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Saturday, 01 April 2000 10:26

Six key elements put into regular use in the workplace to improve equipment performance and reliability is what TPM is all about.

What is it about improvements in the workplace? They all seem to have three-letter acronyms that are unpronounceable and strike fear in the hearts of many plant-floor people. Total Productive Maintenance (TPM) has not been much different in the United States since the late 1980s.

However, when you see real TPM in action you instantly become a believer. It really works! And it works in ways that other alternatives to improving equipment performance and reliability cannot even come close. True TPM is about a culture change in the way people care for equipment that is much more than marking, labeling, checksheets, cleaning machines, or operators doing maintenance work. All too often I believe people mistake the outward signs of a TPM work culture for what TPM really is.

Today, we have some new insights about TPM that go back to its roots in Japan in the late 1960s' insights that have escaped many TPM teachers in the U.S. Once these new insights are understood and operationalized, we should see the beginning of the next generation of TPM in America.

But, first, what is TPM? Total Productive Maintenance is an equipment and process improvement strategy that links many of the elements of a good maintenance program to achieve higher levels of equipment effectiveness. The five key elements, or "pillars," of TPM include:
1. Improving equipment effectiveness by targeting the major losses
2. Involving operators in the daily, routine maintenance of their equipment
3. Improving maintenance efficiency and effectiveness
4. Training for everyone involved
5. Life-cycle equipment management and maintenance prevention designExperiences in facilities where TPM is working bear out what we have discovered in the top NASCAR Winston Cup auto race teams. Teamwork focused on common goals including equipment reliability calls for a sixth key element or pillar for TPM:6. Winning with teamwork focused on common goals

All six elements put into regular use in the workplace to improve equipment performance and reliability is what TPM is all about. The six key elements are interrelated; they directly support each other.

Unfortunately, TPM is often mistaken for operator-performed maintenance or autonomous maintenance. These relate to only one of the key elements of TPM. And, when one of the key elements is used without the others, the efforts, and the results, are not likely sustainable.

About 50 percent of the TPM initiatives introduced in America since 1986 have failed to produce the desired results and have been abandoned not because of the inherent concepts of TPM but rather because of the lack of using all of the key elements of TPM in ways that are connected to the business and focused on results.

Focus on results

Total Productive Maintenance grew out of the early stages of the Toyota Production System (TPS) in Japan in the late 1960s. The fundamental focus of TPS is the systematic identification and elimination of waste to reduce manufacturing cost. Equipment delays, downtime, inefficiencies, and scrap represent sizeable amounts of waste in the manufacturing and related processes. This explains the focus of the first key element of TPM: improving equipment effectiveness (OEE) by targeting the major losses.

The OEE calculation factors in the major losses that the six TPM elements seek to eliminate. There are at least 11 major losses, and they fall into four major categories:

1. Planned shutdown losses: no production, breaks, and/or shift changes; planned maintenance
2. Downtime losses: equipment failure or breakdowns, setups and changeovers, tooling or part changes, start-up and adjustment
3. Performance efficiency losses: minor stops or delays, reduced speed or cycle time
4. Quality losses: scrap product/output, defects or rework, yield or process transition losses

The bottom line is that all of the TPM key elements should be based on the focus of the first element and be measured by the first element metrics. Given that the first key element of TPM focuses on measuring equipment effectiveness, it also measures the effectiveness of the TPM initiatives. It stands to reason then that the initial TPM activities should address problem areas in the plant, poor-performing equipment, and high maintenance cost areas of the facility. This approach would contribute to the "systematic identification and elimination of waste to reduce manufacturing cost"--the foundation of the Toyota Production System.

Calculating OEE

Equipment availability x performance efficiency x rate of quality =Overall Equipment Effectiveness

For example, equipment operating at 85 percent effectiveness would be determined by the following factors:

Equipment availability (90 percent) x
Performance efficiency (95 percent) x
Rate of quality (99 percent) =
Overall Equipment Effectiveness (84.645 percent)

New insights about TPM

In the September-October 1999 issue of the Harvard Business Review magazine, researchers H. Kent Bowen and Steven Spear reported on a four-year research project to determine what actually makes the Toyota Production System work. In their article "Decoding the DNA of the Toyota Production System," the authors detail their research, what they discovered, and what the Toyota Production System leaders validated. "How the Toyota Production System works grew out of the workings of the company over five decades," they wrote. "As a result, it has never been written down. Observers confuse the tools and practices they see on their plant visits with the system itself." This is very consistent with what we are seeing happen with TPM in America people often mistake TPM activities for what really makes TPM work.

Since TPM grew out of TPS there are some powerful new insights for those of us who are teaching, coaching, and directing the implementation of TPM practices in America.The Harvard researchers identified four rules that govern everything within the Toyota Production System. Three of the rules govern the design of work. One rule governs improvement. Essentially, with the way work is designed and improved, Toyota has created a "community of scientists."

Let's explore the rules and see how they may link to TPM. Rule 1 indicates that all work shall be highly specified as to content, sequence, timing, and outcome. For a TPM work culture this may mean, for example:

- Anything done to maintain and improve equipment effectiveness must be documented in

procedures that everyone follows.

- Detailed and planned maintenance schedules govern all maintenance work.
- Equipment history includes thorough documentation of parts used, labor hours, problem descriptions, root causes, and corrective action taken
- Daily and weekly joint production/ maintenance planning and status meetings keep efforts focused and aligned.Let's look at rule 2 and its application to TPM: Every customer-supplier connection must be direct, and there must be an unambiguous yes-no way to send requests and receive responses. Here are a few examples:
- Proper maintenance tools, parts, and supplies are available when and where needed and in the quantity needed.
- Spare parts are maintained within the proper min/max levels with effective internal and external supplier alliances.
- Maintenance requests are sent and acknowledged promptly with visual cues or signals.
- Equipment problems are identified so there is no doubt where the problem is." Visual systems and signals are used to eliminate long drawn-out explanations and reading.
- When proper repairs or improvements are made, the requestors sign off on them.Rule 3 states that the pathway for every product and service must be simple and direct. From the TPM perspective this includes:
- Every equipment operator knows where to go for help with maintenance problems, often directly to the maintainers themselves.
- Every maintenance person knows where his expertise applies in the plant and on what specific equipment he is qualified to work.
- Every maintenance person knows where to go to get help when the problem exceeds his expertise.
- Documentation for specific equipment is within easy access to those who need it.

The first three rules govern the design of the TPM work processes. Everything that people do, regardless of their roles or positions in the facility, is highly specified with direct customer-supplier connections and simple pathways for obtaining resources to get the job done.

If the first three rules govern the design of work, then there must be a similarly structured way to solve problems and improve performance. This is where rule 4 comes into play.

It states that any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level in the organization. In a TPM environment this means:

- Root cause analysis and problem solving are applied to eliminate chronic and sporadic equipment-related problems.
- Data is collected, analyzed, and made available to make the improvements more efficient and effective.
- Small cross-functional groups of informed people closest to the problem work out possible solutions (hypotheses) and conduct experiments to determine if their solution is workable or not.

- Formally experienced and trained problem solvers lead improvement efforts." Changes are made in the equipment and supporting work processes and people are trained in the new methods.

Where else do we see these four rules in action? Have you watched any of the top NASCAR Winston Cup race teams lately? Much of their work is governed by these same rules whether they know it or not. Whether at the track or in the shops, these teams demonstrate the concepts of the four rules in action.

Toyota Production System

The four rules that define how the Toyota Production System works are:

Rule 1: All work shall be highly specified as to content, sequence, timing, and outcome.
Rule 2: Every customer-supplier connection must be direct, and there must be an unambiguous yes-no way to send requests and receive responses.
Rule 3: The pathway for every product and service must be simple and direct.
Rule 4: Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level in the organization.

From "Decoding the DNA of the Toyota Production System," Harvard Business Review, September-October 1999, H. Kent Bowen and Steven Spear

The discipline of TPM and North American culture

When we explore the inner workings of the Toyota Production System along with TPM successes and the literature, it becomes obvious that it takes discipline in the workplace to accomplish TPM in a sustainable manner. Workplace discipline obviously varies from place to place and industry to industry. The four rules described above define the basic structure of workplace discipline.

Let;s look at workplace discipline in action. Take, for example, the aircraft maintenance industry. There is a high degree of discipline present from the certifications of those who perform the maintenance to the suppliers of parts and materials used on the job.

Procedures are highly specific and documentation abounds. Consequently, we do not experience a problem with aircraft falling from the skies. With over 27,000 take-offs and landings every day in the U.S., aircraft crashes due to equipment failure rarely happen.

Now, let's look at NASCAR Winston Cup racing; the best-of-the-best in stock car racing depend on reliable equipment to do their job and earn their sponsors financial support. First and foremost the racecars must meet rigid safety guidelines. Then they must be reliable--"if you can't finish you can't win." To achieve 100 percent reliability there is not only a workplace discipline but a discipline of teamwork.

In the petroleum exploration and producing business there is extensive use of pumps, internal combustion engines, and compressors. Getting oil and gas out of the ground and back into the pipelines, or re-injection wells, depends on reliable equipment. Because of the harsh operating environment in many oil fields, equipment availability can be well below optimum. Our experience has shown that even in the middle of the Alaskan tundra 30-year-old integral engine/compressors have run well over 8 yrs without a breakdown. While in the Gulf of Mexico the same unit has breakdowns weekly and major overhauls every 18 mo to 2 yrs. What is the difference we saw? Discipline in the workplace in the Alaska facilities that we did not see in the Gulf--equipment was properly restored, religiously maintained, and operated according to good reliability practices.

We have all been in plants where there is a complacent attitude about equipment maintenance and reliability. "Equipment is expected to fail." Maintenance is primarily reactive. Preventive maintenance plans are sketchy, often ignored, and not used because "we're experienced and don't need that sheet." Spare parts are stored in conditions that significantly reduce their useful life. People often ignore the early warning signs of pending failure. And, there are at least 10 reasons why "we can't change the way we do things around here." These all represent a lack of discipline in the workplace.

TPM requires leadership to be effective from the start. That is part of the meaning of "total" in Total Productive Maintenance. Without effective leadership that links TPM efforts to the business and holds people accountable for performing "highly specified work," equipment

performance and reliability will continue to decline and TPM initiatives will be short lived. Seems easy enough to correct. But it's not. Many of today's business leaders came up through the ranks when maintenance was responsible for "fixing things." The recent focus on reliability and performance was not in their upbringing. Coupled with that, maintenance is often seen by them as a nonvalue adding support to the business and is often subjected to cutbacks so that the core value-adding work can sustain the business revenue stream.

So, where will workplace discipline come from that will enable TPM to truly lead to improved equipment performance and reliability? Oh, if we could only change the work culture with the wave of a magic wand.

Focus on results and change the culture along the way

One sure way to get the attention of business leaders and decision makers is to show bottom line results quickly and in a sustainable manner. Unfortunately, implementing TPM over a three- to five-year period may not work fast enough in our dynamic global economy. Results may be achieved, but it takes a gigantic, long-term leap of faith. However, generating quick bottom-line results may provide the kind of breakthrough for which business leaders and plant floor people have been looking.

The best way to generate those quick bottom-line results and make a big impact on the work culture is to begin TPM in areas of the plant or facility that are plagued with equipment problems, or in high-maintenance cost areas, or on equipment that takes lots of tending. In manufacturing, focus TPM on the constraints or the bottlenecks in production and eliminate the causes of poor performance. Using all six key elements of TPM to eliminate equipment-related losses in this manner is truly a breakthrough strategy. Bottom-line results will be achieved quickly, people can see and measure the difference, and the new workplace discipline can be showcased then leveraged to improve other areas.

Total Productive Maintenance must be fully understood not only in terms of its six key elements and features but also in terms of the workplace discipline to be successful. On the contrary, if TPM is misunderstood and misapplied like many other improvement programs that have come along over the past few decades it too will fall on the pile of "we tried that" which litter our business landscape. Learn what TPM is, what it truly is, and don't take any shortcuts along the way to improving equipment effectiveness. There is no doubt that TPM works when properly implemented. Your opportunity is to do it right the first time, every time. **MT**

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