

# Competitive advantage in plant reliability

The concept of total plant reliability aims to integrate the approach to improving production and reducing costs. By lowering workloads, improving reliability and using effective procedures, says the author, plants greatly improve their performance

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Total plant reliability (TPR) is the second generation of the concept of total productive maintenance (TPM), which was developed in Japan. The essential elements of TPM have been retained – care and management of assets, the importance of operators knowing their equipment, the use of planning and scheduling of work and the high emphasis on preventive maintenance.

The practice of TPR is based on four pillars: asset management, focused empowerment, maintenance prevention and balanced “scorecard”. From this has evolved market-based maintenance, focused empowerment for individuals and the proprietary Reliability Balanced Scorecard (RBS) programme.

Under asset management, the fundamental building blocks for work management include the control of emergency type work, the essentials of planning and scheduling and the support of supply and services. Operator-performed maintenance and the proper use of a maintenance management system is an important part of asset management.

Under focused empowerment, the need for a vision and mission that includes reliability needs to be embraced by all levels of the organisation. This includes the need to identify the roles and responsibilities of individuals, teams, and functions, and the equal importance of supervisors setting levels of expectations. How leadership should be used is one of the principles included under focused empowerment.

Maintenance prevention involves reliability-centred maintenance for each production system, in addition to a total focus on root cause failure analysis extended into the plant culture. When implemented, TPR will have taken plants to the level of a learning organisation that exceeds customer expectations by optimising plant reliability, production and flexibility.

Implementation of a TPR programme (Figure 1) provides access to the variety

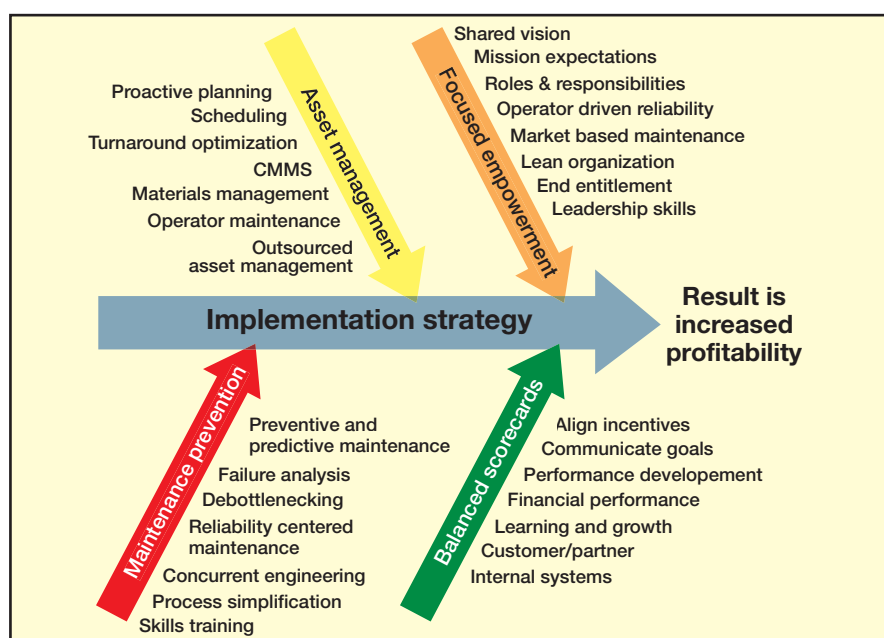


Figure 1 Total plant reliability

of changes and activities that will make best practices the norm. The original Japanese TPM approach dealt with small groups and was focused on assets that were defined as people and equipment. Its thrust was to improve the condition of equipment through effective preventive maintenance (PM) programmes and to restore equipment to an original operating condition.

The goal was to keep the equipment at peak condition. TPR extends the concept of TPM in several areas. First, for a plant or corporation to become a TPR candidate it must have senior leadership that wants to be world class, the humility to know that they can improve, acceptance that improvement is required and a path to get to world class.

Every part of the organisation must be committed to achieving optimum reliability. The vision, mission and strategies need to be an integral part of all levels of action from the plant manager to the entry-level craftsperson. The organisation needs to be committed to optimising production. This means the

best balance between reliability, production, and flexibility.

The focus is not on the administrative side of a plant or corporation, but on reliability. Reliability covers three distinct areas: the reliable performance of personnel within the plant, reliability of the processes used to accomplish plant work, and also the classical definition of reliability – “Are you running? How fast are you running? What is your first pass quality?”

The focus of TPR is reliability. One of the considerations is where do the losses occur in the plant and what new or revised processes need to be implemented to minimise or eliminate the causes of these losses. The eight major areas that cause plant losses include:

- Shutdown
- Product adjustment
- Normal production loss
- Abnormal production loss
- Equipment failure
- Quality defects
- Process failure
- Reprocessing.

World-class processes bring greater reliability of performance and thereby will minimise or eliminate many or most of the causes of plant losses. A suggested vision for plants would be to become a learning organisation that exceeds customer expectations by optimising plant reliability, production and flexibility.

**Reliability balanced scorecard**

Through the RBS, plants and companies are able to avoid the common pitfall of companies in the last 50 years – a focus on only financial results. Robert Kaplan and David Norton developed the balanced scorecard. Their assumption was that tracking performance purely on financial measures often forced companies to make the wrong decisions. Financial measures are lagging in the sense that they report the results of what has occurred.

Kaplan believed that integrating a combination of leading and lagging groups of performance measures would provide a more comprehensive method to help companies integrate their vision, mission, strategy, and tactics.

One salient comment that all companies and plants need to consider is that they can often be fooled about where a plant or company stands in relation to world-class standards of performance. Therefore, one of the standard assumptions that all should make is to only use hard performance data to determine where they are and where they are going. Norton, in writings found in the *Harvard Business Review*, stated that financial data should not be used to guide a company.

Using financial data was like steering a boat up a crooked river by looking at the wake. His inference was that financial datum was lagging indicators and did not tell companies where they were headed. The RBS was structured on the balanced scorecard and integrates four categories of performance measures from financial, internal process, learning and growth, and customer/partner.

One of the keys to developing a fully integrated RBS is to have a vision and mission that has been accepted by all and that state what the plant or the company wants to achieve. From the vision and mission, the strategies are set up to support the goals set for achieving the mission.

The RBS was set up to link the four areas shown in Figure 2. The reliability and maintenance (R&M) measures illustrated are just an example of how process and results measures can be used to integrate internal process and learning and growth (leading indicators) to drive improvements in financial and customer/partner (lagging indicators) per-

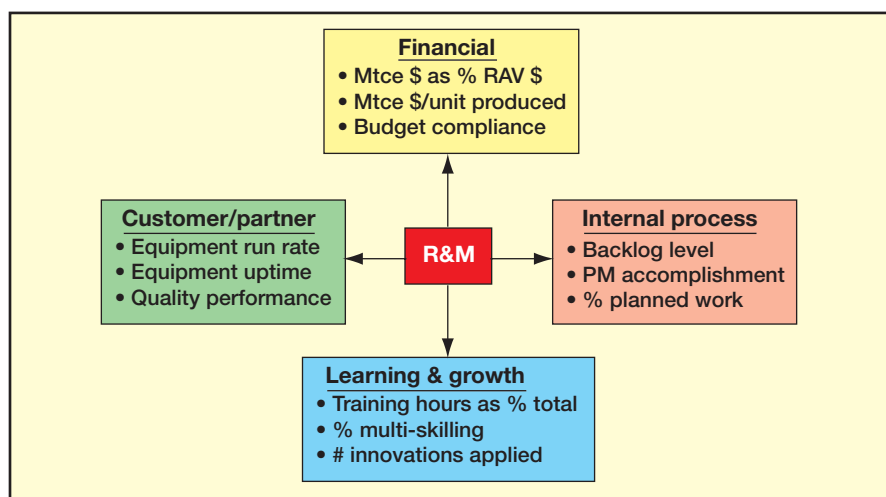


Figure 2 The balanced scorecard

formance measures. Training needs to be included in improving both operations and maintenance support and coordination of planning and scheduling. Through R&M scorecard improvement in the percentage of planned work, the money spent on maintenance can be reduced and therefore the financial measure of maintenance dollars per unit produced (Mtce \$/unit produced) can improve.

As PM accomplishment improves, then costs go down and the reliability improves. This is reflected on the customer/partner measures of equipment run rate and uptime, and in addition quality performance improves.

One of the keys to establishing the RBS within a company or plant is to develop the linkages between a practice such as planning and scheduling with both the process indicators and process results. Process indicators show where change is taking place and where you are in relation to goals. The process results indicate where you are in terms of results but not in terms of the process that drives the results. Through the practice of planning and scheduling a macro indicator, such as maintenance cost per unit of measure, can be linked (Figure 3).

The RBS touches all levels of the organisation. It has been used to facilitate budgeting into the strategic planning and execution process. It can be

used to improve compensation as the linkage between practice and financial results are very easily tracked. One of the best aspects of the RBS is that it brings senior management and the lowest organisational unit into alignment.

**Focused empowerment**

The second pillar of TPR is focused empowerment. This pillar brings all personnel into a reliability-empowered mode. The first aspect considered in building reliability empowerment is the company or plant culture. Culture defines the rules, both formal and informal, that define behaviour. As such, the culture also is a foundation of the vision that will be developed.

Vision must be embraced by all within the organisation and become a part of each vision. If the vision is a set of nebulous concepts developed by the leader, then it is only a dream and cannot be a true vision.

The mission developed to support the vision provides what the plant or company will work on to achieve the vision. In support of the mission, a set of strategies are developed that will enable the company or plant to achieve the mission. Developing reliability empowerment within plants will require an understanding of how the current organisation operates from leadership to what is supported. In addition, individual and group roles and responsibilities

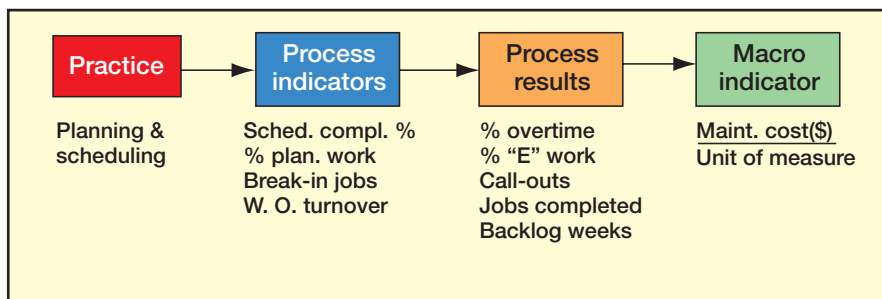


Figure 3 Performance measurement flow path

must be defined. Then a full understanding of the level of expectations, including goals, needs to be documented. The final area of definition is how accountability is treated. Once these have been established for the current organisation, a change to focused empowerment can begin.

To achieve TPR, one of the key empowerment elements is a transition to operator-driven reliability (ODR). Several steps are necessary to achieve ODR. First, the types and amount of maintenance work that will be transferred to operations must be defined. Then operators must be trained and achieve a working knowledge of the priority system, work identification, and the work order system. Mechanical awareness and root cause failure analyses are additional training requirements.

Then, a clear definition of the revised roles and responsibilities for both operations and maintenance needs to be developed. Only when the workforce thoroughly understands their individual roles and responsibilities, including performance expectations, can reliability empowerment be achieved in full. ODR is very important in building an institutionalised operator ownership culture.

In the process of moving to ODR, operations and maintenance become an integral team. Through teamwork, equipment clearing and coordination are improved. This provides a high pay-off because operations-maintenance coordination is the second leading cause of breaks in the work process. Lack of planning is the biggest cause.

### Asset management

As one of the pillars of TPR, asset management improves focuses on the basics of effective use of resources. This includes establishing a reliable work order process that encompasses the initiation of properly defined work requirements from operations (focused empowerment) to the concepts of planning, scheduling, and backlog management. Throughout the work order process a computerised maintenance management software system provides the tool to support the improvements in the work order process.

There are several assumptions that form basis for the need of effective planning. These assumptions are listed as follows:

—A planned job has a better chance of being performed effectively than an unplanned job

—Planned work is easier to do than unplanned or emergency work

—Any job that is not a true emergency should be planned – to some extent.

These assumptions have been proven valid time after time. For example, a

planned job provides the opportunity to define what technically needs to be done and all or most of the resources necessary to do the job. Thus, when the work is performed, maintenance will have the technical guidance to do the job correctly and have the right resources available to get the job done.

Planned work has less variability and fewer unknowns than emergency work. The job has already been scoped so completing the job will be easier. Unless work is a true emergency, some level of planning will make the job easier to accomplish and performed more effectively.

There are also some misconceptions about planning that need to be set aside. These misconceptions include:

—All jobs must be planned down to the smallest detail

—No job will be done unless it is planned

—A supervisor cannot deviate from the job plan.

All of these misconceptions have been used to avoid planning. If management or technicians take the approach that plans must be detailed down to the minutest detail, then there will be a bias against doing effective planning. The other misconception is that all jobs must be planned. Certainly, there are emergencies that must be immediately addressed without planning.

The final misconception is that supervisors are precluded from adjusting plans. When the job begins, the reliability empowered technicians or supervisors can certainly adjust a plan if restoration to full operability and reliability depends on a different approach. Each of these misconceptions must be overcome in order to eliminate the bias against an effective planning process.

There are several impacts on the employees when planning is not a key tactic. Employee morale will be down and they will lose respect for management. Low job satisfaction will contribute to the lower morale. Through little or no planning, variability becomes the norm in daily operations. This variability contributes to many of the negative impacts discussed – low morale, poor job satisfaction, and lack of respect for management. From a reliability perspective, lack of planning contributes to inadequate and “BandAid” repairs.

The essence of planning is to determine the scope of the job and identify the resources that are necessary. Jobs that require detailed planning include the following: expensive repairs, large repairs, new repairs, critical equipment repairs and repair by new or inexperienced technicians. Estimating resources for a job is influenced by many factors. For example, the size and age of the

facility impacts on the amount of resources needed. In addition, weather and physical constraints impact the amount of resources and time necessary to effect the repair. Of interest, if the maintenance work force is divided into several crafts, a multiplier is added to effective planning.

Once plans are accomplished, then effective backlog management is possible. Backlog is essentially the management of the input and output of the work requirements. Much like a surge tank, backlog management keeps the work input and output in balance. Unless effective planning is included in the work input, then the “real” backlog is not known. Backlog can be measured in several different ways. It can be measured by number of work orders, by hours per craft, by crew weeks, and/or by full time equivalents. If it is measured in work orders only, that provides a very limited knowledge of the true backlog.

In addition to acting as the surge tank to keep work output and input in balance, backlogs can be used to help make staffing decisions, shift work force within the plant, estimating annual budgets or analysing performance levels of planners, schedulers and supervisors.

Over the long term, inputs should equal outputs. The output side of the backlog surge tank is scheduling. Scheduling fundamentally answers the question, “When are we going to do the work?” Proper scheduling considers such factors as the work order priority and availability of people, parts, material, outside contractors, and equipment.

The most essential aspect of effective scheduling is the communication between maintenance and production. Maintenance cannot schedule in isolation. If production is not an active member of the scheduling team, then many of the benefits of effective scheduling can be lost.

Maintenance and operations should have weekly and daily scheduling meetings. The weekly meeting should include a review of schedule effectiveness of the previous week. Successes should be highlighted and problems with tentative solutions should be developed. In addition, major jobs for the next week and coordination of special equipment and ancillary staff should be reviewed.

The daily scheduling meeting’s goal is to ensure that maintenance and operations have a mutual understanding and support of the schedule, and commitment to helping the schedule get completed. All work orders scheduled for completion should be reviewed to ensure resources are available to support the schedule, operations commitment to release the equipment and

accomplish necessary lock out/tag out and safety requirements. Any problems should be highlighted and resolved. Some of the performance measures that can be tracked for the planning and scheduling practice include:

- Planned work
- Scheduled compliance
- Overtime
- Work order turnover
- Emergencies
- Call outs
- Work order late closure.

When these measures are integrated into the RBS, both maintenance and operations can track their contribution to improved performance and better financial and customer support results.

### Maintenance prevention

The last pillar of TPR is maintenance prevention. In every plant in the world, there are opportunities to reduce a significant amount of work that should be considered unnecessary. In many cases, this unnecessary work is generated by incorrect operator performance, maintenance rework, or lack of management oversight of PM and predictive maintenance (PdM) programmes.

Under the pillar of focused empowerment, the “incorrect operator performance” problems are overcome. Ownership, operator performed maintenance, and revised roles and responsibilities eliminate almost all failures induced by operators.

Under the pillar of maintenance prevention, implementing an effective PM and PdM programme is the first priority. One of the keys to an effective PM and PdM programme is full management support. The levels of management support needed are sufficient labour resources, money for parts, materials and testing devices, willingness to free up production equipment and corrective action on discovered defects and equipment deterioration.

Without this level of ongoing support, the PM and PdM programmes will not attain the level of failure prevention that is possible to achieve.

One of the other keys to ensuring the PM and PdM programmes are as effective as they should be is to use what is called an “evergreen” approach. This is similar to the review of stock levels on a recurrent basis. Stock levels are reviewed to ensure that changes in demand patterns are reflected in the amount of stock kept on the warehouse shelf. A similar concept should be applied to PM and PdM requirements.

On a recurring basis, all PM and PdM requirements need to be reviewed for how well they have identified future problems and generated work to preclude catastrophic failures. If they have never

identified a problem, then they need to be reviewed for elimination.

The next area under maintenance prevention falls under a “reliability” section. For a plant to fully implement TPR, it needs an organisational element dedicated to reliability. This is the group where you will find a reliability engineer. When we think in terms of reliability, we need to consider what happens if we operated without error 99.9 per cent of the time.

The reliability engineer and the reliability group need to understand many concepts to effectively perform their jobs. First, they need to understand reliability theory from the basics concepts to the sophisticated analytical tools available. Second, they need to understand how the functions of operations, maintenance, engineering, and ancillary elements operate. This understanding will enable them to effectively work within the plant culture and get the reliability improvements accomplished.

The reliability group needs to have good technical skills so they can lead the analysis of failures and consequences. They also need to understand root cause failure analysis, failure modes and effects analysis, and reliability centred maintenance.

Reliability engineers need to always focus on getting to the real solutions for

eliminating failures. Some have said that in excess of 50 per cent of failures can be eliminated from plants. With that level of possibility, the reliability engineers represent a powerful adjunct to the plant staff. It has also been said that the reliability groups using all of the root cause analysis tools take too much time; take away the “gut feel” that has always worked; bring another layer of effort into already full plates; and don’t provide any lasting results.

However, those that bring reliability engineering to their plants have this to say: “For the first time, we did not have any failures on our critical systems last year. No one can remember when that happened before”.

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