Precision Maintenance … what is it?

Many folks think that PrecMtce is a class and that once they take the class … well that's it, we're doing it, check and done. Well nothing is further from the truth. PrecMtce is only one part of a multi phased process to achieve Reliable Manufacturing[sm]. Some of the other phases to achieve this state can include; Process Excellence, Organizational Excellence and Asset Condition Assessment. Within each of these phases there are many independent directions and key learnings but, let's focus on PrecMtce.

PrecMtce is an approach of how work is identified or determined, planned for an improved state, executed with discipline, precision, control and audited for reliability. It begins with the question; "*What failures do you wish to control?*" The work is not only about the assembly, installation and repair of machinery, but also about how machines that are not failing, and how they can be improved before entering the failure cycle. It carries on after the work is completed. It includes a measurement of how the machine is performing post work to identify what improvements were achieved dynamically. The improvement results are audited over time to identify where the same actions can be applied on other types of machines.

For those of us who are familiar with the works of Nolan, Heap and Moubray (who together, fathered RCM), it is about changing the probability of "infant mortality". Infant mortality can exist in any work, in any process and is responsible for the highest probability of loss of machinery life, early failure and mediocre performance.

So, What Drives "Infant Mortality" …?

The good news is that infant mortality, has a relatively brief list of sources. Short and to the point, consider the following as the most probable in "infant mortality":

- Design
- Assembly
- Installation
- Commissioning
- Operation
- Service

While we should start with "*reliability in design*" and the consideration for "life cycle" performance, let's deal with the assets we have; that are in place and functioning today. Facilities have made this machinery work, to do what is needed (and in some cases, redesigned it as well). Within the maintenance world, the "assembly and installation" of machinery are where we can have an immediate impact. This can alter the performance of machines and manufacturing performance in the most positive sense. **If**, the way that we assemble, and then install all assets is;

- incrementally controlled (with knowledge in experience),
- sequentially applied with discipline to known and proven standards,
- always performed in the most precise manner possible,
- documented to maintain a correct history of exactly what improvements were performed
- and then audited with dynamic condition measurements,

Consequently … we would begin to reduce the problems typically witnessed and associated with equipment "infant mortality".

Now as with the application of any good work, will there be times when production needs demand that we get the machinery up and running before our work is complete? Of course there will be, we have to remember that the purpose of any company is to make money and increase margin and profitability. But getting it going doesn't mean that we forget about the machinery. It just means that at the earliest opportunity we return to the asset and continue the improvement work. In the discovery of what was required to place a machine into a precise state, one must sometimes return three or four times to the machine to get it into that final precise state all between production run periods. OK, so let's remember, we've already *determined* which failures we are going to control. In order to accomplish this a set of guiding principles needs to be created, approved and applied in the determination of what work happen and just how far you go.

What are these "Guiding Principles" …?

The guiding principles in work development and execution are not a long list but should assist everyone to make scientifically based non-emotion decisions. Before we can lay them out though, let's point out that before we do *any* work, we must always perform this work so we:

- work safe in all things,
- exceed environment and government regulations,
- positively enforce production performance,
- reduce the number of unscheduled losses and the cost of maintenance.

Secondly, we should review and determine …

- has the failure happened before?
- is it likely to happen again?

And finally, in the application of these principles we must always ponder "In what I/we are about to do, will it be accomplished:

- in a manner that is sensible and defensible?
- so that the work is technically feasible and worth doing?
- with efficiency and effectiveness?
    - Where "efficiency" is "how fast" we perform this work and "effectiveness" is "how well" the work is done.
        - As a side question, "What do most organizations concentrate on"?

So Where Should Organizations / Companies Begin …?

Core values, what an interesting couple of words. Open the annual report of any company and there will be a couple of interesting statements that define their "*Core Values*". As an example, they sometimes might state something like this:

- We value the importance and need to have a safe work force. Our goal is zero recordables with no loss time accidents. We have a zero tolerance for those who knowingly work unsafe and consistently strive to improve our safety performance.
- We are a responsible and industry leading environmental steward, and as such we not only meet but exceed all government controls and regulations. Where possible we work with government agencies in the promotion of new technologies and the improvement of our carbon and waste footprint.

Fundamentally, companies perform to what they clearly communicate and what they measure. It is always the old adage of; "What gets measured gets done". So when companies clearly say "Work Safe", they mean it. It has been proven over a few decades that an unsafe work force drives to many different types of losses that can't be afforded. The safety records of industry prove that while we still need to improve, we have come a long way from where we are. The same is true and can be proven for environmental responsibility.

In the growth of how we learn in manufacturing, it is beginning to be recognized that another core value has to be included in this valuable communication. The core value of "*reliable performance in manufacturing*" is just as important to the customer deliverable products and bottom line net shareholder value. It just hasn't been driven yet by corporate heads and government agencies and so it is new. As in any "*core value*" it needs to be always applied from "top to shop". Therefore, *sustainable reliability improvement* within manufacturing is everyone's responsibility.

How do You Apply …?

We first of all we have to understand that "Precision Maintenance℠" in its application is defined as a strategy. Like any good strategy, its application and "Best-In-Class" practices must be well planned. Within this strategy, there is a need to develop a "Reliability Road-Map℠". This road map has identified points where other organizations become included in the improvement process. As an example, what good is it to place a machine in a precise state when we do not change the way in which that machine is operated? Hence, there is a defined need to spend time on, "Process Excellence℠", this is the improvement of production asset "reliability" within the machine system operating context. Simplified, this means that one must operate to process requirements while ensuring that the asset is ran "correctly". Once, we have begun to move towards "Process Excellence℠", we can rethink "Asset Condition Monitoring". Unlike many typical condition monitoring programs where we concentrate on finding and determining upcoming failures, we need to also include using the predictive analysis systems to:

- determine that improvements have been made,
- ensure that the asset is performing correctly,
- prove that we can utilize these improvements across machines that perform similar functions,
- realize that best-in-class work and performance results are shared across manufacturing departments and sites to gain real advantage.

Within the strategic development and at any management level, we need to ensure that we develop a correct strategy. This strategy needs to define:

- purpose … why you are doing this?
- products … what are going to get out of it?
- process … how it will get accomplished?

This strategic work lays out the approach, the need to accomplish with deliverables, and provides tactics with measures that determine what and how the work will be applied on the floor. From this application Best-In-Class methods can be found.

Infant Mortality and the "Mechanical Failure Pie" …?

As we've discussed, we need to understand that in the reduction of infant mortality there are mechanical reasons why these failures happen during system assembly and installation. Now before going too far, let's realize that all failures are "mechanical" by design. Yes, this includes electrical and instrumentation components as well. There's nothing that fails "electrically" in an electric motor failure. Every component in that motor is part of a mechanical system. Now this doesn't mean that electrical or instrumentation performance or the lack of precision in the application of work doesn't drive the mechanical failure. So, let's start by approaching these "mechanical" failures first of all as a failure source "pie". Not a pie chart but as a pie. As we do so, we begin to realize that in looking at this "pie" that there are opportunities that are easy (let's say assembling the ingredients of the pie), other work that comprises most of our activities (mixing the ingredients), and then the hard work (the crust … there is high value but it takes a lot work to get it out).

Let's break this pie into four pieces with one piece being ten percent and the others each being 30 percent respectively. These three major failure pieces are: misalignment, imbalance and assembly errors. Let's take a moment to briefly list a few of the problems found within each.

Misalignment …
Without going into the correction devices or into "alignment" methodology let's begin with an understanding that the retention of alignment starts with all of the appendages that are attached to the machinery including the frame and base-work. This means that alignment starts with the "driven" machine first and then continues through the line to the driver, whatever that may be. Without going into too much detail, here are many of the major alignment items that need to be in "control":

- Pipe stain
- Angled and short foot/leg
- Torque and torque sequence
- Retention of bearing radial internal clearance
- Coupling position
- Thermal growth compensation, in all directions and planes
- Transferred vibration from other machines in the area
- Resonance from excited natural frequencies
- Published final position tolerances
- Case deflection and distortion
- Several others

Imbalance …
Our second piece of the pie is "imbalance" or the loss of balance. In many cases the retention and improvement of balance quality is just not deemed as important as alignment. Part of a precise mechanical work order is to; retain the original balance as provided by the manufacturer, potentially improve the system balance through component and system assembly and last of all utilize new technologies to improve the dynamic balance as systems run over time. Some of the major sources of the loss of balance include:

- Casting porosity
- Peripheral Run-out
- Machining Tolerances
- Operation
- Erosion
- Corrosion

Assembly Errors …
This last 30% part of the pie (and at some facilities the percentage may be larger), drives most of us crazy, as the faults don't show up as "independent" source frequencies, but "add" to or look like something else. Historically, we have considered these as "little" things that don't affect the performance of a machine. Perhaps each by itself will never cause a "good" machine to perform poorly, but as the "many" together, they will cause a machine that should run precisely to perform "OK". Here are a few for the list, with how they might add in analysis.

- Key length and positioning – unbalance
- Bolt torque pattern & sequence- misalignment
- Electrical termination box hard piping - misalignment
- Setscrews - unbalance
- Pulled threads - misalignment
- Offset collars - unbalance
- Grease quantities - unbalance
- Position of the grease in couplings - unbalance
- Applied lubricant torque changes – bearing life, unbalance, misalignment

Others …
The last 10% of this "pie" involves the "others". As an example, think about shorted, open, loose rotor bars. Do they happen? Yes, but do they happen often? Now as an example, with a dataset of 2000 plus motors you might see one of these failures every few years but, they are a part of the pie. Gearbox failures are included in this set and a few others. The point is that this piece of the pie holds those failures that just don't happen very often.

What are the Results …?

Where can we begin? Let's start with an understanding that, if we fail to define the behaviors we seek to change and define the measurable results we expect as a return, then all work just becomes "busy" work with "tick mark" boxes checked. In the application of Precision Maintenance, here's an opportunity to start with measurement areas that matter. While there are many more areas that we can discuss, let's quickly review the following improvements:

- *enhanced asset reliability* … we have measured improvement changes from 67% uptime to a new sustained 91%, measurements include doubling to quadrupling asset life cycle performance
- *improved production* (quality / quantity) … we have seen a two to three sigma improvement change and measured production line speed enhancements of better than ten percent.
- *reduced maintenance* costs … after three years of sustained application efforts we've measured a reduction of 30 percent in cost, while we've also measured a 50% reduction of parts consumption.
- *optimized energy* consumption …through the removal of frictional sources we've measured a reduction average of 20 percent.

All of these results are completely attainable with the correct application of precision maintenance techniques. The value of these results are dependent on the

"sponsorship" and direction that is received from management. The decision to improve is based on how well we will walk the talk.

We've only discussed just the start of Precision Maintenance℠ application. As a side bar "thinking" conversation we must also include:

- *Preventive and Predictive Routes* … many times we measure that up to 50% of the routes completed are attempting to control failures that have never happened in the past and not likely to happen at all. We also find that many times the inspection routines are being accomplished with redundant inspections that span multiple responsible parties. How many times must we inspect for the same failure?
- *Component Failure* … in the continued reduction of repeating failures we need to take the time to learn how to identify and control the other failures that happen. There are many other ways that bearings (as an example), can fail. Do we readily recognize the failure mechanism on the floor as parts are removed or changed?
- *Root Cause Problem Elimination* … instead of completing a failure analysis, let's eliminate the failure. While doing this, let's also explore the fact that there may be many more failure modes that can result in the same loss. Let's not just get one, let's get them all.
- *The improvement of significant Assets …* this is the inclusion of specialty courses and field application such as; fluid power (hydraulics), pneumatics, pumps and pump systems and more advanced courses in all of the above. The improvement needs to be ongoing, you might say "continuous". The results can be "contagious".

Isn't Everyone Doing Something Like This Already …?

Over the last couple of decades there has been many improvements made on everyone's operating and maintenance floors. All of these changes have some value, all have had some improvement, and some have had much more value than others. But universally we've been faced and continue to be faced with some pretty big challenges.

As an example we see few shop classes in high schools (I think we're too afraid that someone might get hurt so we fail to introduce these young budding minds to working with their hands and minds). It is obvious that if we are going to improve reliability within our manufacturing workforce we need to begin to encourage the development of "hands-on hard skills" activities before we release these young folks into the college, university, technical school and working world. Consequently, we and many others have witnessed an *erosion* in standard trade performance, a reduction of apprenticeships and apprenticeship criteria that no longer approaches "how to repair" but instead focuses on a component "remove and replace" mindset. Let's also include (before we go too far down in the weeds), that today's front line management recognizes the need, but as of yet they have not been directed to concentrate on a reliability driven precision maintenance initiative. Remember, we do what we measure and reliability with precise maintenance activities in the everyday application of the work has not historically been on everyone's radar.

Why wouldn't you do this …?

Well it seems that the compelling story is pretty straightforward but, the other side of the coin is that your organization has to be ready. Precision Maintenance within a Reliable Manufacturing drive is not easy. This will be some of the most uncomfortable work you will do. This work will constantly be met by the grenade hurlers whose antecedents do not allow them to move forward. Be ready for the old "We've always done it this way and it's always been enough". Be aware that there are those out there who think that placing Band-Aids on and patch fixing is the way to go. But believe me when I say that they who think and act this way will go the way of the dodo bird. Determine if your organization is ready. There's a bunch of pre work that needs to happen before you begin and a bunch of post work that happens after each and every training element (more on this later). Be ready though for excitement, discovery and a work force that will jump in with both feet if you'll only let them. Precision Maintenance in the larger part of Reliable Manufacturing is a major part of the work force development required for the future.