

An Introduction to the Maintenance Scorecard

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Some people make the future; most wait for the future to make them. - Anonymous

Overview of the Book

The Maintenance Scorecard is the first book to seriously tackle the issue of aligning asset management with other areas of corporate activity. This is a particularly relevant topic given the growing importance of the area as a source of strategic advantages and as a centre for risk management.

Among the many unique features of this book are:

- A focus on the detail of implementing each phase of the MSC approach
- An introduction to the technical change management system
- An introduction to the RCM Scorecard
- An introduction to Problem Elimination Logic
- An overview of a range of industries and their unique concerns regarding asset management
- A catalogue of regularly used indicators, their benefits, limitations and details about how to produce them

The Growing Strategic Importance of Maintenance

The years of 2003 and 2004 have been watermark years for the importance of physical asset management. During this period there were numerous events throughout the world that have highlighted the importance that this activity has at a corporate level. However four events in particular have had effects that continue reverberating throughout the world.

- The disaster of the space shuttle Columbia
- In August of 2003 New York was struck by a power outage, a failure of physical assets that caused thousands of people to be stranded and left it without power for over 24 hours. This was followed shortly after by similar but briefer outages in the United Kingdom and Italy.

- Four charges of manslaughter were dropped in August of 2004. These were placed on people in charge of maintaining or managing the railways in the United Kingdom in relation to the Hatfield train disaster. They included the ex-CEO of the company that owned the asset base. This has reinvigorated the debate in that country regarding "corporate killing".
- Enactment of legislation in Canada to impose criminal liability on businesses and individuals in the event of workplace accidents.

The reaction to these dramatic events has been the culmination of decades of change in the area of asset management. Even in the most cavalier of boardrooms more attention is being drawn to asset management as an area where corporate risk exposure can be managed, as well as a source of substantial strategic advantages.

Risk Exposure

At a corporate level risk can mean many things, it may mean reducing the variability of income, reducing the corporate exposure to legislation or reducing the likelihood of catastrophic events. From an asset management perspective, risk often reflects concerns about exposure to incidents in the areas of safety or environmental damage and the potential for punitive measures in legal and regulatory terms.

Changes in the Legal Environment

Asset managers have a unique responsibility with regard to the man-

agement of risk. The actions or omissions of the maintenance effort contribute directly to the level of risk that an organization, its workers and, at times, the surrounding communities, are exposed to. Over the past two decades in particular, this unique role has been recognized through rafts of legislative and regulatory changes around the world. This has included changes in Australia, the United Kingdom, Canada and the United States.

For instance, in Canada changes were made to the Criminal Code that imposes criminal liability on business and individuals in the event of workplace accidents. These changes became applicable law as of January 1st of 2004. These changes in law were made in response to the Westray Mine Disaster where 26 miners were tragically killed in an explosion in Nova Scotia in May of 1992. The public inquiry that investigated the disaster uncovered a serious disregard for workplace safety by the corporation and its managers.

The Act provides significant penalties in the event of a conviction. This includes imprisonment to a maximum of 25 years for individuals and fines of up to \$100,000.00 for corporations. It is important to note that these penalties would be in addition to any existing penalties provided by provincial occupational health and safety legislation or other regulatory statutes. The Act's provisions will not supersede the existing penalties provided by these statutes but will add additional criminal liability.

Upon conviction, the Act also provides a number of new factors that will be considered in any sentencing.

These factors include whether the organization realized any advantage as a result of the offence, the level of planning involved, the cost of the investigation, and any regulatory penalties imposed and any actions taken by the organization to reduce the likelihood of future occurrences.

The Act also expands the scope of individuals who may be held liable. It broadly defines those who are involved in directing the work of others within an organization. It places a positive burden on such individuals to take reasonable steps to prevent bodily harm to employees. This provision could result in personal liability for individuals such as floor supervisors, managers and anyone else directing the work of others.

The Act also applies to "representatives", which is defined as a person who plays an important role or are responsible for managing an important aspect of the organization's activities. They include directors, partners, employees, members, agents and contractors. The terms "important role" and "important aspect" are not defined and will likely be the focus of much litigation in the future.¹

In the light of other events in the United Kingdom, which are still underway at the time of writing of this book, this global trend looks set to continue. It is becoming increasingly clear that in the future decisions regarding physical asset management will be subject to greater questioning. It is also becoming clear that it will be

¹ Joe Morrison - Goodmans LLP - Criminal Liability for Workplace Accidents Posted on www.mondaq.com

individuals rather than corporations who will be asked to provide the answers.

Perhaps the strongest and most recent example of this lies in the recent publication of the report titled "Final Report on the August 14, 2003 Blackout in the United States and Canada - Causes and Recommendations" published in April of 2004. This report was a joint US – Canada investigative effort which was completed over an 8 month period.

The very first recommendation of this report, which is also alluded to in the covering letter, reads as follows-

Make reliability standards mandatory and enforceable with penalties for non-compliance.

Although currently merely a recommendation, it clearly indicates the overwhelming trend towards more accountability in asset management decisions. In this case it is with specific reference to reliability standards. Further details throughout the report speak of further formalization of accountabilities and practices throughout the institutions and regulatory bodies involved with this particular industry. At the time of publication there were several bills being considered by the US senate with regards to the enforcement of regulation in the area of electrical network and energy reliability.

Wide Ranging Impact in the Areas of Risk Management

The change in technology for managing assets is a good example of where the impacts of these changes in legislative pressures may be felt.

During the last decade of the 20th century the world went through the most dramatic advance in technology ever. Today large-scale ERP, EAM and CMMS² systems are in place in most organizations whether they are small operations or large multi-nationals. This has evolved to a stage whereby the growing reliance on software, to resolve issues related to asset management, is one of the more prominent features of early 21st century asset management.

As a result of the dramatic change in the use of technology there has been a large influx of professionals from other functional areas making, or managing, decisions regarding the management of assets. Often these professionals have no depth of knowledge or experience in the area. This is particularly true when it comes to areas such as system selection, implementation and ongoing management. More and more often decisions are being made based on other issues and not driven by the issues affecting the assets themselves or asset managers.

This continues to happen regularly throughout the world. Prior to 2003 maintenance was often seen as a secondary rollout of a large-scale system originally selected for financial or supply chain reasons, regardless of whether the solution was truly fit for the purposes of asset management or not. In even worse case scenarios maintenance processes are built to

² These are three commonly used terms to refer to software used for the administration of asset management **ERP** – Enterprise Resource Planning, **EAM** – Enterprise Asset Management, **CMMS** – Computerized Maintenance Management System

suit data management or information technology requirements.

Outsourcing of the maintenance function is another area likely to feel the effects of these changes. This is often one of the more predictable proposals by managerial consultants the world over as a means of reducing direct costs, increasing the level of access to specialized skills and of avoiding the complication inherent in finding and maintaining a skilled workforce. This has resulted in dramatic shifts in employment throughout the globe. Technical and repetitive roles such as software development, call centre management and some engineering functions such as drafting are frequently being transferred from 1st world economies to countries where labor costs are much lower for people with similar competency levels.

In asset management this has resulted in more specific forms of outsourcing ranging from specialized services such as predictive maintenance, short-term / high volume works such as outage or shutdown execution up to outsourcing of the entire asset management function. This separation of asset owner and asset manager provides a particular set of difficulties in the area of physical asset management. While it is possible to outsource the responsibility for such tasks, there is currently no form of outsourcing the accountability for the consequences of such decisions. Recent events throughout the world have shown that this remains with the asset owners regardless of any contractual arrangements in place.

With the prospect of punitive individual measures such as twenty-five years in jail, in the case of the Legislation introduced in Canada, outsourcing contracts may need to be managed in a different manner than has traditionally been the case. Asset owners may find themselves needing to become more involved in decisions over what work is done and how such work is carried out.

It is this combination of "doing the right job" and "doing the job right" that is at the core of responsible asset management. As such outsourcing contracts may need to include a higher degree of control, even involvement, in how these decisions take place. Also to be able to prove that decisions have been taken in a manner that ensures every reasonable precaution is taken to minimize and mitigate risks in the areas of safety in particular. This goes far beyond ensuring that safety procedures are in place and involves a deeper understanding of what maintenance tasks and policies are in place, when these are done, and how these are done.

Today's maintenance-intensive organizations are no longer able to ignore the corporate risk exposure generated in areas such as these. This global trend appears set to continue as it has over the past ten years and, as awareness increases of its implications, may force a re-thinking of asset management as well as a review of past decisions to understand fully their implications. While there is some justification in the use of *quasi*-experts in other areas of corporate activity this is not the case in asset management, the stakes are

management, the stakes are simply too high. This is equally true for the use of third parties to make decisions that asset owners may find themselves having to defend.

Although this phenomenon will impact upon a very wide range of areas of corporate activity, fundamentally it means that there is a need to change the way that physical assets are viewed and managed within corporations. This applies particularly to the areas of who makes decisions, the knowledge and information used to make them and the process by which they are made.

Fuelling Economic Growth

Asset management, as with all functional sections of an organization, needs to contribute to the economic growth of the company. Over the past thirty years there has been a great increase in the level of understanding regarding exactly how asset management is able to contribute in this area.

More than at any other time in history we are dependent on machinery to perform many industrial tasks. Many of these tasks were formerly performed by people, however, as levels of automation in particular have increased so too has our reliance on mechanization. While this has been responsible for dramatic increases in productivity levels it has also placed considerable pressures on the direct costs of asset management over the past fifteen years in particular.

However, as we go into the 21st century there is even more upward pressure on the direct costs of main-

tenance management. Through increases in legislation, regulation and the complexity of the machines and capital costs of new assets, organizations are being challenged to reign in direct maintenance costs in a manner that is not only effective but also sustainable over the medium and longer term.

At the same time global competition is at a higher level than ever previously. Years of opening market barriers, waves of privatization and increasing technology have placed pressures on corporations that were unheard of a mere decade ago. In some companies, such as recently privatized transport and utilities companies, these pressures are being experienced for the first time during the last ten years.

These opposing pressures are what initially attract the attention of corporate boards to the areas of asset management. The drive for increased competitiveness and reduced costs draws attention to the cost of operational maintenance in particular. In many capital-intensive businesses this cost, although able to be reduced through the adoption of best practices, still takes up a large percentage of the operating budget. (OPEX)

Asset replacement and new asset acquisition are prominent features of the operating environment of capital-intensive industries. This is particularly the case in the mining industry and some of the recently privatized utilities and transport infrastructure services throughout the world. The resulting perception of a need to replace aging assets has led to multi-

billion dollar capital expenditure plans. (CAPEX)

It is the combination of these two factors that have placed asset management as one of the dominating elements of corporate expenditure. In some industries it has come to represent the largest single area of costs, in others it remains a vitally important influence on future effectiveness of the organization.

This array of pressures poses a unique economic challenge for organizations as we enter the 21st century. Primarily this challenge is to release as much economic value from the investment in asset management as possible. This challenge manifests itself in three areas in particular-

- Minimization of the life cycle costs of asset ownership
- Minimization of direct costs associated with asset management.
- Minimization of the costs associated with new asset purchases and asset renewal programs. (overhauls and renovations)

These issues, and the manner that organization respond to them, are determining factors in the ability of organizations to achieve economic growth in the management of their physical asset base. This is a difficult task that has been made even more difficult by the fact that much of what has previously been recognized as common sense in these areas has been proven to be either false or, at best, only partially correct.

Disjointed Approaches to Asset Management

That these economic and risk management pressures exist is not news for the majority of organizations. Striking the important balance between issues such as risk and cost, or long-term growth and short-term gain are a part of the daily decisions that are required as a part of their daily decision making process. However in attempting to balance these issues they are often confronted with a bewildering array of possible solutions to their problems. The full range of the potential solutions in the market is extremely large, however a partial list would include-

- Reliability-centered Maintenance
- Preventive Maintenance Optimization
- Root Cause Analysis
- Total Productive Maintenance
- Planning and Scheduling
- Availability Modeling
- Decision Support Tools
- CMMS
- Hazop Studies
- A vast and growing number of software solutions claiming success in either part or all of the asset management function.

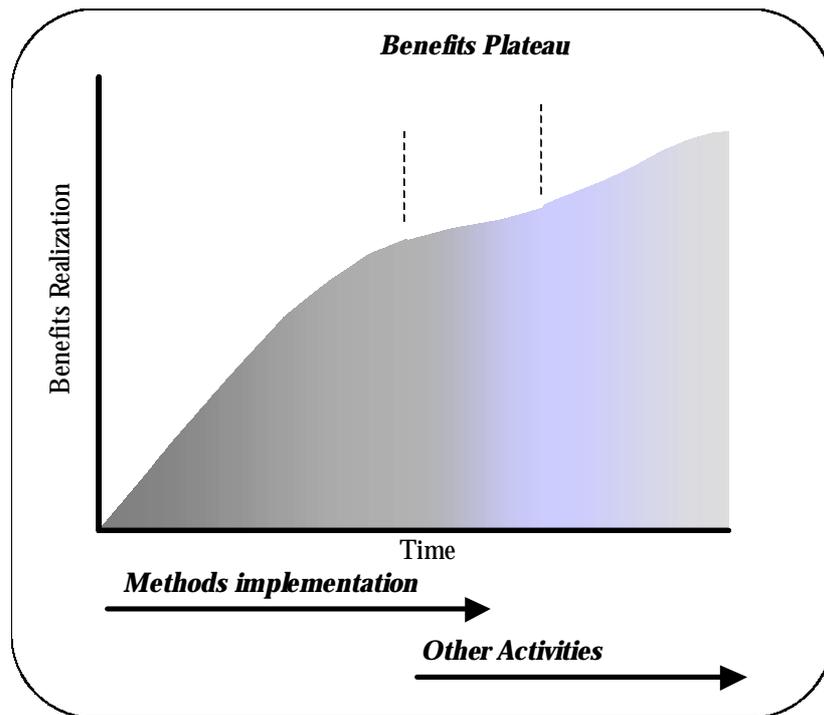
At a corporate level this is even further compounded by an equally

bewildering number of choices and methodologies including Total Quality Management, Six Sigma, enterprise management systems, team building methods and many others.

All of these systems, methodologies and processes, make varying claims to be able to assist companies to become more effective, more efficient and, as a consequence, more profitable. As such they all compete for the attention of corporate decision makers and corporate funds. The result is often a patchwork of different approaches, each with a slightly different, and at times uncomplimentary, focus.

In this scenario the goal becomes not only gaining the attention of corporate sponsors, but one of maintaining that attention. The adoption of a patchwork of solutions is often done unintentionally, generally bought about by a lack of understanding of the inter-related nature of asset management issues, or in larger corporations a lack of knowledge of what other initiatives are currently being undertaken. It is also accompanied by a number of negative effects. Among these are the lack of adequate support levels and a continual lobbying effort that is required to maintain attention to a specific initiative. This is particularly the case when there are conflicting aims associated with one or more of the initiatives being attempted. What an adoption of a patchwork approach clearly illustrates is a lack of strategic planning, generally due to a lack of understanding, of some of the fundamental concepts governing asset management.

Figure 1.1 The Benefits Plateau



Often the result of such an approach is an effect known as “benefits plateau”. This is an effect whereby there are some quick-wins or early successes from the implementation initiative. After the early successes those charged with implementing the method or process are then left to “get on with it” as the corporate decision makers turn their attention to other initiatives or industry trends. The lack of a strategic plan, clear objectives or continued corporate support results in a falling away of momentum and no further benefits are realized until the next initiative begins to take effect.

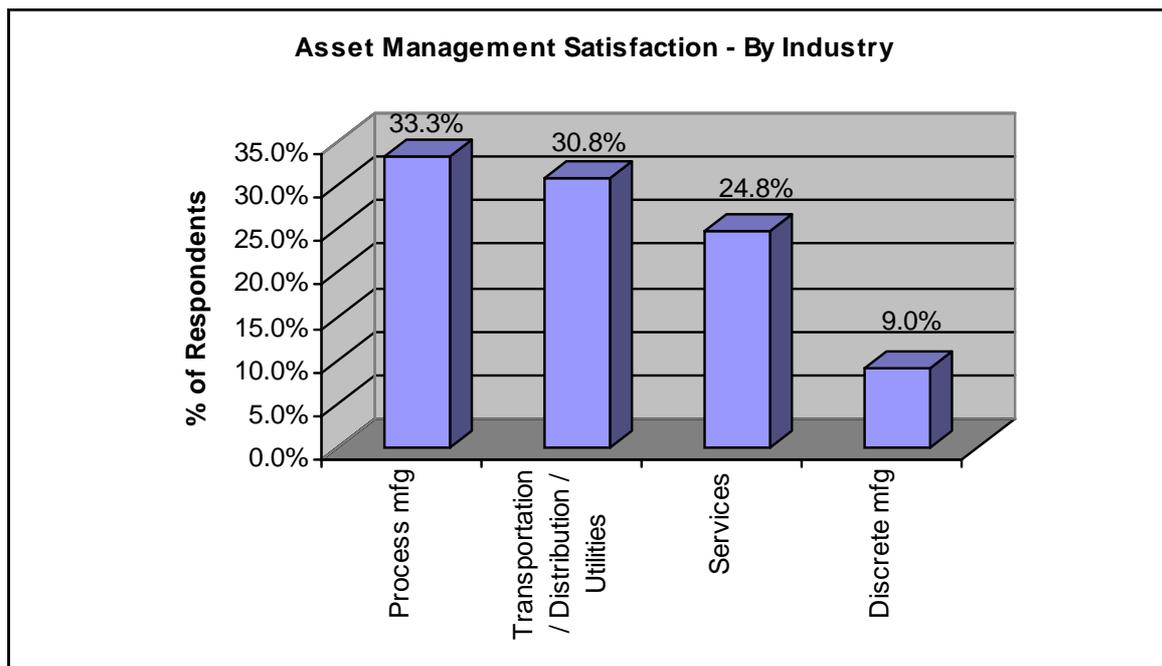
Improvement initiatives in this environment are also vulnerable to failure when either the principal sponsor or the champion of a particular program leaves the organization. In fact this is the dominant reason for an inability of reliability and asset management improvement programs to become part of the daily routine of

many organizations. A side effect of failure is that the organization itself becomes cynical towards a particular methodology regardless of any success that may have been achieved in similar companies or industries.

The same effect occurs when methods or systems are implemented with a limited vision. For example, an implementation of a reliability initiative without integrating it into the wider maintenance administration processes, and continuous improvement initiatives, will be equally limited in the results that it achieves. The “benefits plateau” effect is true for every major initiative in the area of physical asset management, from Reliability-centered Maintenance to large-scale EAM system implementations. (See Figure 1.1)

Figure 1.2 clearly shows the degree of satisfaction of various industry sectors with the asset management function. The industries included

Figure 1.2 Asset Management Satisfaction – By Industry



within this graphic include those of process manufacturing, transport / distribution, utilities, services and discrete manufacturing. Within these industry sectors a decidedly low level of satisfaction with the performance of the asset management function was noted. In fact, within the industry of discrete manufacturing only 9% of respondents stated that they were satisfied.

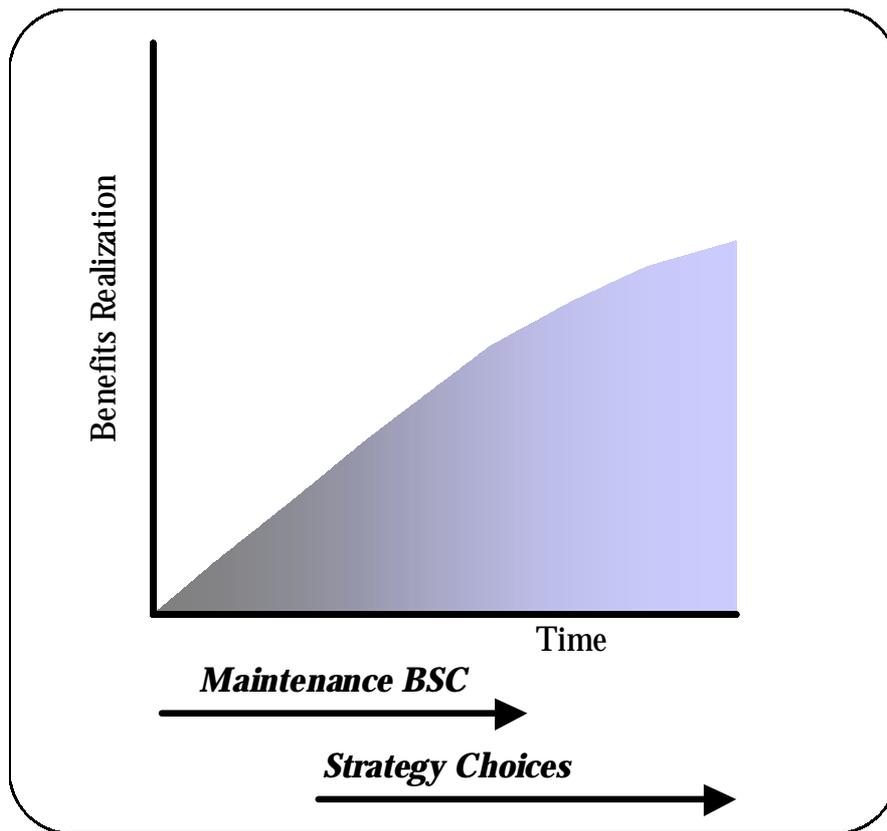
There can often be a number of reasons behind figures such as these. At times it can be that asset management is still seen at a corporate level as a liability rather than an asset, it could be that there is no visibility of the asset management processes and performance, or it could be genuine low levels of performance. In order to effectively respond to the challenges facing asset managers, in the areas of risk and economic performance, it is necessary to adopt an approach that will allow a continuous realization of benefits from improve-

ment initiatives adopted. Within this book the approach aimed at addressing this issue is The Maintenance Scorecard. (**MSC**)

The MSC is a comprehensive approach used to develop and implement strategy in the area of asset management. It also serves to identify strategic improvement initiatives, along with the areas that they are focused on, early in the process. (See Figure 1.3)

As a methodology based in the measurement of performance, the MSC is built around a use of management indicators, or metrics, to lead the development and implementation of strategy. It also recognizes that sustainable competitive advantages come from the implementation of strategy, not merely it's development. While the balanced scorecard has been in existence for over a decade at the time of writing, the level of take-up within the areas of asset management has been very low,

Figure 1.3 Avoiding Benefits Plateau



despite the growing strategic importance of the area.

An Introduction to Measurement Systems

All assets have a purpose. This is true for physical assets, human assets, electronic assets or intangible assets such as skills, knowledge and experience. The way that these assets do what we require of them is generally referred to as their performance. The Merriam-Webster online dictionary defines performance as the execution of an action.³ If we are going to measure performance however, there is a need to define *what level* of execution, and *what action* specifically is being undertaken. A conveyor belt may be able to

deliver 100 products per hour to the next process in the line, however it may only be required to deliver 80 per hour under normal operational circumstances. Delivery of 100 products per hour is not required and may not be able to be managed by upstream processes. It can be seen that regardless of what the equipment is capable of doing, it is what it is required to do that determines its desired performance.

In this scenario the level of *execution* is 80 products per hour while the *action* is to deliver product. The inclusion of the level of execution required, as well as the specific action that is required, is a fundamental part of any performance expectations and defines the output that is required from the asset. Also present is a reference to time. Time is a part of all perceptions of performance, this may

³ www.m-w.com

be obvious or implied, or it may be subtle. For example

- Availability is a measure of the ability of assets to be used for operations during a specified time.⁴
- A mechanical crafts person is required to perform a certain task within a limited time, particularly in breakdown situations.
- Risk is managed with respect to the probability of an event within a certain timeframe, given a set of circumstances.
- A training course is undertaken in the belief that it will improve certain skills within the time allotted

Within the MSC performance is defined as the result of effort applied to obtain a desired output within a desired timeframe. Effort can refer to any actions such as those by maintainers, operations, information management systems or design engineers. (See Figure 1.4)

Asset managers are generally people from technical backgrounds. maintenance engineers, technicians and other specialist functions understand that performance is the key objective and generally use some form of engineering measurement initiative to regularly guide their decisions and actions.

Engineering measurement takes the form of either formal or informal systems. Where there are no formal measurement systems in place the

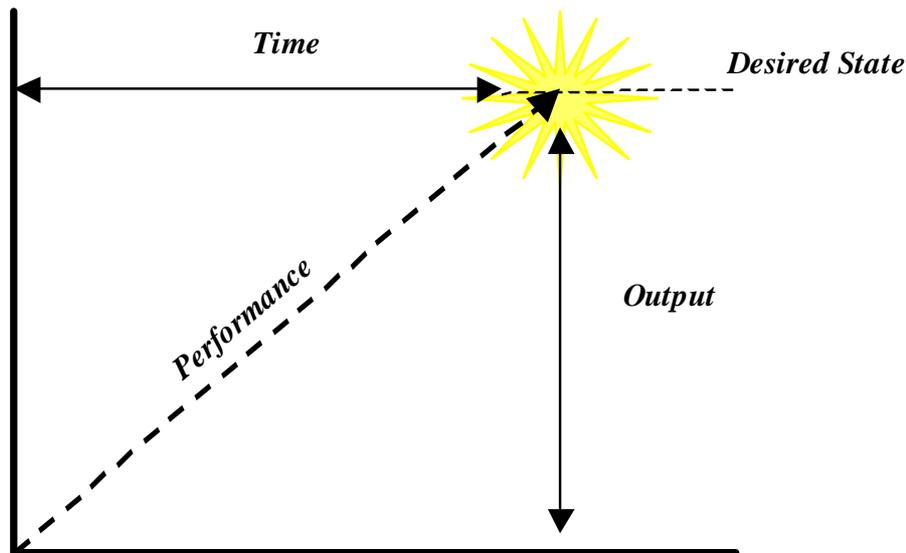
performance is stated as being good, acceptable, poor, bad or any range of other qualitative measures. These are often based on observed performance and are made against a perception of what the operations require. Formal measurement systems produce regular information regarding the key performance criteria of a plant, installation, item of equipment or other facet of work output.

However without a quantified reference to what it is that the assets have been required to achieve then these figures can be misleading and are of little use to the maintenance effort. In the case of the conveyor a production rate of 80 products per hour, when the rated capacity is 100 products per hour, could be seen as being unproductive despite the fact that this may cause problems upstream. Similarly a turnaround time of a maintenance task of 2 hours less than normal could be seen as highly desirable, despite the fact that critical steps may have been left out or poorly done.

Defining the desired levels of performance provides an understanding of how the equipment, people, or other asset types, are performing. 80% availability may be poor if the plant requires 95% to achieve operational goals, however it may be ideal if an average of 75% is required for production targets.

⁴ Either operations required time or calendar time depending on the requirement

Figure 1.4 Defining Performance



Desired performance levels need to be determined based on what companies require of their assets, not based on the design capacity of the assets. Basing objectives and targets on what is required, rather than what is currently possible, is the first step in strategic planning and is a core element of the MSC approach.

Measurement systems highlight the level of improvement that is required to move from the current levels of performance to the desired levels of performance. (See Figure 1.5) In order for a measurement system to be successful there is a need to know-

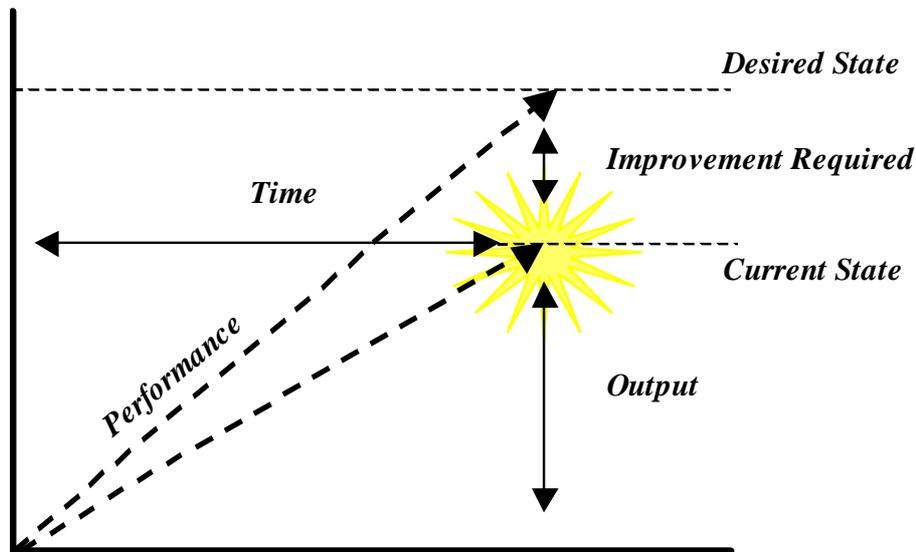
- what the desired level of performance is in quantified terms
- how the current levels of performance are able to be determined
- what actions can be taken to improve performance from the current level to the desired level of performance

By defining the difference between desired and current states of performance companies are able to determine the actions, strategies or acquisitions that they need to undertake. They are also able to clearly understand the limitations or over-capacities of their current resources.

Current Practices in the use of Performance Indicators and Metrics

To understand how measurement systems such as the MSC can assist maintenance-intensive organizations it is important to understand how indicators are used today. As stated previously, asset managers are inherently aware of the benefits of measurement programs. Yet the way in which we use key performance indicators has remained unchanged since the beginning of the modern maintenance era.

Figure 1.5 Measurement Systems



This does not imply that the underlying indicators have not become more sophisticated, in some cases they have. However the manner in which we apply indicators and use them in daily management, has not changed. Changes in this area have been made more difficult by the fact that *any* measurement effort will highlight potential areas of improvement.

Historically we have used indicators and measures to determine the efficiency and effectiveness of management initiatives, modifications and team or equipment performance. As a management discipline we are yet to realize the full potential and benefits of using performance measurement as a tool to implement strategy throughout an organization - that is, using it as a proactive rather than a reactive management tool.

When a maintenance department begins to focus on performance indicators it generally does so in an uncontrolled and unfocussed manner. This normally occurs in one of the following ways, regardless of whether

the department has some indicators in place or not.

- **Imposed Metrics-** A request for regular information from higher management
- **Legacy Metrics-** A new manager putting in place familiar management tools. This also occurs with suggestions from employees or others wanting to put in place familiar management tools.
- **Influenced Metrics-** Suggestions from employees based on an article or indicator they have heard of
- **Ad-Hoc Metrics-** Employees using database or spreadsheet skills to create indicators in an uncontrolled and unfocussed manner

In all cases the approach is one that delivers a list of indicators. However it is based on a purely reactive focus and in a way that incorporates a number of inefficiencies into the process of measuring maintenance.

These areas of inefficiency can be grouped as follows-

- Inefficiency in measurement
- Indicators used in a reactive, as opposed to a proactive, manner
- Inefficiency in implementation

Inefficiency in Measurement

The decision regarding what to measure is one of the primary reasons for failure of measurement regimes. Without a clear identification of the desired performance, as well as the reasons for this desired performance, companies often generate long lists of indicators.

Regardless of how well documented a long list of indicators may be, different people refer to different indicators, coming to different conclusions regarding the implications of these indicators and the courses of action that they dictate. In addition, long lists of indicators lead to poor usage. Certain indicators may remain unused and unnoticed despite the fact that they may represent vital decision-making information.

Furthermore, and most important, long lists of indicators are rarely linked to corporate goals and objectives. At best they are loosely linked. One of the key points regarding metrics is that they drive behaviors. Particularly if people know that they are being reviewed regularly. In an uncontrolled application of performance indicators there may be the unintentional result of driving behaviors that are detrimental to organizational objectives. In a worst-case scenario,

they may unintentionally cause dangerous situations.

For instance, a mining company in Latin America had a management initiative to increase production levels. Part of this initiative was to measure team performance and financially reward teams with higher outputs. At first this initiative provided surges in production levels until a point was reached where it leveled off. After this it began to fall away, in some cases dramatically.

On further inspection it was found that in some cases the off-going shift was actually sabotaging the equipment in order to create difficulties for the oncoming shift in reaching targets. Not only that but it was determined that the original surge in production was due, in part, to an unacceptably high level of risk taking among the workforce in order to achieve higher levels of production.

This initiative, although well intentioned and inclusive in its focus, was actually driving detrimental behaviors. Through the measures applied it actually reduced production and created an environment of almost enforced high risk for the workforce.

The example above provides an insight into indicators driving poor behaviors, however there were other side effects of this particular application of metrics. The company in question had an actual stated goal of high safety levels and of high levels of teamwork as two of its key objectives. So along with the dangerous and unproductive behaviors that the performance measurement system encouraged, they also caused the

company to drift significantly from two of its prime objectives.

Indicators used in a reactive, as opposed to a proactive, manner

We have always seen the use of maintenance indicators as a purely reactive measure. That is to say we are measuring what *has happened* in order to make decisions. This is a key driving point behind many management initiatives involving metrics. Managers at various levels decide that they want to know what is going on, how their plant and teams are performing and how the corporations' investment is performing.

Reactive measurement is also one of the key reasons for inaction in the realm of indicators. *Any* organized measurement and monitoring initiative can highlight opportunities for improvement. However they do not necessarily do this in a manner that is efficient, nor in a manner that drives the correct behaviors or sends the correct messages regarding the physical asset management regime.

Inefficiency in Implementation

As with all reliability projects there is always the possibility of a vast difference between the theory and strategic planning, and the eventual reality. More often than not it is a positive difference whereby eventual results far outweigh the investment made, however this can also be a negative difference. In the use of metrics three principal areas generally cause a lack of benefit realization-

- a) A lack of understanding regarding whether or not they have the software and information systems

in place to produce the desired indicators

- b) A lack of attention to the administrative processes that are needed in order to capture the data
- c) A lack of adequate linking of the metrics being implemented and the corporate objectives of the company

This is particularly startling as today almost all maintenance management organizations, large or small, have a CMMS system. The majority also has some form of reporting system. Advanced reporting systems have a number of tools available for representation and analysis of information. One of the principle reasons that metrics programs fail is that, as with many other technological tools, maintainers either do not know they exist, or are not able to access them.

Second, very little if any focus is placed on the element of embedding of metrics. Very few in the organization actually understand what is being measured, why they are measuring it or what the supporting processes are. This includes how to access and interpret them on a regular basis.

In worst-case scenarios, metrics begin to be generated on an as required basis by any and all people who are able to manipulate databases, spreadsheets or the company reporting system. This is a particular area of danger because the integrity of the information, and hence the resulting decisions, is no longer guaranteed. Of course the other point is that these people, instead of analyz-

ing and acting on reports, are wasting their time creating them.

Myths in the Measurement of Maintenance

Deciding what to measure is a key element of a structured approach to measuring maintenance. So too is deciding how to measure it. Many of the indicators that are used in maintenance are “traditional” indicators. (Legacy metrics) However there are new indicators gaining prominence in maintenance management. Some of these are accepted without question as a new way of driving continuous improvement. It is in these myths that we find some potentially dangerous and misleading practices.

Frequently, corporations that are using these measures or the individuals that champion them are full of praise for their effectiveness. *Any* measurement regime can highlight opportunities for improvement. Merely placing a set of existing performance measures around business processes will highlight areas of potential improvement. This is regardless of the fact that they may be inefficient, inaccurate or encouraging behaviors not inline with corporate objectives.

One of the dominant myths today is that of using one specific measure to understand the effectiveness or overall performance of plant or equipment. This stems from either a misunderstanding of what the indicator actually represents, a misunderstanding of what the corporate objectives are – or both.

As most asset management professionals know, any complex piece of machinery is controlled via a number of indicators and gauges. Even an automobile is managed via gauges for fuel consumption, oil, temperature, revolutions of the engine and various indicators for speed and indications. If only the miles/hour indication were used there would be the risk of running out of fuel. If only the fuel gauge were used then there would be an increased risk of a traffic infringement.

The same principles apply when controlling assets on a larger scale. One indicator of performance, no matter how complex, is only ever telling us a part of the story. So, if we are to successfully run any enterprise involving physical assets we need to understand a variety of indicators, what their level and manner of interrelation is, how to interpret and how to use them to influence continuous improvement strategies.

Some other areas where there are myths in the measurement of maintenance performance can be found in the following headings. All of these issues are dealt with in further detail later in this book.

- The use of metrics as reactive measures rather than proactive measures
- Availability as Effectiveness
- Misunderstandings of the levels where metrics are used
- A belief that all performance measures are one-dimensional metrics only

- A general misunderstanding of benchmarking, best practice and world class classifications

The Maintenance Scorecard - A Structured Approach

Financial analysts have long told us that developing strategy is good, but it is the implementation of strategy that separates successful organizations from average and failing organizations. The MSC approach provides companies with a tool to implement and communicate corporate strategy throughout the company. It is also a means of facilitating innovative thought within an organization, particularly in terms of new and more efficient means of creating economic growth or the management of risk.

Corporate Goals and Objectives

The beginning of any measurement regime is firstly to understand what we want to measure and why. These are the desired performance standards that were discussed earlier in this chapter. Corporate goals and objectives need to be linked with the competitive advantages that an organization wishes to achieve.

Competitive advantages can exist in many areas. They can be based on productivity, knowledge retention, employee skills improvement, risk reduction, service improvement and numerous other areas where there is corporate activity.

Competitive advantages are typically described as-

“The set of unique or hard to duplicate abilities, competencies and

capacities contained within an organization that allows it to better compete within the markets that it operates in.”

Competitive advantages can be represented in a hierarchy of advantages and goals. This provides for the first step in the communication of corporate objectives. It also allows for the initial step in the creation of the strategy-map that will be used to drive these goals and objectives through the entire organization. A competitive advantage is achieved through the achievement of one or more strategic advantages. Instead of taking the approach to measure everything and anything that can be measured, the process first identifies what is needed in order to achieve the overall goals of the company.

For example- A company is a leading manufacturer of engine components for a popular SUV. It has determined, as a part of its strategy planning, that it needs to achieve a competitive advantage by achieving “a high level of continued overall quality of the parts it sells while remaining competitively priced”.

During the strategy mapping process the following are determined as key strategic advantages necessary to achieve the competitive advantage- (In a real life example there would likely be many more items listed)

- 1. Best possible purchasing of quality raw materials at the best competitive prices (low failure rate from raw materials)*
- 2. Best possible continued performance from machine operators*

(low failure rate due to human errors)

3. *Low leakage rate of high talent levels in operating the equipment (low failure rate due to inexperience)*
4. *Continuous high levels of performance from machines in use (low failure rate due to machine failures)*
5. *Cost effective operation of machines (Supporting the cost effective production goals)*

Four of the five strategic advantages defined above can be affected by, and may require some effort from, maintenance management. Also each one of these strategic goals would be quantified in a way that allows for performance to be measured against their achievement. Strategic advantages can be described as-

The set of unique or hard to duplicate abilities, competencies and capacities contained within an organization that support the companies competitive advantages

Achievement of competitive advantages depends on the strategic advantages that we are able to create. A company seeking to retain high quality craftsmen may have as a strategic advantage a profit sharing plan, or a career improvement plan for example. These two capacities, in this case, are the things that separate it from other employers. Another illustration of this could be a utilities company seeking to develop competitive advantage by offering its services, such as the supply of electric-

ity, in a provable continuous manner. A strategic advantage that it may develop to ensure this could be a high level of reliability in its operating plant.

The last level of the hierarchy used in the structured approach is that of strategic assets. The principal goal of using the top-down structured approach is the development of strategic assets, which can be explained as-

The abilities, competencies or capacities that are required in order to achieve strategic advantages

Strategic assets represent the component parts, or the functional level activities, that comprise a strategic advantage. Within the context of the MSC, strategic assets does not refer to critically important equipment specifically, it refers to intangible skills, abilities and capacities that are contained within an organization. A requirement for a high level of reliability of the operating plant may require the generation of such strategic assets such as-

- Maintenance policies dedicated at reducing the risk of failure to a tolerable level, with measurement of these at the equipment and component functional level.
- Craftsmen highly trained in reliability methods and theories.
- Incident review processes to avoid reoccurrence of previously unforeseen events.

At all times these are to be focused on measures of actions, abilities or capacities at the functional

level of the maintenance delivery function.

For example - In the engine parts plant, one of the Strategic Advantages highlighted was that of "Continuous high levels of performance from machines in use (low failure rate due to machine failures)."

In order to determine what strategic assets are required, this advantage needs to be first analyzed and then broken down into the component capabilities, skills and capacities that are required.

In this case the strategic assets may include-

- *High amounts of time (quantified) available at full capacity for production*
- *Low failure rate of machines (quantified) leading to quality failures*

Once we have determined the strategic assets that are required we can begin to highlight the measures and initiatives required to achieve them. These will vary depending on the equipment and situation in each case. However some alternatives include applications of RCM, Root Cause Analysis or Maintenance administration efforts.

One of the benefits of this system is that by driving down from the top of the organizations requirements we are able to identify specific measures and actions for specific areas of the operation. The method also promotes the open questioning of measures and activities in place. If an activity does not contribute to the achieve-

ment of competitive advantages in some manner, there are generally few reasons for the company to continue doing them.

The Development of Strategic Assets

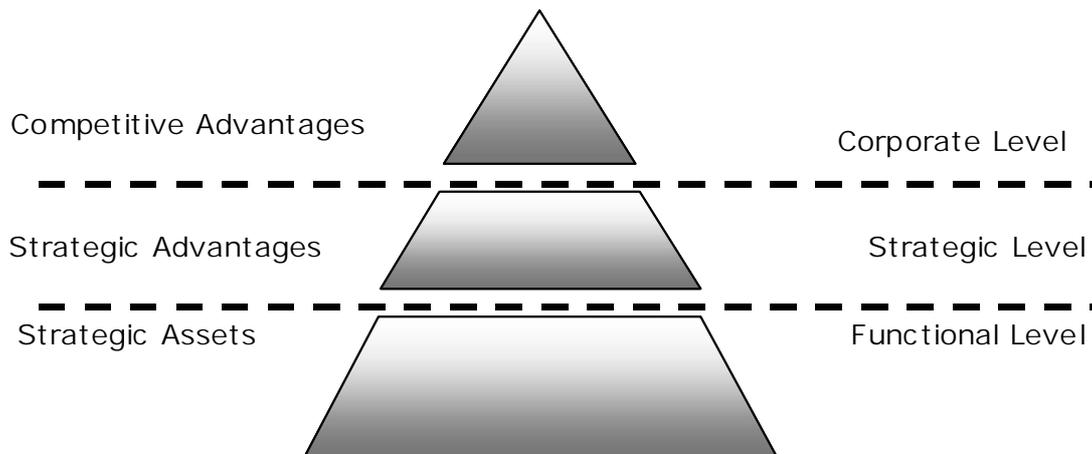
In order for this hierarchy of objectives to be useful to the company it needs to be translated into measures and goals. The diagram in Figure 1.6 shows the representation of goals and objectives in terms of performance indicators. In this manner we can ensure the true measurement of performance that is key to our operations.

The structure in metrics is best represented by corporate level indicators, strategic level indicators and lastly by functional level indicators. Each of these represents the goals that have been determined in the strategic planning stage of the process. The process provides many benefits, however its principle objectives are-

- To facilitate the creation of corporate objectives, or desired levels of performance
- To facilitate the measurement of actual levels of performance
- To provide a means of focusing the organization on the improvement initiatives that are required to achieve corporate goals and objectives.

To allow for easy and deliberate diagnosis of any deviations from the plans to achieve the desired levels of performance.

Figure 1.6 A Structured Approach to Measuring Maintenance



One of the interesting effects of applying the structured approach is that when determining measures there is more of an effort to develop requirement-specific measures instead of generic, widely used, measures.

Implementing The Maintenance Scorecard

The implementation of the MSC needs to be flexible and inclusive. While it is best applied from an organizational standpoint it can also be applied at a departmental level, a project specific level or an equipment specific level. In fact even once the MSC has been developed and embedded within an organization there is often a need to develop specific scorecards for specific initiatives. Ensuring always that these are tied to the original MSC. The three steps to implementing the MSC are development, creation and embedding.

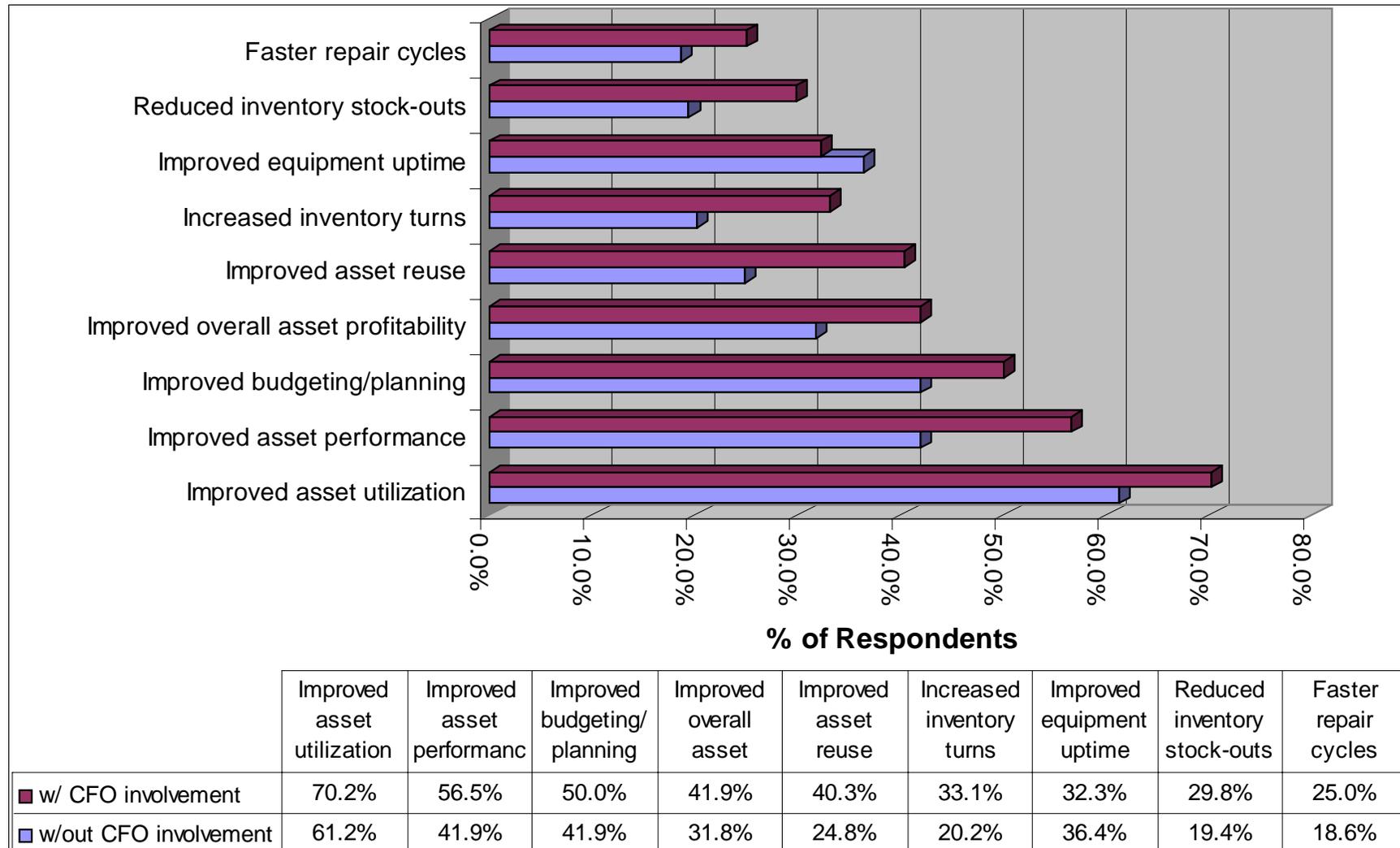
Development

As with any change to the way that we do things there is firstly a need to change the way that people

think about what they are doing. This is recognition of one of the underlying truths regarding asset management. Although the results of work in this area are seen in the safe performance and reliability of machinery, asset management is about the management of people. The communication, interaction and cooperation between people in different roles throughout the organization remains the number one driver of good practices and of improvement. The development phase of the approach requires participants to understand how to create a focused indicator structure, recognize what are the common myths in measuring maintenance and how to ensure the benefits of doing so.

The development phase begins by defining the desired states of performance required to achieve corporate goals and objectives. The outcome of these actions is a series of quantified measures, goals and statements that represent the corporate objectives. At the corporate level an array of pressures; market forces and opportunities need to be analyzed.

Figure 1.7 Benefits gained through a cross-functional approach



Among these are such areas as current and planned market share, current and possibly future regulation and legislation, defining tolerable risk levels, as well as the interaction with other corporate strategic plans.

The graphic in Figure 1.7 shows the dramatic effect of involvement of other functional areas within the organization. It is taken from an EAM benchmark study conducted by Aberdeen group in 2002 and has particular relevance to the themes within this book. The implementation of the MSC in a cross-functional manner is key to achieving the benefits of an accurately targeted organization, as well as the full achievement of the benefits that are planned.

This leads directly to the strategic level of indicator creation. At this point strategic plans are put together to ensure that the goals and objectives can be achieved. This step often acts as a reality check to show where there are differences between the physical reality and the corporate vision. It is also the level where the majority of detail is required. This plan is usually a combination of both long-term and short-term elements. The strategic level development of indicators can relate to either departmental levels, national or regional levels; or even at a plant level. Much of this will depend on the size and nature of the organization. It can also cover such areas as-

- details of the performance of crucial asset groups, systems or equipment
- equipment or asset condition and investment levels that are targeted
- the detail of legal and regulatory requirements
- desired outcomes and measures

This section is also best managed via a combination of strategic analysis work and facilitated workshop sessions. In keeping with the focus on cross-functional implementation a typical workshop for the development of the strategic level indicators and strategy may include-

- Maintenance managers
- Maintenance engineers
- Operations supervisors
- Craft level workers from maintenance and operations
- Inventory management representatives
- A representative from the company IS or IT department

Attempting to carry out this work in isolation can generate difficulties for an organization, particularly in the later embedding processes essential for change of

corporate thinking and acceptance. However the MSC can also be implemented as a standalone entity focusing specifically on the desired performance requirements of a work team, specific plant or a piece of equipment.

One of the desired outcomes of this process is that of inter-departmental and inter-discipline awareness throughout the organization. The value of this cannot be underestimated, particularly in strongly integrated departments.

Among the outcomes of this stage are the following -

- Development of causal links between the competitive advantages desired and the strategic actions that contribute to these
- An understanding of the work to be done to achieve these indicators and a plan of the resources and timeframes to accomplish this work
- Understandings of what indicators are to be used by which roles in the organization. This needs to be accompanied by a strong focus on the possible benefits of realizing these competitive advantages, with a view to both the financial and non-financial benefits.
- An understanding of any processes, previously a part of the organization, that may no longer be required
- A detailed list and detailed understanding of the Strategic Assets and Functional Level Indicators that will be required to ensure the MSC is implemented throughout the company. Functional, or tactical, indicators are the resources that will be needed to achieve the strategies set forth in the development phase.

Creation

The creation phase of the project needs to be managed in the same manner as any improvement project. During this phase much of the work defined in the development stage is carried out. In particular the creation phase focuses on the definitions that are gained of the information portfolio that is required to sustain the MSC. This is a missing part of many corporations approach to indicators and is an integral part of the structured implementation approach.

Throughout the development stage there is an understanding gained of what information is going to be needed in order to adequately represent the measures required, within the timeframes required and in a manner that is accessible to the roles that need to see it. This is further defined in the development stages by the adoption of strategy initiatives.

These initiatives may include putting in place business and data management processes for the capture of the

information required. They may also include the initiation of reliability growth, knowledge engineering or business improvement initiatives. Each of which will need to be planned, potentially with a related scorecard, and implemented.

This phase can typically include-

- Report creation, implementation of reporting software if necessary
- Staged implementation of administrative processes and reliability initiatives. This part of the entire plan is a crucial element to the success or failure of the overall improvement initiative.
- Preparation of material for the embedding process.

Embedding

The embedding phase of the project is the most vital and the part of the project and is designed to ensure its success as a permanent strategic initiative. This stage actually begins from the very start of the entire process.

Embedding involves three basic actions. Firstly there is the need to communicate the work being done. From experience this initial communication is best done through the delivery of a one-day course aimed at transferring knowledge regarding some of the important points regarding the MSC combined with descriptions of the indicators that are to be implemented. This course would generally include a focus on the myths in measuring, the indicators chosen and the reasons why as well as what the indicators mean to the various levels of people throughout the organization. This would also require explanations of the various strategic initiatives that have been put into place, their intent and focus as well as their progress to date.

Training in the intentions and structure of the companies MSC should contain elements of reliability and asset management theory, however it does not replace or remove the need for general asset awareness styles of training. Although not widely implemented throughout companies until the end of the 20th century this form of targeted training is becoming widely recognized as a means of raising the reliability understanding of the workforce as a whole.

The second basic action is the implementation of the processes and initiatives required to achieve the competitive advantages that were initially decided upon. This need not start during at the end of the project and could be commenced once the development phase has been completed. The embedding phase will then give context to this work, further justifying and explaining the overall intent throughout the organization. When and how such initiatives are commended is determined almost entirely

by the operating environment and characteristics of the company where the MSC is being implemented. A corporation with an already high level of sophistication regarding asset management themes may find that it is able to act on strategic initiatives early in the process while others may not be able to until after the strategic level indicators have been defined.

The final part of embedding requires a close monitoring of the results of the management initiatives and communicating these results, and the achievements of those involved, to the remainder of the organization. This can at times be linked to personnel performance reviews; it can be the subject of toolbox meetings and safety meetings and should be referred to regularly.

The strategic initiatives underway should also be referred to regularly and should become the focus of discussion throughout the company. Embedding also involves the implementing of review sessions, of the MSC team, so that feedback on progress can be evaluated. This allows for improvements to strategy and improvements to the way in which strategy has been implemented in the organization.

Results of The Maintenance Scorecard

The most notable result of the maintenance scorecard is to produce an asset management function that is focused on the goals and objectives of the corporation. It is useful for virtually any industry type that has a need to manage a physical asset base. However the Maintenance Scorecard is particularly useful within capital-intensive industries. Through the continual process of consultation, communication and engagement the MSC reinforces the concept that asset management is about people, not just about machinery.

As a direct result of this there is also an increased visibility of the asset management function, the performance of the asset base and the costs and factors that are in effect on the assets. This is often a driving force in large capital-intensive corporations. Large electricity utilities with assets that span sometimes 100s of miles, train infrastructure operators with literally millions of assets, defense organizations with large asset bases of equipment in differing levels of age. These are just some examples of where visibility of the asset base provides a benefit that is not easily quantifiable.

The ability of the MSC to focus the organization and raise the visibility of the asset base manifests itself in three ways throughout the organization-

- An understanding of the capabilities and limitations of the asset base to achieve the goals of the corporation
- An understanding of the data that will be required to effectively make decisions and manage this function

- An understanding of the processes and initiatives required in order to meet corporate objectives and a thought out plan for achieving these objectives

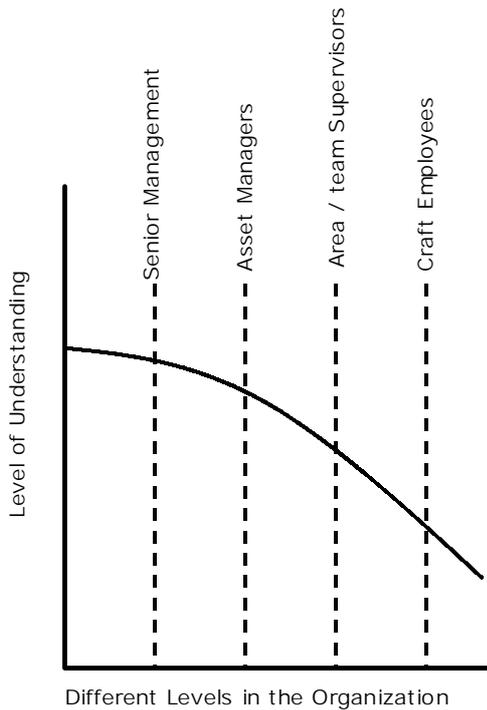
While these factors alone justify the time required to implement this tool, there are also a number of more specific benefits and advantages to the application the MSC.

Communication

There are a myriad of benefits to be gained in using a structured approach to performance measurement. However the most obvious of these is the communication and execution of goals and objectives throughout the organization, either at the level of the organization, department or a specific improvement project.

Figure 1.8 illustrates one of the most common problems encountered in executing strategy. This effect is often more exaggerated in the world of maintenance, as it is often seen as a large complex and difficult area. As such some of the actions that are taken within this area can be disjointed and at times counter-productive.

Figure 1.8 Errors in Communication



The falling off of communication reflects the common problems encountered by companies in executing strategy. The same effect can also be recognized in failed reliability and maintenance projects, although the effect in maintenance initiatives is often reversed with front line personnel having a strong understanding of the benefits of any improvement project.

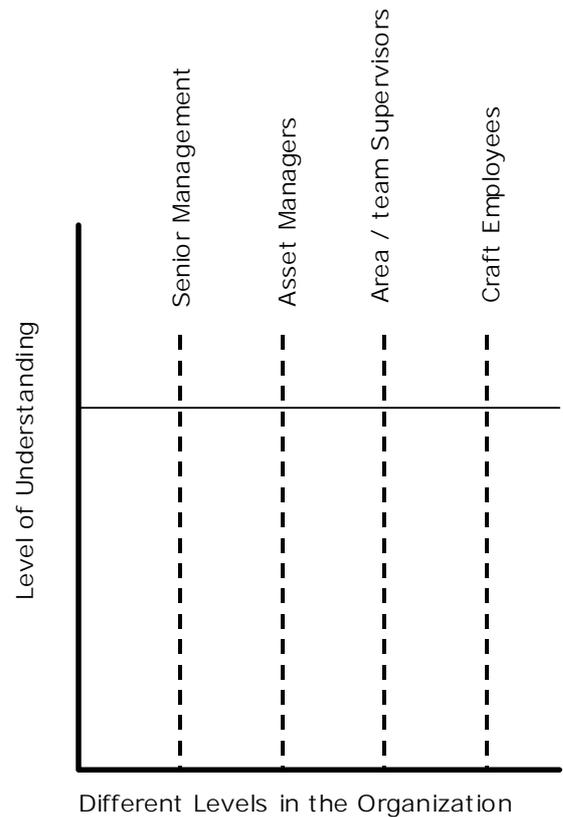
There are various reasons why this happens however part of the cause generally lies with the failure to convey

the objectives, impact, urgency and importance to the corporation. The effect of a structured approach is principally one of inclusion and communication. Using the three-step approach all of the organization are exposed to and taught what the indicators represent, and through these are able to understand what the overall goals and objectives are and their part in achieving this.

Proactive Focus

As well as communication, a structured method changes the overall approach to maintenance. As previously stated indicators today are used as a reactive measure. That is measuring what has happened and taking decisions based on this information. A prime example of this would be the managers daily or weekly reports. Decisions are taken and questions are asked based on this information. This practice is valid and one of considerable merit.

Figure 1.9 Focusing Resources



However many organizations have the admirable goal of striving to achieve a "proactive" state of maintenance. The MSC assists this by using indicators in such a way so as to drive future events. Instead of looking purely at what has happened it focuses on what should happen. This occurs through the goal setting that is integral to the overall process. In this manner the MSC is an entirely different focus to the use of indicators and to the extraction of value from their use.

Other Benefits

There are many other advantages to the structured implementation approach. Some are immediate, other more gradual.

- Inter-discipline and inter-departmental thinking and working
- Understanding the processes, acquisitions and initiatives required to achieve a desired end state
- Easy and deliberate diagnosis of any deviations from stated goals
- A process for attacking specific problems or issues at a corporate, departmental or improvement project level
- Full use of corporate reporting tools where they exist, an understanding of the information portfolio required in asset management and some direction as to the technology required to put this into place
- The achievement of competitive advantages

Although it is still not largely understood that maintenance management is one of the strategically vital areas of corporate activity, leaders of corporations are beginning to understand the benefits available in terms of cost effectiveness, risk management, productivity and quality specifically.

It is also an area where there are numerous methodologies, technologies and systems claiming to improve maintenance performance. Despite this there are still many failures in the implementation of maintenance improvement initiatives. This is partly due to the weakness of some of the solutions offered and partly due to the lack of embedding of these solutions. In all cases part of the cause of failure is always attributed to a lack of managerial support.

As the discipline of maintenance management progresses from the modern age of maintenance it is of great importance that we are able to adequately link the function of asset management to the corporations competitive advantages. The structured approach couples these linkages with a comprehensive method for defining and implementing strategy and improvement throughout the organization.

The remainder of this book is separated into three major areas. Firstly, chapter 2 through to Chapter 6 will explain the MSC in detail. This includes the unique perspectives model contained within the MSC, understanding the creation and importance of strategy for asset management, an overview of risk assessment and mitigation practices and an overview of implementation of the MSC.

Chapter 7 to Chapter 9 deals with a brief overview of some of the strategy initiatives that are available to those in leadership roles in asset management. These chapters are of vital importance as there is a need to understand how the MSC fits with major continuous improvement initiatives in asset management as well as how it is implemented. It needs to be emphasized that these are only a few of the very many strategy initiatives that could be applied.

Chapter 10 is an overview of the benefits available from the MSC and includes some brief references to successful implementations. The intention of this section of the book is to show what have been successful attempts at implementing the MSC throughout various industries and companies. It highlights some potential areas of danger, methods for maximizing the leverage of information and some of the areas to watch out for in the embedding stages.

Appendix I, at the end of this book is a collection of indicators, measures and graphical displays that are often used within the fields of asset management. This is not intended to be a conclusive list and will surely continue to grow over time. What is intended, however, is that it forms a useful part of the arsenal of any company with a need to manage physical assets.

About the Author

Daryl Mather is a specialist consultant in the areas of asset management, reliability and risk management. He has enjoyed a career spanning over 20 countries and the majority of industrial sectors throughout the world. He currently assists selected organizations to achieve strategic advantages through the management of their physical asset base. He also publishes the monthly newsletter called "Strategic Advantages".

What are others saying about the Maintenance Scorecard?

"The Maintenance Scorecard is an important work in the field of maintenance management. It is important because it weaves together several disparate threads into an insightful and useful whole. Implementation of the ideas presented in The Maintenance Scorecard could focus attention of both top management and maintenance leadership to meaningful improvements."

Joel Levitt, President Springfield Resources