Written by Ricky Smith, Life Cycle Engineering, Inc
Friday, 01 October 2004 13:26

Elements that need to be in place for success

Much has been written about lean manufacturing and the lean enterprise—enough that nearly all readers are familiar with the concepts as well as the phrases themselves. But what about lean maintenance?

Is it merely a subset of lean manufacturing? Is it a natural fall-in-behind spinoff result of adopting lean manufacturing practices? Much to the chagrin of many manufacturing companies, whose attempts at implementing lean practices have failed ignominiously, lean maintenance is neither a subset nor a spinoff of lean manufacturing. It is instead a prerequisite for success as a lean manufacturer. This article will explain why.

The definition

The best starting point is to define lean maintenance:

Lean maintenance is a proactive maintenance operation employing planned and scheduled maintenance activities through total productive maintenance (TPM) practices using maintenance strategies developed through application of reliability centered maintenance (RCM) decision logic and practiced by empowered (self-directed) action teams using the 5S process, weekly Kaizen improvement events, and autonomous maintenance together with multi-skilled, maintenance technician-performed maintenance through the committed use of their work order system and their computer managed maintenance system (CMMS) or enterprise asset management (EAM) system. They are supported by a distributed, lean maintenance/MRO storeroom that provides parts and materials on a just-in-time (JIT) basis and backed by a maintenance and reliability engineering group that performs root cause failure analysis (RCFA), failed part analysis, maintenance procedure effectiveness analysis, predictive maintenance (PdM) analysis, and trending and analysis of condition monitoring results.

That is lean maintenance in a nutshell, albeit a rather large nut (except for a few details that were omitted here but will be covered later in the article). Let's discuss the highpoints of this definition to be sure everyone understands the terms used:

• Proactive. This is the opposite of reactive where the maintenance operation reacts to equipment failures by performing repairs. In the proactive maintenance operation the

prevention of equipment failures through performance of preventive and predictive maintenance actions is the objective. Repair is not equivalent to maintenance.

• Planned and scheduled. Planned maintenance involves the use of documented maintenance tasks that identify task action steps, labor resource requirements, parts and materials requirements, time to perform, and technical references. Scheduled maintenance is the prioritization of the work, issuance of a work order, assignment of available labor resources, designation of the time period to perform the task (coordinated with operations/production), and breakout and staging of parts and materials.

• Total productive maintenance. TPM is the foundation of lean maintenance. It is an initiative for optimizing the reliability and effectiveness of manufacturing equipment. TPM is team-based, proactive maintenance and involves every level and function in the organization, from top executives to the shop floor. TPM addresses the entire production system life cycle and builds a solid, shop floor-based system to prevent all losses. TPM objectives include the elimination of all accidents, defects, and breakdowns.

• Reliability centered maintenance. RCM is a process used to determine the maintenance requirements of physical assets in their present operating context. While TPM objectives focus on maintaining equipment reliability and effectiveness, RCM focuses on optimizing maintenance effectiveness.

• Empowered (self-directed) action teams. Action team activities are task-oriented and designed with a strong performance focus. The team is organized to perform whole and integrated tasks, hence requiring multi-department membership. The team should have defined autonomy (that is, control over many of its own administrative functions such as self-evaluation and self-regulation—all with limits defined). Furthermore, members should participate in the selection of new team members. Multiple skills are valued. This encourages people to adapt to planned changes or occurrence of unanticipated events.

• 5S process. There are five activities for improving the work place environment: sort (remove unnecessary items), straighten (organize), scrub (clean everything), standardize (standard

routine to sort, straighten, and scrub), and spread (expand the process to other areas).

• Kaizen improvement events. Kaizen is the philosophy of continuous improvement, that every process can and should be continually evaluated and improved in terms of time required, resources used, resultant quality, and other aspects relevant to the process. These events are often referred to as a Kaizen blitz—a fast turnaround (1 week or less) application of Kaizen improvement tools to realize quick results.

• Autonomous maintenance. This refers to routine maintenance (e.g., equipment cleaning, lubrication, etc.) performed by the production line operator. The maintenance manager and production manager will need to agree on and establish policy for where in the production processes autonomous maintenance will be performed, what level and types of maintenance the operators will perform, and how the work process for autonomous maintenance will flow. Specific training in the performance of designated maintenance responsibilities must be provided to the operators prior to assigning them autonomous maintenance responsibilities.

• Multi-skilled, maintenance technician. Multi-skilled maintenance technicians are becoming more valuable in modern manufacturing plants employing PLCs, PC-based equipment and process control, automated testing, remote process monitoring and control, and similar modern production systems. Maintenance technicians who can test and operate these systems as well as make mechanical and electrical adjustments, calibrations, and parts replacement obviate the need for multiple crafts in many maintenance tasks. The plant processes should determine the need for and advantages of including multiple skills training in the overall training plan.

• Work order system. This system is used to plan, assign, and schedule all maintenance work and to acquire equipment performance and reliability data for development of equipment histories. The work order is the backbone of a proactive maintenance organization's work execution, information input, and feedback from the CMMS. All work must be captured on a work order—8 hours on the job equals 8 hours on work orders. The types of work orders will include categories such as planned/scheduled, corrective, emergency, etc. The work order will be the primary tool for managing labor resources and measuring department effectiveness.

• Computer managed maintenance system. The information (maintenance) management software system performs, as a minimum, work order management, planning function,

scheduling function, equipment history accumulation, budget/cost function, labor resource management, spares management, and a reports function that utilizes key performance indicators (KPI). To be effective, the CMMS must be fully implemented with complete and accurate equipment data, parts and materials data, and maintenance plans and procedures.

• Enterprise asset management. The EAM system performs the same functions that the CMMS does but on a more organization-wide, integrated basis, incorporating all sites and assets of a corporation. Even broader enterprise systems incorporate fully integrated modules for all the major processes in the entire organization and offer the promise to effectively integrate all the information flows in the organization.

• Distributed, lean maintenance/MRO storeroom. Several stores locations replace the centralized storeroom in order to place area-specific parts and materials closer to their point-of-use. Lean stores employ standardized materials for common application usage. The lean stores operation also employs planning and forecasting techniques to stabilize the purchasing and storeroom management process. This method requires that a long-term equipment plan is developed and equipment bills of material (BOM) are entered into the CMMS as soon as the purchase order for new equipment is issued.

• Parts and materials on a just-in-time basis. Stores inventories are drastically reduced (as are the costs of carrying large inventories) through a strong supply chain management team that uses JIT suppliers, and practices such as vendor-managed inventories in which the vendor is given the responsibility for maintaining good inventory practices in replenishment, in ordering, and in issuing the materials. The vendor is charged with the responsibility of controlling costs and inventory levels, the sharing of information with the facility, and making improvements in the process.

The supply chain management team advocates day-to-day supplier communication and cooperation, free exchange of business and technical information, responsive win-win decision-making, and supplier profit sharing.

• Maintenance and reliability engineering group. Because statistics indicate that up to 70 percent of equipment failures are self-induced, a major responsibility of maintenance engineering involves discovery of the causes of all failures. Reliability engineering is a major responsibility of a maintenance engineering group.

Their responsibilities in this area also include evaluating preventive maintenance action effectiveness, developing PdM techniques/procedures, performing condition monitoring/equipment testing, and employing engineering techniques to extend equipment life, including specifications for new/rebuilt equipment, precision rebuild and installation, failed-part analysis, root cause failure analysis, reliability engineering, rebuild certification/verification, age exploration, and recurrence control.

Other terms

Here are descriptions of some of the terms related to the maintenance and reliability engineering group:

• Root cause failure analysis. One of the most important functions of the maintenance engineering group is RCFA. Failures are seldom planned for and usually surprise both maintenance and production personnel and they nearly always result in lost production. Finding the underlying, or root, cause of a failure provides an organization with a solvable problem, removing the mystery of why equipment failed. Once the root cause is identified, a fix can be developed and implemented.

There are many methods available for performing RCFA, such as the Ishikawa, or Fishbone, diagramming technique; the events and causal factor analysis; change analysis; barrier analysis; management oversight and risk tree (MORT) approach; human performance evaluation; and the Kepner-Tregoe problem-solving and decision-making process.

• Failed part analysis. Examination, testing, and/or analysis by maintenance engineering on failed parts and components, removed from equipment, determines whether the parts were defective or an external influence, such as operating conditions, faulty installation technique or other influence, caused the failure. Physical examination is often required in order to determine where to begin RCFA. For example, when a bearing fails the mode of failure must be determined by examining the bearing,. If electrical erosion/pitting is found, then stray ground currents (the cause of electrical pitting in bearings) must be found and eliminated.

• Procedure effectiveness analysis. Among the responsibilities of maintenance engineering for the establishment and execution of maintenance optimization is the use of CMMS-generated unscheduled and emergency reports and planned/preventive maintenance reports to

determine high-cost areas, and establish methodologies for CMMS trending and analysis of all maintenance data to make recommendations for changes to preventive maintenance frequencies, corrective maintenance criteria, and overhaul criteria/frequency. It also must identify the need for the addition or deletion of PMs, establish assessment processes to fine-tune the program, and establish performance standards for each piece of equipment. The maintenance engineering group also establishes adjustment, test, and inspection frequencies based on equipment operating (history) experience.

Additional responsibilities include the optimization of test and inspection methods and the introduction of effective advanced test and inspection methods. Maintenance engineering performs periodic reviews of equipment on the corrective maintenance (CM)/PdM program to delete that equipment no longer requiring CM/PdM, or to add to the CM/PdM program any equipment or other items as appropriate. The maintenance engineering group also communicates problems and possible solutions to involved personnel and controls the direction and cost of the CM/PdM program.

• PdM analysis. A major role of maintenance engineering is optimizing maintenance. One of the most widely used tools in this regard is PdM to forecast necessary maintenance actions. Depending on the quantity and kinds of production equipment in a plant, the array of PdM techniques can range from as few as two or three to as many as 10 or more. Whether a PdM technique is outsourced or performed in-house, the results and recommendations must be analyzed by maintenance engineering and maintenance actions scheduled prior to predicted failure or out-of-specification condition.

• Trending and analysis of condition monitoring. Condition monitoring, actually a subset of predictive maintenance, usually involves the use of installed metrology (gauges, meters, etc.) to derive the equipment's operating condition. Examples can be as simple as a differential pressure gauge across a filter or the head-flow characteristics of a pump.

Maintenance engineering must establish operating limits for the condition(s) being monitored and trend the observed data, obtained from a log sheet or planned maintenance procedure, to determine when the operating limits will be exceeded so that required maintenance can be performed. This is referred to as condition-based maintenance and can be both more effective and less costly than periodic or fixed frequency maintenance.

Leadership changes

The foregoing provides a good, basic definition of lean maintenance by describing the activities and job responsibilities of those involved in the lean maintenance operation. Lean maintenance is also about fundamental changes in attitudes and leadership roles. In the lean environment the shop floor-level employee is recognized as the company's most valuable asset. Management and supervisory roles change from that of directing and controlling, to a role of supporting.

The lean maintenance organization is a flat organization with fewer layers of middle management and supervision because, with the establishment of empowered action teams, much of their direction comes from within. The remaining supervisors spend the majority of their time on the shop floor providing technical advice and guidance and identifying first-hand the problems and needs of the action teams.

The foundation elements, in particular TPM, must be in place before an organization can effectively build on the maintenance management pyramid with elements such as autonomous maintenance and before it can sustain continuous improvement.

A company transitioning to lean manufacturing will not have a sound basis of maintenance support without first implementing many of these necessary and fundamental changes in the maintenance operation. As the foundation of lean maintenance, TPM must be operating and effective, as shown by the key performance indicators, prior to launching a plant's lean manufacturing initiative. **MT**

Ricky Smith is the executive director of maintenance solutions at Life Cycle Engineering, Inc., 4360 Corporate Rd., Ste. 100, North Charleston, SC 29405-7445; (843) 744-7110