

## **MAINTENANCE STRATEGY DEVELOPMENT WITHIN SME'S: THE DEVELOPMENT OF AN INTEGRATED APPROACH by Dr David Baglee University of Sunderland UK.**

Over recent years, the importance of maintenance, and therefore maintenance management within UK manufacturing organisations has grown. This is a result of increasing pressure upon manufacturing organisations to meet customer and corporate demands, and equipment availability and performance is central to achieving these. Chan et al (2005) has highlighted that “recent trends have indicated that, in general, many manufacturing systems are not performing as intended, so far as cost effectiveness in terms of their operation and support. The majority often operate at less than full capacity, with low productivity, and the costs of producing products are high”.

A number of modern maintenance practices, of which Total Productive Maintenance (TPM) is one example, have been developed to allow organisations to strategically direct their resources to the maintenance tasks that are considered critical to the effective and efficient running of their equipment. A number of organisations have claimed improvements in equipment availability, reliability and a reduction on maintenance costs when implementing TPM. The academic literature regularly reports on the success of TPM within large organisations, (see Waeyenbergh and Pintelon 2002; Karden and Fredendall 2002). However, SMEs, who according to the DTI (1999) account for 99% of companies in the UK, would appear to be less likely to have implemented TPM. This factor is largely assumed due to the absence of case studies within the academic literature concerning TPM implementation within SMEs. SMEs typically adopt a run-to-failure maintenance strategy, as this largely requires limited knowledge on why and how the equipment failed. In addition, senior management within SMEs rarely view maintenance as a strategic issue that will translate to a significant contribution to the company profit margins. This paper sets out our work in three specific areas:

1. Through interviews with SME, owners/senior managers the barriers that impede TPM implementation within this type of organisation are identified.
2. The development of a new maintenance methodology for SMEs based upon the selective integration of TPM and RCM elements, to help overcome the identified barriers
3. The implementation of AIMMS within one of our case study companies is described and the issues and benefits discussed.

Data were collected by means of semi-structured interviews with owners and senior managers from 36 small and medium-sized manufacturing companies. The aim of the interviews was to identify the possible barriers to TPM implementation within their organisations. The companies were from a range of sectors in the Northeast of England, including food and drink, automotive engineering, process manufacturing and textiles. The number of employees within the organisations ranged from 12 to 180.

### **BARRIERS**

#### **Finance**

The majority of management responses (80%) claimed that the adoption of a new maintenance initiative is usually constrained by the lack of finances. The belief amongst the respondents is that because no clear way exists to overcome this problem, and so the high percentage of unplanned and reactive maintenance places a significant cost burden on businesses, one that is rarely recognised by management. Consequently, the owners or senior managers often need to look for quick returns on investment. In addition, the majority of respondents do not view maintenance as an important part of achieving their overall business strategies.

### **Increase in Maintenance Costs**

The perceived costs to implement a strategy that could possibly require an increase in capital spending for new equipment automatically increases the likelihood that the development of a new maintenance strategy will be based upon the cost of allowing the equipment to run-to-failure. The introduction of a maintenance system, according to the majority of respondents (84%), would need to be supported by detailed and continual training programmes. However, all the senior management respondents stated that finance would not be made available for training programmes.

### **Time**

Due to the perceived time required to collect and analyse equipment data to determine which maintenance task is best suited to a particular piece of equipment, the majority of respondents (78%) believe that a different maintenance strategy would require six to nine months to develop, plan and implement. Therefore, the length of time to implement and to realise the benefits must be short. The development of a maintenance methodology to suit the individual company would allow the implementation to progress at their pace and scheduled maintenance to avoid busy production periods.

### **Skills**

The management respondents indicated that maintenance engineers were employed based upon their skills and experience. However, the maintenance skills and diagnostic capabilities of equipment operators were not generally considered important when employing operators. Therefore, the discussion only centred upon the equipment operators and not the maintenance engineers because it is the operators, according to the majority of respondents, who must develop and implement the maintenance strategy.

### **Management Awareness**

The lack of awareness of the problems associated with reactive maintenance and the failure by senior management to recognise that reactive maintenance can be costly and unsafe, are the result of barriers that have hindered organisations in the pursuit of improved maintenance. Our analysis has shown that organisations wishing to improve their maintenance must firstly understand their current situation. An interesting point is that the majority of respondents stated that the collection and analysis of equipment data would need to be the first task in order to develop a benchmark from which to measure their efforts. It can be argued that this is the reason why few of the companies have made progress and still rely on maintenance engineers or equipment operators fixing a breakdown, rather than identifying the root cause of a problem and presenting a solution.

### **THE DEVELOPMENT OF AIMMS**

The outcomes from the literature and the data analysis were considered. The specific issues regarding inclusion of TPM and RCM elements are now discussed.

### **Improve Overall Equipment Effectiveness (OEE)**

The use of OEE to calculate the efficiency of the equipment is regarded as necessary to identify the benefits in terms of equipment availability, performance and product quality. In order to create an OEE calculation an examination is required of the current maintenance system in order to determine availability, performance and quality therefore accurate measurements are required.

### **Autonomous Maintenance**

The involvement of the operators in maintenance activities is seen as the first step in creating and enforcing basic standards by combining cleaning and inspection, with additional tasks identified by operators and maintenance engineers. This pillar, whilst advocated by Nakajima (1988) is also deemed essential by the respondents due to the fact they have very few, and in some cases no, maintenance staff. Therefore, it is a requirement that operators are involved in developing and undertaking maintenance

activities which is developed via the inclusion of autonomous maintenance task selection process embedded within AIMMS.

### Planned Maintenance

Planned maintenance tasks such as time based inspections, overhauls and periodic efficiency measurements will allow the operators/engineers to develop their maintenance tasks. In the SME environment, it is essential that scarce resources are used effectively and efficiently when applied to the maintenance task. It is a requirement, therefore this pillar is included within the development of AIMMS, that it allows maintenance tasks to be selected and applied in a logical, visible, and consistent manner to ensure equipment is maintained correctly, without omissions and duplication.

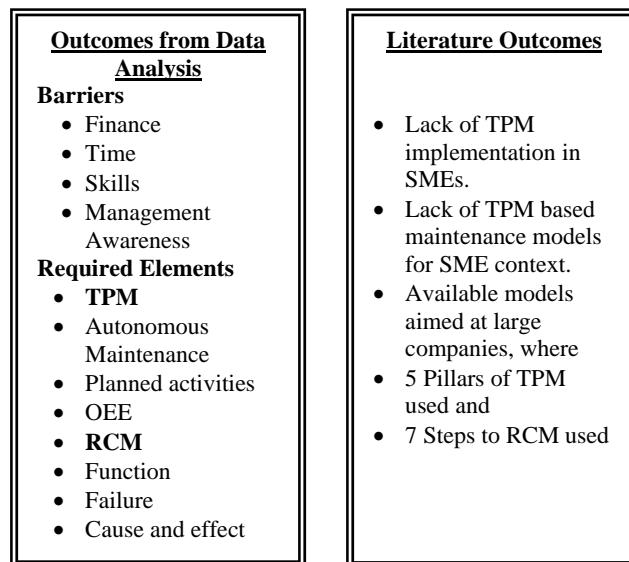
### Train to Improve Operator and Maintenance Skills

The skills of the operators and maintenance personnel must be improved if autonomous maintenance is to be successful (Nakajima 1988). However, the aim is to introduce structured training methods, which will increase the skills of both operators, and maintenance personnel before the company develop a new maintenance strategy. In particular, if operator autonomous maintenance is to be successful, operators must understand the structure, function and inspection methods for each piece of equipment. However, due to the barriers outlined previously, this approach would require finance and time for operators to learn and develop new skills, which are not available in this context, therefore this pillar is not included within the development of AIMMS.

### Early Equipment Management

The aim is to introduce improvements in the equipment at the earliest possible stage in order to develop maintenance-free equipment. This approach is aimed at preventing breakdowns and defects by considering maintenance during the equipment design phase. However, the majority of respondents are unable to use this approach due to the age of their equipment, and if new equipment were to be purchased the majority would be supplied with maintenance guidelines and therefore not require additional maintenance activities.

FIGURE 1: THE INFLUENCE ON THE AIMMS METHODOLOGY



## **AIMMS**

The AIMMS methodology provides a list of possible data collection and analysis techniques from which the company can decide to implement. The seven-stage process of AIMMS for SME management, maintenance engineers and equipment operators to follow are:

1. Identify current maintenance practice. (Reactive, planned, run-to-failure)
2. Identify cause and effect of equipment failure. (failures and likely failures and how they effect the production process)
3. Establish current maintenance costs. (Identify cost of planned and unplanned maintenance to provide a benchmark from which to calculate a Return on Investment ROI)
4. Examine new maintenance options and select appropriate strategy using elements of TPM and RCM)
5. Design new strategy based upon ROI. (Compare cost of new strategy against current strategy and calculate ROI)
6. Implement new strategy. (Identify resources and actions to develop, implement and monitor new strategy)
7. Evaluate and refine. (Continually monitor tasks and calculate benefits using ROI and OEE)

This approach provides a 'planning tool' since the processes and subsequent activities that need to be considered when starting to develop a new maintenance initiative are shown in order.

## **CASE STUDY IMPLEMENTATION**

The case study companies chosen to evaluate AIMMS are considered medium sized (more than 50 employees, but less than 250). The first company approached to evaluate AIMMS (Company A), are a medium sized company (120 staff) who manufacturing printing presses. Their maintenance department consists of one maintenance manager, one electrical engineer and two mechanical engineers. The current maintenance strategy is predominantly reactive (71% of tasks are reactive). Due to the predominantly reactive approach to maintenance, the maintenance manager had not identified the different maintenance tasks available and compared them against the needs of the equipment. The maintenance manager understood the cause of the failures but was not always clear on how to solve the problem. The maintenance manager, an equipment operator and a maintenance engineer used the AIMMS methodology in stages.

### **Establish Current Maintenance Practice**

The operator is required to collect and record the number of hours the equipment is not in production in one calendar month. An identification of the normal function of the equipment, how the component fails to perform its function and the cause and effect of the failure were recorded. The failure and cause and effect data is based upon a detailed examination of the recent failure.

### **Establish Current Maintenance Costs**

Maintenance costs are collected from direct costs such as labour and materials. Hidden costs or indirect costs that are often harder to measure are identified by examining unplanned breakdowns, changeovers and adjustments, idling and minor stoppages, reduced speed, start-up and quality defects).The calculation of the losses provides the data to determine the overall equipment effectiveness (OEE). To complete the financial analysis, data are recorded which outline the number of hours operators are unable to perform their production tasks due to stoppages.

### **Examine New Maintenance Options**

Based upon experience and the identified problems the appropriate tasks to develop the optimum solution are selected from a list of tasks that include basic cleaning and inspection, preventive and predictive tasks. The person required to carry out the tasks are identified, in this example the operator and a cost estimate is included to develop the ROI

### **Design New Strategy Based Upon ROI**

During the implementation of the first strategy, further information will be gained and the costs and benefits can be updated through feedback loops placed between the different stages. This allows the Return on Investment (ROI) calculation to be carried out on a continual basis and therefore, allows the most appropriate strategy to be selected.

### **Implement New Strategy**

This involves an identification of the resources and actions required to implement the maintenance policies. This would involve revising task instructions and specifying restoration or repair procedures. However, these tasks should include a list of tools, parts or instruments required to perform the task. The case study company has now an understanding of the costs involved in addition to increasing their understanding of the maintenance issues and problems. They have also have developed a basic task list which is placed next to the equipment.

### **Evaluate and Refine**

Once the strategy is implemented, the frequency and type of tasks will need to be adjusted. This includes the identification of work undertaken which is performed too often. If a task does not remove or reduce the problem, the task frequencies need to be adjusted. If the frequencies are left uncorrected, the benefit will not be shown. To help minimise this problem, the framework allows the user to re-evaluate either the costs involved or the maintenance tasks and the person undertaking these tasks. The key to this approach is maintenance performance reporting. The continual recording of maintenance data (the intensity and cost of tasks) is required to ensure the correct performance measurement. However, this stage will depend on the 'will' of the management to improve maintenance activities. Within one month the maintenance manager claimed that the new maintenance strategy had increased equipment availability and reliability by over 75%.

## **CONCLUSION**

The evaluations have shown that it is important to ensure that the current maintenance costs are identified, and the implementation costs of a new strategy are identified and compared to establish the true cost of maintenance. The number of hours of un-planned maintenance was reduced sufficiently to determine that the implementation was a success. However, the development of the new strategy was not based upon cost to develop, but on the potentially high costs associated with not developing the maintenance system. A concern of the management teams was the perceived time to implement the new strategy and to measure the benefits. AIMMS has proven that within one month benefits have been realised. Financial gains have been recorded and the equipment availability has increased. This has significantly increased the production time, and a consequence of increased reliability is a decrease in maintenance costs. In addition, within the month the operators have:

- Increased their skills and knowledge.
- Developed a detailed task selection process.
- Focused improvement activities on increasing the effectiveness of the equipment.

It is clear that the contribution of the AIMMS methodology is that it can assist in the development of a company specific maintenance strategy which can be implemented with the benefits realised within a short period. Overseeing changes in their maintenance strategy has created new challenges for senior and

middle managers involved with the implementation. After examining AIMMS, many of the managers have recognised that their roles must change and have modified their approach to maintenance to support the new strategies. The management teams have attempted to move decision making down to lower levels to empower the employees with appropriate ownership and authority.

Finally, the results have shown that AIMMS has helped SMEs to develop a tailor-made maintenance strategy utilising their available skills and resources. In addition, the results have shown that data collection and analysis is possible by utilising the necessary components of AIMMS. However, introducing this new maintenance strategy has created far-reaching changes in the case study companies.

**Bio:** *David Baglee holds a PhD in maintenance strategy development in SMEs from the University of Sunderland. In addition, David lectures in maintenance tools and techniques, manages several European projects examining and developing maintenance strategies for different sectors and is currently developing a large European project which will develop energy efficient technologies to support new maintenance methodologies.*