The Journey to RCM (Reliability Centered Maintenance)

Evolution: From Firefighter to Technician

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The term Reliability Centered Maintenance (RCM) is becoming a more popular term each year as companies move into the thought process of how to make their equipment and processes more efficient. The process was developed in the late 60s and early 70s by two workers at United Airlines. They were at the time looking for a justifiable reason to perform each maintenance task on a commercial airliner. The completion of this task resulted in great savings for the airline industry and improved reliability and functionality of commercial aircraft. All of us in industry would love to have the same reliability and safety record of the airline industry.

Over the remainder of this two-part article we will review the four major types of maintenance that are used in the manufacturing world. The progression through this evolution will guide us to the process of RCM. RCM is a very effective tool to improve maintenance and operation efficiencies, but you have to establish some fundamental elements before it can be highly effective. The four methods of maintenance we will discuss in the article are: Reactive, Preventive, Predictive, and Proactive.

Being involved in maintenance activities for the last 25 years has been an evolution for myself and the industrial world, or at least it should have been. I have transformed from the firefighting mode in reacting to equipment failures to the world of predicting failures, and now to the current evolutionary world of being proactive in extending equipment life. This is doing the right things at the right time while the equipment is running at its peak performance level.

How did this progression take place? I remember my first experiences with maintenance operations, and how I observed the work being performed. I first noticed that with eight maintenance people, they all performed similar functions in many different ways. Each had their own method of changing a bearing, installing a set of belts, or changing a roller chain. I knew to be effective we had to be consistent and do things right the first time.

- Was there only one way to do each task?
- Was my way the best way?
- What makes the difference anyway?

All tasks do have a best way to perform the basic functions of the task to end up with a consistent result. There can be variances in some of the hands-on work, but all the tasks should have written procedures to assure consistent work results. At first I tried to impose that my way was the best way and realized I was way off on this one. The best way was the group discussion and decision on how we would perform each task. The team did not always agree one hundred percent, but we did agree to agree on our decision. In most examples it was the maintenance personnel who actually wrote the procedures after we agreed on the method. The procedures included all the parts, tools, precision tasks, and safety procedures for the task. This was the start of work planning which is a Proactive Method.

The UE Ultraprobe 10,000, left, can detect bearing failures in the very early stages of failure. In the photo on the right, you can see the predictive technique used in the 1970s for detecting bearing failures, and possibly the fault correction tool.

What makes the difference? Many equipment failure modes result from poor rebuild or installation practices. It's hard to believe, but we can rebuild a piece of equipment and it may have more failure potential than it had before the rebuild. Training and written procedures reduce the chances that these practices are used in our maintenance work functions. Consistency in the work methods is the key to reducing these failures. This is exactly what United Airlines discovered in the RCM process study. Many scheduled rebuilds of airlines engines and components were leading to early failures after the rebuild. This is called infant mortality. The US Navy found in a study that failures after rebuilds were much lower. Why? They have written procedures for all tasks!

Next was the transformation of improving individual job skills. The second item I noticed was that we would send two people to perform each task. As I watched the work process I noticed that one maintenance person was the technician and the other was the runner. By the "runner" I mean that since the job wasn't planned, one of the maintenance people became the parts and tool fetcher. We even gave them nicknames like "Tote." Well, to be effective and efficient I needed eight technicians, not four technicians and four runners. This new way of working by yourself was not well received by the crew, but after a few months their planning skills in preparing for the job tasks improved and the eight technicians were evolving. They were preparing the tools and the parts they needed to perform each job. I remember the comment I used nearly every week in training sessions, "One person can do anything by himself, and even build a pyramid, if they will plan the work."

Reactive Maintenance

Firefighters in the maintenance world are the maintenance people who exist to fix things that are functionally failed in the quickest possible method. Not necessarily using the written procedures, but getting equipment up and running using what we sometimes referred to as the fifth maintenance method, "Creative Maintenance." An example is using wood blocks to help hold a shaft when a bearing is failing. And we were very good at both. I had developed the best crew in the USA at fixing breakdowns faster than anyone else. We had training meetings and discussed what we could do to be ready for failures and have the quickest response and repair as possible. We set up tool kits and specific equipment to be ready on a moments notice. We even at one point worked as a group to plan the building of an "Emergency Downtime Trailer" that would hold all the tools and parts needed to fix anything that would break.

And Response Time. We were very proud of the fact that we would race to the plant and work quickly and hard to get the plant back on line. We enjoyed our "hero status" of saving the day and strutted and boasted of our success. Many times I would reward the crew with food or gifts for our great successes in this maintenance method. I would even answer the phone at two o'clock in the morning like I was wide awake and would also respond to the calls so I could be part of the effort.

So what is wrong with being great at something? It's not the success at what we were trying to do, but it was like training for a marathon by only practicing crossing the finish line. We were not preparing ourselves for the job of keeping the fires from starting. You can't compete in the main event and expect to even make it to the finish line in front of the competition. You can't compete in the manufacturing industry without preventing the fires (failures) from starting.

Was it age, wisdom, or knowledge that forced the evolution out of the Reactive Method? My first motivation was my wife. I remember her saying, "If that phone rings one more time at two in the morning you are moving to the basement!" Enough said, lets move on to what we need to do. We started having meetings at every failure to decide what to do to make sure this doesn't happen again. Yes, we were still doing some reactive work, but we had started our first attempt at RCA (Root Cause Analysis) in the mid 80s. We then started redesigning processes with better bearings, bigger shafts, and whatever it took to make it more reliable. This was our first experience in our plant with RCD (Reliability Centered Design). These are Proactive tools which we will review later in the article. This was the start of our transformation to a Preventive Maintenance process that will be reviewed in our next evolution step.

Preventive Maintenance

The next method of maintenance is preventive maintenance. As we progressed from being reactive, we decided that we had better be making more inspections and following the O.E.M. (original equipment manufactures) requirements for the equipment maintenance. To accomplish this we needed to develop a systematic approach to make sure we covered all the equipment and equipment functions. In this type of maintenance approach, we set up many different programs to perform inspections, lubrication, and make adjustments. What did all these tasks accomplish?

Inspections

Inspections would incorporate many different functions ranging from use of the human senses to using equipment to gather information. So what could the human senses tell us? The goal at this time was to physically check every piece of equipment once per week. While we were at the equipment we would use our human senses to detect possible failure modes. Using the sense of feel we would touch the equipment to not only feel for temperature abnormalities but sense vibration issues coming from the equipment. We would use the sense of sight to look for visual problems. The sense of hearing lets

us determine changes in the audio frequencies from the equipment. And finally the sense of smell, which can detect odors from oxidizing of lubricants and foreign material or tell us that something is burning. As far as I know, the crew did not use the sense of taste for inspections, but I had a few I wondered about.

Inspections using detection equipment included the U.E. Ultrasonic device. This device can detect ultrasonic frequencies from bearings that are in the early stages of failure. As bearings enter the failure state, the frequency generated by the bearing increases and further increases until it fails. This equipment was used with a baseline established, and when the equipment bearing would get above the baseline, the equipment would be scheduled for replacement. This was our beginning of the Predictive type of maintenance method. Other inspection tools that were used in the 80s and early 90s were handheld temperature devices, UE's ultrasonic listening devices for gearbox internals, and balance checks.

Lubrication routes were set up to check oil levels and condition along with applying grease to all bearings. At this time, all bearings were greased every week whether they operated or not. Some maintenance personnel would make a judgment and not grease if the equipment had not operated but others greased because it was the procedure. At this time we all thought more grease is better and this surely can't hurt anything. And the amount we added to each bearing was a very scientific formula developed by yours truly. I didn't think I needed an MBA from Northwestern University to figure this out. If it was a 1-inch bearing, it received one shot per week, a 2-inch bearing would receive two shots per week. You can figure out the rest. Did it make any difference how fast it was turning? Until the early 90s, more was usually better!

Through our rigorous inspection program we were able to get the maximum life from every component. We were running gearboxes, belts, and chains to the last hours of operation. And we all thought this was the goal—to maximize the life of the component. In doing this we didn't realize that we were creating collateral damage of multiple parts in our equipment and were making some equipment impossible to bring back to like-new standards in the rebuild process.

> **Example:** When you know a gearbox has a failure through PM inspection and you do not remove and rebuild at the earliest detection, you damage other components in the gearbox. Your first detection may be a single bearing failure, and by continuing to operate the unit, you damage shafts, gears, and bearing bores. This takes many more expensive parts and in some cases destroys the unit. When you operate a roller chain too long, the sprockets are damaged which will wear out the next chain you install. The same thing happens with belts and sheaves.

Our preventive program was working well in the 80s, how I'm not sure. We had a long run at being the best in equipment run time and operating hours above everyone else. We had less emergency and scheduled downtime than other plants doing the same operation. I even wrote some articles in the 80s on our successes—hope none of those are still around! Our program was working, and our costs were under control. How could anything be better?

The main purpose of the RCM process is to make a logical decision on what preventive maintenance is performed on what components. Most times we just do preventive maintenance because it's the way we always did it, the vendor recommends it, or it just makes sense to do it.

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Next month: Predictive Maintenance and Proactive Maintenance.