CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In this era of globalization, manufacturing sectors are facing several challenges. Complexity in taking decision due to the immense availability of information, randomness in the system which affects performance, heterogeneity in events occurring all making modeling for performance prediction difficult. To maintain a competitive business means, getting more from the assets already had.

1.2 PERFORMANCE MEASUREMENT

Performance Measurement is defined as the process of quantifying the efficiency and effectiveness of the action (Adnan Hassan et al 2000). Performance measurement is a complex issue, and in order to choose appropriate performance measure to analyze and improve productivity many aspects must be considered (Tsang et al 1999).

(i) The purpose of the measurement
(ii) The level of the measurement
(iii) The level of information required
(iv) The time available for measurement
(v) The existence of available predetermined data
(vi) The cost of measurement.

1.3 PERFORMANCE MEASUREMENT FOR VARIOUS HIERARCHICAL LEVEL

Different performance measures are needed for various hierarchical levels of an organization (Arne Ingemansson and Jan Oscarsson 2005 a). For instance, the management of a company will not have the same performance measures as the personnel working at an assembly line. However, it is vital that there is a clear link between the performance measures at all hierarchical levels, so that, each function in a company works towards the same objective. Normally, most decisions at the top of an organisation have a strategic focus, while decisions at lower levels are more tactical and operation oriented.

(i) At the strategic level, performance measures are related to decisions having effect on issues with a time scale of several years. Such measures can tell an organisation about the soundness of their strategic decisions.

(ii) At the tactical level, performance measures covers a minimum of a month and maximum of a year period, and can be said to encompass issues like, which suppliers are used, which overall manufacturing technologies are utilised etc. These measures are important in setting boundaries for the actual operations of the organization (De Toni and Tonchia 2001).
(iii) At the operational level, performance measures deals with operations and business processes of the organisation on a daily, weekly or monthly basis.

Figure 1.1 shows the performance measure at the strategic level should be broken down into specific measures in the tactical level, and further down to the operational level (Jackson 2000).

![Performance Measure Diagram]

**Figure 1.1 Performance measure at various hierarchical level**

1.4 MANUFACTURING DISTURBANCES AND LOSSES

It is of vital importance to understand and measure disturbances to the manufacturing process. Disturbances are classified as chronic and sporadic according to their frequency of occurrence.
(Orjan Ljungberg 1998). Chronic disturbances are usually small, hidden and complicated because they are the result of several concurrent causes. Sporadic disturbances are more obvious since they occur quickly and as large deviations from the normal state (Patrik Jonsson and Magnus Lesshammar 1999). Sporadic disturbances occur irregularly and their dramatic effects are often considered to lead to serious problems; however, research evidence suggests that it is the chronic disturbances that result in the low utilization of equipment and heavy costs because they occur repeatedly (Nord et al 1997). Chronic disturbances are more difficult to identify, since they can often be accepted as the normal state of the process. Identification of chronic disturbances is only possible through comparison of performance with the theoretical capacity of the equipment. Chronic and sporadic disturbances both have different negative impacts on the manufacturing process. They consume resources without adding any value to the final product. OEE attempts to identify these losses (Bulent Dal et al 2000).

Different types of problems (e.g. failures, breakdowns, material defects, lack of material) usually occur when a manufacturing system is operational, which in turn cause disturbances in the production flow and reduce the systems output (Raouf 1994). In order to achieve high productivity, it is therefore necessary to have a reliable manufacturing system where disturbances are kept to a minimum level (Stefen Tangen 2003). Reasons for disturbances in the production flow vary, meaning that many different types of losses can be found within a manufacturing company. Losses can indeed be defined and classified in numerous ways.
1.5 TOTAL PRODUCTIVE MAINTENANCE (TPM)

Total Productive Maintenance (TPM) is a maintenance program, which involves a newly defined concept for maintaining plants and equipment (Masud et al 2007) and (John J. Lawrence 1999). Total Productive Maintenance combines total quality management and proactive maintenance policies in order to achieve maximum production efficiency (Bohoris and Vamvalis 1995).

Bamber et al (1999) summarized the various factors affecting TPM implementation and it is shown using Cause and effect diagram.

![Figure 1.2 Cause and effect diagram – a generic model of factors affecting successful implementation of TPM](image)

The history of TPM originates from the preventive maintenance and reliability engineering research from the 1950s (Selladurai et al 2007).
The reliability engineering paradigm was combined with Japanese quality management in 1970s. As a strategic management paradigm TPM emphasizes the importance of quality and employee participation in maintenance management (Vinoth Kumar Khanna 2008). The most central objective of TPM is the maximization of the Overall Equipment Effectiveness (OEE), which is calculated by (Seiichi Nakajima, 1988)

\[ \text{OEE} = \text{Availability} \times \text{Performance} \times \text{Quality}. \]

1.6 OVERALL EQUIPMENT EFFECTIVENESS (OEE)

A key performance measure in production environment is the Overall Equipment Effectiveness (OEE). OEE was introduced by Nakajima (1988) in the context of Total Productive Maintenance (TPM) and is directed towards equipment/machines (Jose Arturo Garza Rayes 2005). OEE is a simple and clear overall metric, and managers appreciate such an aggregated metric instead of many detailed metrics (De Ron and Rooda 2006). The concept of OEE is becoming increasingly popular and it has been widely used as a quantitative tool essential for the measurement of productivity in semiconductor manufacturing operations, because of extreme capacity constrained facility investment.

Samuel H. Huang et al (2003) stated that, traditional metrics for measuring productivity, throughput and utilization, are insufficient for identifying the problems and underlying improvements needed to increase productivity. Semiconductor Equipment and Materials International (SEMI 2003) has developed a standard for the definition and measurement of OEE as introduced by Seiichi Nakajima (1988) and Chien et al (2006).
1.7 **PURPOSE OF OEE**

The OEE measure can be applied at several different levels within a manufacturing environment (Bulent Dal et al 2000). Firstly, OEE can be used as a ‘benchmark’ for measuring the initial performance of a manufacturing plant in its entirety. In this manner the initial OEE measure can be compared with future OEE values, thus quantifying the level of improvement made. Secondly, an OEE value, calculated for one manufacturing line, can be used to compare line performance across the factory, thereby highlighting any poor line performance. Thirdly, if the machines process work individually, an OEE measure can identify which machine performance is worst, and therefore indicate where to focus TPM resources.

1.8 **CONCLUSION**

Different opinions appear to exist within the OEE literature as to what levels of availability, performance efficiency and quality constitute acceptable levels of OEE performance (Steve Eldridge and Jose Arturo Garza Reyes (2005). Whilst this situation is potentially confusing, it also reflects the difference in potential OEE achievement across different business sectors and industries. Second, whilst OEE provides useful benefits as a production monitor, it is as a measure of improvement that the real potential of OEE can be seen. If this measure is used not just to monitor but to manage improvement, OEE will provide a useful guide to the production process where inefficiencies can be targeted. This leads to a third point, that of accurate performance data. In order to utilise the OEE measure effectively, it must be convincing
and plausible to production management (Bulent Dal et al 2000). As with many production systems, inaccurate data will quickly lead to a lack of credibility. It is therefore essential to invest time in the improvement of the source data collection and recording methods (Jeong and Philips 2001). OEE provides an excellent perspective on production improvement, provided, the OEE measurement and method of arriving its value is accurate (Robert W. Freck 2000). If the OEE measurement techniques are accurate then this OEE information will be very much useful for the management decisions (Philip Godfrey 2002).

Chapter 2 gives the basic concepts of six big losses, Availability, Performance, Quality, Reliability, Maintainability, Production Equipment Configuration, Yield, Bottleneck machine. The basic concepts of TPM are discussed. The optimization tool, Evolutionary Programming (EP) and the mathematical tool Principal Component Analysis (PCA) are also discussed.

A detailed literature review for TPM and OEE is given in Chapter 3. The work done by earlier researchers in this area are classified into five groups. From the literature it is clear that the OEE measurement has widened its application in many areas in the manufacturing sector.

In Chapter 4 an OEE model with the new term Yield is proposed. In casting process, yield plays an important role in assessing the overall performance of the firm. So, the term “yield” is introduced in the OEE calculation. A case study has been carried out in a casting industry. The REE calculation with yield will give the exact picture to the management about the material utilization in the process. Also, the optimization tool
Evolutionary Programming (EP) is used with MATLAB 7.0 for the optimization of REE parameters.

A new model, to determine the Overall Process Effectiveness (OPE) based on OEE metrics is proposed in Chapter 5. In this model, analysis is made to compare the OPE values, while using the term yield instead of quality term in OEE calculation. This model is analysed in a tyre manufacturing industry.

In Chapter 6 a new model is proposed to determine the effect on Overall Line Effectiveness (OLE) when a bottleneck machine is supported with a parallel machine. In this model, different approaches were followed to calculate overall line availability, overall line performance and overall line quality rate. The proposed model is analyzed in an automobile ancillary production industry.

Chapter 7 gives a detailed conclusion about the research carried out in this thesis. Also, it provides the scope for the further research in this area.