

A look back at World Class Maintenance (thoughts back in 1999)

The twenty steps to world class maintenance was first published in Maintenance Technology (10-92) magazine and then refined as an audio tape in 1993. It was revisited in the book Managing Factory Maintenance (1996) as "The Attributes of World Class Maintenance." This summary reflects the author's current thoughts (as of 1999) on the drive for world class excellence.

The wave of organizational changes required to run a comprehensive quality program has hit the maintenance department. Consistent quality depends directly on the maintenance department. Maintenance professionals the world over have heroically struggled against inadequate support, old equipment, inadequate engineering, little time to test processes, excessive run time before service to provide uptime, high tolerances and uninterrupted utilities.

This wave of change is great news for maintenance. Maintenance wisdom has long been ignored. Maybe now, the maintenance department will get the respect it deserves and support it needs.

Competitiveness in world markets and survival now drives the changes in how top management views maintenance. A World Class Maintenance department enhances their organization's ability to provide their product or service. Maintenance department becomes a strategic asset of the organization rather than a necessary evil.

These twenty attributes are derived from the author's visits to many maintenance facilities and the excellent work of W. E. Deming, Don Nyman and others. For additional discussion of some of these steps see the chapter on maintenance quality.

1. Top management has awareness and appreciation of the significance of maintenance to the overall objectives of the organization.

The first key to world class maintenance effort is the support, understanding and trust of top management. These factors are frequently missing. One mission of the world class maintenance department is education of top management. While much of maintenance is unknowable, (the exact minute a gear will crack) much of maintenance reality (machines do break down if they cannot be serviced) can be taught. Only a short sighted executive would ignore the dire warnings of their finance Vice President. Yet many Managers routinely ignore the warnings, knowledge and experience of their Maintenance Managers.

A power utility builds a generating station in the Midwest with the design specification that it will be able to have 85-95% availability. To support this level of availability the designers have long and detailed meetings with the maintenance leadership. Every failure mode is

discussed, looked at, planned for and (where possible) designed out. The capital spares inventory was 24 million dollars (just reduced by the maintenance department to 15 million). This utility realizes that profit in power generation hinges on the wisdom of the maintenance input to the design and operation of the plant. This is an example of support, appreciation and understanding of the role of maintenance to the success of the operation.

2. Mission statement

A mission statement is necessary to run a world class maintenance department. The mission statement becomes the primary benchmark that the staff can use for effective decision making. The mission statement covers the issues of customer orientation, continuous improvement, quality, safety, environmental position, employee development, down time, proactive stance, and any industry specific areas.

In the executive conference room of a vehicle manufacturer was a beautiful poster titled Mission Statement of their Corporation. This poster cost in excess of \$5000 to produce and print. I asked a class full of maintenance supervisors sitting in the room at the time "did the company have a written mission statement?" At least half said no and the others thought they did. No one in the room could remember any of the statements of the document. This is an example of a fake mission statement since it will not guide anyone toward better quality, safety or anything.

The mission statement defines the organization in concrete terms. This is particularly useful for a trade's people in the middle of the night, far from the other workers, or is new to the company when there is no supervision to ask. The mission answers the questions how much effort do I put into quality, safety, etc.

In organizations that are serious about their mission everyone knows the critical items on the mission statement. If you doubt this ask a DuPont employee about safety or a Saturn employee about product quality.

3. Constancy of purpose (emphasis on long term goals and views)

There is nothing more debilitating to the effectiveness of a maintenance department than the management 'flavor of the month club'. That is, a management that jumps on the band wagon of every new guru and loses the focus necessary for world class performance. Last year it was empowerment, this year its stay close to the customer, and next year we worship at the alter of quality.

The march of equipment and facility deterioration moves at a slow inexorable pace. The march of deterioration can be slowed by good lubrication, cleaning and bolting practices. The effects of the march can be treated by effective corrective maintenance. The results of this march of decay can be previewed by predictive maintenance techniques. No technique can

stop the march.

Upgrading a reactive department to preventive then to predictive then to World Class is usually a six year effort. Great achievements like world class maintenance require a long term steady hand.

This attitude should be reflected in a long term budget. A five or even ten year budget for maintenance and rehabilitation is needed. This will provide information into the corporation as to future needs. Many of the assets that maintenance supports have long decay cycles. These long cycles respond best to a constant approach where we look, record, document the deterioration for years while planning an intervention. The intervention is then well conceived, reasoned, planned, investigated and executed.

4. Both maintenance and management have patience

Going hand-in-hand with constancy of purpose is patience. Maintenance problems take a long time to develop and consequently they take a long time to fix. Substantial maintenance system and procedure improvements require time and investment. Initial results often take a year or more. Managers used to dealing with monthly results will be uncomfortable with the longer time spans.

Steven Covey, a leading business thinker, speaker and consultant sums up the paradox in saying that there must be an unchangeable core at the center of the organization to be able to react quickly and effectively to the marketplace. This core consists of the essential values that make the organization successful in the marketplace. While the marketplace makes different demands on a month to month basis the core values stay the same.

One of the core values is the way we treat the people and assets under our stewardship. That value is the organization's attitude toward maintenance and maintenance leadership. Patience is also an expression of trust.

5. Focus on service to the customer

Another core value of the organization is excellent service to all the customers. The maintenance department is a service vendor for all other departments of the organization. These departments are the customers and need to be understood through regular communication, periodic surveys and needs assessment. When maintenance efforts fail it is the customer that suffers. Every member of the maintenance work group should be familiar with the impact of their actions on the customer.

No maintenance department in the over three thousand that have attended the author's classes has ever gotten bad feedback from attending to the customer too well. Maintenance brainpower would be well spent if it concentrated on faster delivery of higher levels of service. The maintenance department must strive to serve the real needs of the

customer.

Some effort would be rewarded in determining what maintenance changes could impact the outside customer (the big C). How can what you do impact them and their business. How can you make your outside customer's life easier? It is hard to see what you can do to help the outside customer beyond doing your job inside but the rewards for success are great. Any substantive improvements will enhance the competitive position of your whole organization.

Many maintenance organizations take a superior attitude toward production (the customer). They say "we are the real brains and production is a bunch of idiots". They can prove it by showing you all of the stupid things that happen in production. These departments miss the fundamental point in that our purpose flows from service to the customer. Maintenance leadership misses opportunities to coach maintenance workers that their attitude impacts the level of service.

6. Customer participation in Maintenance (with training!)

World Class Maintenance requires the operators' involvement. The more the operator is involved the better for all concerned. The benefit for the operator is the feeling of being the owner of the process/machine, improved responsibility and higher total productivity. The operator is the logical person to perform basic PM tasks because he/she is in daily contact with the machine. The machine is really theirs.

The benefit for the company is improved tracking of responsibility, improved quality and improved knowledge which leads to improved productivity. A knowledgeable operator who feels responsible will make better parts at a higher rate. Downtime will be reduced and small problems will be addressed quickly.

If we did all of the PM's we should do we rapidly find there is more maintenance to do then maintenance has people to do it. We need an additional resource. The largest hidden resource of the maintenance department are the users themselves. In some industries (such as the trucker checking his/her own oil and doing the pre-trip inspection) it is common place for operators to participate in the Preventive Maintenance procedures. In fact, the pre-trip inspection is the law in trucking and aviation. In other industries operators don't touch the equipment. The operator just pushes the button or watches a gauge.

This ownership takes another step in some departments where the operator acts as a helper on large repairs or safety watch person if confined space entry is required. Once properly trained, the operator can be a great asset. In factories the best implementation of this idea is called TPM (Total Productive Maintenance).

7. Proactive not reactive

The world class maintenance department does not allow critical assets to deteriorate to the point of a breakdown. The proactive maintenance department does not wait for the breakdown but goes out onto the plant floor looking for impending problems. Implicit in the proactive approach is the will to take equipment out of service for repair before the breakdown. The reactive approach says 'don't fix it if it ain't broke.' The proactive approach says 'don't let it breakdown- period!'

Examples of proactive tasks include inspection, cleaning, tightening, lubrication (all PM activity), complete testing of new equipment, operator certification programs, continuous training programs, well thought out storerooms, reviewing designs before construction for maintainability, etc. In fact all activity related to avoiding breakdown in the future.

Consider the attitude at a program to preserve assets in a museum of art. Of course, an art museum has a great restoration department after damage has been done. The bulk of their activity is in creating an atmosphere that will prevent deterioration in the first place. Maintenance departments need to get in front of the action out on the shop floor and not wait for bad things to happen

There is another aspect to proactivity. A proactive maintenance department will spend a significant percentage of its assets on maintenance prevention. The most proactive stance of all is to eliminate the need for maintenance.

The toughest aspect of proactivity is self discipline. You must maintain your proactive activity without feedback and support. In fact, proactivity requires doing things that may seem irrational to outsiders without a long explanation.

8. Root cause analysis

Getting to the root cause and fixing it is the best way for a maintenance department to gradually improve the delivery of maintenance service to the customer. Root cause treatment comes in two stages.

Most good mechanics will work on a breakdown until they understand and repair the root cause. This is the first stage. This distinguishes the real mechanic from the parts changer. Root cause analysis requires some time to study a system. Many organizations imagine that they do not have the time and force premature decisions on the mechanic. I say 'imagine' because they seem to have the time to repair the problem over and over again.

The second stage is to re-engineer the system to avoid that mode of breakdown in the future. This may be well beyond most mechanics on complex systems. In factories competition, service requirements and the sheer cost of maintenance require this level of expertise.

Root cause analysis can be done by anyone that has knowledge about the actual

situation and ideas about elimination of the problem. Root cause investigations are an excellent area for using the team concept and breaking down interdepartmental barriers (building teams with maintenance mechanics, engineers, customers, etc.).

Root Cause Analysis is a proactive skill. It requires attention to equipment history, engineering, and the details of the failure. The mechanic who successfully undertakes this analysis has the ultimate cross training experience.

9. Benchmarking

The benchmark is the mark old world craftspeople made in their benches that was used for measurement. All parts they made were compared to the benchmark to assure they would fit. Today a benchmark is the standard for performance and means of measurement. We use benchmarks to tell if an operation is improving, stagnant, or declining. A world class department wants to know how it is doing.

One of the problems of maintenance has been the difficulty of finding benchmarks that effectively measure the performance of a maintenance department. Some measures that can be effective would be number of completed work orders verses number of incoming w/o's, PM hours to total maintenance hours, percentage and quantity of emergency work, number of callbacks, downtime (or uptime include downtime reason), production quantity/quality, maintenance cost per product shipped, and many others.

There are three ways to compare the benchmarks for maintenance. The first is the traditional historic internal benchmark. This takes a common measure (such as downtime, time to respond, number of work orders issued, maintenance cost per revenue dollar) and compares this year to historical numbers. The historic benchmark is the most widespread and most widely understood. Usually, three years of comparisons by quarter is most useful.

The second benchmark called best-in-class. This benchmark looks outside your plant and compares your maintenance department against the best in your industry. You have to study your competitors and look for the best maintenance department in your industry and compare yourself to them. This information may be available from trade journals or associations. The bench marks are so critical to some organizations that they spend a \$100,000 or more to have unbiased outsiders collect this data. Organizations with several plants of the same type will create their own best-in-class bench mark.

The third type of benchmark is the best in the world. This is very hard to do well. You compare yourself function by function to the best in any industry. One function might be handling customer complaints. Compare yourself to the best customer complaint handlers in the world such as Federal Express or Lands End (catalog retailer).

10. Willingness to run controlled experiments

Controlled experimentation is the key to new knowledge. Using the Shewart cycle or other technique ideas are introduced by the work force, tested, refined, retested. Root cause analysis (what is the root cause, how can we fix it) will also suggest needs for experimentation. Controlled experiments support continuous improvement.

Every maintenance budget should have some money set aside for maintenance experiments. A good starting figure might be 1%-2% of the regular budget. Returns on investment should be tracked and successes publicized.

The only way to improve is to try different ideas, technologies, techniques, approaches, etc. Coupling experimentation with job enlargement and training will propel your maintenance department to the forefront of its field.

11 Team concept

Many maintenance problems today are too complex to be solved by a single person. World class maintenance departments recognize and capitalize on the different skills and expertise of different members of its crews and the other departments. Teams are used extensively to solve problems, plan jobs, and institute improvements. A single maintenance worker might be involved in several teams simultaneously. Some teams might be ad hoc (setup for one problem) and others might be standing teams (for safety, environmental, etc.). Leadership training and opportunities to safely exercise leadership are part of the team concept.

One of the most interesting examples of team projects was in the automotive industry. Automobile companies routinely buy competitor's products and disassemble them. In one company they assemble a volunteer, ad hoc (one time, as required) team consisting of design engineers, people from general assembly, maintenance people and even administrative people. This team would take the car apart and attach the parts to boards for display. They would analyze the part counts, assemble techniques, and prepare a report and presentation for the larger new car staff. It was considered a fun assignment.

12. Information sharing

Information essential for effective maintenance exists in many locations in the organization. Maintenance touches many different levels of activity. Each level has important information. Some examples of critical information that impacts maintenance decision making are fixed asset accounting methods/decisions, overhead costs, downtime costs, equipment retirement cycles/budgets, interdepartmental priorities, etc. World class maintenance can happen only in the atmosphere of open exchange of financial and production data.

Without critical information the maintenance department is out of the loop and cannot make effective decisions. Worse than being out of the loop, maintenance can make good

maintenance decisions that work against the organization.

For example, in a plastic extruder in Maryland a maintenance worker found a problem with an extruder using the latest predictive maintenance technology. Immediate repair to prevent breakdown would cost \$500. After breakdown the bill jumped to \$5000. He was very proud because the savings was estimated at \$4500.

He discussed the plan with the shift manager and the maintenance manager and they decided to do the repair immediately on 2nd shift and go for the savings. The next day the manager walked into the Wednesday morning production/ maintenance scheduling meeting. He was greeted by a chilly silence before the meeting. Production had missed a just-in-time delivery for a new customer that morning. They asked "did he know why unit 5 was taken off line for an entire shift and a half?" Almost \$40,000,000 of new business was put at risk. Lack of information (lack of communications) created a costly blunder.

13. Fading of traditional interdepartmental barriers

Significant amounts of expertise needed for successful maintenance is hidden away in other departments in the organization. The world class department taps into these storehouses of expertise by breaking down interdepartmental barriers. Traditional departments that support maintenance (engineering, stores, safety, purchasing, and housekeeping) are actively involved in maintenance issues.

Non-traditional departments (finance, cost accounting, data processing, marketing, strategic planning) are also brought into the Maintenance decision processes. The team idea includes interdepartmental teams with significant input from the different departments. For world class maintenance to take hold and flourish, detailed maintenance knowledge must cross departmental boundaries.

Part of the goal of fading these barriers is the distribution of maintenance knowledge throughout the whole organization. Unfortunately, under old departmental structures, maintenance knowledge is not well distributed throughout the organization. The result was ill advised decisions such as the oil refinery mothball project. When the oil prices fell an oil company decided to mothball one of their refineries.

The accounting department estimated that the savings would be \$10 to \$15 million per year. They further estimated that the refinery would cost \$75 to \$100 to put back on line. To maximize the savings they laid-off the entire maintenance staff and just had security personnel on the site. After 8 years the price of oil recovered to the point that they wanted the refinery back for some large contracts.

Because of a lack of basic maintenance knowledge and a lack of effective communication the refinery was almost a complete loss and cost almost \$700 to bring back. Maintenance knowledge would have alerted accounting that a small investment of \$2 to \$3

million per year would have preserved the plant. Eight years without investment caused significant deterioration. Of course, the return on investment would have been \$16 to \$24 million lower.

The rest of the effort in fading barriers is directed toward bringing sophisticated cost accounting, finance, engineering and other skills to the maintenance department.

14. Cross training (also known as multi-skilling)

High levels of productivity require some level of cross training. Cross training simplifies job planning. Less time is lost coordinating different crafts. Many maintenance departments have enough people but have inadequate staffing in particular crafts or skills. Cross training also provides a more secure job because of the possibility of changing to jobs where the craft is more scarce when times are slack.

The major reasons for cross training is to improve productivity and allow one person do more of the job so they can feel ownership. A powerful motivator of the maintenance worker is the feeling of pride in a job well done. A cross trained worker is more likely to feel the pride because they did the whole job.

Multi-skilling depends heavily on a successful training and testing program. In all multi-craft shops training is an initial issue. Many firms bring in outsiders, tech schools or other training professionals to organize the massive training effort. Some of the best maintenance departments pay the craftspeople for qualifications in extra crafts.

In an aluminum mill in northern Alabama there are 11 crafts in the maintenance shop. In a worst case scenario it could take 4 people and their supervisors to change a small motor. We would call out the pipe fitters (if we needed to disassemble or change the piping), sheet metal mechanics (for modifications to the shroud or cover), an electrician to remove the wires and the trusty mill wrights to remove and replace the motor. While the quality of each craft would be great the productivity would be well below world class standards.

15. Continual training

Your factory has increasingly sophisticated technology. The technology is 1980's through 1990's vintages. Your crew was last in formal training 15, 20, 25 years ago. This gap must be filled by updating skills through continual training. The alternative is lower and lower quality, increased downtime and a increasingly complete inability to perform even routine root failure analysis.

You and your staff are involved in continual training. This is an investment that organizations make in their major assets (people). Training has three steps (if followed they give the most results from the least training dollars, see chapter 13): Analyze the job for needed knowledge, skills and attitudes. The second step is to evaluate the candidate for training against the job's requirements. The last step is to develop a training prescription. Traditional 'shotgun'

approaches are too expensive. The training process does not stop.

In a new auto maker's plant the standard for training is 96 hours per year for all people. A high tech manufacturer in the upper Midwest requires 5% (104 hours) of all direct hours be spent in class of some type. These firms realize that this investment pays interest in the ability of the craftspeople to adapt to new technology, new processes and new organizational structures. Topics could include engineering, craft skills, multi-craft skills, computerization, maintenance management, safety or your industrial process.

16. Application of statistical tools to maintenance

In the great move toward quality in the late 70's and 80's production and top management discovered some old statistical tools. These tools explained the problem of natural variation. They also would help identify when a process went out of control. Maintenance can learn from statistical thinking with failure analysis, PM intervals, replacement life, and other areas.

The excellent reliability record of the commercial aviation industry is due, in a great part, to the application of statistical tools to aircraft reliability. Much credit for reliability goes to the aircraft companies, component suppliers and engine manufacturers. The actions that really keep the planes up, even after 20 or 25 years are the scheduled replacements, inspections and the tremendous database kept by the FAA.

Statistical techniques are only as good as the data base they are derived from and the reliability of the intervention. The data base includes information, maintenance records and utilization data on all of the commercial aircraft in the US. Reliability is based on millions or billions of miles and hundreds of thousands of take-off/landing cycles.

Part of basic training for maintenance apprentices should be calculation of Mean Time Between Failures (MTBF), standard deviations and how and when to use them. The countries' PM systems would improve overnight as we get rid of emotional PM intervals.

17. Attachment to the people rather than technology or computer systems.

We run the risk of thinking that if only we had a new computer, bar coding with a new scanner, or other tool our maintenance department would finally get better. The truth is that most good maintenance practices are basic and low tech. Having our everyday people, our first line maintenance workers do the basics well is critical to manage breakdown. Our people are the important asset. Our thoughts toward improvement should look to their needs first. Any system changeover should consider good employee treatment, adequate adjustment period and sufficient training.

We routinely see systems that have run amok. These systems will spit out PM tickets for equipment retired a decade ago. There seems to be no one left that can change (or wants to change) the file to get rid of the irrelevant PM. To add insult the PM tickets in question have to

be closed out as complete or all of the reporting will be off. In another case the maintenance manager got a 1400 page weekly maintenance report. It included everything for all divisions mixed together. Data processing could never suppress the extra information.

18. Attachment to people so that every other option is looked at before layoffs (W.E. Deming says drive out fear).

Many organizations layoff people as a first resort rather than a last resort. Mindless expansion and contraction of the permanent work force is immoral in today's competitive world. Every other option should be tried before layoffs including shortened work weeks, slashing executive salaries, using maintenance for construction work, accelerated retirement, transfer of maintenance to production, staff, even marketing jobs. Companies need new strategies to cope with expansion, contraction, plant closings, and changes in the product mix.

It is quickly becoming clear that the true asset of a manufacturer is the knowhow of the employees. This specific knowledge is essential in all aspects of modern management. Processes cannot be improved, products cannot be made more consistently and bench marks cannot be achieved without specific knowledge. This knowledge comes from years of solving problems in a factory or an industry.

In all theories of motivation when a person's paycheck is threatened they are not available to perform their highest quality work. It is difficult in an anxiety producing environment to concentrate on the details that create quality and safety.

19. Self motivation

A self motivated work force is the result of management doing hundreds of little things right. The principles of world class maintenance will result in a self motivated work force and an environment that is exciting to work in.

20. Continuous improvement

There are many factors that contribute to an organization's survival. Continuous improvement is one of the big contributors. Continuous improvement is everyone's job. The world class challenge is to produce the same or greater output at a higher quality with fewer inputs. One of the inputs is maintenance effort and parts. You should establish the inputs needed per unit of output (output is measured as cars assembled, cases of soda bottled, barrels of oil refined, etc.). Through your ongoing continuous improvement processes the input per unit output should drop. Last year's numbers can be the benchmarks to beat for this year.

Continuous improvement is also an attitude. Many maintenance people fall into a dangerous rut where when a system is understood and its failure modes familiar they feel satisfied. They feel as if they can handle anything that might happen. They are not at risk. While

it is nice to feel as if you can handle anything that might happen it is deadly to accept the status quo. You have to fight this tendency to maintain the attitude of continuous improvement.

There are great opportunities for organizations that put major effort in making products, understanding the real maintenance issues, and becoming experts in their activities. The 1990 begins the decade of expertise. The marketplace will no longer tolerate amateur manufacturers, governmental institutions, hospitals, or any other institution.

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