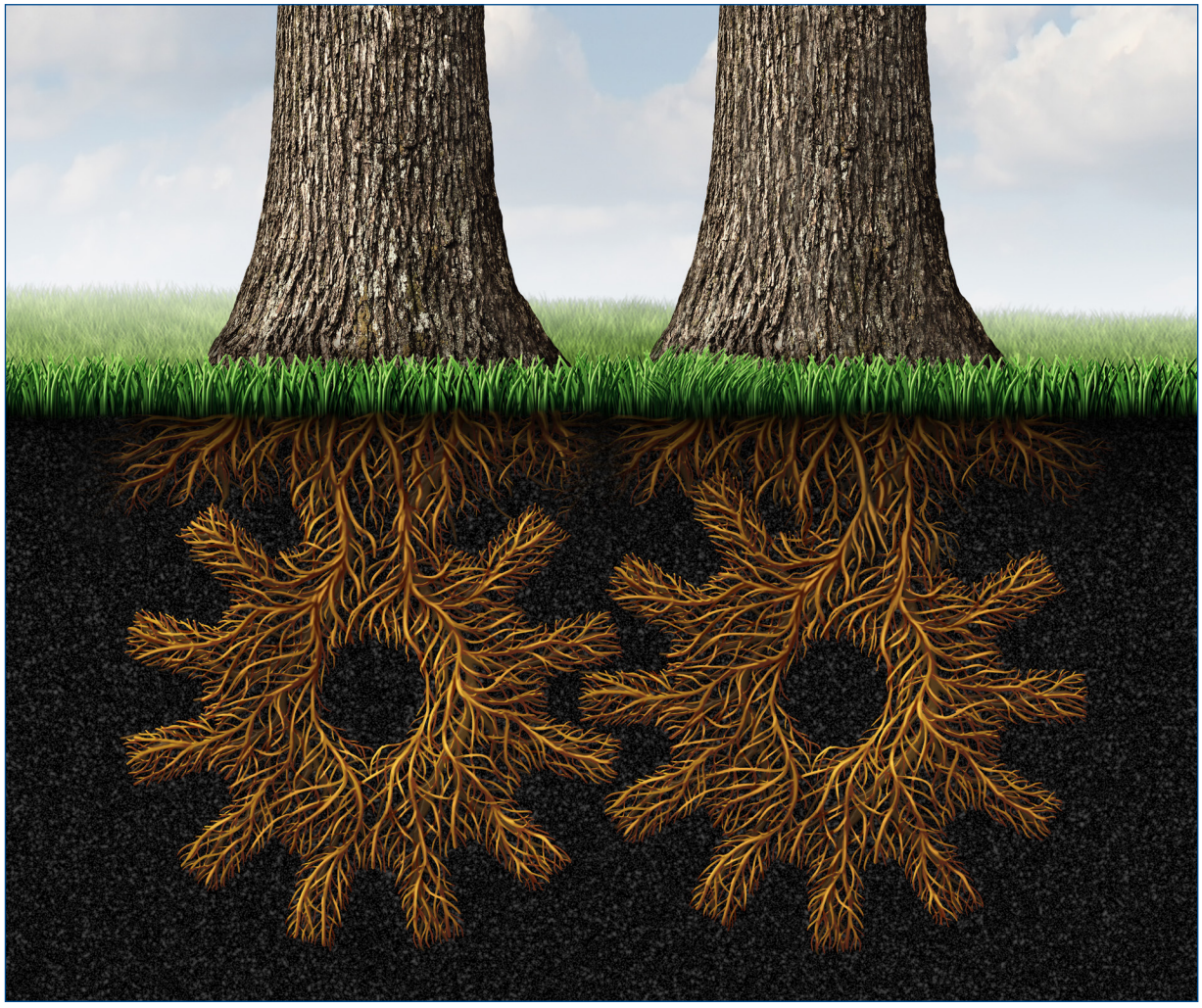
# Top Five Maintenance & Reliability Enablers for Improved Operational Performance

This white paper describes some of the underlying maintenance- and reliability-based enablers that can have a significant impact on operational performance.



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# Introduction

Random House defines “enable” as:

1. to make able; give power, means, competence, or ability to; authorize: This document will enable him to pass through the enemy lines unmolested.

2. to make possible or easy: Aeronautics enables us to overcome great distances.

3. to make ready; equip (often used in combination): Web-enabled cell phones.

## Synonyms

**1. empower, qualify, allow, permit.**

The word “enabler” often has a negative connotation because it is commonly used to describe someone who helps another person travel a destructive path. For example, an enabler might give liquor to an alcoholic or narcotics to a drug addict. However, an enabler is not limited to a negative influence. In fact, an enabler can facilitate positive results. Part of the cure for people on a destructive path is to distance themselves from negative influences, and surround themselves with those who enable positive change. This concept is true in business too. By surrounding yourself, your projects, and your initiatives with positive enablers, you will strengthen your ability to succeed and, in some cases, transform a negative situation into a positive one.

Think back on successful projects or initiatives both in business and your personal life. Consider why they were successful. Think about the key things than enabled these successes, particularly long-term sustained successes. By truly understanding the positive enablers that bolstered success and leveraging that understanding, chances of future success are significantly improved.

Many improvement initiatives put a significant amount of focus on the benefits they can provide, including potential cost savings and improved productivity. Unfortunately, we often don’t spend enough time discussing and identifying the enablers that must be in place to achieve the projected benefits. While understanding the benefits is important, there are two additional parts to any business case: the upfront cost or investment and the level of management fortitude required to achieve the goal. I believe that management fortitude is primarily measured by how the enablers for success are addressed. If considerable effort and focus is applied to the enablers, an initiative is likely to be successful and sustainable. If the enablers are left to chance, then failure will likely be the result.

**The bottom line is that taking the time to understand, establish, and surround yourself with a foundation of positive enablers is key to success.**

This paper will discuss some of the underlying maintenance- and reliability-based enablers that can have a significant impact on operational performance. For each enabler, I will cover the following points:

- Characteristics - Key characteristics of the enabler
- Impact - How the enabler impacts operational performance and why it is important
- What To Do - What “to do” and “not to do” when establishing the enabler

I have chosen these because they are some of the most basic and most impactful enablers. By focusing on these key areas, readers can help improve their success rates. This paper provides a wide range of ideas and food for thought and will be particularly helpful for corporate and plant leaders who are trying to generate major change within their organizations.

## 1. Enabler - Catastrophic Failure Elimination Focus

*Characteristics:*

- Extensive emphasis on understanding asset health
- Organizational focus on turning data into actionable information

*Impact:*

Elimination of "catastrophic" events through the identification of failures very early in the failure cycle gives the organization a stable operating platform. Production and maintenance plans and schedules can be set with a reasonable expectation of achieving them. Reducing the frequency and severity of failures helps control costs, which frees up money for other investments.

> Example: Early identification of increasing vibration levels provides time to lubricate the bearing and eliminate the vibration instead of letting the bearing fail, which would damage other components and result in expensive repairs and lost production time.

Eliminate surprises and focus on executing the plan.

*What to Do:*

- Condition Monitoring – Extensive use of predictive maintenance technologies, including vibration analysis, infrared, motor circuit analysis, ultrasonics, laser alignment, etc. These technologies should be your primary work identification methodology and be used extensively on your asset base, not just on highly critical equipment.
- Quantifiable PMs – Engineered preventive maintenance procedures that measure the condition of the asset quantifiably. For example: belt tension, chain wear, differential pressure, etc. Track and integrate trends into the PMs with your predictive program.
- Asset Health Matrix – Red/Yellow/Green asset scorecards that consolidate condition monitoring and PM results into an actionable and usable visual report. This report should be continuously updated to ensure data is kept current. Even better, utilize software that automatically pulls data from multiple sources into a consolidated database.
- Act on the Information Immediately – Any indication of potential failure derived from one of the activities above should be addressed early before it becomes a problem. Don't delay; start submitting work orders and scheduling corrective work immediately before a failure happens.

## 2. Enabler - Minimize All Shutdowns

*Characteristics*

- Shutdown occurrence, frequency, and duration are based on the early identification of work through CBM, PdM, and Quantifiable PM and are not preset to a regular duration or period. Any shutdown time is managed very tightly to reduce downtown. Every hour of avoided shutdown is an additional hour of production.
- All down time is treated as controllable. This includes scheduled and unscheduled downtime. Planning and scheduling a shutdown does not make it uncontrollable down time.
- Calendar-based repairs and overhauls are not the norm because equipment just doesn't fail on a predetermined schedule. Therefore, calendar-based tasks to mitigate failure don't really provide value and usually cost more money than they are worth.

*Impact*

- Depending on the industry and the mindset of management, shutdowns can eat up 1% to 5% of the available production time and in some extreme cases up to 10%. This is nonproductive time that can't be recovered.
- Unnecessary repairs and parts replacement causes infant mortality in equipment due to improper repair, improper use of parts,

improper start up, etc. Significant run-in problems often occur after a shutdown. Eliminate the shut downs, and eliminate many problems.

*What to Do:*

- RCM/FMEA – Conduct an RCM or FMEA analysis on all of your assets and act on the results. Reliability Centered Maintenance (RCM) and Failure Modes & Effects Analysis (FMEA) are methods that examine asset functions and how those functions might breakdown. This information is often taken for granted as companies tend to follow the easier path of performing time-based maintenance strategy. The problem with the time-based method is that it is a reaction to past problems and not based on current information. Being reactive rather than proactive is not a good way to do business.
- PdM Education – Make sure your organization has a complete and detailed understanding of how to properly utilize predictive technologies. Most organizations take it for granted that the people responsible for making maintenance decisions really understand how to use available technologies, and more importantly, what those technologies have the potential to do. Ensure your organization has the right knowledge to make the good decisions by providing detailed regular education on PdM technologies. Include some practical hands-on exposure to the technologies and cover considerations for proper management of the technologies. A high level of understanding will help ensure that technologies are properly used, ensuring early warnings and preventing failures.
- Before you employ a maintenance strategy that requires you to shut down equipment, consider other options. Include others in the discussion to come up with a better solution. Protect your running time at all costs. With the technology available today, there should be far less necessary time-based replacement and fewer shutdowns.
- Work Management Process Design and Implementation – When a shutdown is unavoidable, the work must be completed accurately and quickly, and it must be done right the first time. The best PdM Program in the world won't matter if corrective actions can't be done in a timely manner. An efficient work management process will ensure work is completed quickly and accurately. Document work processes, train the organization on the processes, and integrate the processes into the requirements for your CMMS.
- A good work management process will include the following sub processes:
  - Work Identification
  - Work Requesting
  - Work Review & Approval
  - Work Planning
  - Work Scheduling
  - Work Assignment
  - Work Completion
  - Work Documentation
  - PdM Follow Up
  - Materials Issuing
  - Materials Kitting
  - Materials Returns
  - Quality Check Process
  - Management Of Change (MOC)
- Make these processes the center of your reliability effort, and you will find that you will have control of your assets, your time, and your money.
- Planner Training – The planner is core to the work management process. This role can have a tremendous impact on your maintenance organization. The planner should be one of the most experienced employees, preferably with some hands-on craft experience and someone who carries the respect of the organization. A good planner can triple the productivity of a craftsman by reducing lost time activities such as trips to the storeroom, hunting for parts, finding information on the equipment, etc.

## 3. Enabler - Aggressive Failure Elimination to Minimize "Recurring Failures"

*Characteristics*

- Creating a culture that believes all failures are unacceptable will enable a high-performing business culture to thrive. The relentless tracking, identification, and addressing of what may appear to be small, repetitive failures will often pay significant benefits as the combined impact of repetitive failures is often greater than a catastrophic failure.
- Functional Failure - An organization that defines failure as "functional failure" will have a greater impact on improving its performance. Many organizations recognize failure as the point at which a piece of equipment doesn't work anymore. Organizations that recognize failure as the point at which the asset no longer performs its intended function or at its intended level will always perform better because such organizations address problems as soon as they have an impact on the function of the assets.
- Analysis Mindset – An organization that provides extensive training and deployment of a wide range of tools and methodologies to enable employees to accurately determine the root cause of problems. People in the organization are held responsible for using the tools and documenting findings and corrective actions. All groups in the organization participate in failure analyses on a regular basis and are familiar with the tools and how to use them.

*Impact*

- Failure elimination helps ensure that the business is operating on a stable platform. A stable platform allows for flexibility in operations, product sequencing, and increased production rates. It also enables an operation to execute on practices such as Six Sigma and Lean Manufacturing.
- Over time an organization that focuses on failure elimination will find that it is dealing with smaller problems that initially didn't even make it onto the radar screen because major problems were always getting in the way. This will lead to fewer stops and slow downs, fewer repetitive failures, and a more reliable process.

*What to Do*

- RCFA Training & Analysis – Set an expectation that problem solving should be based on sound analysis and validation techniques, and train all functions in the organization in Root Cause Analysis techniques.
- Don't select a single methodology because different problems require different tools. Set an expectation that the proper tools are to be used on all types of problems, not just big equipment issues. The same techniques can be used to solve Human Resources problems. Train all levels of the organization to use analysis methodologies appropriate for the roles they play. This training should include the shop-floor personnel.
- Execute the solutions. Quite often an analysis is performed, but the execution falls flat. Execution is the important part.
- Ensure your process has a rigorous validating step to confirm that the problem was resolved and not just hidden. Whenever a solution is put in place, there should be a corresponding validation step defined.
- Living Maintenance Strategy – Make sure you have a continuous improvement process in place for your maintenance strategy. There should be a regular review of the maintenance tasks including PdM, PM, and condition-based and operation-based tasks. This review should be done, at minimum, annually. The review should encompass the following:
  - Review all tasks and frequencies for an asset
  - Review all failures – severity, frequency, business impact, and timing with the maintenance tasks for the asset
  - Determine what the failure modes are for the failures that have occurred
  - Determine what changes have to be made to the maintenance strategy to eliminate the impact of the failure mode occurring again
  - Add, modify, or delete tasks to reduce the impact of failure to the business
- Bad Actors List – Maintain a running Top 10 List of the assets that have the biggest negative impact on the business. There may be

a number of lists sorted by:
- Maintenance cost
- Down time cost
- Production loss value
- Safety risk

Of course it's not just about maintaining the list; there should be a detailed strategy and plan to address each asset on the list with the goal of getting it off the list. Here again, this will drive the focus to smaller and smaller problems.

- Failure Data Analysis – All of the activities above require accurate and complete data, so one of the first things to do in this area is make sure that processes, systems, and tools will generate the data necessary to identify issues, determine the impact of the issues, and make sound decisions. Make data collection and recording a primary part of the job. If it isn't recorded in the system, then it didn't happen.
  Religious use of work orders to track the timing and occurrence of work and create accurate and detailed history is an absolute must and should require that:
  - All work is tracked on a work order that is assigned to the correct Equipment or Functional location record
  - All parts are issued or ordered against a work order that is assigned to the correct Equipment of Functional Location record

## 4. Enabler - Eliminate Self-Induced Failures

*Characteristics*

- It takes a long time after a shutdown to get the process back up and running due many starts and stops.
- Operations fights to avoid shutdowns because the process always runs worse when equipment is restarted.
- A repair is revisited within a couple of weeks because something didn't last.
- Maintenance will pick a new component over a rebuilt component because they don't trust the rebuild.
- Brand new parts fail shortly after being installed.

If these sound familiar, you are most likely your own worst enemy because you are creating more problems than you are fixing. These issues are usually caused by things like poor installation practices, poor or nonexistent repair or rebuild procedures, dirty rebuild and storage environments, lack of precision maintenance techniques, lack of repair validation, lack of shutdown, and start-up procedures.

*Impact*

In poor performing organizations, self-induced failures make up as much as 75% of the failures an organization experiences. The impact of these types of failures on an organization includes:

- A process that is highly unreliable and extremely expensive to run.
- Low morale, burned-out employees, and a significant loss of confidence in the maintenance organization.
- Skyrocketing maintenance costs coupled with extreme levels of scheduled and unscheduled down time.

*What to Do*

- Utilize Precision Maintenance Skills – Equipment is typically engineered to precision tolerances. These tolerances require precision maintenance techniques to properly repair, install, and overhaul. How often have we seen things like:
  - Bearings being hammered on to a shaft
  - Alignment being done with a straight edge
  - Belts being tensioned by feel as opposed to a tolerance
  - Excessive pipe strain when a crow bar is used to line up a pump because there are no jack bolts on the pump base

These are just a few examples, but the point is that archaic techniques are often used for precision equipment. Precision maintenance covers a wide range of topics, but some specific examples include:

- Precision balancing using vibration analysis tools
- Laser alignment for shafts and belts
- Elimination of pipe strain
- Clean room bearing installation with proper bearing installation techniques
- Installing jack bolts on all bases

- Reduction of Overhaul Maintenance – Many organizations think that by overhauling their equipment on a regular basis they are bringing their equipment to "as new" condition. The problem with an overhaul strategy is that ripping a piece of equipment apart to replace parts creates many opportunities to induce failure. Replacing parts with the wrong parts, improperly installing parts, introducing contamination, installing a faulty part, and improper assembly are all ways to introduce failure where none exists.

A better approach and a way to eliminate induced failures is to establish a robust monitoring process utilizing Predictive Maintenance techniques, conducting inspections that measure the condition of the asset, and only making repairs when needed.

- Improved Repair and Rebuild Procedures – This is an often overlooked area of opportunity. Equipment such as motors, pumps, and gearboxes are common rebuild items. We often rely on the experience of the person assigned to rebuild the equipment to determine how to do the work. This is the case for internal and external rebuilds. Do you know the standards of repair your motor rebuilds shop uses? It's quite possible that they don't have any. Some examples of things to include in your procedures are:
  - Contamination control - Set the standard that rebuilds will only be done in a clean area because if gear boxes and pumps are opened in the relatively dirty environment, there's a good chance of inducing failure through contamination
  - Bearing installation methods
  - Brand of bearings to use
  - Type and brand of grease and oil to use
  - Alignment tolerances
  - Vibration tolerances
  - Clearance tolerances

- Repair Validation and Acceptance Testing – Utilizing condition monitoring and PdM technology to validate that a repair has been done properly will help ensure that the equipment will run for a long time. This also requires that acceptance standards for each test are well defined to ensure a high-quality, repeatable repair.

For example, if vibration analysis identifies a problem that requires a motor be replaced, the repair process should include an operational test where vibration readings are taken to determine if the new motor was installed properly and to establish a new baseline. This requires that repair validation be incorporated into the overall work management process. If the installation does not meet the defined standards, the repair would be reworked until the standards are met. The same process would apply other technologies such as infrared and ultrasonic testing.

- Proper Storage of Parts – Often critical new and rebuilt parts are stored on site for extended periods of time. The storage condition for these parts is critical to ensuring that we don't induce failure into the parts while in storage.

Cleanliness is the first part of proper storage. If you store parts such as motors, pumps, bearings, and electronics in a dusty open storage area, you are prematurely aging the parts by introducing contamination. If your parts come with a built-in layer of dust and grime, you are not storing them properly. Electronics should be stored in a static-free environment to prevent premature failure. Your storeroom should be enclosed, dry, and dust free no matter what type of business you are running.

Vibration isolation is another major problem. Motors, pumps, and other parts that have rotating bearing elements are often stored in the production areas or in sheds with incredible amounts of inherent vibration. The vibration causes the rolling elements to develop worn areas and flat spots, which often results in a "new" part with a built-in failure that would never meet a vibration analysis validation inspection when it is installed. Basically, at that point, a failed part is being installed. At minimum the storage racks should be isolated from the vibrations, and regular maintenance activities to rotate the shafts should be done.

## 5. Enabler - Data Driven Decision Making

*Characteristics*

An organization that values data for decision making will establish expectations that data gathering, management, and analysis are a required part of everyone's job. If leadership doesn't insist on this, it is highly likely that the rest of the organization won't value information either. An organization that values data will also treat their information as a strategic advantage and will ensure that:

- Software systems are implemented properly.
- Master data is built from the initial implementation of the systems and that an aggressive master data management plan is in place. It is understood that accurate and complete master data is what makes a system work.
- Data development processes are clearly defined and not taken for granted.
- If data is found to be inaccurate, it is corrected, and the process that allowed the inaccurate data to be inserted is corrected to prevent it from happening again.
- There is a requirement to support all decisions with data. The requester must supply the supporting data.

*Impact*

Decisions that are not based on data but on "gut feel" can have catastrophic results and lead to inflated spending and poor problem solving. Data-based decisions help to ensure that money, time, and energy is spent in the appropriate place and that the expected results are actually achieved.

Organizations that focus on managing by data development will be able to measure and track performance in greater detail, which will allow for adjustments to achieve desired results much earlier. Think of a process control chart. If you have the appropriate data for your control charts, you can maintain your process within the appropriate parameters much easier than if you don't have that information and have to wait until the process gets out of control to act.

An example is repair/replace/redesign decisions. If there is a detailed failure history on equipment, solid condition monitoring tracking and detailed operating information can determine if simply replacing a component will correct a problem. Without that information, a guess must be made about the right corrective action, often resulting in just replacing the failed component and ultimately a repeat of the failure.

*What to Do*

- Master Equipment List (MEL) Development – Ensure that you have an accurate, complete, and detailed MEL. This means that assets are properly classified in a standard manner. Complete means that all assets are recorded, and as assets are removed or added, the MEL is immediately updated. Detailed means that all technical data such a class, subclass, manufacturer, model number, and specification attributes are collected and documented in the CMMS. The MEL is the foundation of your maintenance data, and if this is not built correctly, it will be impossible to build accurate work history because reports will not be accurate and data will not be reliable for decision making.

This is one of the most commonly ignored parts of a CMMS or EAM implementation. Too often companies opt to do the minimum up front and instead plan to build the data over time because they view the costs to build a detailed MEL to be too high. Such an approach is a clear sign that an organization does not fully understand the value of their data. Spending hundreds of thousands of dollars on software but not investing appropriately in the master data that is required to make the system function is a big mistake.

- Materials Master – The same concept outlined above for the MEL—accurate, complete, and detailed—also applies to Materials Master Data. This is particularly valuable for quick and accurate location of materials, elimination of duplicates from inventory, accurate tracking of usage, and leveraging purchasing power at an enterprise level.
- Master Data Standards and Management – Detailed definition of static and transactional data elements is critical to developing usable data. The enforcement of these standards and the correction of data that does not meet the standards is also a key

component of sound Master Data management. Examples of elements of data standards are:

- Standard equipment and material classes and subclasses
- Standard equipment and material attributes and domain values
- Standards for OEM parts descriptions
- Defined minimum required data for all data elements
- Standards to write work order to the lowest level asset
- Standards for PM Procedure Descriptions

- Failure Hierarchy – Most CMMS systems have functionality for a class-specific hierarchal failure coding structure, which allows for a class-specific failure coding when closing a work order. A typical structure will be Class àProblem à Cause à Remedy. An example of a failure hierarchy is shown below:

| PROBLEM | CAUSE | REMEDY |
|---|---|---|
| MOTOR BEARING DAMAGE/FAILURE | BEARING WEAR | REPLACE BEARINGS<br>REPLACE MOTOR |
| | MOTOR MISALIGNED | REPLACE BEARINGS / REALIGN<br>REPLACE MOTOR |
| | INSUFFICIENT LUBRICATION | ADD LUBRICANT AND ADJUST LUBRICATION SCHEDULE |
| | EXCESSIVE LUBRICATION | REMOVE LUBRICANT / ADJUST LUBRICATION SCHEDULE |
| | INCORRECT/CONTAMINATED LUBRICANT | REMOVE LUBE, CLEAN, USE CORRECT LUBE |
| MOTOR ARMATURE/STATOR FAILURE | INCORRECT MOTOR | REPLACE WITH CORRECT MOTOR |
| | LOAD EXCEEDED | REDUCE LOAD & REPLACE MOTOR<br>REPLACE WITH MOTOR OF CORRECT RATING |
| | ARMATURE/STATOR DAMAGED OR SEIZED | REPLACE MOTOR |
| | MOTOR INSULATION FAILURE | REPLACE MOTOR |
| MOTOR CIRCUITRY FAILURE | STARTING CIRCUIT FAILURE | REPAIR/REPLACE STARTING CIRCUITRY |
| | FAULTY WIRING | TIGHTEN CONNECTIONS<br>REPLACE WIRING |
| | BLOWN FUSE | REPLACE FUSE |
| | ELECTRONIC COMPONENT FAILURE | REPLACE THE ELECTRONIC COMPONENT |
| MOTOR SHAFT FAILURE | SHAFT WORN | REPAIR SHAFT<br>REPLACE SHAFT<br>REPLACE MOTOR |
| | SHAFT BENT/BROKEN | REPLACE SHAFT<br>REPLACE MOTOR |
| | KEY DAMAGED | REPLACE KEY |
| | KEYWAY DAMAGED | WELD AND RE-GRIND KEYWAY<br>REPLACE MOTOR |
| | MOTOR OVERLOAD | REPLACE MOTOR |

## Summary

The strategies discussed here apply to a wide range of businesses. I believe that if you think about what has had the greatest positive or negative impact on your maintenance, reliability, and operational performance, you will find that the five enablers discussed above—either through their presence or absence—are key to the results you have achieved.

- Catastrophic Failure Elimination Focus
- Minimize All Shutdowns
- Aggressive Failure Elimination to Minimize "Recurring Failures"
- Eliminate Self Induced Failures
- Data Driven Decision Making

I suggest taking stock of your organization in relation to the enablers discussed in this paper and determining if the organization surrounds itself with positive or harmful enablers.

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