											0	41
Wages	25217	47827	47832	0	20613	0	0	67846	21927	48932	280194	42
Water			3414								3414	43
Total	62116	98526	162415	42402	353835	31580	283860	218773	160604	138700	1552810	44

Table 7.2 : Overhead Expenses for Month April

APPENDIX E

INCOME STATEMENT - MAY PERIOD 2

Responsibility Centres

INCOME STATEMENT (Rand) Month:MAY	1 Raw Material Intake	2 Distri-bution	3 Enginee-ring	4 Manufac-turing Admin.	5 Marke-ting	6 Person-nel	7 Finan-cial	8 Product Group 1	9 Product Group 2	10 Product Group 3	11 Total	Line Ref.
Sales volume(tons)								1760	2171	1357	5288	1
Production volume(tons)								1867	2179	1385	5431	2
Gross Revenue								4409660	1891611	1136319	7437590	3
Inventory Adjustment								4649648	1895730	1110770	7656148	4
Sales Returns								26321	0	7321	33642	5
Promotions								13245	0	5436	18681	6
Net Revenue								4370094	1891611	1123562	7385267	7
Cost of Sales:												
Raw Materials								2001103	1127438	502441	3630982	8
Packaging								699982	0	72011	771993	9
Railage In								62345	83543	66754	212642	10
Insurance								2341	934	3654	6929	11
Storage Premuims								11765	251454	0	263219	12
Total								2777536	1463369	644860	4885765	13
Gross Margin								1592558	428242	478702	2499502	14
Variable Costs :												
Commission Paid								13235	0	8754	21989	15
Promotions								0		0	0	16
Discount allowed								162625	56710	150757	370092	17
Royalties Paid								500	0	0	500	18
Railage Out								72765		21049	93814	19
Shipping Cost								12765		3564	16329	20
Vehicle Hire								1567		980	2547	21
Road Transport								71111		25876	96987	22
Total								334568	56710	210980	602258	23
Gross Contribution								1257990	371532	267722	1897244	24
Overheads (see Table 7.4)	52894	92913	152534	41951	375256	19465	142990	211597	154729	132510	1376839	25
Profit before Interest/tax											520405	26
Interest											9878	27
Profit before Tax											510527	28

Table 7.3: Income Statement for month May

Responsibility Centres

OVERHEAD EXPENSES (Rand) Month:MAY	1 Raw Material Intake	2 Distri--bution	3 Enginee-ring	4 Manufac--turing Admin.	5 Marke--ting	6 Person--nel	7 Finan--cial	8 Product Group 1	9 Product Group 2	10 Product Group 3	11 Total	Line Ref.
Assessment Rates							14532	0	0	0	14532	1
Audit Fees							2399	0	0	0	2399	2
Bad Debts							3986	0	0	0	3986	3
Bank Charges							1432	0	0	0	1432	4
Canteen						2134		0	0	0	2134	5
Cleaning		1814						2432	1254	2243	7743	6
Computer Expenses							7864				7864	7
Depreciation	5645	20987	2323	5432				81234	120343	43043	279007	8
Donations					341						341	9
Fines & Penalties											0	10
Forklift Expenses	1051	3432						2132	0	3241	9856	11
General Expenses							1654	0	0		1654	12
Insurance							45324				45324	13
Laboratory Expenses				5865							5865	14
Launch Costs											0	15
Legal							456				456	16
Licences							342				342	17
Marketing Expenses					187659						187659	18
Merchandising Expenses					5134						5134	19
Factory Expenses	167							453	60	543	1223	20
Motor Car Expenses		821	872	1478	8456	784	1544	821	632	834	16242	21
Postage							654				654	22
Power:Coal			18987								18987	23
Power: Electricity			50985								50985	24
Printing & Stationery							6209				6209	25
Property Maintenance			876					2712	986	3287	7861	26
Protective Clothing						2865					2865	27
Profit Provision							10000				10000	28
Regional Service Levies							4743				4743	29
Factory Maintenance	2315	751	7654					16540	800	16321	44381	30
Research & Development				3798	80						3878	31
Salaries	4234	9876	12450	14569	119065	6654	32541	22343	4532	7765	234029	32
Security				7189							7189	33
Staff Costs	5267	10442	10875	2812	26822	1284	6280	16953	4869	10127	95731	34
Staff Recruitment											0	35
Staff Training						5432					5432	36
Sterilization	1098							265	312	133	1808	37
Telephone Services	298	563	201	154	4132	205	2654	216	245	267	8935	38
Transport Vehicle Cost	9765										9765	39
Travel & Ent: Local				654	3656	107	376				4793	40
Travel & Ent: Overseas											0	41
Wages	23054	44227	43897		19911			65496	20696	44706	261987	42
Water			3414								3414	43
Total (Rand)	52894	92913	152534	41951	375256	19465	142990	211597	154729	132510	1376839	44

Table 7.4: Overhead Expenses for month of May

APPENDIX F

PRODUCTIVITY STATEMENT

1	2	3	4	5	6	7	8	9	
TOTAL OUTPUT	April Current Total Value	April Tons	April Derivrd Unit Price	May Current Total Value	May Equiva. Tons	May Constant Unit Price	PRODUCTIVITY Index	Profit Movement	Line Ref.
						(Rand)			
Product Group 1	4767658	1859	2564.64	4649648					1
Product Group 2	2260224	2616	864.00	1895730					2
Product Group 3	1026207	1253	819.00	1110770					3
Total output	8054089	5728	1406.09	7656148	5445	1406.09			4
					5431	1409.71 --Actual May Month			

Table 7.5: Extract from Productivity Statement: Total Output.

1	2	3	4	5	6	7	8	9	
LABOUR INPUT	April Current Total Value	April Tons	April Derivrd Unit Price	May Current Total Value	May Equiva. Tons	May Constant Unit Price	PRODUCTIVITY Index	Profit Movement	Line Ref.
Salaries	R241,166	5728	R42.10	R234,029	5559	R42.10	98	(R4,779)	5
Wages	R280,194	5728	R48.92	R261,987	5355	R48.92	102	R4,363	6
Motor Cars	R16,615	5728	R2.90	R16,242	5601	R2.90	97	(R448)	7
Staff costs	R104,272	5728	R18.20	R95,731	5260	R18.20	104	R3,389	8
Staff recruite	R215	5728	R0.04	R0	0	R0.04		R204	9
Staff training	R15,733	5728	R2.75	R5,432	1975	R2.75	276	R9,524	10
Prot. Cloth.	R3,121	5728	R0.54	R2,865	5306	R0.54	103	R102	11
Canteen	R3,256	5728	R0.57	R2,134	3744	R0.57	145	R961	12
LABOUR	R664,572	45824	R14.50	R618,420	42650	R14.50	102	R13,316	13

Table 7.6: Extract from Productivity Statement: Labour input.

1	2	3	4	5	6	7	8	9	
MATERIALS INPUT	April Current Total Value	April Tons	April Derivrd Unit Price	May Current Total Value	May Equiva. Tons	May Constant Unit Price	PRODUCTIVITY Index	Profit Movement	Line Ref.
Raw Materials	R3,818,548	5728	R666.65	R3,630,982	5447	R666.65	100	(R1,103)	15
Railage IN	R209,602	5728	R36.59	R212,642	5811	R36.59	94	(R13,396)	16
									17
Packaging	R789,747	5728	R137.87	R771,993	5599	R137.87	97	(R21,266)	18
									19
Insurance	R6,547	5728	R1.14	R6,929	6078	R1.14	90	(R705)	20
Storage Premium	R261,454	5728	R45.64	R263,219	5767	R45.64	94	(R14,683)	21
MATERIALS	R5,085,898	28640	R177.58	R4,885,765	27513	R177.58	99	(R51,154)	22

Table 7.7: Extract from Productivity Statement: Materials Input.

1	2	3	4	5	6	7	8	9	
CAPITAL INPUT	April Current Total Value	April Tons	April Derivrd Unit Price	May Current Total Value	May Equiva. Tons	May Constant Unit Price	PRODUCTIVITY Index	Profit Movement	Line Ref.
Depreciation	R282,260	5728	R49.28	R279,007	5662	R49.28	96	(R10,693)	24
Interest	R13,254	5728	R2.31	R9,878	4276	R2.31	128	R2,721	25
CAPITAL	R295,514	11456	R25.80	R288,885	11197	R25.80	97	(R7,972)	26

Table 7.8: Extract from Productivity Statement: Capital Input.

1	2	3	4	5	6	7	8	9	
MATERIALS HANDLING	April Current Total Value	April Tons	April Derivrd Unit Price	May Current Total Value	May Equiva. Tons	May Constant Unit Price	PRODUCTIVITY Index	Profit Movement	Line Ref.
Railage Out	R102,697	5728	R17.93	R93,814	5232	R17.93	104	R3,809	28
Shipping	R17,987	5728	R3.14	R16,329	5200	R3.14	105	R769	29
Vehicle Hire	R5,202	5728	R0.91	R2,547	2799	R0.91	195	R2,398	30
Road Transport	R111,863	5728	R19.53	R96,987	4966	R19.53	110	R9,349	31
Trans Veh. cost	R12,087	5728	R2.11	R9,765	4628	R2.11	118	R1,725	32
Forklift	R9,856	5728	R1.72	R9,856	5730	R1.72	95	(R487)	33
									34
Electricity	R54,654	5728	R9.54	R50,985	5344	R9.54	102	R969	35
INT:MATERIALS									36
HANDLING	R314,346	40096	R7.84	R280,283	35750	R7.84	107	R18,532	37

Table 7.9: Extract from Productivity Statement: Materials Handling.

1 INTERMEDIATE INPUT Marketing Support Services	2 April Current Total Value	3 April Tons	4 April Derivrd Unit Price	5 May Current Total Value	6 May Equiva. Tons	7 May Constant Unit Price	8 PRODUCTIVITY Index	9 Profit Movement	Line Ref.
Pomotions	R28,978	5728	R5.06	R18,681	3692	R5.06	147	R8,865	40
Commission	R22,407	5728	R3.91	R21,989	5624	R3.91	97	(R689)	41
Discounts	R409,281	5728	R71.45	R370,092	5180	R71.45	105	R18,967	42
Donations	R341	5728	R0.06	R341	5683	R0.06	96	(R17)	43
Market. Expense	R160,675	5728	R28.05	R187,659	6690	R28.05	81	(R34,923)	44
Merchandising	R2,178	5728	R0.38	R5,134	13511	R0.38	40	(R3,064)	45
Royalties	R500	5728	R0.09	R500	5556	R0.09	98	(R25)	46
Bad Debt.	R3,986	5728	R0.70	R3,986	5694	R0.70	96	(R197)	47
Travel Local	R5,659	5728	R0.99	R4,793	4841	R0.99	112	R586	48
Returns	R38,046	5728	R6.64	R33,642	5067	R6.64	107	R2,524	49
INT:MARKETING									50
SUPPORT SERVICE	R672,051	57280	R11.73	R646,817	55142	R11.73	99	(R7,971)	51

Table 7.10: Extract from Productivity Statement: Int. Marketing Support Services.

1 INTERMEDIATE INPUT Production Support Services	2 April Current Total Value	3 April Tons	4 April Derivrd Unit Price	5 May Current Total Value	6 May Equiva. Tons	7 May Constant Unit Price	8 PRODUCTIVITY Index	9 Profit Movement	Line Ref.
Coal	R19,765	5728	R3.45	R18,987	5503	R3.45	99	(R199)	54
Property Maint	R7,123	5728	R1.24	R7,861	6340	R1.24	86	(R1,090)	55
Fac. Maint.	R52,876	5728	R9.23	R44,381	4757	R9.33	114	R5,882	56
Sterilization	R2,198	5728	R0.38	R1,808	4758	R0.38	114	R281	57
Water	R3,414	5728	R0.60	R3,414	5690	R0.60	96	(R169)	58
Assesment Rate	R14,532	5728	R2.54	R14,532	5721	R2.54	95	(R718)	59
Cleaning	R7,541	5728	R1.32	R7,743	5866	R1.32	93	(R575)	60
Insurance	R45,324	5728	R7.91	R45,324	5730	R7.91	95	(R2,239)	61
Laboraty Exp.	R4,432	5728	R0.77	R5,865	7617	R0.77	71	(R1,652)	62
Factory EXp.	R1,552	5728	R0.27	R1,223	4530	R0.27	120	R252	63
Research	R5,132	5728	R0.90	R3,878	4309	R0.90	126	R1,000	64
Security	R7,124	5728	R1.24	R7,189	5798	R1.24	94	(R417)	65
INT:PRODUCTION									66
SUPPORT SERVICE	R171,013	68736	R2.49	R162,205	65143	R2.49	100	R358	67

Table 7.11: Extract from Productivity Statement: Int. Production Support Services.

1 INTERMEDIATE INPUT Administration Support Services	2 April Current Total Value	3 April Tons	4 April Derivrd Unit Price	5 May Current Total Value	6 May Equiva. Tons	7 May Constant Unit Price	8 PRODUCTIVITY Index	9 Profit Movement	Line Ref.
Audit Fees	R2,399	5728	R0.42	R2,399	5712	R0.42	95	(R119)	70
Bank charges	R1,432	5728	R0.25	R1,432	5728	R0.25	95	(R71)	71
Computer Expens	R7,645	5728	R1.33	R7,864	5913	R1.33	92	(R597)	72
Fines	R30	5728	R0.01	R0	0	R0.01		R29	73
General	R1,325	5728	R0.23	R1,654	7191	R0.23	76	(R394)	74
Legal	R1,743	5728	R0.30	R456	1520	R0.30	358	R1,201	75
Licences	R432	5728	R0.08	R342	4275	R0.08	127	R69	76
Postage	R563	5728	R0.10	R654	6540	R0.10	83	(R119)	77
Print & Stat.	R6,754	5728	R1.18	R6,209	5262	R1.18	103	R211	78
Regional Serv.	R3,893	5728	R0.68	R4,743	6975	R0.68	78	(R1,042)	79
Telephone	R9,313	5728	R1.63	R8,935	5482	R1.63	99	(R82)	80
Travel o/s	R0		R0.00	R0		R0.00			81
INT:ADMIN									82
SUPPORT SERVICE	R35,529	63008	R0.56	R34,688	61943	R0.56	97	(R914)	83

Table 7.12: Extract from Productivity Statement: Int. Admin. Support Services.

1 TOTAL INTERMEDIATE INPUT	2 April Current Total Value	3 April Tons	4 April Derivrd Unit Price	5 May Current Total Value	6 May Equiva. Tons	7 May Constant Unit Price	8 PRODUCTIVITY Index	9 Profit Movement	Line Ref.
INTERMEDIATE	R1,192,939	229120	R5.21	R1,123,993	217407	R5.17	100	R10,005	86

Table 7.13: Extract from Productivity Statement: Total Intermediate Input.

1 TOTAL INPUT	2 April Current Total Value	3 April Tons	4 April Derivrd Unit Price	5 May Current Total Value	6 May Equiva. Tons	7 May Constant Unit Price	8 PRODUCTIVITY Index	9 Profit Movement	Line Ref.
TOTAL INPUT	R7,238,923	315040	R22.98	R6,917,063	301004	R22.98	99	(R35,805)	88
PROF.PROVISION	R150,000	5728	R26.19	R10,000	382	R26.19			90
PBT	R889,457	5728	R155.28	R510,527	3288	R155.28			91

Table 7.14: Extract from Productivity Statement: Total Input.

APPENDIX G

SALES TRENDS

Product Group 1. Gross Sales Volume (tonnes)

Product	Oct	Nov	Dec	Jan	Feb	March	April	May	TOTAL
A	812	680	622	656	752	848	904	808	6082
B	496	630	590	630	630	805	783	721	5285
C	144	113	112	124	139	143	181	140	1096
D	71	67	54	61	70	80	83	78	564
E	10	9	6	6	8	8	9	9	65
F	4	3	3	3	3	4	4	4	28
Total	1537	1502	1387	1480	1602	1888	1964	1760	13120

Product Group 2. Gross Sales Volume (tonnes)

Product	Oct	Nov	Dec	Jan	Feb	March	April	May	TOTAL
G	812	569	476	530	696	886	1006	804	5780
H	595	960	842	960	960	1568	1483	1258	8627
I	115	71	70	85	107	114	110	109	781
Total	1522	1601	1388	1576	1764	2567	2600	2171	15188

Product Group 3. Gross Sales Volume (tonnes)

Product	Oct	Nov	Dec	Jan	Feb	March	April	May	TOTAL
AA	430	360	329	347	398	464	495	490	3314
AB	154	103	94	110	114	124	142	140	982
AC	133	137	129	136	156	182	194	192	1259
AD	131	108	98	104	119	139	148	146	992
AE	115	88	93	107	124	132	131	118	909
AF	106	81	86	98	114	122	121	107	835
AG	87	75	72	76	80	82	84	82	638
AH	54	49	47	47	50	53	52	50	402
AI	23	23	23	24	25	27	30	30	205
Total	1233	1024	972	1049	1181	1325	1396	1357	9536

APPENDIX H

EFFICIENCY REPORTS

- DAILY
- WEEKLY

LOTUS 12/1 PACKING WORK STATIONS REPORT DAILY MACHINE EFFICIENCY PRODUCTION DAY 13/09/90 /90

DATA	PRODUCT GROUP 1			PRODUCT GROUP 2										PR. GRP.3
	33	34	35	41	42	43	44	45	46	47	48	49	50	60
OUTPUT RATE/MIN.	140	150	45	45	45	45	50	60	50	49	45	50	49	66
MACHINE RATE SETTING	0.8	0.85	0.9	0.9	0.96	0.96	1	1	1	0.8	0.9	1	1	0.95
PAID PRODUCTION TIME	540	540	540	540	540	540	540	540	540	540	540	2,760	2,760	2,760
TOTAL DOWNTIME	95	45	245	540	115	92	192	360	120	212	145	332	286	395
MANAGERS TIME	30	0	180	540	0	0	60	310	0	120	0	0	0	0
REST PERIOD PAID	30	30	0	0	30	30	30	30	30	30	30	150	150	150
CLEANING	15	10	15	0	15	30	12	20	10	50	15	87	67	125
MACHINE	20	5	50	0	70	32	90	0	80	12	100	95	69	120
REJECTS UNITS	107	80	2	0	6	7	13	12	43	76	455	232	432	26
DROPS PRODUCED	45,760	62,675	6,400	0	17,654	20,323	16,987	10,987	20,543	12,654	16,321	119,876	122,343	146,546
INNERS WASTE KG	3.75	1.76	0.32	0.00	0.32	0.55	0.12	0.55	0.06	0.00	0.04	2.34	1.43	7.65
OUTERS WASTE QTY	13	6	1	0	0	0	0	5	0	0	5	9	132	5
"AFTER" METER LOADING (C)	1,906	2,666	527	0	507	1,105	588	465	575	559	1,072	4,986	4,966	6,101

LOTUS 12/1 PACKING WORK STATIONS REPORT: DAILY MACHINE EFFICIENCY PRODUCTION DAY 13/09/90

WORK STATION REF.	33	34	35	41	42	43	44	45	46	47	48	49	50	60
A. DROPS														
TOTAL CAPACITY AVAILABLE	60,480	68,850	21,870	21,870	23,328	23,328	27,000	32,400	27,000	21,168	21,870	27,000	26,460	33,858
TOTAL CAPACITY UTILIZED	45,653	62,595	6,398	0	17,648	20,316	16,974	10,975	20,500	12,578	15,866	21,264	22,363	27,966
TOTAL CAPACITY (GAIN)/LOSS	14,827	6,255	15,472	21,870	5,680	3,012	10,026	21,425	6,500	8,590	6,004	5,736	4,097	5,892
OPERATORS CAPA'Y AVAILABLE	57,120	68,850	14,580	(0)	23,328	23,328	24,000	13,800	27,000	16,464	21,870	27,000	26,460	33,858
OPERATORS CAPA'Y UTILIZED	45,653	62,595	6,398	0	17,648	20,316	16,974	10,975	20,500	12,578	15,866	21,264	22,363	27,966
OPERATORS LOSSES	11,467	6,255	8,182	0	5,680	3,012	7,026	2,825	6,500	3,886	6,004	5,736	4,097	5,892
B. CAPACITY LOSSES														
MANAGER SCHEDULING	3,360	0	7,290	21,870	0	0	3,000	18,600	0	4,704	0	0	0	0
WORK STATION: REJECTS	107	80	2	0	6	7	13	12	43	76	455	57	87	14
REST	3,360	3,825	0	0	1,296	1,296	1,500	1,800	1,500	1,176	1,215	1,500	1,470	1,881
CLEANING	1,680	1,275	608	0	648	1,296	600	1,200	500	1,960	608	750	392	1,565
MACHINE	2,240	638	2,025	0	3,024	1,382	4,500	0	4,000	470	4,050	1,250	1,127	1,254
UNDECLARED	4,080	438	5,548	0	706	(969)	413	(187)	457	204	(324)	2,179	1,021	1,176
C. PACKAGING LOSSES														
INNERS LOST	112	53	10	0	10	16	4	16	2	0	1	10	16	0
OUTER UNITS	13	6	1	0	0	0	0	5	0	0	5	7	6	0
D. DROPS PERCENTAGES														
TOTAL CAPACITY AVAILABLE	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
TOTAL EFFICIENCY	75.48%	90.92%	29.25%	0.00%	75.65%	87.09%	62.87%	33.87%	75.93%	59.42%	72.55%	78.76%	84.52%	82.60%
TOTAL CAPACITY LOSS	24.52%	9.08%	70.75%	100.00%	24.35%	12.91%	37.13%	66.13%	24.07%	40.58%	27.45%	21.24%	15.48%	17.40%
OPERATORS CAPA'Y AVAILABLE	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
OPERATORS EFFICIENCY	79.92%	90.92%	43.88%	0.00%	75.65%	87.09%	70.73%	79.53%	75.93%	76.40%	72.55%	78.76%	84.52%	82.60%
OPERATORS LOSSES	20.08%	9.08%	56.12%	0.00%	24.35%	12.91%	29.28%	20.47%	24.07%	23.60%	27.45%	21.24%	15.48%	17.40%
E. LOSSES PERCENTAGES														
MANAGER SCHEDULING	5.56%	0.00%	33.33%	100.00%	0.00%	0.00%	11.11%	57.41%	0.00%	22.22%	0.00%	0.00%	0.00%	0.00%
WORK STATION: REJECTS	0.19%	0.12%	0.01%	0.00%	0.03%	0.03%	0.05%	0.09%	0.16%	0.46%	2.08%	0.21%	0.33%	0.04%
REST	5.88%	5.56%	0.00%	0.00%	5.56%	5.56%	6.25%	13.04%	5.56%	7.14%	5.56%	5.56%	5.56%	5.56%
CLEANING	2.94%	1.85%	4.17%	0.00%	2.78%	5.56%	2.50%	8.70%	1.85%	11.90%	2.78%	2.78%	1.48%	4.63%
MACHINE	3.92%	0.93%	13.89%	0.00%	12.96%	5.93%	18.75%	0.00%	14.81%	2.86%	18.52%	4.63%	4.26%	3.70%
UNDECLARED	7.14%	0.64%	38.05%	0.00%	3.03%	-4.16%	1.72%	-1.36%	1.69%	1.24%	-1.48%	8.07%	3.86%	3.47%
INNERS LOST	0.24%	0.08%	0.15%	ERR	0.05%	0.08%	0.02%	0.15%	0.01%	0.00%	0.01%	0.05%	0.07%	0.00%
OUTER UNITS	0.68%	0.23%	0.19%	ERR	0.00%	0.00%	0.00%	1.08%	0.00%	0.00%	0.47%	1.31%	1.07%	0.00%

LOTUS 12/2 PACKING WORK STATIONS REPORT WEEKLY SUMMARY MACHINE EFFICIENCY PRODUCTION WEEK/ENDING 13/9/90

DATA	PRODUCT GROUP 1			PRODUCT GROUP 2										PR. GRP.3
	33	34	35	41	42	43	44	45	46	47	48	49	50	60
OUTPUT RATE/MIN.	140	150	45	45	45	45	50	60	50	49	45	50	49	66
MACHINE RATE SETTING	0.8	0.85	0.9	0.9	0.96	0.96	1	1	1	0.8	0.9	1	1	0.95
PAID PRODUCTION TIME	2,760	2,760	2,760	2,760	2,760	2,760	2,760	2,760	2,760	2,760	2,760	540	540	540
TOTAL DOWNTIME	356	368	825	540	397	471	540	1,838	526	458	440	70	61	75
MANAGERS TIME	30	0	180	540	0	0	60	780	0	120	0	0	0	0
REST PERIOD PAID	150	150	150	0	150	150	150	150	150	150	150	30	30	30
CLEANING	100	120	60	0	123	87	98	143	178	143	123	15	8	25
MACHINE	76	98	435	0	124	234	232	765	198	45	167	25	23	20
REJECTS UNITS	543	432	76	0	19	54	120	154	234	654	1,023	57	87	14
DROPS PRODUCED	246,765	302,345	75,434	0	107,876	98,798	112,543	54,654	110,123	83,456	89,876	21,321	22,450	27,980
INNERS WASTE KG	13.76	7.54	4.54	0.00	1.32	5.43	1.32	5.65	2.45	3.54	9.65	0.35	0.54	0.00
OUTERS WASTE QTY	56	30	29	0	45	87	34	54	54	35	98	7	6	0
"AFTER" METER LOADING (C)	10,226	12,568	3,114	0	4,450	4,030	4,655	2,223	4,534	3,442	3,647	533	561	635

LOTUS 12/2 PACKING WORK STATIONS REPORT WEEKLY SUMMARY MACHINE EFFICIENCPRODUCTION WEEK/ENDING 13/9/90

WORK STATION REF.	33	34	35	41	42	43	44	45	46	47	48	49	50	60
A. DROPS														
TOTAL CAPACITY AVAILABLE	309,120	351,900	111,780	111,780	119,232	119,232	138,000	165,600	138,000	106,192	111,780	138,000	135,240	173,052
TOTAL CAPACITY UTILIZED	246,222	301,913	75,358	0	107,857	98,744	112,423	54,500	109,889	82,802	88,853	119,644	121,911	146,520
TOTAL CAPACITY (GAIN)/LOSS	62,898	49,987	36,422	111,780	11,375	20,488	25,577	111,100	28,111	25,390	22,927	18,356	13,329	26,532
OPERATORS CAPA'Y AVAILABLE	305,760	351,900	104,490	89,910	119,232	119,232	135,000	118,800	138,000	103,488	111,780	138,000	135,240	173,052
OPERATORS CAPA'Y UTILIZED	246,222	301,913	75,358	0	107,857	98,744	112,423	54,500	109,889	82,802	88,853	119,644	121,911	146,520
OPERATORS LOSSES	59,538	49,987	29,132	89,910	11,375	20,488	22,577	64,300	28,111	20,686	22,927	18,356	13,329	26,532
B. CAPACITY LOSSES														
MANAGER SCHEDULING	3,360	0	7,290	21,870	0	0	3,000	46,800	0	4,704	0	0	0	0
WORK STATION: REJECTS	543	432	76	0	19	54	120	154	234	654	1,023	232	432	26
REST	16,800	19,125	6,075	0	6,480	6,480	7,500	9,000	7,500	5,880	6,075	7,500	7,350	9,405
CLEANING	11,200	15,300	2,430	0	5,314	3,758	4,900	8,580	8,900	5,606	4,982	4,350	3,283	7,838
MACHINE	8,512	12,495	17,618	0	5,357	10,109	11,600	45,900	9,900	1,764	6,764	4,750	3,381	7,524
UNDECLARED	22,483	2,635	2,934	89,910	(5,794)	87	(1,543)	666	1,577	6,782	4,064	1,524	(1,117)	1,740
C. PACKAGING LOSSES														
INNERS LOST	411	225	136	0	39	162	39	169	73	106	288	70	43	228
OUTER UNITS	56	30	29	0	45	87	34	54	54	35	96	9	132	5
D. DROPS PERCENTAGES														
TOTAL CAPACITY AVAILABLE	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
TOTAL EFFICIENCY	79.65%	85.80%	67.42%	0.00%	90.46%	82.82%	81.47%	32.91%	79.63%	76.53%	79.49%	86.70%	90.14%	84.67%
TOTAL CAPACITY LOSS	20.35%	14.20%	32.58%	100.00%	9.54%	17.18%	18.53%	67.09%	20.37%	23.47%	20.51%	13.30%	9.86%	15.33%
OPERATORS CAPA'Y AVAILABLE	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
OPERATORS EFFICIENCY	80.53%	85.80%	72.12%	0.00%	90.46%	82.82%	83.28%	45.88%	79.63%	80.01%	79.49%	86.70%	90.14%	84.67%
OPERATORS LOSSES	19.47%	14.20%	27.88%	100.00%	9.54%	17.18%	16.72%	54.12%	20.37%	19.99%	20.51%	13.30%	9.86%	15.33%
E. LOSSES PERCENTAGES														
MANAGER SCHEDULING	1.09%	0.00%	6.52%	19.57%	0.00%	0.00%	2.17%	28.26%	0.00%	4.35%	0.00%	0.00%	0.00%	0.00%
WORK STATION: REJECTS	0.18%	0.12%	0.07%	0.00%	0.02%	0.05%	0.09%	0.13%	0.17%	0.63%	0.92%	0.17%	0.32%	0.02%
REST	5.49%	5.43%	5.81%	0.00%	5.43%	5.43%	5.56%	7.58%	5.43%	5.68%	5.43%	5.43%	5.43%	5.43%
CLEANING	3.66%	4.35%	2.33%	0.00%	4.46%	3.15%	3.63%	7.22%	6.45%	5.42%	4.46%	3.15%	2.43%	4.53%
MACHINE	2.78%	3.55%	16.86%	0.00%	4.49%	8.48%	8.59%	38.64%	7.17%	1.70%	6.05%	3.44%	2.50%	4.35%
UNDECLARED	7.35%	0.75%	2.81%	100.00%	-4.86%	0.07%	-1.14%	0.56%	1.14%	6.55%	3.65%	1.10%	-0.83%	1.01%
INNERS LOST	0.17%	0.07%	0.18%	ERR	0.04%	0.16%	0.04%	0.31%	0.07%	0.13%	0.32%	0.06%	0.03%	0.16%
OUTER UNITS	0.55%	0.24%	0.93%	ERR	1.01%	2.16%	0.73%	2.43%	1.19%	1.02%	2.69%	0.18%	2.66%	0.08%

APPENDIX I

EFFECTIVENESS REPORT

- WEEKLY ONLY

Transfer Lotus 12/2 PACKING WORKSTATIONS REPORT: WEEKLY EFFECTIVENESS WEEK ENDING 13/09/90

	PRODUCT GROUP 1			PRODUCT GROUP 2										PR. GRP.3
WORKSTATION REF.	33	34	35	41	42	43	44	45	46	47	48	49	50	60
CLEANING														
Target	18,900	20,250	6,075	6,075	6,075	6,075	6,750	8,100	6,750	6,615	6,075	6,750	6,615	8,910
Actual	25,200	21,000	5,310	0	3,150	3,375	2,500	1,200	3,000	2,940	5,355	8,500	8,820	7,920
B/(W)	(6,300)	(750)	765	6,075	2,925	2,700	4,250	6,900	3,750	3,675	720	(1,750)	(2,205)	990
MACH/UNDISC/REST														
Target	32,007	34,757	6,743	0	10,899	11,099	11,898	13,657	11,977	4,023	10,577	11,297	3,469	11,456
Actual	25,957	28,025	6,458	0	6,886	7,138	13,522	2,635	12,235	9,748	10,380	13,535	9,335	19,986
B/(W)	6,050	6,732	285	0	4,013	3,961	(1,624)	11,022	(259)	(5,725)	197	(2,237)	(5,866)	(8,530)
REJECTS														
Target	2,561	2,781	539	0	872	888	952	1,093	958	322	846	904	278	916
Actual	470	301	6	0	0	0	0	0	0	0	0	0	77	92
B/(W)	2,091	2,480	533	0	872	888	952	1,093	958	322	846	904	201	824
WASTAGE INNERS														
Target	1,600	1,738	337	0	545	555	595	683	599	201	529	565	173	573
Actual	448	179	60	0	10	29	40	30	42	4	26	136	26	0
B/(W)	1,153	1,559	277	0	535	525	555	653	557	198	503	429	147	573
WASTAGE OUTERS														
Target	25	39	5	0	5	5	6	1	6	3	10	6	3	6
Actual	43	98	21	0	0	0	0	5	0	0	54	9	8	0
B/(W)	(18)	(59)	(16)	0	5	5	6	(4)	6	3	(44)	(3)	(5)	6
TOTALS														
TARGET	55,093	59,565	13,699	6,075	18,396	18,621	20,200	23,533	20,289	11,164	18,036	19,521	10,538	21,862
ACTUAL	52,118	49,603	11,855	0	10,046	10,542	16,062	3,870	15,277	12,692	15,815	22,180	18,266	27,998
BETTER/(WORSE)	2,976	9,961	1,845	6,075	8,350	8,079	4,138	19,663	5,012	(1,528)	2,221	(2,659)	(7,728)	(6,136)

5,4% 16,7% 13,4% Better.

APPENDIX J

LABOUR PRODUCTIVITY REPORT

- WEEKLY ONLY