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Measuring Maintenance Effectiveness: The Bulls and the Bears

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There has been a lot of debate over the years revolving around how maintenance should be measured. The theories vary far and wide, but in essence, most of the debate concerned how to measure the end results of what has been accomplished. Should it be measured on maintenance cost per unit output, cost as a percent of replacement value, or on equipment uptime, etcetera? The debate continues to rage, but we contend that the debate is focused on the wrong timeframe; all of these measurements, as stated, concern themselves with “outcomes” or after the fact measurements.

If we look back seventy or eighty years, to when most of the current accounting and measurement methods were developed, we can compare today directly with that time period; not much has changed about how we report and measure effectiveness. But times have changed significantly. There are three primary reasons why new performance measures are required:

- o Traditional accounting and measures are no longer relevant to a company moving toward a world-class plant environment
- o Customers are requiring higher standards; competition is pressed
- o Management techniques and technology used in plants are changing significantly

The most compelling reason for the need for change is that these measures are based on lagging indicators, which are after the fact results, unchangeable once the time period of measurement has been completed. Additionally, many decisions are now pushed down to the shop floor and the old high level lagging measures are inadequate. We want measures that are meaningful to the entire hierarchy that we want to use to promote particular behaviors by our employees.

Today’s environment requires measurements that can predict outcomes, not just measuring outcomes themselves. We need to be able to affect the final outcomes for the month by measuring interim indicators. Measuring maintenance is like investing in the stock market. Our investments should be geared to high value returns that are provable. A common strategy is to look at leading “market” indicators to judge how well the investments are going to pay back, which is the lagging indicator

- If the leading indicators are “Bearish”, you have time to correct your actions
- If the leading indicators are “Bullish”, you know that your efforts (investments) are going to produce the required return

Managing the Bull and Bear trends of the leading indicators is our view of successfully managing your investment in maintenance. So the premise is to measure both leading and lagging indicators; but it must be done in some context, some overall process that integrates with your direction. We call such a process the “Managing System.” This forms the basis for integrating people and processes within a common framework. The “Managing System” is the umbrella process used to guide the organization on a day-to-day basis and is considered a foundation process. The managing system integrates the overall strategy for the plant to a series of cascaded goals and objectives that are linked down through the organization. It then is used to establish the measurements of these goals at each level, and the key process indicators needed to ensure that the processes remain healthy. These measures are a mixed set of the proper leading and lagging indicators.

This is the mechanics of setting the system up; the key is in utilizing the system. The system is used as the primary vehicle to review how well we are performing against what we said we would do. It’s the “Plan, do, review, act” model. To make this work, it should be used at all levels of the organization, have the reviews on a scheduled frequency, publish the results of the measurements, and hold people accountable for the end results. By using a mix of leading and lagging indicators, as we review the leading indicators on a

weekly basis, we have the ability and time to correct deviations from expectations by the time we review the lagging indicators at the end of the month. As we assess plants we see a semblance of this system in place, but it's often disjointed and based on lagging indicators that do not tie the strategic direction to tactics used at the floor level. In most cases, the measurements used are wrong and don't relate to the behaviors that you want to produce; so it doesn't provide a vehicle for change management.

It's important to measure, we all know that, but it's imperative to measure the right things! Maintenance measurements are a part of a global set of indicators that gauge your facilities viability. So it is important to ensure that we measure these right sets of information. We next need to look at what are these right measures for maintenance within this set. We will start by looking at the comprehensive set of Leading and Lagging indicators, which we call Process and Outcome.

The following chart illustrates the set of leading or "process" indicators that we recommend. For this discussion, we will concentrate on the Process-type of indicators. The Outcome indicators are important, but most of them are well known and used requiring just a brief discussion toward the end of this presentation.

Estimated Backlog in Crew Weeks. Backlog is defined as the total amount of work that has been identified but not yet completed including work in progress, but excludes PM inspections.

Process Indicators
<ul style="list-style-type: none"> • Estimated backlog in crew weeks • Percent available hours for: <ul style="list-style-type: none"> •Emergent work •PM work •Corrective work (from PM) •Routine work • PM compliance • PM effectiveness • Inventory stock outs • Compliance to planned hours • Schedule attainment by week • Schedule Loading Factor • Work Capacity Index

It requires that all work requests receive a rough estimate by the planner prior to going into the backlog. It is calculated by dividing the estimated work contained in the crew's area by the available crew hours in a week. We suggest also using the same for total work in the department and total and the crew.

The backlog indicator should be managed to 5 to 7 crew weeks. It is used to balance the amount of work being received versus executed, and to justify the need for contractors as supplementary help as the backlog gets out of control.

The reason for the 5 to 7 week level as a control is to allow a buffer time for planning and logistics to prepare and gather the resources required to perform the work. We are assuming that the organization in question is using a forward scheduling model. This measure can also use this to view the backlog by type of work, i.e. a growing trend in work resulting from inspections would show that your PM program is being more effective (or your equipment is quickly deteriorating).

Percent of Preventive/Predictive Work. Preventive Maintenance is the base load work for the organization as it is a known quantity and can be planned for well in advance. This base load should be smoothed through the year so that the fluctuation of manpower requirements does not vary significantly. You should be spending 30% to 35% of your available hours on this type of work as it is the basis for getting control of your equipment. The better this works, the lower that the emergent work will be.

Most people do too much PM (sounds like heresy!) As we move from client to client, the sad fact is that few have gone back to the original PM routines that were established when the equipment was installed to look at the need, the results or the frequency of its performance. PM routines are seldom rationalized or justified based on equipment failure history. The task before you is to analyze your program to assure that: the mix of PM and PdM is correct, which will require less manpower, and that the program is based on a rational approach.

Percent of Routine Work Performed. This is basically all of the other work that you will be doing of an expense nature. The target here is about 10% of all work

Summing up types of work

You must look at multiple indicators to get the big picture from these of what is happening in your plant. Analyzing the percent of available hours by type of work gives you the macro view; it enables you to say whether you are in control of the facility or if the facility's demands are driving you. Charting these variables on a weekly basis is a good way to feed the Bulls and watch out for the Bears that bite you at the end of the month.

We should spend a little more time on the PM side of the business. In most cases there is only one indicator of PM performance when we assess a facility: PM Compliance to Schedule. But this tells only a small portion of the story and is too easy to “manage” in the field. We have seen many cases of filling out the form to turn in the routine as completed and get credit. There are generally no qualitative measures associated with PM and without this type of measure, how do you know if your investment in PM is justified? Let’s look at this aspect.

Percent PM/PdM Compliance. This is the measure of whether you are keeping up with the program as scheduled. If you have rationalized and smoothed the requirements, it is easier to manage this process and the measurement should be more stable. Mature /proactive organizations settle for no less than 100% compliance as this is the key to getting control.

PM Effectiveness. This indicator measures the amount of work generated from PM’s measured as the number of defects found per PM performed. It is invaluable in determining whether the frequency of a routine is correct or needs to be revised. If few or no defects are being found, the PM is either not being done or the frequency of inspection needs to be lengthened. This is the aspect of the equation that is usually missing in PM programs and it is key in gaining a balanced view of the health of the process.

Inventory Stock Outs. Spare parts supply can have a major influence on how well maintenance can perform its work. How well your supply chain is working can be a determinant of maintenance overall effectiveness. The major leading indicator for the inventory is “Stock Outs”, which measures the number of items issued versus the number of items requested. This should be measured weekly as all other leading indicators and be at 97% consistently.

There is a caveat, however: these numbers are based on a maintenance operation that uses advanced weekly schedules, and does not schedule work unless the parts are in hand. Too many times, the spares warehouse is blamed because ineffective, reactive requests for parts do not give them adequate time for their supply chain process to work. Again, the processes need to be correct for the indicators of any nature to be useful to you.

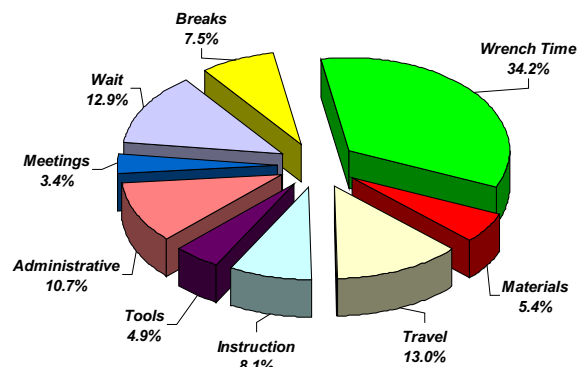
How Well Is Our Work Management Process Performing?

Work management is the most important process in the sphere of maintenance and contains the sum of all of the parts of the work order system. Knowing how well this process is operating is crucial to your success. The root question is who is the customer of Work Management? In essence the maintenance crews are the customers, and their productivity is a direct reflection of how well the process is performing. Most crews perform poorly due to barriers placed

in their way. These take the form of looking for parts; waiting on instruction or a lockout or an operator to shut down the equipment or a crane that no one scheduled; and all the other things that go wrong for the crew members. Let’s now look at how we develop the view of Work Management effectiveness.

Compliance to Schedule. Again, we presume that you have forward scheduling and that this week’s schedule was prepared last week. Once this is established we measure how many jobs were completed against the schedule. This includes all PM work as this by definition is work planned in advance and scheduled accordingly. This indicator should be 90%, which takes into account that you will have some level of emergent work specified to be 10% or less as discussed. This too is measured on a weekly basis by crew and by department total. As you can understand, this takes good cooperation from production to attain these figures. That’s the first piece of the measure of Work Management effectiveness.

Schedule Loading Factor. This measures the percent of available man-hours that are scheduled on a weekly basis. Having high schedule compliance, but few people scheduled makes little sense. There has been lot of debate on what this number should be, either a 100% or a 90% loading factor. A 90% load assumes that you are having about 10% emergent work on a continuing basis, so why load more? The 100% scenario is used by more stable operations where emergent work is low, but about 5% of the man-hours are scheduled on very low priority work. When the schedule is broken, these people are sent to perform the emergent work. Schedule loading is the second factor in the WM measurement.



Wrench Time. Wrench time is the measure of the percent of a workday that the craftsmen spend performing actual work, and is in reality a lagging indicator, but it is part of the overall measure of Work Management effectiveness. The world class number for this indicator is about 65%, but most clients that

we initially assess are measured at 28% to 35%. We find many barriers are placed in the way of the workers which keep them from being effective. Typically, we see high “wait”, “travel”, and “materials” delays, which are all controllable by a proper work management process.

Wrench time should be measured quarterly by performing a “Day in the life of...” study using multiple assessors that spend several days with a single craftsman each and measure the time spent in the categories shown on the preceding chart. Additionally, the studies are performed on non-PM work.

Gauging the Work Management Process

The method that we use to measure the overall effectiveness of the work management process is what we call the Proactive Work Capacity index (PWCi). The previous part of this discussion has given us the information we need to gauge this process. We now take the previous three figures and multiply them together to get an indicator

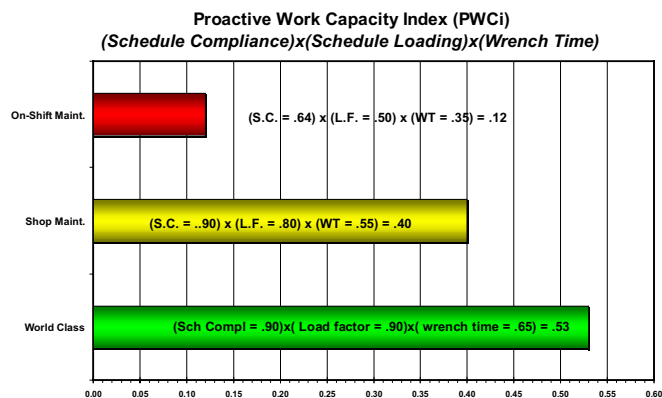
$$PWCi = (\text{Schedule Compliance}) \times (\text{Schedule Load}) \times (\text{Wrench Time})$$

Using the best of class numbers quoted for the individual components, world class levels would be:

$$PWCi (\text{World Class}) = (0.90) \times (0.90) \times (0.65) = 0.53$$

The following chart shows this graphically:

Current Processes Are Constraining Work Capacity At This Client



- The first bar was for a client “as assessed”;
- The second shows our projection following a 1-year intervention; and
- The third demonstrates the above equation

This index should be calculated weekly and trended over time; it is the best overall measure of the effectiveness of

your entire work management process as it measures the key factors that you are trying to improve: Scheduling at a maximum number, complying with that schedule, and the productivity of the workers that are executing the individual jobs on the schedule.

So those are the key indicators that we recommend for watching the operation on a weekly basis. There are many more such indicators that can be used, but they measure other sub-systems. It’s OK to have more than the suggested set, just don’t get carried away with a scorecard full of measurements; it dilutes the effect of the important numbers. Focus on what is important!

It is appropriate that we say a few words about the lagging indicators. Lagging or outcome indicators are generally those that are reported upward through the organization and form the basis of the view of your operation from the top of the hierarchy. These are used to gauge how well you are perceived. Few plant managers or VP’s of Operations care what your proactive work capacity index was last week, nor will they fully understand its impact. That’s your job and your measurement set. The outcome indicators are important, for they do tell the final story of your organization’s effectiveness: Cost per unit produced; Maintenance cost as a percent of replacement value; equipment uptime; and inventory turns; all these have a place in telling the world how you are doing. They are the higher level indicators of long term success when maintenance is viewed as a business.

The one thing that can be said is that if you don’t watch your progress in the Leading indicators, the Bears will get you at the end of the month! At that point, it’s too late to affect the results, for these indicators are just that - Final Results for the month, year, etc. So the answer then is to stay bullish.

A few suggestions for keeping away from the bears:

- The purpose was to emphasize the need to manage your business incrementally;
- Watch those things that make up the end result for which you will be judged and rewarded;
- View all indicators, both leading and lagging, as a whole picture never relying on one or two to predict success;
- Keep a manageable set of indicators, and follow the principles of the managing system to promote change;
- Manage to trends rather than single point numbers;
- Never knee jerk to instantaneous information, again, look for trends; and
- Share the results with everyone, good or bad - you rely on others to perform, so tell them how they are doing.

And remember, cattle raising is always easier than trying to corral a bear!