<u>MAINTENANCE - ORGANISATIONAL MISFIT?</u>

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INTRODUCTION

The position of maintenance within an organisation continues to be the subject of debate, ranging from an activity that can be bought in when needed through to full integration with the manufacturing or production process. This paper concentrates on the maintenance of production process plant and equipment found primarily in the manufacturing and utility industries.

Having carried out a literature search on maintenance management, it should be noted that very few books have been written on the subject of maintenance since the 1970's, apart from fairly extensive coverage of building maintenance, which is not covered in this paper. Recent papers and journal articles have mainly addressed the topics of Totally Productive Maintenance and experiences associated with use of contractors for provision of maintenance services.

There will be significant use of references throughout the paper to demonstrate the common themes that have arisen from all the literature sources, culminating in recommendations for the positioning of the maintenance function in an organisation.

MAINTENANCE - THE TRADITIONAL VIEW

BS 3811 : 1974 states that maintenance is "a combination of any actions carried out to retain an item in, or restore it to, an acceptable condition", and companies traditionally geared themselves up to restoring process plant to an acceptable condition as quickly as possible following failure, without considering how to maintain the plant in good working order to prevent failure.

Technological development in the late 1960's/early 1970's together with a recognition that the Maintenance Department was giving poor value for money as a reactive body, led to a spate of maintenance targeted initiatives throughout the 1970's, principally led by the DTI's establishment of a Committee for Terotechnology, who defined terotechnology as "A combination of management, financial, engineering and other practices applied to physical assets in pursuit of economic life cycle costs", and later adding "... its practice is concerned with the specification and design for reliability and maintainability of plant, machinery, equipment, buildings and structures, with their installation and replacement, and with the feedback of information on design, performance and costs".

Perhaps it was the word terotechnology which put people off, or even the fact that the initiative was Government led, but every single maintenance related development since this committee reported, be it planned maintenance (time or condition based), predictive maintenance, reliability centred maintenance, totally productive maintenance, or total care plans has been based on the terotechnology principles of establishing value for money through Whole Life Costing, of which maintenance forms a part of that equation. Why, then, do companies gear these initiatives to attack the perceived overhead of labour and materials costs without addressing some of the hidden issues? a topic I will return to later.

Maintenance Cycle

The uncertainty as to the role of the maintenance function has been demonstrated in the Steel Industry, where maintenance was described as a "12 year cyclical" function. Initially, craftsmen would be integrated within the production workforce, and repair plant on failure. This reactive mode of working would subsequently lead to bottlenecks in the production process, as repetitive failures in key areas of the plant would lead to poor overall productive performance. This was recognised in the 1970's, and craftsmen were brought out of production, and established within the maintenance function as a service provider to production, where the necessary expertise could be pooled to address production bottlenecks, implement preventative maintenance techniques to improve plant availability, and establish a service ethic within the maintenance function. This always eventually led to the misconception that because there were relatively few failures, then a reduction in personnel could take place, and more effective use of craft resources would be achieved by integration into the production process to carry out productive duties and provide a quicker response to failure, typically introduced in the 1980's. This approach fairly quickly led to production bottlenecks and the cycle started again.

Production and Maintenance

Husband (1976) stated that

"The relationship between the maintenance and the production functions is notoriously delicate. Both functions are highly interdependent and yet often find it difficult to maintain a well balanced relationship. The problems are fairly obvious. The production function is often stretched to its utmost to attain the necessary output yet must allow the maintenance department access to its plant and equipment for preventive maintenance or safety inspections. Similarly the maintenance function is often stretched to meet its workload but must find the time and the resources to respond to yet another urgent call from the production function. The balance between the two departments is not easy to achieve but is clearly of vital importance to the overall effectiveness of the firm."

This view was further corroborated by Priel (1974) who presented the dilemma as follows:

"A production orientated executive must accept the maintenance function whose aims do not conform to the familiar frame of reference and which may even appear to conflict with his normal operations. While all his efforts are concentrated on producing more, reducing costs and purchasing only what is needed, maintenance service seems to distract him from his goals and reduce his achievements. Thus it is not surprising that a recurrent theme in every survey in this field is the lack of a proper attitude of management towards maintenance. What does this sweeping and oft-repeated statement really mean? Findings point to attitudes that range from a lack of interest on the part of management to grave misunderstandings"

and developed by stating that

"As long as no profitability equation exists, short-sighted management will consider maintenance a necessary evil. 'Let us consider it as an insurance premium', so the argument goes, 'money down the drain, none of it ever to be recovered, etc'. The contribution of production planning or quality control is undisputed, while that of maintenance is considered an eternal debit."

It is clear that production must make plant available to maintenance to ensure that it is maintained in good working order, whilst maintenance must provide a fast and efficient service to production when the plant is operational. Striking the balance between these two needs is vital if asset availability is to be maximised.

<u>The Iceberg Effect</u>

Recognition that there was more to maintenance than labour and materials costs, with whole life costing as the asset management goal, a model of maintenance described as "The Iceberg Effect" was developed to promote Totally Productive Maintenance, described by Hilligoss (1992) in his paper on "Maintenance .... the business opportunity of the 1990's -"

"Another misconception about maintenance that has a major impact on product quality, cost and delivery objectives is the maintenance budget. And, it may be one of the most difficult to

correct because it appears to conflict with traditionally acceptable financial and accounting procedures and practices.

The significance of this misconception is dramatically illustrated when the total cost of maintenance is viewed as an iceberg. Only a small part of the cost of maintenance is visible above the waterline. This is the maintenance budget. Most of the total cost of maintenance is hidden from view (below the waterline) within the accounting structure of the organization."

Consider the impact on plant and equipment due to:

- Excessive spare parts inventories when spare parts are not properly managed;
- Accelerated depreciation of capital investment when plant and equipment is not properly maintained; and
- Excessive capital investment in plant, equipment and floor-space to assure production capacity because standby facilities are required to cover for downtime.

Also, consider the impact on production when operational problems are encountered, such as:

- Production operators are idle, inefficient or caused to work overtime;
- Inability to run at full speed;
- Either scrap is produced or rework is required.

Finally, consider what happens to the product when a production problem causes problems in the product, such as:

- Poor quality and reliability;
- Failure to meet delivery targets;
- Lost future sales.

The costs of these maintenance related performance issues is generally not identified, and is usually significantly higher than the actual maintenance budget itself. Totally Productive Maintenance introduces measures to determine the hidden costs of maintenance, as this is the area where major savings and benefits can be made.

Hilligoss still believed that the majority of companies continued to address the visible maintenance budget

"Because the maintenance budget is so large, normally there is pressure from the financial organization to constrain, or even reduce it. Actually, it is not difficult to reduce maintenance department spending. Stop doing discretionary work, including planned

maintenance. Scrutinize every requisition for spare parts and either delay ordering, and/or reduce the amounts requested. Transfer people from budgeted expense accounts, to appropriated capital accounts. If necessary, lay off people. The inevitable consequence of this scenario - the 'total cost of maintenance' will almost certainly increase.

Well intentioned people may focus blindly on minimizing maintenance budgets, squeeze the visible costs, and risk even greater costs elsewhere in the plant system. Maintenance budgets may need to be increased (at least temporarily) to achieve total minimum costs. Until financial managers understand the concepts of 'total minimum cost of maintenance' and manage the business to that end, maintenance costs will always be excessive."

and recognised that the business opportunity of the 1990's was the introduction of Totally Productive Maintenance to establish real maintenance costs through the application of terotechnology principles to ensure assets are managed from initial development to decommissioning at the end of their life, a subject I will return to later.

MAINTENANCE - THE SERVICE FUNCTION

One of the maintenance functions primary roles is to the production department, provided that production release plant for essential planned maintenance to ensure that the life of the assets is maximised. Husband (1976) described earlier the essential nature of the relationship between maintenance and production, and if the production function perceive that their assets are being used to the maximum of their potential, then the relationship is working well.

Some companies have successfully integrated craftsmen into the production function through building sufficient redundancy into the assets to ensure that no failures will stop production. This need has become more apparent as manufacturing to order techniques necessitate no stoppages in production processes, or delivery deadlines will not be met. The downside on this strategy is high initial capital investment costs to build in additional plant, although failures are few and far between, and effective service shutdowns ensure the plant is maintained in first class condition. It would seem logical in this scenario to allow the craft workforce to be supervised directly by the production function. This would be a retrograde step, as the production culture of maximising quality and throughput would influence the craft workforce, resulting on a return to "respond on failure" operation and subsequent reduction in plant availability.

All craft related tasks should be managed and controlled by the maintenance function, (excluding simple inspection and lubrication tasks) who should strive to provide a service that meets the needs of the production function, without there being a requirement for direct control of the activities. Priel (1974) corroborated this approach by stating that:

"Maintenance should not be responsible to production. It is a primary function which cannot be managed as a part-time activity of the production manager. If in certain departments repairmen are required on a full-time basis they can be so assigned and still be responsible to maintenance. This is one aspect of decentralisation."

Having established the maintenance function as a service department, with asset management responsibilities for maximising plant life, then how should the service be delivered?

MAINTENANCE - IN-HOUSE OR CONTRACT?

Why should companies consider maintenance as an activity for contracting out. Strangely enough, maintenance in many companies has been a victim of its own success. Ineffective maintenance departments, who spend their whole life responding to failure are the "heroes of the hour", and are regarded as totally indispensable. With the introduction of planned and preventative maintenance techniques in the 1970's and 1980's, effective maintenance departments prevented failure and their work was generally unseen. Unfortunately, the misconception is created that no crises or failures are occurring, therefore there is less need for maintenance, and companies started to examine their maintenance costs, especially labour costs which usually accounted for at least 50% of the overall maintenance costs. Comparisons were made with the craft labour rates applying to different trades and most companies determined that they were paying above the market rate, and started to question whether buying in of craft services was more cost effective. These comparisons were usually made with craftsmen in the construction industry, who generally carried out installation work which attracted low basic rates but with high bonus payments and overtime opportunities, distorting the attempt at benchmarking craft rates of pay. Dr Michael Cross (1988) carried out research on trends in the provision of maintenance services in manufacturing industry, and concluded that:

"Almost without exception there has been an increased use of contractors to carry out maintenance work. The use of contractors has become most pronounced on oil refining and chemical sites. In terms of engineering craft hours the degree of maintenance work done by contractors ranges between 15 to 60 per cent. Often this shift to a high use of contractors has been seen as desirable. However, it has been found, usually through direct experience, that the extensive use of contractors has not yielded the cost or performance benefits sought. There are now signs that with the improved quality of the in-house maintenance service the use of contractors is showing a decline.
In those companies with an explicit, long term manufacturing and site development strategy, contractors have been used as a short term means of achieving changes in working practices of their own employees. Plus, contractors have provided in these cases a buffer to allow the quality of the in-house service to be improved.

In summarising his paper, he stated that

"While many site based maintenance functions look and feel as if they are under siege, a situation which is unlikely to change in the near future, the long term future could be bright. When the long term view is taken it is becoming evident that high quality, low cost manufacturing status will only be achieved on the basis of an adequately resourced maintenance function. There remains an urgent need for the strategic importance of maintenance to be recognised before the existing maintenance resource base is reduced any further."

One area where successful maintenance has been introduced on a contractual basis has been that of buildings maintenance, which primarily involves the maintenance of office blocks, covering lighting, heating and ventilation and decoration. The success of contract maintenance in this area has been due to the ability to define the measuring parameters on which to base the contracts, such that cost and performance criteria can be readily compared, thus establishing value for money. In addition, the customer cannot adversely affect the condition of the assets as their only interface is generally with turning things on and off. Liability for failure of plant in buildings maintenance contracts can be laid firmly at the door of the contractor.

Maintenance Standards

Defining maintenance standards for contractual purposes becomes more difficult as the assets to be maintained become more complex. Add to this the fact that production are expected to carry out simple first line maintenance tasks such as inspections and lubrication, then setting standards for a potential maintenance contract requires definition of the measures to be used. The logical measure is plant availability, yet this is dependant on the production function carrying out its first line maintenance duties and operating the plant with due care and attention. The volume of work carried out by the maintenance contractor could be a measure, but this only tells part of the story, as no measure of effectiveness can be applied. Attempts have been made to establish a unitary cost measure for the work carried out by maintenance, but such is the variety of the work that benchmarking has been fraught with difficulty. During the 1980's, attempts were made by companies to outsource their maintenance, but all faced difficulties with liability. The Oil and Gas Industries in the North Sea established partnering contracts with maintenance service suppliers, enabling common goals and cost savings targets to be set, but these have largely been abandoned as the contracts brought little added value to the client, and the contractor (quite naturally) concentrated on maximising profit while delivering the contract requirements. More recently, British Airways established arms length engineering/maintenance business units to introduce competition and reduce costs. Mann (1992) described the strategy as follows:

"The heart of the change is the segregation of heavy maintenance - major teardowns of aircraft every 5-6 years - from operational, quick-turnaround maintenance."

With strict safety standards applying, and standard operational maintenance routines which are easily defined, there is the opportunity to drive down costs through contract maintenance, though it was interesting to note the comments of John Perkins, British Airways Chief Engineer

"There is plenty of competition around, and there is an opportunity for the airline to take its heavy maintenance elsewhere if it so wished. However, there is no real alternative for the airline at the moment.   Establishing a heavy maintenance and operational maintenance business units means that these two units will pace toward true profit centers at different rates. You don't want one holding the other up."

British Rail have similarly established maintenance depots as profit centres to introduce competition and drive down costs. They, too, have strict safety standards and standard operational maintenance routines making the definition of contractual requirements possible.

In both these examples routine servicing forms the key part of the day to day tasks and is easily measurable. Major overhauls of aeroplanes and trains can be carried out in a controlled environment, where the customer at any time can witness progress of the overhaul and can be a key decision maker at various stages of the work. This is not the case in most industries, as the key decision maker is invariably the craftsman, who will be guided by the best interests of the company that he works for.

Cultural Issues

In-house craftsmen understand the plant processes, and will always make decisions which maximise plant availability. Contractors take each job at face value, ensure the needs of the contract are met, and very rarely look at the wider picture when carrying out maintenance work. Paul Smith (1992) made this point:

"Work sparingly with contractors. Contracting maintenance should be reserved for discrete, clearly definable jobs where a set of requirements can be written down. If the company accepts the premise that the majority of corrective maintenance can be eliminated by a continual improvement program, then contracting daily maintenance is a conflict of interest. Contractors generally make money by supplying large numbers of people to perform repetitive tasks, not by implementing continual improvement programs. Savings expected by using contractors usually are offset by such administration costs as additional levels of supervision and approvals. Give operations a maintenance role. Operations can have a tremendous effect on the service life of the equipment it uses. Operations personnel are the most cost effective and knowledgeable form of condition monitoring. Training operators to look for early warning signs and causes of impending equipment failure goes a long way toward increasing efficiency in operations and maintenance."

Note Smith's comments about conflict of interest. Continual improvement programmes are about reducing maintenance costs and maximising plant availability. Maintenance contractors aim to maximise workload for their employees, a direct conflict of interest.

A recent paper by Belinski and Koehler (1995) examined outsourcing of maintenance in the highly competitive paper manufacturing industry. The major driver for moving to outsourcing was the significant difference in craft rates of pay with that of the proposed contractors (between 30 and 50% dependant on the trade). Not all maintenance work was outsourced as:

"Highly skilled, complex jobs closely linked to the process or other proprietary interests may not lend themselves well to outsourcing. Internal resources should perform these jobs.

Many jobs in the mill, however, require only tangible levels of basic and generic industrial skills and little onsite training. These jobs present excellent targets for subcontracting since local labor markets, not the mill's overall wage structure or labor agreement, control the corresponding wage ranges".

The relationship between customer and contractor was seen as vital.

"In many respects, working relationships between the owner and the contractor are more important to success than the actual performance of the work. Both sides lose when a service arrangement is no longer economically viable for the contractor".

However, even in this case where outsourcing of the majority of maintenance work had been successful, there were contradictions in the role of the contractor and his relationship with the client.

"The team must constantly work to break down barriers between the mill's organization and the contractor's personnel. It is very easy to fall into the trap of viewing, and thus treating, contractors like second class citizens. Encouraging team involvement and sharing common facilities are two ways to suppress this 'we/they' syndrome."

as opposed to

"As far as is practical, contractors should use separate facilities to include parking, mill entrances, locker rooms, cafeterias, etc. Contractors should maintain their own offices and clerical staff, even if on the owner's premises."

It is little wonder that confusion can occur in this scenario. Who do the contractor's personnel actually work for?

Understanding the cultural issues when contracting out maintenance work is of paramount importance, or the working relationship with the contractor will not deliver a win-win situation. This is why it is vital that clearly defined and measurable activities can be contracted out, but those requiring on the spot decision making must be retained in-house.

ASSET MANAGEMENT

Having established that maintenance is primarily a service supplier to the production department, there has been a recognition in recent years that "retaining in acceptable condition" means strategic alliances with other departments. Avery (1993) stated that:

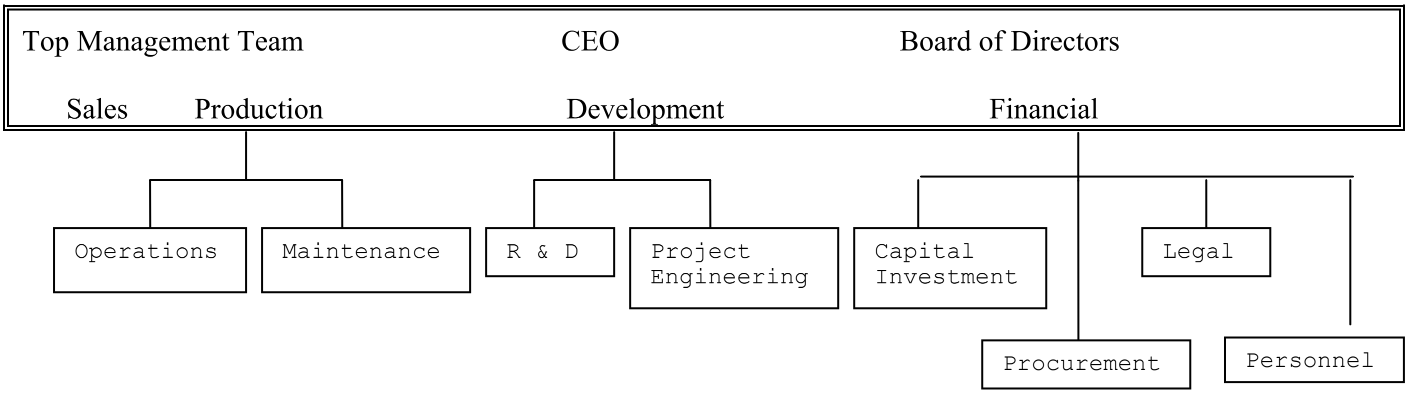
"Operations is not the only department maintenance is beginning to align itself with. Capital-project engineering is another. This group increasingly is calling on maintenance input while it is designing new machinery/production lines for the plant. Learning beforehand how maintenance plans to maintain machinery after it's been built can help to minimize upkeep and reduce costs. Another area that promises concrete results is purchasing. A close purchasing/maintenance match-up will help deliver quicker response for spares needs through just-in-time inventory management programs, heightened awareness of customer service, and supplier partnering. These principles, highly successful when used to purchase production materials, are increasingly being found to work just as well with maintenance supplies and equipment. Some manufacturers are taking these informal alliances one step further and totally abandoning the organizational chart. At these organizations, maintenance works with other departments on high-performance teams. Set up in a manner similar to product-development teams such as those at Chrysler and other manufacturing giants, personnel from pertinent departments (maintenance, production, training, human resources, safety, and purchasing) work together to set/achieve maintenance goals. Each member has equal responsibility with a facilitator named to help steer the group towards targeted goals."

Furthermore, Smith (1992) identified similar compatible areas.

"Couple engineering with maintenance. Engineering and maintenance should be coupled tightly. If engineering can be easily distinguished from maintenance, something is probably wrong. Maintenance is the proving ground for engineering. The maintenance staff's experience should be passed on to engineering promptly to avoid mistakes and exploit successes. In addition, technically skilled personnel, engineers included, must be appropriately trained and compensated if American industry is to compete in a global economy. Work with purchasing and stores. These departments affect maintenance costs and can contribute significantly to reducing them. Purchases should be based on performance instead of price. Paying more for equipment that breaks down less often saves maintenance costs."

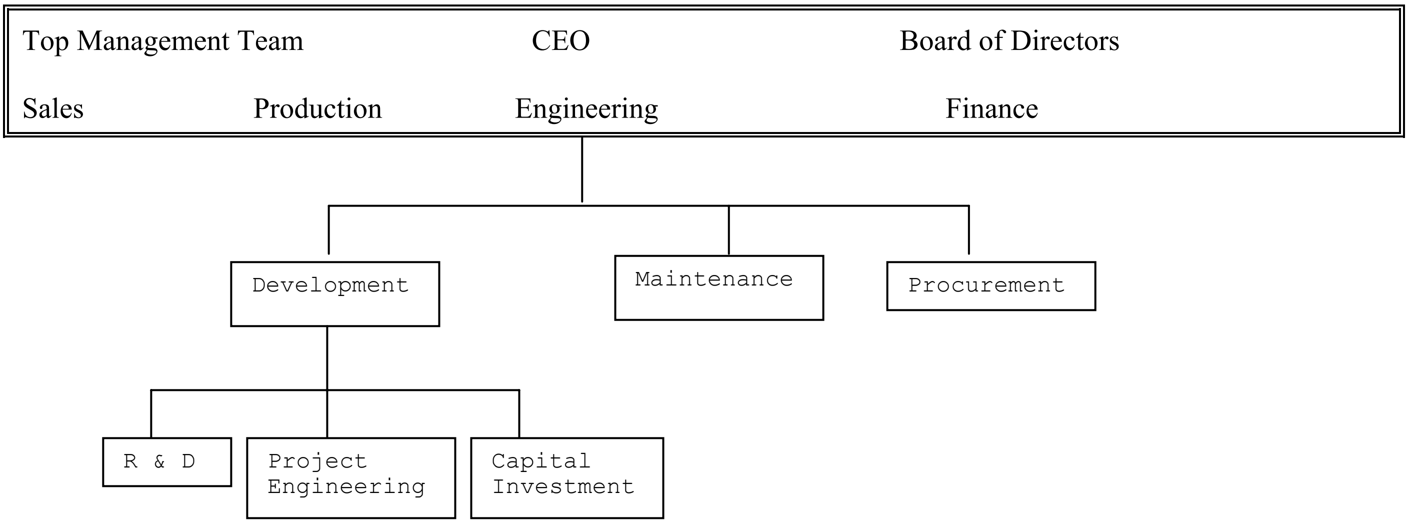
In line with terotechnology principles, it became clear that closer alignment with engineering development was essential to achieve whole life costing goals. There is no doubt that combining capital costs with operation and maintenance costs to determine the most cost effective investment solution is the business opportunity for the 21st century.

This requires a move from the traditional organisational structure in manufacturing:-



adapted from Corder (1976)

to a structure showing.



The incorporation of procurement as an engineering rather than financial activity is not usually seen as a logical fit, yet the vast majority of purchase orders placed by a company are for the maintenance function, although in cost terms they don't constitute the major area of spend. Purchase of raw and consumable materials usually forms the major area of expenditure, and is generally concentrated on. However, spares and materials requirements contribute significantly to whole life costing principles, and major savings can be made, especially in terms of spares requirements.

Maintenance is a key player in any company's asset management strategy if best value for money and whole life costing principles are the major goals. The DTI continue to pursue this theme through their "Managing into the 90's" video series where they state that:

"Maintenance rarely appears on Boardroom agendas, yet effective performance is generally less than 50%, for an activity which spent £14 billion in 1991 in UK manufacturing industry".

It appears that some twenty years after development of terotechnology, most UK companies have not taken it on board, yet most foreign manufacturing investment, especially Japanese, has brought with it Totally Productive Maintenance and other initiatives which embrace the principles of terotechnology, and German companies recognise asset management principles and are generally structured with Engineering as a Board function. It is clear that if overall cost reduction goals are to be achieved, then companies must introduce terotechnology principles through asset management to deliver whole life cost efficiency.

CONCLUDING DISCUSSION

Maintenance is required to carry out a number of key roles in any organisation, including maintaining assets in good working order, providing a fast response to failure for the production function advising engineering development of maintenance experience for asset renewal purposes, and managing a cost effective spares and materials supply system.

In the maintenance function's two primary roles of maintaining assets in, and returning them to good working order, a mixture of in-house and contractor support must be used to achieve cost effective solutions. Contractors should be primarily used in non-core activities such as painting, groundskeeping, as proposed by Wordehoff (1994), together with peak lopping for routine tasks, and back-up for highly specialised plant and equipment.

Primarily, though, the maintenance function must establish a service ethic with its major customer, the production function. Provided both parties agree that asset management is vital, and release of plant for servicing is as important as responding to failure, then benefits will be realised, as Wordehoff (1994) states:

"Making the transition from a functionally-focused to a customer-focused maintenance operation yields an immediate improvement in customer service, a focus on zero defects, lower maintenance costs, greater emphasis on planning and scheduling, and quicker response to critical problems. Although many of these benefits are intangible, it is not uncommon for costs to drop 15% to 50% once these concepts are fully and properly implemented."

It is vital, however, that maintenance fits within an engineering function represented at board level, where asset management responsibility will ensure that whole life costing principles are applied to a company's assets delivering the lowest cost solution in a competitive environment.

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