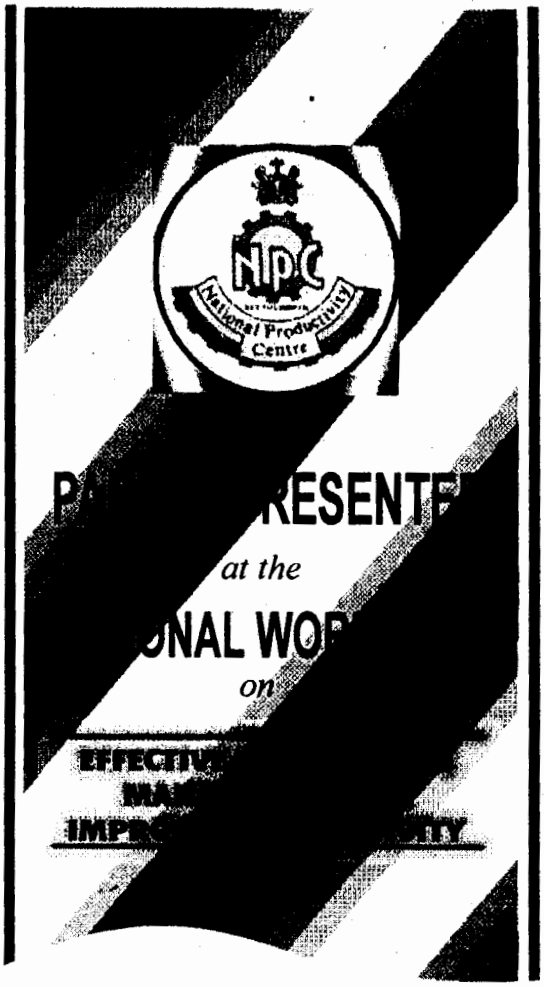

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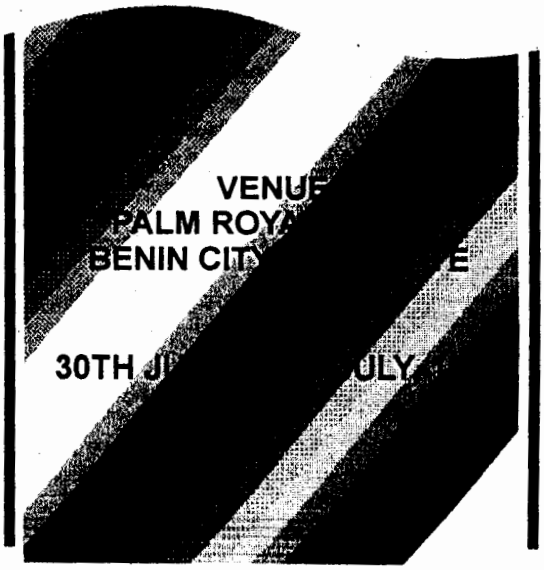

STRATEGIES FOR EFFECTIVE MAINTENANCE MANAGEMENT (INCLUDING FUNDAMENTALS OF AVAILABILITY, RELIABILITY & MAINTAINABILITY)

By

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AT A NATIONAL WORKSHOP ON "EFFECTIVE MAINTENANCE MANAGEMENT FOR IMPROVING PRODUCTIVITY"

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1. ABSTRACT

The paper considers effective maintenance management vis-à-vis improving productivity. The scope of effective management was dealt with and the relationship between management techniques and availability, reliability and maintainability. An attempt was made to clearly define important terminologies. The paper profers that increased productivity is impossible without effective maintenance of plant, equipment and labour.

2. INTRODUCTION

There are different ways in which improvement in productivity can be considered. Also the scope of productivity is a function of plant, equipment and labour which have a direct bearing on finance. All these will affect the quality of the products individually, corporately and sectorially as the case maybe. Productivity however can be considered variously as follows: output-input ratio; (Economists); overall production efficiency and effectiveness; (Business Managers); return on investments (Accountants); output-volume of manpower

used (Human Resource Managers); doing the right things properly that is in a manner and degree such that resources are optionally converted in a transformation process to produce goods/or services (Engineers). Also the product quality, workmanship quality, customer satisfaction, low absentee and turnover rates and other difficulties are the concern of Engineers in their bid to improve on productivity. Since manpower, time, money, plant and machinery are chiefly involved in the transformation of raw materials from various resources into finished products/goods, the availability of these components is of paramount importance. Proper management of these resources is the bane of maintenance whereas profitability, effectiveness and satisfaction are derivable from effective management. It is worthy to note that technology enhances productivity [Kuznet, S. (1971); Drucker, P. (1955)].

3. FACTORS AFFECTING PRODUCTIVITY

Other eminent scholars have considered productivity as follows:

i. "An attitude of the mind", Quick, J.H (1973);

ii. "Output produced by each unit of input". Udo, Udo-Aka (1973);

iii. "It is a measure of efficiency (a balance between all factors of production which will give the greatest output for the smallest effort" – Kuznet, S. (1971) and Drucker, P. (1955).

The following are thus other factors that maybe used to measure productivity: profit/capital employed, profit/sales, sales/capital employed; sales/stocks, sales/fixed assets, sales/employees, net earnings/labour charges, added value (net output)/internal expenses, total earnings/operation costs, sales revenue (gross sales)/total factorial inputs).

To improve on productivity will require a quantitative measure on the use of resources viz: production time, labour and material requirements, waste level, available space and machine utilization. The variables thus include: labour, capital materials and output and only effective maintenance management can guarantee this.

4. SECTORS UNDER CONSIDERATION

These are the various areas were managers and system planners aim at improving productivity and this include the various sub-sectors: manufacturing, agriculture, building, utilities (water, electricity), transport, communication, distribution, education etc. (Iboanugo, A.C. 1999).

5. MAINTENANCE AND MAINTENANCE STRATEGIES

5.1 MAINTENANCE – INTRODUCTION

This is an activity applicable to all systems (natural or artificial) aimed at keeping the system unaltered or unimpaired. The application of engineering science to the maintenance or repair of systems (plant, machinery or equipment) is the scope of maintenance engineering. Proper maintenance leads to efficiency which is the key to profitability in any industry as this leads ultimately to improvement of product volume, income and satisfaction. To maximize production efficiency (towards improving productivity), it is essential that the productive and operational life of a plant, machinery or equipment is as long as possible. However, the maintenance cost should be as low as possible, that is the availability of the machinery should be very high but at a minimal cost of maintenance.

Maintenance work is thus made necessary by the desire to ensure that the system either remains unaltered or if altered, is restored to its original state within the shortest possible time.

5.2 THE SCOPE OF MAINTENANCE

General and specialized knowledge are required to undertake this multi-disciplinary activity. An effective maintenance programme will include the following: human understanding and appreciation, planning, manpower and training, management of spare parts and materials, documentation and behavioural influence.

Maintenance, therefore, has a potentially devastating influence on business achievement and hence corporate survival.

5.3 BENEFITS OF EFFECTIVE MAINTENANCE

The efficiency with which maintenance activities are carried out may influence the following: finished product quality, efficiency and cost of production (poor energy utilisation), customer reaction, labour reactions. Maintenance is thus a costly business requiring some reasonable level of investment.

5.4 CHARACTERISTICS OF AN EFFECTIVE MAINTENANCE SCHEME

These include the following :

- The capacity to reduce the need for breakdown maintenance;
- The ability to meet the manufacturer's stipulated maintenance proposals;
- Achievement of cost reduction through adequately selected maintenance scheme;
- Regular manpower training;

- Awareness for new and improved maintenance techniques;
- Maintenance personnel confidence engenderment;
- Effective modulation of company cash flow;
- Possession of effective control and feedback mechanism.

5.5 MAINTENANCE STRATEGIES

Two types viz: technological and administrative strategies exist.

5.5.1 TECHNOLOGICAL

These are technical in nature. An effective maintenance programme is based on a well conceived and laid out strategies based on equipment utilisation and their behaviour, production requirements and policies and corporate objectives. Thus, technological strategies can be grouped as follows: Breakdown or corrective maintenance; preventive maintenance (time-based or scheduled, condition monitor, condition based); Design-out or improvement maintenance in a progressive order of effectiveness in terms of value cost.

Whereas breakdown maintenance allow for system collapse before any attention is accorded the system, preventive maintenance is aimed at minimising the effect of failure while design out maintenance aims at eliminating the cause of maintenance. However, equipment availability is a function of maintenance at the operating stage and other factors inherent in other stages of the equipment life cycle from design to replacement (specification, design, manufacture and installation, commissioning, operation and replacement) with data from commissioning and operation being fed back to the specification, design, manufacturing and installation stages. This is a new strategy known as terotechnology, Okah-Avae, B.E. (1995).

5.4.2 ADMINISTRATIVE STRATEGIES

These are purely administrative policy decisions which come to bear on the maintenance function thus affecting effectiveness, negatively or positively since it has some influence on technological strategies. Such policies that affect maintenance functions include: selection and purchase of machinery and equipment; authority to shut down equipment or machinery; shift arrangement; use of external contractors, centralised or decentralised maintenance function. These have their relative merits and demerits.

5.5 REQUIREMENTS OF AN EFFECTIVE MAINTENANCE MANAGEMENT SCHEME

This can only result from a systematic approach in the formulation and documentation of maintenance programs and includes the following :

- Equipment Standardization.
- Training of Maintenance Personnel.
- Development of Trained Personnel.
- Project Personnel.
- Special Maintenance Tools.
- The Product/Output Expected.
- Spare Parts.

6. AVAILABILITY, RELIABILITY & MAINTAINABILITY

6.1 RELIABILITY

This is the ability of a product to perform without failure a specified function under given conditions and for a given period of time. This is specified by some parameters which give indication of the failure rate of such a system or equipment and is independent of

operation time. Such parameters also enable comparison of performance between different systems with different operating periods. Two such parameters are the mean time between failure, MTBF (mean or average time between failures) and mean time to fail MTTF (the average time it takes the component to fail).

The length of time a system will run without failure is very important and is a measure of reliability. The reliability of a system must be less than that of any individual component. MTBF is applied to repairable systems while MTTF is for non-repairable systems (filament lamps, fuses, resistors, capacitors) or "throw-away items.

6.2 AVAILABILITY/AVAILABILITY RATIOS

Availability (A) is the sum total of the uptime, U (time during which the machine is working normally) and the downtime, D (time during which the machine is faulty or undergoing repairs) that is A = U + D.

Since availability per se is not a reliability index but a valuable index of equipment performance, for the purpose of planning, availability ratio shall be applied. This involves knowing how many hours would be lost repairing faults. Availability ratio is a portion of the total time the machine is expected to function that the machine is actually in working order. That is AR = U/U+D and non availability ratio (NR) is given as D/U+D.

$$\frac{\text{MTBF}}{}$$

Availability also is given as MTBF + T; where T is the average repair time.

6.3 MAINTAINABILITY

This together with reliability determines the availability of machinery. This controls the prime function of maintenance. It is a very important factor to be considered during design since it is desired to achieve a reasonable level of maintainability. It is a factor of the time required and resources needed to restore equipment in case of a failure. Also, maintainability is the characteristics of an equipment related to the ease with which it can be repaired, that is, the measure of the speed with which the loss of performance is detected, the fault located, repairs completed and a check made to see if the equipment or system is functioning normally again. Thus, the probability that an equipment or system will be restored to operational effectiveness within a given period of time when the maintenance action is performed in accordance with prescribed procedures (WARA, S.T., 1997).

7. ASPECTS OF EFFECTIVE MAINTENANCE ENGINEERING TOWARDS IMPROVED PRODUCTIVITY

7.1 RELIABILITY AND MAINTENANCE COST

With higher quality components with better MTBF values, equipment reliability can be increased. This inadvertently will lower maintenance cost and increase procurement cost. Reliability optimisation must be considered at the design stage. Optimal reliability occurs when the total life cost is minimum.

7.2 RELIABILITY AND PREVENTIVE MAINTENANCE

Practically, all components making up an item or all items making up a unit have different lengths of useful lifespan. The component with the shortest lifespan need to be replaced or repaired prior to failure inorder to maintain the

reliability level of the item or unit. This is known as Preventive Maintenance (PM). Thus, a good knowledge of the components useful lifespan or MTBF (or MTTF) would be invaluable in preventive maintenance planning.

7.3 RELIABILITY AND MAINTENANCE PLANNING

With a knowledge of the mean downtime for failures and scheduled repairs respectively, it is possible to determine the optimum interval between equipment overhauls. This is possible when data records for equipment and shut down are analysed to provide the MTBF value.

8. CONCLUSION

Productivity is a measure of output of goods and services relative to input labour, material and equipment. To be more productive results in lower unit cost and thus increased competitive effectiveness. Improving productivity implies getting more out of what is put in; doing better with what you have; working smarter (not harder); and in today's context doing more with less people, money, time, space and fewer resources in general (not increasing production through addition of resources such as time, money, materials or people) [Wayne F. Casio, 1995]. To remain continuously and effectively in the production business is to reduce threat to facility life, reduce levels of production loss, reduce effects on product quality and reduce risk to human life.

All these aspects bother on maintenance, maintainability and availability which in turn has a direct effect on reliability. Increased productivity, therefore, can never be discussed outside the aegies of maintenance engineering and maintenance strategies (technological and administrative aspects). Thus towards improving productivity is giving a new lease of life to maintenance administration as a corporate component to stability in the production sector. System Managers,

Planners, Administrators, Governments and Society must accept with all seriousness the importance of maintenance and maintenance administration as a live wire of all systems and subsystems involving plant, equipment, machinery and people the simple reasons being that effective maintenance management is required in factories, workshops and plants to ensure that the plant is in a serviceable condition so that work of the appropriate quality is produced; to preserve the fixed assets in a satisfactory condition and to reduce the cost of loss of production due to plant and system breakdown in order to guarantee productivity, (WARA, S.T., 1997).

REFERENCES

1. Okah-Avae, B.E. (1995): "The Science of Industrial Machinery and Systems Maintenance Spectrum books limited, First Edition.

2. Wayne, F.C. (1995): "Managing Human Resources: Productivity, Quality of Work Life, Profits Mc.Graw-Hill Publishing Company, 2nd Edition, pp. 14.

3. Wara, S.T. (1997): "Maintenance And Maintainability, (An Introductory Course)".