ALL-TEST Pro
A Division of BJM Corp

September/October 2004
Maintenancetalk.com

Penrose Lecture Series™: Estimating Time to Failure

Developing Your Motor Diagnostics Program And Selling to Management

This lecture series may be viewed online through www.maintenancetalk.com
Or by downloading the Tristana Reader from www.reliabilityweb.com

Howard W Penrose, Ph.D.
ALL-TEST Pro
A Division of BJM Corp
123 Spencer Plain Rd
Old Saybrook, CT 06475

Contact Phone: 860 399-5937 ext 123
Fax: 860 399-3180
Email: hpenrose@alltestpro.com
Web: www.alltestpro.com

The lecture series represents a continuing educational lecture on Motor Diagnostics started in 2003.

 $50

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 1: Introduction

Howard W Penrose, Ph.D.
ALL-TEST Pro, A Division of BJM Corp

Unfortunately, there has been a number of negative discussions concerning semantics by those who do not understand the true purpose of 'predictive maintenance,' condition based monitoring, reliability centered maintenance and estimating time to failure. Their purpose is to promote negative attacks on successful technologies. It is disappointing that, for strictly commercial reasons, these few try to convince others that technology should be working backwards towards the dark ages of motor testing.

It is the purpose of this lecture series on developing your motor diagnostics program to provide positive materials on the development and success of programs and the potential to improve your bottom line.

I have been involved in system conditions since starting my career in electric motors as an electric motor repairman in the US Navy on board the USS Theodore Roosevelt, CVN-71 (Plank Owner). My family's background (mother's side) in electric motor repair back to 1905 (Great Grandfather and Grandfather with Westinghouse Canada rewinding large hydro-generators), and my father's work with the environment in St. John's, Newfoundland then as Environmental Division Department Head at Argonne National Labs, Illinois followed by his work in estimating volcanic eruptions using chemical analysis (including development of the instrumentation), has driven a deep-rooted passion in developing time to failure estimation techniques for electric motor systems.

My work in motor repair research started in 1992 with research on repairing motors for inverter application, testing and repair methodology, followed by motor management development, starting in 1994, and energy research, starting in 1994. The research continued with industrial energy and reliability program development during my time at the University of Illinois' Energy Resource Center as a Senior Research Engineer and Adjunct Professor of Engineering.

At this point, I was struggling with the systems that were available for motor testing, energized or de-energized. I had negative experiences with motors not starting following surge comparison, and other high voltage testing, in my time in the Navy, as a motor repair specialist and field service specialist, which created awkward situations with customers. There was also something missing in my work with vibration, infrared and insulation to ground testing as I felt that I needed something more to assist in my research. Other than vibration, none of the technologies that I had worked with, nor the technologies that I had reviewed, to date, were able to produce the results that I had been looking for: To provide information that would allow an estimation of time to failure in an electric motor system.

In 1998, I was tasked with developing a program for promoting premium efficient electric motor retrofits for PG&E in California as the recognized motor system support expert for the US Dept of Energy's Motor Challenge Program (Partner). In this funded project, I recommended the development to be in the direction of electric motor energy and condition analysis. The project manager recommended the review of motor circuit analysis as part of the project which was to include other technology reviews such as vibration analysis, infrared analysis, data logging and the use of the US Department of Energy's MotorMaster Plus software. Not having much luck with MCA through this time, I returned to users of the technologies that I was aware of, and determined that they were not as effective as hoped. In particular, the issues included user friendliness, size, price and the amount of training necessary to utilize the systems.

In a twist of fate, the president of BJM Corp and owner of ALL-TEST Pro, contacted me for assistance with a technical support question. I got my hands on an ALL-TEST IV PRO 2000 instrument and in testing found that it met the project criteria for size, price and ease-of-use. Testing in the field and in a motor repair shop provided the necessary information to show that it produced the pass/fail criteria for motor condition that we were looking for. It also showed tremendous potential for estimating time to failure in motor windings, cables and rotors. In order to continue my passion for estimating time to failure in electric motors, I joined ALL-TEST Pro with the understanding that I would be able to continue my work in electric motor system reliability, motor-system management and time to failure estimation.

The work has continued with the BJM Corp, Pruftechnik and Dreisilker Electric Motors, Inc. funded modifications to the US Department of Energy's MotorMaster Plus software program to allow motor circuit analysis and vibration test results to be entered. This allowed the energy and condition analysis and motor management work to continue. The addition of electrical signature analysis increased the ability of the system to perform a complete analysis and data collection (or data logging) for energy and condition analysis of systems. The selection of this system and the following findings finally satisfied the criteria of my career work on developing time to failure estimation capabilities as no other system or technology had succeeded to date. Third party work, comparisons, etc. also confirmed that industry agrees.

Continued work, starting with data collection and test limit analysis, found that MCA has been able to evaluate three phase motors and generators, DC motors, servo equipment, transformers (including transmission and distribution), hybrid vehicle motors and transmissions, wound-rotor and synchronous motors, coils, etc. The work also allowed for instrument users, ALL-TEST Pro research engineers and BJM Submersible Pump personnel to track and trend winding insulation faults and develop a system for estimating time to failure.

This research was absolutely crucial for the development of a successful motor management program. In particular, it's proven capability to detect early winding

degradation that leads to winding faults. This work, research and third party analysis is well-established.

Now that we have established this information, and history, we will begin the discussion of the development of motor management programs.

DEFINITION:

Motor Management: The combination of partnering with vendors and company departments, condition-based-maintenance testing, commissioning, repair standards, spare management, RCM and trending condition in order to reduce motor system related unplanned downtime in such a way that is non-intrusive and provides a significant return on investment.

Tomorrow we will discuss motor system failure and how to manage them.

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 2: Motor Failure Considerations

Howard W Penrose, Ph.D.
ALL-TEST Pro, A Division of BJM Corp

One of the first things that has to be considered when putting together your motor management program is that your motor system will not 'instantaneously' fail. This is a fact supported by consistent research projects on reliability, regardless of any negative commercial suggestions to the contrary. If faults occurred instantaneously, there would be no need for testing, predictive and preventive programs, industrial or reliability engineering, product warranties, assurances that equipment would be able to operate as designed nor would business survive the chaos of systems that failed without warning. In every single case, without fail, there is some condition that leads to a fault.

The good news is that all systems wear out gradually over time. This is viewed in reliability and industrial engineering terms as availability or resistance to failure. As equipment ages, its resistance to failure decreases as does the availability, both of which change as a natural log that consists of time and the mean time between failure (MTBF). This amount never quite reduces to zero until the equipment actually fails.

With all of this in mind, a motor management program can be developed that utilizes motor diagnostics, and other test systems, to evaluate, trend and estimate time to failure.

There are two basic types of motor system failures: Passive and active.

In a passive failure, winding insulation breaks down, winding contamination occurs, rotor fractures or voids and similar faults. As long as the motor is running, these problems may not be obvious until the fault becomes active.

In an active fault, the motor ceases to operate. It may stall or experience a catestrophic failure of some component of the system such that it can no longer perform its job.

The purpose of the conditioned based monitoring portion of your motor management and motor diagnostics program, you will be observing, using instrument measurements, the condition of the equipment. The time to failure estimation begins once degradation is indicated.

The proper implementation of your motor management program will nearly eliminate all unplanned failures, but not all. There will always be problems caused by improper operation, 'lightning strikes,' improper maintenance, sabatoge and other un-plannable problems which may quickly degrade equipment condition. These are not high risk conditions, in most environments, and, as such, should not be given high regard when managing your program. You need to consider just those conditions that you can manage.

In the next lecture, we will begin to review the seven steps to developing a successful program.

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 3: Seven Steps 1

Howard W Penrose, Ph.D.
ALL-TEST Pro, A Division of BJM Corp

The Seven Steps Overview

There are seven basic steps to developing your motor management program. We will cover each of the steps each day:

Step 1: Know Your System
Step 2: Select Stake-Holders
Step 3: Selection of Equipment
Step 4: Training
Step 5: Developing the Program
Step 6: Calculate Return On Investment
Step 7: Promote the Program.

Step 1: Know Your System

1. Do not rely upon perception. It is human nature to associate with what we feel most comfortable with, such as mechanical problems. Or, you may think of the system, such as a critical fan system, while forgetting the fault, such as a winding failure, after time passes.

2. Rely upon examples of problems, including root-cause-analysis reports, both internal or from vendors.

3. Review paperwork, work orders, invoices, repair and supply vendor information for accurate system information.

4. Know the number and types of critical motors in your systems. Basically, what motors will effect production if they fail unexpectedly.

5. Know the total number and types of motors in your plant.

6. Determine the failure modes of the machines and systems in your plant.

7. Determine time for corrective action, repair costs and associated production costs for the critical systems.

8. Review your existing programs for success.

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 4: Seven Steps 2

Howard W Penrose, Ph.D.
ALL-TEST Pro, A Division of BJM Corp

Step 2 – select stake-holders for your system.

In any program, communication is key. Involve all aspects of the company and your motor system vendors in the development of the program. This involves the true generation of a partnership with the interest of your motor systems in mind.

When you involve vendors, and they know that you are testing and commissioning new and repaired motors, the vendor will pay more attention to what is being shipped to you. The reason is simple: Warranty returns and customer complaints cost the vendor more than identifying problems in the beginning, just as they affect your business. By making the vendor aware of your testing and test criteria, they are more likely to correct any problems before their product arrives at your doorstep. In addition, the vendor should also be able to work with you in the development of a root-cause-analysis.

Communicate training requirements and coordinate between departments. Many excellent diagnostic programs have failed due to miscommunication. Work with the group in selecting and reviewing technologies and testing requirements. Part of any successful program includes the ability to communicate between technicians and technologies in order to provide a comprehensive view of the motor system. (note: there is no 'Holy Grail' condition-based monitoring technology, at this time, just CBM systems that are part of the Reliability Professional's toolbox.

Determine manpower requirements and work with the appropriate departments for the skills. You can provide all of the CBM equipment available, but if it is not used, or used effectively, then it is not a successful program.

Set return on investment requirements and success metrics for the program. Some of these metrics may include fault cost avoidance, repair cost reduction, production equipment availability, reduced cost per unit of production and even energy cost improvements.

Communicate and coordinate findings and corrective actions. This is vital in that if no-one is aware of the successes, then a successful program may be perceived as being unsuccessful. The communication should include all partners in the program as well as others within the company in order to promote the program and its use.

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 5: Seven Steps 3

Howard W Penrose, Ph.D.
ALL-TEST Pro, A Division of BJM Corp

Well, I have returned from my four week 'tour' around the country. Lots of great new things discovered and fantastic motor diagnosticians met. From where the industry has been to where I am seeing it now, I am impressed. In the meantime, I am back for a short while, so will get back up to speed with this lecture series.

Step 3 – Selection of Motor Diagnostics equipment

Review instruments from same technology. You will want to set up a table to compare equipment, in particular, your actual needs versus bells and whistles that cost additional resources but provide little to no return.

One of the key things that I have learned over the years, being both engineering, an end user, then on the sales side, and, thank goodness, back on the tech side, is that many will purchase based upon the salesperson's personality. This is actually termed as 'personality selling' in sales training manuals. The problem is that, for the user, once the sale is complete, you must work with what you have purchased.

Another sales tactic is, simply, 'if you do not buy my product, and you make a mistake, I will make sure your boss is aware of who made the decision.' Or, for the repair shops, 'If you do not buy the product that your customer is purchasing, they will go to your competitor.' (note for repair shops: If you perform your repairs to industry standards, including appropriate standard testing, you should be able to pass any legitimate MCA device testing – instead, the consideration should be providing your customer with a test report that the customer can understand, if they are using MCA). This tactic is known as 'fear sales,' commonly also referred to as 'high pressure sales,' in which there are whole libraries and sales training programs developed around it. This style is often used by either weak salesmen or salesmen trying to sell a weak product.

Sales involving a weak product often break down into direct attacks on other products, stating that they are not a legitimate system, also, having to keep pointing to standards, personal attacks, etc. This type of sales approach is not unique, it stems from dying technologies or methodologies and those trying to prevent change. Einstein suffered such attacks from his detractors, as former methods of physics changed based upon his theories, Galileo had the entire Catholic church attack his ideas (Earth was the center of the universe prior to this time), Thomas Edison created the electric chair trying to stop the proliferation of AC induction motors that Nikola Tesla had developed and provided to Westinghouse, and so-on throughout history. The method also involves trying to compare apples to apples by making an orange an apple – in other words, trying to show how the new system compares to the old by using the physics involved with the old

system to disprove the new system instead of looking at the physics of the new system (ie: just like comparing the physics involved in subsonic to supersonic flight. As discovered by Yeager, if you try to fly a supersonic aircraft the same as you flew a subsonic aircraft, you will crash.) A final tactic used is to confuse the issue by continuously changing positions (and this has nothing to do with the upcoming US elections) or by using pseudo-science (in a recent one, a company tried to state that motors are commonly operated at 140% of load). If you run into this one, I would recommend considering rejecting the product as this style usually has the flip-side of, once the product is selected, when a miscall occurs by the technology the problem is blamed on the person using it. By the way, I have actually seen this sales style presented as a 'training class' in which the instructor spends most of his time trying to disprove other methods instead of educating.

My personal favorite is actually quite different: Industry training. I believe that the best approach is to discuss and train the technology so that you, the potential, or existing, user of technology, understand what you are looking at and comparing to. My intention is simple: You need the information to help select the best technology for your application. This has a secondary effect of generating a few angry marketers and salespeople as, the more that you are educated, the less the previously described methods work. Basically, positive feedback, for me, is to see how much others are complaining, attacking or generally trying to misquote me. Basically, this approach requires a sense of humor, a thick skin and passion for what you do.

My recommendation, when selecting a motor diagnostics tool (or for most purchases), is to make a list of perceived needs, then see how each product compares. After any sales presentation, take 1-2 weeks following the last presentation, and review the checklist to see how they compare. This way you avoid ending up with a system that is expensive, underperforms and really does cause trouble (this is advice, not the fear sales style).

Some particular considerations may be:

- Is the equipment hand held or 'portable.' Does it require an extension cord to operate and how long do batteries last between charges or battery replacements.
- What is its weight?
- Is it a data collector?
- Will the results allow for long-term trending? Will associated software provide conclusions or just basic guidance.
- What is the actual cost of the instrumentation? Are there extras that have to be purchased to get the equipment to operate for your needs? Are there annual fees for maintenance? What are the calibration costs?
- How much training is required to operate the system? Does it require dedicated operators?
- What kind of support is available?
- Will it operate in variable load environments, for online? Does it test all of the types of equipment that I wish to test?
- Is data history maintained during upgrades?

- Does it require additional or potentially destructive tests to positively identify faults (is it actually trend-able)?
- Asides from claims, how long does it actually take to collect data and evaluate?

You may wish to obtain a copy of the "Multi-Technology Approach to Motor Diagnostics," which provides an overview of the components that different technologies can evaluate and trend in your motor system:
http://www.alltestpro.com/pdf/multitechnologyapproach.pdf

You can also go to http://www.motordiagnostics.com for additional information that can assist you (one of my personal sites).

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 6: Seven Steps 4

Howard W Penrose, Ph.D.
ALL-TEST Pro, A Division of BJM Corp

Stage 4: Training

Manpower is one of the most significant issues when developing the program for, if you do not have the manpower, all the equipment purchased will not be useful. Within this scope of manpower is one key ingredient that is so important that it deserves its own point. In virtually all instances where there is a failure of a system, program, maintenance, etc., that involves human error, training is the key recommendation. In order to avoid failure of a program, training needs to be considered up-front.

Determine the training levels required for the implementation of the technology at your plant. Ensure that the training includes guidance for the application of the equipment and not just how to operate it. Some instruments require no formal training while others may require up to 4 or 5 days.

Select the personnel who will be working with the equipment as well as including personnel who will be required to support the program. Taking the mystery out of the system will generate additional 'buy-in' from the key people involved.

There are five basic levels of training that can be incorporated:

1. Self-training: Usually used to learn the instrument basic operation. Can be completed through using a user/training manual, books or software. It allows a flexible pace, but makes it difficult to ask questions. Depending on the equipment, it may be the quickest way to implement a program, but you may miss some important opportunities.
2. Off-site training: This involves traveling locally or to the manufacturer's training center. The environment is controlled, other companies are normally in attendance (experience opportunity) and questions can be asked. The focus is normally generic, but concepts and ideas are shared.
3. On-site training: Involves training performed at your location. This is usually focused on your particular application and equipment. It relies upon interaction between co-workers and an outside trainer.
4. In-House training: Performed by trainers within your company.
5. Online training: Performed on the internet or through computer based training (CBT). Some interaction is usually involved via email or real-time through the training program.

When possible, use the associated equipment and software to generate questions for any classes that are attended.

Ensure that you consider that some motor diagnostics equipment requires constant education and training. Annual budgets should allow for this training.

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 6: Seven Steps 5

Howard W Penrose, Ph.D.
ALL-TEST Pro, A Division of BJM Corp

Stage 5: Develop the program.

At this point, you need to start implementing the program. For many, this will be the challenging part.

First, lets assume that we have selected personnel, equipment and have performed the initial training, as outlined in the past steps. Now, we need to consider what exactly we are going to do with this program. For that, we will break it up into digestable pieces including: A commissioning program for new and repaired equipment; A condition-based monitoring program; and, A troubleshooting and root-cause-analysis program.

Commissioning Program

The purpose of a commissioning program is to prevent un-needed downtime and wasted maintenance time by identifying potential problems with new and repaired motors and components prior to installation, or, post-installation and prior to bringing the system back on line. It is important to understand that, just because something is new or has been in a repair shop, it may still be defective. In the next Blog series, we will discuss electric motor repair practices so that this can be understood a little more.

You can expect that approximately 1 percent of new motors and 5 percent of repaired motors will have defects. These percentages will increase or decrease depending on the manufacturer or repair facility. However, you should not see an extremely high failure rate resulting from your program. For instance, a failure rate of 25%, or higher (I have actually been quoted numbers like this resulting from one test method), should indicate that something is severely wrong. If this is occuring across a number of manufacturers and repair facilities, either the test method is incorrect, or it is being incorrectly used (for instance, DO NOT fail motors because of inductive unbalance – see my previous lecture series on ‘Quantum Mechanics and Motor Diagnostics’).

By avoiding issues related to defects, you will decrease your equipment’s ‘infant mortality’ probability and avoid additional downtime, installation/removal costs and possible troubleshooting and finger-pointing time lost (being tied up in a finger-pointing fight takes valuable resources and focus’ attention away from other issues). For instance, lets say that a particular line has an associated operating loss of $10,000 per hour when it is out of commission. It takes 2 hours to remove and 3 hours to install and align a particular electric motor. Excluding any other outage costs, a new motor is purchased and installed, then ‘bumped’ for rotation. Within hours of startup, the new motor

overheats and fails. It takes 3 hours to troubleshoot the system and nothing is found. The motor is determined to be at fault and is replaced: (3 hours install + 3 hours troubleshooting + 2 hours removal) x $10,000 per hour = $80,000 in unnecessary losses.

Condition-Based Monitoring Program

The development of a Condition Based Monitoring (CBM) program will have a significant effect on your production and company's bottom line. However, many companies think that the best approach is to test everything and repair everything that is found defective. These programs do not last very long. It is more important to implement an effective program rather than a global program.

If you are just starting your program, or are implementing a new technology, determine which machines are critical and will cause a major distruption to your plant or critical lines. Place these machines on your scheduled route. My recommendation is that the following schedule is used to start the program (for critical machines):

- ✓ Clean/Dry environment: Quarterly
- ✓ Average environment: 2-3 months
- ✓ Wet/Dirty environment: Monthly

A frequency greater than once per quarter is not really trend-able, but is, instead, condition testing.

Once the program is underway, start using Time to Failure Estimation™ (to be discussed in-depth following the completion of the 'seven steps') techniques in order to determine whether the equipment should be removed or trended more frequently.

Periodically, return to the program and review it for effectiveness. For instance, if no problems have been detected in an area, increase the frequency, gradually. Start adding other equipment to the program that is less critical, but can be an inconvenience if they fail.

Troubleshooting and Root-Cause-Analysis

One of my favorite sayings is "when a motor fails, it is normally acting as a fuse." What I mean by this statement is simply that some outside force is normally the cause of motor failure. That cause may be contamination, power supply, load/mechanical, power quality or some other driver that causes the motor to stop operating as designed.

Motor Diagnostic technologies can assist in the identification of the root cause of the failure. MCA will identify loose connections, insulation breakdown, developing shorts, cable faults, overheating, airgap problems and other insulation and rotor-related faults.

ESA will identify both power supply, electrical and driven/mechanical load problems, if the equipment can be operated.

When a critical piece of equipment fails, it is absolutely critical that the root cause is determined in order to avoid a duplication of the failure. One of my first encounters with a truly interesting problem, that was resolved with MCA, came from a series of small induction motors that were reported as 'single phasing.' However, the motor owner was unable to find any cause for this condition, such as open fuses or bad connections. MCA identified a severe impedance phase unbalance that did not exist in similar motors that did not have the problem. When disassembled, it was determined that the motors were being repaired and connected incorrectly (connections in the windings). The motors were sent to a different repair facility and the problem ceased.

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 8: Seven Steps 6

Howard W Penrose, Ph.D.
ALL-TEST Pro, A Division of BJM Corp

Step 6 – Calculate Return on Investment

One of the common areas that is often overlooked because, we, as maintenance professionals, want to fix the problem and move on is the return on investment for our work. Well, what is the problem with that? The equipment is running and everyone is happy.

Until, it is time to determine the success of the program by management. If you do not have something to show, the program will be ignored, or worse, dismantled.

To calculate the ROI, you will need the following information:

- Past lost time history during failures. This provides a very accurate metric.
- Cost per hour downtime for the associated system. Do not be surprised at how high this value will be.
- The average time to troubleshoot or correct the problems

One key metric that can be used is the reduced cost per unit of production over time. Proper application of a motor diagnostics program will have a significant impact on the bottom line.

Individual analysis of each finding and correction should be calculated. You will also have to remember that you will be reducing the number of problems, not necessarily eliminating them. The ratio of savings to misses can be used to set goals and also remind everyone that continuous improvement is a goal.

Promote and post the savings! Do not be shy… One of the common things found with maintenance and reliability personnel is that we are all proud of our accomplishments and want to solve the next problem. Posting our successes may seem to be ego. However, in reality, this promotion is for the sake of the program, ensuring continuation of the program and, potentially, more resources.

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 9: Seven Steps 7

Howard W Penrose, Ph.D.
ALL-TEST Pro, A Division of BJM Corp

Step 7: Promote, Promote, Promote

It is absolutely essential to promote the program. Bring attention to it and all of the positive results including goal achievement.

In this part of the process, there are four minimum steps:

- ✓ Update Partners: Work with the partners and vendors by keeping them up to date with successes and suggestions. This can be accomplished via email, phone conference or, my preference, direct meetings. Allow each partner to present their view on the success of the program and where it should go from that point.

- ✓ Post Findings: Production will often post their production goals and schedules in a manufacturing plant. Do the same. Post achieved goals, machine availability improvements, cost avoidance, reduced maintenance turnaround times, etc. This is very important as it is the public relations portion of your program. This posting could be on a board or even a small newsletter sent out regularly (My recommendation is that it is sent out at least once per month).

- ✓ Put together case studies of maintenance and reliability successes. Present them both within your company and, if able, publicly in local papers, conferences, etc. This brings attention to your company, your maintenance program and, in many instances, will bring positive attention from senior management. Who does not like to brag about the successes within a company that they are responsible for? You may suddenly find that people within your company actively try to participate in the success of the program. The final step will assure that.

- ✓ Promote Success and Active Participants: It is a fact that most people want to see their name in lights. What better way to increase individual participation by promoting specific individuals, and their affiliation (ie: vendor, etc.), in the case studies.

In all of your messages and promotion of the program, always keep it positive. It only takes one negative to destroy 20 positives. In the following lectures, I will discuss the development of the program more in-depth, including how to sell the program to management.

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 10: Selling the Program to Management 1

Howard W Penrose, Ph.D.
ALL-TEST Pro, A Division of BJM Corp

I would say the single most frustrating part of the development of a grass-roots reliability program is selling the concept to management. The reason for the frustration is that the average maintenance and reliability technician or manager is not trained in marketing or sales. This is a serious issue as management must be 'sold' on the concept.

Understanding and embracing the concept of selling/marketing is complex only in that there is a resistance to the concept by the average person. When we think of selling, what comes to mind? For me it was always picturing the slick, fast talking, high pressure used car salesman, or, the clerk in the store who won't leave you alone to browse. Once, in a store, my wife said that she couldn't stand salespeople, they never leave you alone… Until I reminded her that part of my job was marketing and sales, at which point she said, "No, you're an engineer!"

This gave me a unique opportunity to explain to her that any successful engineer, scientist, consultant, manager, even parent, must be good at marketing and sales. For instance, why is 'Edison' a more well known name, even in the rotating machinery industry, than 'Tesla?' 'Einstein' over Niels Bohr or Richard Feynman? Because Edison and Einstein were good at selling their ideas. Even then, they were not readily accepted, the Theory of Relativity and Special Theory of Relativity, for instance, took nearly a decade to accept. At home, if you have teenagers (you have to trust me on this one, if you don't), you have to sell them on why it is good for them to do their homework, not play video games so much, not watch so much TV, go out and play, etc. etc. (some may have other selling with teenagers or, the toughest crowd, toddlers). We are, all of us, constantly marketing and selling ourselves.

The key, however, to selling a program, is to understand a few marketing and sales rules. Once we have established those, we will discuss how to use them to present and sell the concept of motor diagnostics to management in such a way that the program will be supported and championed. We will cover the first rule today:

Rule Number 1: Patience

As we go through this part of the series, you will see that the concept of selling and marketing a program is not as simple as walking in and telling your boss, or a committee, that this is necessary. It requires patience and work. The reward is the sense of accomplishment when the process is complete. With engineering, it is the same as the feeling you get when you discover something new, with maintenance, it is the feeling

when you solve a problem that no one else was able to fix it… a sense of euphoria. It is the reward that many salespeople get when they close a sale, and it can be addictive!

However, in order to get to there, there is much work to do. You have to lay the groundwork for acceptance of the concepts, be repetitive, present your case, defend your case, listen and close. You must, above all, be passionate about what you are presenting! Believe me, passion for what you do, a basic excitement, will carry you through the process and spreads to those around you.

The reason for patience is that I have seen, and been involved with, selling people on concepts of motor management, motor repair, field service, consulting, energy research, motor system products and support, training, engineering and research projects and, right now, motor diagnostics equipment and concepts. In each case, there are the quick sales where the person I am selling to (prospect) already knows what they want, and there are the projects which may take years to convince the prospect that the product or concept will solve their problems. It has taken a lot of patience and understanding, and the ability to listen to the issues of others while looking for ways to resolve their problems to make life easier.

Have I been successful? You be the judge… I assume that you have been reading the materials that I have been presenting through ReliabilityWeb and, perhaps, other areas, as well. Has it been useful? Have you considered that motor management and motor diagnostics may be a method that is important to what you do? What I have been doing is simply this: Rule Number 2 – Laying the Groundwork. Educating you in the importance of your motor system, testing methods, standards, how things work, opportunites, etc. in order to bring attention to an important area in maintenance and reliability for which I can then present you with a solution to the issues that you face. If I have you thinking about your motor system, then I have been successful. We will cover this more in the next lecture.

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 11: Selling the Program to Management 2

Howard W Penrose, Ph.D.

Step 2: Laying the Groundwork

The most important step when preparing to convince, or sell, others on backing the development of your motor diagnostics (MD) program is to lay the groundwork. This means preparing the way through educating the decision-makers on the reasons why the MD program will be important to the company's bottom line. Much of the time, upper management views maintenance and maintenance programs in the wrong business (accounting) column: expense. The purpose of this step is to convince these managers that this is the wrong column and that maintenance is actually selling capacity, or equipment availability, to the company. This is truly important as, for every minute of equipment downtime; the plant has less capacity, resulting in less product, to sell.

Be prepared, in some corporate environments the concept of a reliability program is readily accepted. In others it is violently opposed within management. The battle for the hearts and minds of the key manager(s) to champion your program can be fairly quick, or it can be a long-term project. How you approach management can be different, depending on the personality. The key to this step is patience as most maintenance and reliability professionals can see the opportunity at ground level; most managers cannot see the opportunity at 30,000 feet. It will be your job to show the ground-level opportunities at the higher altitudes.

The 'I told you so' approach

Never use the term, but the 'I told you so' approach can be very effective. People react well to 'pain,' as a matter of fact; pain is a very effective sales tool. This does not necessarily mean physical pain as much as the mental anguish when things do not go well. In context, it is painful for a production, or plant, manager to explain equipment downtime. It results in a real loss in profitability to a plant, which is one of the reasons why upper management may suddenly appear on the plant floor when critical equipment is out of commission. A good sales tool is to remind people of this type of pain, then to show a solution that will prevent the pain in the future. For instance, in the MD test equipment industry, a common type of sale is when you have discussed, on and off, equipment technology with someone for a while. The discussion concerns how to put the equipment into next year's budget. One day the call comes in to see if the equipment can be overnighted. I often ask: "What equipment is down?" And, it will turn out that a critical line has been out of commission for several days.

The I told you so approach works like this:

1. Find recent cases of potentially avoidable electric motor downtime. If you know the actual root-cause or fault, following the repair, and the time it took for the complete maintenance cycle (troubleshooting, swapping parts, if it could have been a minor fault before a major one, could it have been repaired or replaced during a scheduled outage, etc.), you have the tools necessary to perform this approach.
2. Put together a single page, single or 1.5 spaced, 12 point, case study, with a picture, if possible, describing the event and findings. Save a short part, labeled 'conclusion,' at the end stating that if you had the opportunity to use MD equipment, the lost production time (state the time) could have been avoided, or the troubleshooting time could have been reduced significantly.
3. Make sure you state the production time lost and, if you know the associated downtime costs, place that value there, as well. Then show the cost, or hour reduction, if you had the equipment you required (there are quite a few case studies on reliabilityweb.com that can help you with this, also on motordiagnostics.com). You can use this value to show the simple payback of the MD equipment. For instance, if you had a 12-hour unscheduled outage of a line that was worth $10,000 per hour, and 6 hours were involved in troubleshooting, then you have the values of: $120,000 in downtime; $60,000 of which was troubleshooting; If found as part of an MD program, prior to failure, the complete avoidance of $120,000 would have been possible; If used for troubleshooting, 30 minutes, or $5,000 in troubleshooting time vs. $60,000 or an avoidance of $55,000. Even in the worst-case scenario, this would have paid for most systems. It is important, at this step, to realize something very interesting: The values that you will see will be very high. Do not be surprised or nervous as it is expected that the values will be high. When performing $ avoidance, I am always amazed at how much potential is lost or wasted through companies avoiding the application of new technologies.
4. USE SPELL CHECK!!! There is nothing worse than to have someone hung up on a mis-spelled word instead of reading and understanding the document.
5. Circulate the document to the appropriate decision makers, ensuring that you have support of your immediate manager (or you are the manager). And, remember the following sales rule: It takes nine times for someone to recognize a statement or information; one of three written statements will be viewed or observed; therefore, it may take up to 27 sets of case studies to get movement within a facility by managers that do not recognize the need for an MD program. Also, you may first be told that it is an isolated incident, by showing multiple case studies you will be showing that it is not that isolated.
6. Whenever possible, produce these documents as close to the time of their occurrence as possible. There will be a greater impact that way.

Do not be concerned that you might receive a good deal of attention, at first, and then the attention seems to disappear. The rule statement in step 5 is an important piece of psychology. Each time you get and lose the attention of the key manager, or potential MD champion, a part of the solution is absorbed amongst the thousands of other items

that the manager has to consider in the operation of the plant. By repeatedly showing a solution to one of the many problems, and pains, affecting the manager, you will get a decision, usually for the best.

It is important to follow-up once the MD program is put in place (a later step on how to close) by using history to show the difference in time between the way it was done before and the way it is accomplished after the program started. What is found, in a great many instances, is that the return on investment potential used in the case studies was very conservative.

In the next presentation, we will go through how to set up a convincing presentation if you have the opportunity to present to an audience, as part of laying the groundwork.

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 12: Selling the Program to Management 3

Howard W Penrose, Ph.D.

Step 2 Continued: Putting Together a Successful Presentation

Another key to the success of selling management on your motor diagnostics and management program is putting together a successful presentation. Some points to be considered are:

- ✓ Someone with public speaking experience, or someone who enjoys talking about what they do.
- ✓ Use the case studies that you have been using from the last lecture.
- ✓ Use a presentation program such as PowerPoint® and use a computer projector, whenever possible. This gives the air of professionalism.
- ✓ Keep the slides simple, with a few points and as many pictures and graphs as possible. A slide presentation is not meant to be a script for the presenter, but a visual representation of what the presenter is stating.

On the presentation itself:

- ✓ Keep eye contact with your audience. Do not turn your back on them, it takes away from the power of your message.
- ✓ Try to avoid ‘um’s and ‘ah’s during your speaking.
- ✓ Do not read from the slides. If you need to, keeps notes on your presentation, doublespaced, and 12 point or 14 point type, or printed if you are writing.
- ✓ Keep a glass of water nearby. ‘Cotton-mouth,’ otherwise known as dry-mouth, is not uncommon when you do not have a lot of presentation experience. Also, if nervous, a pause to take a drink (occasionally) will give you a second to gather your thoughts. If you do not have experience in presenting, do not drink coffee or soda, they will not help.
- ✓ Ask questions of your audience to get them to be part of the presentation – this is termed as transference. It gets the audience involved, which is a powerful presentation and training tool.
- ✓ Keep all points to seven points, or less. There is an adult learning principle that states that the average person cannot absorb any more than seven points in a subject.
- ✓ Keep the presentation short but informative.
- ✓ Pass out a copy of the presentation. If using PowerPoint®, I highly recommend using the three slides per page setting so that there are lines next to each slide that the audience can keep notes on.
- ✓ If you have power over how the room is to be set up, put it in classroom style:

  - Classroom style gives you the 'teacher' position, which is an authorative position and gives your presentation more power. It is important to have table tops for the audience to use for writing notes.
  - Conference style puts you in a defensive position, which will draw more questions and those will be a little more aggressive. If you are good at 'argument' (as opposed to arguing), then this style may be the best for you.
  - Banquet style puts you in an entertainment position, which is not conducive to your presentation, initially. This situation is best when you are presenting success, such as in an awards banquet or discussing the success of your program.
  - Auditorium style is the same as classroom style.
- ✓ Have a pen and small pad of paper placed at each position. Put them in the front rows to force the attendees to sit up front first.
- ✓ If you have not presented before, it is not unusual to feel panicked right at the beginning of the presentation. I used to feel the urge to run out of the nearest door. After a while (actually about a year of constant presenting), I finally was comfortable in front of any crowd. My recommendation, let the fear in, take a deep breath and count to three (under your breath), then forget about it. Once you start talking, you will find that, in almost every case, your audience will be friendly. In the rare case when one or more people in the audience are not friendly, you will usually find that the rest of the group sides with you and turns on them.
- ✓ If possible, have a pre-set group of questions set up and at least one person in your audience (if ten or more) to ask them. This will prompt others to ask questions. If a smaller group, bring the questions up yourself, then answer them until the audience begins asking questions.
- ✓ Do not be surprised if the audience is very quiet and expressionless. This means that they are absorbing the information. If you get nods, that is even better because you are reaching those people. If they are nodding off, then get things more exciting.
- ✓ Stand relaxed, use hand motions, direct the audience's eyes where you want them by pointing with your hand (worst case), laser pointer, pointer or a pen. You have control of your audience, no matter who they are. Show confidence in your material.

These are important points in setting the environment. In our next lecture, I will instruct you on several successful outlines for your presentation.

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 13: Selling the Program to Management 4

Howard W Penrose, Ph.D.

Step 2 Continued: The Presentation

The initial presentation, itself, should be outlined as follows:

1. Introduction: First slide. Title accordingly, introduce members of your team.
2. Vision Statement: Should outline the objective for the motor diagnostics team. Include long-term objectives such as reducing overall cost per unit of production and reducing maintenance related costs. One slide.
3. Goals and Objectives: What are the short term and long term goals for the program? List easily achievable to more difficult goals. Some may be such things as reducing energy costs by 10%, Reducing unplanned downtime by some percent, etc.
4. Summarize today's situation: As many slides are needed. Use graphs to show associated excessive operating and maintenance costs using the present strategy. Project out to about five years.
5. Discuss how the company arrived at this point. Such things as limited technology, lack of root cause analysis, etc. Discuss original assumptions, such as technology not being available.
6. What are the available options. State alternative strategies such as motor diagnostics, keeping things the way they are, etc. List advantages and disadvantages of each strategy and the costs associated with each option. For instance, list the application cost of the motor diagnostics equipment and the potential cost reduction and list the cost of keeping things the way they are by showing the projected continued losses.
7. Make your recommendations based upon the options. Summarize the results if things go as proposed. State what needs to be done next and identify action items. With the action items, state timelines and who is responsible for each! Use at least one benchmark – success story – from another company in a similar business and the associated costs.
8. On one slide: State that the company cannot afford not to immediately act!

Make sure to use cost figures associated with the actual costs of your facility. Use the case studies that you have put together and ensure that there are images within the presentation.

At this point, you must be ready to defend your case for the motor diagnostics program. How well you have presented the case, and the type of management within your organization, will affect the acceptance and requirements of this step.

In the next part of the lecture, we will discuss how to close management on the concept of motor management.

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 14: Selling the Program to Management 5

Howard W Penrose, Ph.D.

Step 3: Closing Management

"There are no secrets to success. It is the result of preparation, hard work, learning from failure." -General Colin L. Powell

"The heights by great men reached and kept
Were not attained by sudden flight,
But they, while their companions slept
Were toiling upward in the night." -Henry Wadsworth Longfellow

The final step in selling management is, of course, 'Closing the sale.' This is, of course, the most important step before being able to truly start the program. It is not the final step in the sales process, contrary to popular opinion.

There are volumes of books discussing this phase of the sales process written for sales professionals. The primary reason is that many salespeople like to pat themselves on the back and feel that they have found the formula for selling. Personally, my feeling is that, just as there is no 'Holy Grail' of predictive or reliability maintenance, there is no 'magic formula' for selling a program. As a result, I am going to focus on the absolute basic steps common to virtually all sales programs.

There is no 'perfect' time to close management on the program. Following are the steps to ensure the most likely opportunity for success, which will vary depending upon the personality of the manager(s) that you have been communicating with. Also, for most maintenance programs, the best approach, that I have found, is to 'soft sell,' or, get the people you are talking to sell themselves on the program.

1. Ensure that you have been communicating to the proper level. Simply listen. If, during your presentation, you hear that someone else should have been sitting in the presentation, or that someone else should receive the case studies, that person most likely has the power to make the decision, or help make the decision. It is imperative that you get that person involved in the program, or have the managers that you are talking to get that person involved. If the manager(s) state that they have to take the material up to the next level, ask if you can be involved. While they may believe in your program, they have not gone through all the steps in selling the program and may not have the same level for enthusiasm that you do. One of the worst things that a salesman can hear is "I have to take this to [ ]," because it means that they have been talking to the wrong person or group. It is almost the same as hearing, "Don't

call us, we'll call you." However, this is not always the case if the group that you have listened to states that they will have to discuss the topic amongst themselves.

2. The best way to determine if you are at the point of management buying into your program is to do something called the 'trial close.' This is the point where you see if they are ready by asking simple questions and listening to the answer. You may find that you are not ready and that more work is required, or, you will find that they have bought into the program and your enthusiasm. The trial close step is very important as if you have a definite answer, the subject may be closed and, what most do not realize, is that you can pass the time to close, lose all of the work that you have done and have to start over. Not fun. So, during each time that you are in front of the manager(s), ask simple questions such as: "Look at the benefits, why do we not yet have a program?" "What is in the way of starting a motor diagnostics program?" When you feel that management is getting ready to make a decision, it is then time to ask the more straight-forward questions: "Who should we include in the program?" "Should we hire reliability specialists, use our existing personnel or outsource?" and questions of this type. If you get a ready answer, versus an "I am not sure yet," then you are at the point of moving to the next step.

3. 'Closing the Sale' is the final step. The first thing to remember is that there is no guarantee that you will succeed. However, you must show confidence as if you have no doubt! The best salespeople that I have met are those that have a thick skin as, in every business, a salesperson will have more rejection than success. Those that take is personally do not survive long. With that in mind, it is now time to basically ask, "When do we start the program?" The answer you are looking for is simple: "OK, what is the next step?" At this point, you must be prepared to present the next steps.

4. Do not oversell! Once management has determined that they will start on this course, be quiet! Do not bring up negatives! Once you have succeeded, if you are discussing the program with the group, they will start discussing how to approach the program and will appear to be excited. This is a normal reaction and a sign that you have succeeded. Enjoy the discussion even if there are points that you do not agree with and answer the questions that are asked of you with brief answers.

In our next lecture, we will discuss the next steps.

Time to Failure Series Continued

Developing Your Motor Diagnostics Program Part 15: Selling the Program to Management 6

Howard W Penrose, Ph.D.

"Try not to become a man of success, but rather a man of value." Albert Einstein

Step 4: The Next Steps

You have sold yourself into the leadership position and now have the power to move the program forward successfully. This is important to understand as management will consider you the in-house expert on your motor diagnostics program. The reason that, once the program has been sold, you will be asked about the next steps is simple: The decision makers will have made policy, they will be counting on you for the strategy and tactics. Therefore, we will briefly cover key areas that must be considered:

- Personnel: Who will be involved in the program? Determine the expertise that is available in-house and those that would have to be brought in.

- Instrumentation: Has the instrumentation already been purchased? Will it need to be selected? How should it be selected?

- Training: Who and how much training will be required?

- Scope: Which equipment will be included in the program?

- When to Start: Set a timeline for each step.

Set up and have answers for these questions in particular. It would not hurt to have the answers built in to a presentation to show that you have already considered the questions. Expect to have to be flexible, especially in the area of the timeline. Considerations, such as the Motor Diagnostics and Motor Health Study Executive Summary, can be useful:

Go to http://www.motordiagnostics.com for a copy of the MDMH Executive Summary.

This concludes this part of the lecture series. We will be covering Electric Motor Repair in the November series.

