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Advanced Manufacturing Technology: A Strategic Solution To Production Problem

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Abstract

Advanced Manufacturing Technology (AMT) is revolutionizing the way products are manufactured especially in what are termed world-class manufactured especially in what are termed world-class manufacturers (WCM). AMT is a general expression encompassing Automated production technology, Computer Assisted Design and Manufacturing (CAD/CAM), Flexible Manufacturing Systems (FMS), robotics, Total Quality Control (TQC), advances in production management including materials requirement and manufacturing resources planning systems(MRP), Just-in-Time (JIT) Systems and so on. It has been argued by a number of academics, consultants and industrialists that traditional management accounting systems and performance measures are inappropriate and misleading for firm using AMT. This view is supported by Kaplan (1996) when he said that "traditional management accounting produces"… simple the wrong measures. They move the company in the wrong direction, reward managers for damaging the business and provide no incentive for improvement. The best we can do is to switch them off, just stop doing them!"

Keywords: Advanced manufacturing, Total quality control, and Management accounting.

1.1 INTRODUCTION

Strategic production refers to the managerial decisions that relate the organization to its environment, guide internal activities, and determine organization long-term performance (T. Lucy, 2000). The principal responsibility of the manager is to ensure that organization keep in touch with the external environment and this must see the essence of management in terms of service to customers.

Advanced Manufacturing Technology (AMT) is an umbrella word used to capture automated production technology computer assisted design and manufacturing system (CAM/CAM), flexible manufacturing system (FMS), robotics, total quality control (TQC), advances in production management including materials requirement and manufacturing resources planning system (MRP), just-in-time (JIT) systems etc, which are considered to be the new developments in the area of management accounting due to technological advancement. Based on the above, the traditional management accounting system have been found to be inadequate as basis for evaluating performance in companies that have adopted the AMT.

Take for example total quality management (TQM), which is based upon producing quality goods and services as defined by the customers. TQM is quality centered, customer focused, fact-based, team-driven, senior management-lend process to an organizations strategic imperative through continuous process improvement. It is not a programme but rather is systematic, integrated, and organization way-of-life directed at the continuous improvement of an organization. TQM is a proven management style used successfully for decades in organization around the world. However, AMT is not an end in itself but a means to an organizational end. The word manufacturing in AMT shows a concern for customer satisfaction and there is a cost element attached to the sustenance of quality of the products or services by organizations.

This study is meant to examine the justification behind the promotion of AMT. Even though, some consenting views have it that AMT has it own deficiencies.

1.2 The Objectives of AMT

1. Companies need to complete in fast moving, sophisticated world markets, the use of AMT helps them to do this.
2. It increases their capability to produce high-quality goods at law cost.

3. It provides high levels of customer satisfaction.
4. Firms need to be innovative and flexible and to be able to deal with short product life cycles.
5. They need to be able to offer greater product variety whilst maintaining or reducing their costs.
6. They wish to reduce set-up time and inventories.
7. It helps to gain greatest possible manufacturing flexibility.

2.1 Conceptual Framework

The various facets making up AMT are now taken informs according Cole, G.A.(2000)

2.2 Computer-Aided Design (CAD)

This is product component design and testing using a computer terminal. The interaction between the designer, the computer and the database enables many more options and designs to be considered in order to achieve the greatest efficiency and simplicity at the lowest cost. In idea of T. lucy(2000) an important facility is the interrogation of the CAD database to identity standard parts and methods thus simplifying product design, reducing the number of product parts, and thus helping to minimize inventories.

2.3 Computer-Aided Manufacturing (CAM)

This is wide ranging expression to cover the use of computers for the programming and control of production machines. It includes the use of robots, numerically controlled (NT) machines and computer numerically controlled (CNC) machines. However, because of the ability to re-programme or required, CAM offers many merits such as;

- Flexibility
- Greater control over manufacturing
- Reduced set-up times
- Better, more consistent quality
- Fewer reworked items and less scrap
- Less reliance on direct labour

Indeed, many companies CAD and CAM are integrated thus helping to reduce the lead time from the initial produce idea through to the market place.

2.4 Flexible Manufacturing Systems (FMS)

This is a highly-automated manufacturing system which is computer controlled and capable of producing a family of parts in a flexible manner. The main essence is a mixture of CNC machines, robots and automated materials handling equipment to move the components from tool to tool. The final stage in automation would be the complete automation of the whole factory, known as computer-integrated manufacturing (CIM). This stage has not yet been reached as even the most advanced of today‟s factories contain is lands of automation (IAs) linked by human bridges.

2.5 Production Management Systems (PMS)

In addition to improvements in machines and technology there have been major advances in the planning and control of production. Some of these management changes have been so sweeping that they

2.6. Materials requirement Planning (MRP)

MRP is a computerised information, planning and control system which has the objective of maintaining a smooth production flow.

It is concerned with:

- maximizing the efficiency in the timing of orders for raw materials or parts that are placed with external suppliers
- efficient scheduling of the manufacture and assembly of the final product.

The operation of an MRP System requires the following:

a) A master production schedule showing the quantities and timings require for the finished product(s).

b) A Bill of Materials (BOM) which shows the breakdown of each finished product into sub-assemblies components and raw materials.

c) An Inventory file containing the balance on hand, scheduled receipts and numbers already allocated for each sub-assembly, component and type of raw mate

d) A parts manufacturing and purchasing file containing lead times of all planning items and lead times and production sequences of all sub-assemblies and components produced internally.

MRP has evolved into MRPII which attempts to integrate material resource planning, factory capacity planning and labour scheduling into a single manufacturing control system.

2.7 Just-in-time systems

JIT systems developed in Japan, notably at Toyota, and are considered as one of the main contributions to Japanese manufacturing success.

The aim of ITT systems is to produce the required items, of high quality, exactly at the time they are required: JIT systems are characterized by the pursuit of excellent at all stages with a climate of continuous improvement.

A JIT environment is composed of the following:

- a move towards zero inventory
- elimination of non-value added activities
- an emphasis on perfect quality i.e. zero defects
- short set-ups
- a move towards a batch size of one
- 100% on time deliveries
- Demand-pull manufacture

It is this latter characteristic which gives rise to the name of Just-in-Time. Production only takes place when there is actual customer demand for the product so JIT works on a pull-through basis which means that products are not made to go into stock.

Contrast this with the traditional manufacturing approach of production-push products are made in large batches and move into stock.

There are two aspects to JIT systems, JIT Purchasing and JIT Production.

2.8. Just-in-time Purchasing

This seeks to match the usage of materials with the delivery of materials from e suppliers. This means that material stocks can be kept at near-zero levels. For JIT purchasing to work requires the following:

a) Confidence that suppliers will deliver exactly on time.

b) That suppliers will deliver materials of 100% quality so that there will be no rejects, returns and consequent production delays.

The reliability of suppliers is all-important and JIT purchasing means that the company must build up close working relationships with their suppliers. This is usually achieved by doing more business with fewer suppliers and placing long-term purchasing orders in order that the supplier has assured sales and cart plan to meet the demand.

2.9. Just -in -time production

In the word of Osisioma(2004),JIT production works on a demand-pull basis and seeks to eliminate all waste and everything which does not add value to the product. As an example consider the lead times associated with making and selling a product. These include:

Inspection time — Transport time — Queuing time — Storage time — Processing time

Of these, only processing time adds value to the product whereas all the others add cost but not value.

The ideal For JIT systems is to convert materials to finished products with a lead time equal to processing time so eliminating all activities which do not add value. A way of emphasizing the importance of reducing throughput time is to express the above lead times as follows:

Throughput time = Value-added time ± Non-value added time

The JIT pull system means that components are not made until requested by the next process. The usual way this is done is by monitoring parts consumption at each stage and using a system of markers (known as kanbans) which authorise production and movement to the process which requires the parts. A consequence of this is that there may be idle time at certain work stations but this is considered preferable to adding to work-in-progress inventory.

Poor and uncertain quality is a prime source of delays hence the drive in JIT systems for zero defects and Total Quality Control (TQC). When quality is poor, higher WIP is needed to protect production from delays caused by defective parts. Higher inventory is also required when there are long set-up and changeover times. Accordingly there is continual pressure in JIT systems to reduce set-up times and eventually eliminate them so that the optimal batch size can become one. With a batch size of one, the work can flow smoothly to the next stage without the need to store it and schedule the next machine to accept the item.

3.0 JIT production implications

To operate JIT manufacturing successfully and achieve the targets of low inventories and on-time deliveries means that:

a) The production processes must be shortened and simplified. Each product family is made in a work-cell based on flowline principles. The JIT system increases the variety and complexity within work cells. These contain groups of dissimilar machines which thus require workers to be more flexible and adaptable.

b) Using JIT the emphasis is on doing the job right the first time‟ thus avoiding defects and reworking. JIT systems require quality awareness programmes, statistical checks on output quality and continual worker training.

c) Factory layouts must be changed to reduce movement. Traditionally machines were grouped by function; all the drilling machines together, the grinding machines and so on. This meant a part had to travel long distances moving from one part of the factory to another often stopping along the way in a storage area. All these are non-value added activities which have to be reduced or eliminated.

3.1 Benefits from JIT

Successful users of JIT systems are making substantial savings. These arise from numerous areas:

a) Lower investment required in all forms of inventory

b) Space savings from the reduction in inventory and improved layouts

c) Greater customer satisfaction resulting from higher quality better deliveries and greater product variety.

d) The buffers provided by traditional inventories masked other areas of waste and inefficiency. Examples include; co-ordination and work flow problems, bottlenecks, supplier unreliability and so on. Elimination of these problems improves performance dramatically

e) The flexibility of JIT and the ability to supply small batches enables companies to respond more quickly to market changes and to be able to satisfy market niches.

3.2 Total quality control (TQC)

AMT and JIT systems have a total quality control philosophy in which the only acceptable quality level is zero defects. Prominence is given in JIT systems to all defect found so that the reason(s) for the defect can be discovered and put right. A defect found is a learning opportunity. On the other hand, in many Western manufacturers using conventional management accounting, activities and costs associated with poor quality are obscured by the common practice of including in standard costs and process costs „normal" allowances for scrap, waste and reworks. Thus, as long as the production process turned out high volumes and kept within the „normal" scrap levels all was thought to be well. The conventional wisdom was that there was an optimal percentage of defects with a quality-cost trade-off.

3.3 Moving towards TOC

Ututu(2005) said that Companies operating TQC measure defects not as a percentage of outgoing items but as a parts-per-million (PPM) ratio of defects to items produced. They realize that many things have to be done correctly to achieve continual reductions in PPM defect rates. The most important thing is to realize that quality has to be designed in, not inspected in. TQC has to be considered at every stage starting with the initial product idea. It is not something which is solely the concern of Inspectors at the end of the production line.

The following are the key points at which TQC must operate:

3.3.1 Product design

Probably the key stage in Product design should have price, performance, ease of manufacturing and quality in mind throughout the design stage Uturu stated. An important factor is simplicity; fewer parts preferably of standard design. A Product designers should also liaise closely with manufacturing and process engineers. A well designed product not only works well, it is easy to manufacture. During the design stage the technique of value analysis is used extensively. This is the systematic examination of cost factors in order to devise ways of achieving the specified purpose, most economically, at the required standard of quality and reliability.

3.3.2 Production engineering

This is the process of designing the methods for making a product to the design specification. This also includes the tools and processes to be used, the tolerances and finishes required, assembly sequences and so on.

3.3.3 Manufacturing

Manufacturing considerations must be part of product design because it is estimated that only 20% of quality defects can be traced to the production line. The other 80% being attributable to design factors or poor purchasing. In JIT systems the responsibility for defects has moved away from quality control inspectors to the operatives. Operators are expected to maintain their equipment and produce zero defect output. They are, of course, aided in this by CNC machines and automatic equipment which often incorporates computerized gauging and measuring devices. In addition, there is extensive use of Statistical Process Control and Control Charts.

JIT systems emphasized in-process checks rather than waiting until the product is completed before it gets a final inspection Osisioma (2004). This was the traditional method and is s widely used even though it is a less efficient system.

3.3.4 Goods inwards

The quality of output depends on the quality of input materials Drucker,P(2002). This means that Quality requirements are also imposed on suppliers to ensure quality and no inspection is performed on incoming supplies.

3.3.5 Output inspection

Final inspection is being replaced by in-process checking. Final inspection, based sampling, does still take place mainly to satisfy management that quality control production is being maintained.

When TQC is properly applied and the incidence of defects decrease, total manufacturing costs, including warranty and service costs, decrease.

This is not surprising because If Items are made correctly first time money is saved from the avoidance of detection, reworking, scrapping, repairing in the field and so on.

3.4 Management accounting and AMT

Now that the basics of AMY have been outlined we can examine the deficiencies that traditional management accounting approaches have been claimed to possess when they are applied to companies using AMT.

These deficiencies are said to be so severe that a number of leading commentators have stated that much of traditional management accounting is based on incorrect principles and provides misleading information to managers, especially when applied to AMT.

The main problem areas identified are:

Absorption costing — the traditional methods of calculating product costs use absorption costing based on production-volume related absorption rates (direct labour hours or machine hours). These methods are considered inappropriate in an AMT environment. Cost behaviour — traditional management accounting classifies costs as fixed or variable in relation to production volume. In AMT many overheads costs are for support which are related to activities and factors other than production volume. Traditionally, the longer-term variability of many costs has been largely ignored. Labour costs are a declining proportion of total costs so the treatment and understanding of overheads becomes increasingly important.

Standard costing — standard costing and variance analysis are widely used traditional control techniques whose usefulness for AMY and JIT environments have been questioned T. lucy (2000). The doubts arise from both the general philosophy and detailed operation of standard costing. The idea that performance is deemed satisfactory if it meets pre-determined standards is at odds with the philosophy of continual improvement in AMT. Also, standard costing variances focusing on financial numbers produced with a time lag are likely to be of little or no value in a fast changing AMY environment. Many individual variances lose their relevance entirely when AMT is used. For example purchase price variances have little meaning when prices are determined by long-term - contracts where quality and supplier reliability are dominant factors. Bulk purchasing to achieve lower material prices contradicts the AMY philosophy of maintaining near zero inventory levels.

Short-term financial measures much of the output of traditional management accounting consists of short-term financial performance measures, e.g. costs, production efficiency measured by cost per unit, variances and so on. Many of these are produced long after the event and are too narrowly focused. A much wider view is necessary for AMT together with the realization that more speedily available financial performance measures are required. For example, those relating to quality, equipment failures, reject-rates, maintenance and so on.

Cost accounting methods — traditional cost accounting traces raw materials to various production stages, via WIP, to the next stage through to finished goods. This is supported by literally thousands of transaction entries. With JIT this becomes needlessly expensive and uninformative when production flows through the factory on a continual basis with near-zero inventories and very low batch sizes. In addition all piecework payments at the individual worker level and local efficiency measures become pointless. With J1T the only worthwhile efficiency measure relates to the entire JIT line and not to individual stations in the line.

3.5 Activity-based costing (ABC) and AMT

Aroh,J.C(2006), states the principles of ABC have been covered earlier. Here we discuss ABC‟s suitability for AMT environments and some possible problems which may be encountered. Companies using AMT have a high level of overhead costs, especially relating to support services such as industrial engineering, maintenance, production planning, data processing etc. By the use of carefully chosen cost drivers ABC traces these over- heads to product lines in a more logical and less arbitrary manner than absorption on production volume.

Also, many costs previously included in general overheads, and absorbed by a percentage uplift of factory cost can be traced to specific JIT lines. This improves product costing and cost management as the costs are made the responsibility of the line manager. Further, the determination and use of cost drivers helps to measure and improve the efficiency and effectiveness of the support departments.

It forces the company to ask searching questions. For example, what does the department achieve? Does it add value? Why is the department needed? What causes the demand for the activity? Are there better ways of meeting this demand? and so on.

ABC systems may also encourage reductions in throughput time, inventory reductions and quality improvements thus helping to achieve the objectives of AMT.

It would appear that ABC has much to offer firms using AMT although, as is to be expected, there are problems with ABC. For example, a key element in JIT philosophy is the drive towards simplicity yet ABC systems by using multiple cost pools and a variety of drivers can lead to more complexity. Another example is to do with setups. JIT seeks to reduce set-up times so that very small batches (ideally one part only) can be made economically. The aim of set-up time reduction is to allow more set-ups not merely to reduce set-up costs. The use of a cost-driver based on the number of set-ups will therefore work against JIT principles as it will tend to encourage larger batches. All in all however, the use of ABC seems to be more logical and does remove the patent illogicalities and more inaccuracies of traditional product costing applied to AMT.

Conclusion

The concept of AMT was extensively mention by professor Kaplor which he claim that it would improve the production quality of goods and services at reduced cost. For example the development of TQM was made to correct some defects in quality concept in a typical traditional production setting in which product quality determination was based on product design and conformity to certain specified design characteristics, quality control inspection made at end of production process and regarded as solely the responsibility of the quality control department. AMT shifts the emphasis on traditional production to technological production from design specification to customers tastes and preferences while building strong production base.

Many organization still have a long way to go in meeting AMT standards. In Nigeria, customers and clients exists in different cultural and market segments, so firms AMT strategies should try to establish what quality levels their target customers and clients expect, and then produce and market products, services or ideas that continually exceed customer or client expectations.

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