RCM in a Nutshell: The Learnings of Mac Smith

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This is an edited transcript of a one-hour webinar presented on Nov. 14 at the request and sponsorship of Marie Getsug, Chair and on behalf of the SMRP Pharma & Biotech Special Interest Group. Its intent is to share the author's experience of 30 years with classical RCM on selected questions supplied by SMRP attendees at the SMRP Annual Conference.

Our format for this webinar consists of six topics or questions dealing with RCM that were selected from several suggestions given to us by SMRP members. We could easily have had 20 or more topics, but there was an obvious limit to what could be reasonably presented in one hour. So I hope that our selections will prove to be items that will interest you.

Our first topic is simply the question "What is RCM?" Over the past 30 years, I have asked this question in at least 100 Seminars and Training classes.Statistically, the responses fall into three categories:

1. How many have ever heard of RCM? *Currently I get a 100% yes response.*
2. How many of you can honestly say "I know exactly what RCM is? *The yes response here drops to about 33%.*
3. Finally, how many of you have actively participated in at least one full-blown RCM analysis of a plant or facility system? *The yes response here falls to 10% or less.* In other words, even though RCM has been here since the 1960s, it still has a long way to go in broader application to our maintenance strategy throughout U.S. industry. Given its success record in certain areas, this is to me, somewhat surprising.

So let's answer the question "Just what is RCM?" Many of you may know its historical origin in the 1960s when United Airlines, under the direction of Tom Matteson (then VP of maintenance planning) and his small team, developed what we today call RCM for solving how the commercial airplane industry would implement a maintenance program for the 747-100 airplane. In fact, this approach was so successful that every U.S. commercial airplane since then uses the RCM methodology to specify its initial maintenance program to the FAA in order to obtain its type certificate. The full and precise definition of RCM contains just four principles or features as follows:

1. *Preserve System Function* or conversely avoid system functional failure. Notice that this first feature does NOT say anything about equipment. Function is what a system does for a plant of facility—like provide boiler feedwater or provide clean compressed air. (These statements give no hint or definition of what hardware is involved in successfully achieving those functions.) This aspect of RCM is a hallmark of its departure from the conventional maintenance mindset of directly asking to preserve equipment. *It is function that will focus our resources.*

2. Now, we obviously must make a connection between function and equipment, and this is done in feature #2. Namely, look at the system design in detail and meticulously go one-by-one to each component in the system and ascertain *what failure mode (if any) could occur that may lead to a functional failure.* This list now becomes the focus of our attention because each of the failure modes thus identified may be the culprits that deserve specific attention in our maintenance strategy.

3. And this leads us to our third RCM feature. Of the failure modes listed in Step 2, *which ones are truly critical* to our operation? We use a decision logic tree to answer this question (some of you may be familiar with this), and put failure modes into the following categories:

A. If it occurs, we violate a given safety or environmental requirement.
B. If it occurs, it will result in a partial or full outage for the plant.
C. Neither A or B occurs, so from a function viewpoint, the failure mode is essentially benign. (Enter the possibility that such failure modes are possible run-to-failure candidates).
D. Finally, we ask if each failure mode would be known to the system operator, if it should occur. If NO, we have identified what we call a hidden failure; a very special area of concern to us if it is not only hidden, but also a safety or outage issue.

4. Finally, in the 4th RCM Feature for the critical failure modes, we now must *define the PM task* to implement, assuring a proactive approach to its prevention, mitigation or discovery if it is hidden.

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In a nutshell, RCM is these four features: Nothing more or less. One caveat in an RCM analysis is that all four features must be addressed. An analysis that ignores or short circuits any one or more of these features may be what you wanted to do, but it is *not* an RCM analysis and should not be labeled as such. Not to belabor this point, but there have been several instances over the years where this has occurred with ultimately less than successful results, and labeling this as RCM led some people to conclude that RCM does not deliver what was expected. Not an accurate picture. Enough said!

Moving on to our second topic, I am frequently asked to express my views on similarities and differences between classical RCM and RCM2. I am the classical RCM guy, and a very good well-qualified friend of mine: John Moubray, the RCM2 guy. By the way, all other forms of RCM that you may have seen are in one way or another are derivatives of classical RCM or RCM2.

A brief word about John Moubray. John suddenly passed away about five years ago, and the maintenance community lost a true giant in the world of creative maintenance thinking and strategy. John and I had more similarities than differences and this was because we both learned the RCM process from the inventors at United Airlines. I learned from Tom Matteson, and John, from one of Tom's chief lieutenants, Stan Nowland, whom I also knew, and he also passed away several years ago.

So, given philosophically that John and I were on the same page, what are the differences? Well, as the saying goes, the devil is in the details. Here are a couple of the important ones.

1. The classical RCM process starts with the premise that every plant typically has what are called 80/20 systems: That is 80% of your maintenance grief comes from only 20% of the plant systems. And it is absolutely uncanny how true this rule applies, no matter what plant or facility is involved. Twenty percent of the systems are the culprits that, as we say, eat your lunch. In the classical RCM world, my view is that these systems alone are the ones that deserve the majority of our individual attention and the focus of our scarce and precious resources. (There are other less resource-consuming areas that we can use for the lesser critical or 20/80 systems—more later on this). John and RCM2, on the other hand, preach that *every* system of a plant needs the full RCM treatment. On this I respectfully disagree.

2. Another item of difference that deserves mention involves the manner in which the second RCM feature is accomplished. That is, how do we go about connecting potential equipment problems with its ability to initiate a functional failure? Both processes use the failure mode and effects analysis (FMEA) approach, but differ in two important ways on how an analyst is instructed to use it. These differences, by the way, are visibly displayed in the respective software forms that are used to record the FMEA data.

- In the first instance, the classical RCM uses two separate columns to record both the failure mode and then the related estimate of the failure cause. With RCM2, there is a single column to record what is labeled failure mode but it is parenthetically subtitled failure cause. In other words, RCM2 basically makes no distinction between failure mode and failure cause. I will discuss in a moment why I feel this is a fundamental and important mistake.

- In the second instance, classical RCM requires that the effect part of the FMEA be recorded for each failure mode at *three* levels of assembly: Local level for the specific equipment involved, the system level in which that equipment resides, and finally at the plant level. Using these three levels assures the analyst must carefully consider the possible *cascading* consequences of the failure mode all way through to its possible effect on the entire plant. RCM2, however, has a single column to record failure effect, and this tends to *precipitate an inconsistent portrayal* of the failure mode consequences, which is sometimes recorded only as a local effect, sometimes only a system effect and sometimes only a plant effect. The problem is that, absent a complete picture of failure effect at all three levels, a later difficulty arises in assuring an accurate determination of the potential safety or outage criticality imposed by the failure mode.
- A third area of concern in the FMEA is the manner in which RCM2 records the selection of a PM task for each critical failure mode. In the classical RCM process, the documentation requires that *all* reasonable PM actions that were proposed be recorded; not just the final selection. In RCM2, only the selected PM task is recorded. Since these RCM analyses are often revisited for a variety of reasons, I have found it very useful to know all of the task options that were originally considered, especially if the original selection does not seem to be providing the expected result, and we must now look for an alternate PM task solution.

But, as I said a moment ago, the devil is in the details of how we go about analyzing the four RCM features though both methods retain these four features and satisfy the recognized SAE RCM Std JA 1011.

I would now like to move on to our third topic and return to our discussion of a few moments ago about the distinction between failure mode and failure cause in the FMEA, and how the classical process strongly believes that these are two distinctly different concepts while RCM2 views them as synonymous terms. Let's look at some generally accepted definition of these terms. Very simply, the failure mode describes what went wrong, and is usually defined in two or three words; one of which is a verb, e.g., "connecting shaft *cracks*" or "pipe joint *leaks*." Failure cause, on the other hand, describes "why it went wrong," such as "low cycle fatigue" or "gasket age deterioration," respectively for the two failure mode samples. Each of the same 80 RCM studies in which I have participated contain anywhere from 100 to 200 or more such separate lists of failure modes and related failure causes like these two examples. And here is why this separation of these two terms is absolutely necessary. Our maintenance strategy is ultimately to specify the task definitions that will be used to issue PM work orders that benefit the elimination or mitigation of the failure *modes.* We know how to avoid or mitigate the occurrence of shaft cracks (e.g., vibration monitoring or alignment checks), but we do not know how to write a work order for maintenance techs that will stop low cycle fatigue. Likewise, we know how to write a work order to avoid serious leaks (e.g., tighten the joints periodically, or just inspect periodically for signs of leakage), but we do not know how to write work orders to stop the natural degradation that occurs over time with gasket materials.

Stated somewhat differently, it is the failure mode that ultimately eats our lunch and directly results in a corrective maintenance action and possibly a plant or system outage, and from a maintenance strategy point of view, it is the failure mode that our maintenance techs and craft people can effectively stop or mitigate before it gives us that unwanted failure effect. Conversely, maintenance work orders cannot address realistically the elimination or mitigation of a failure

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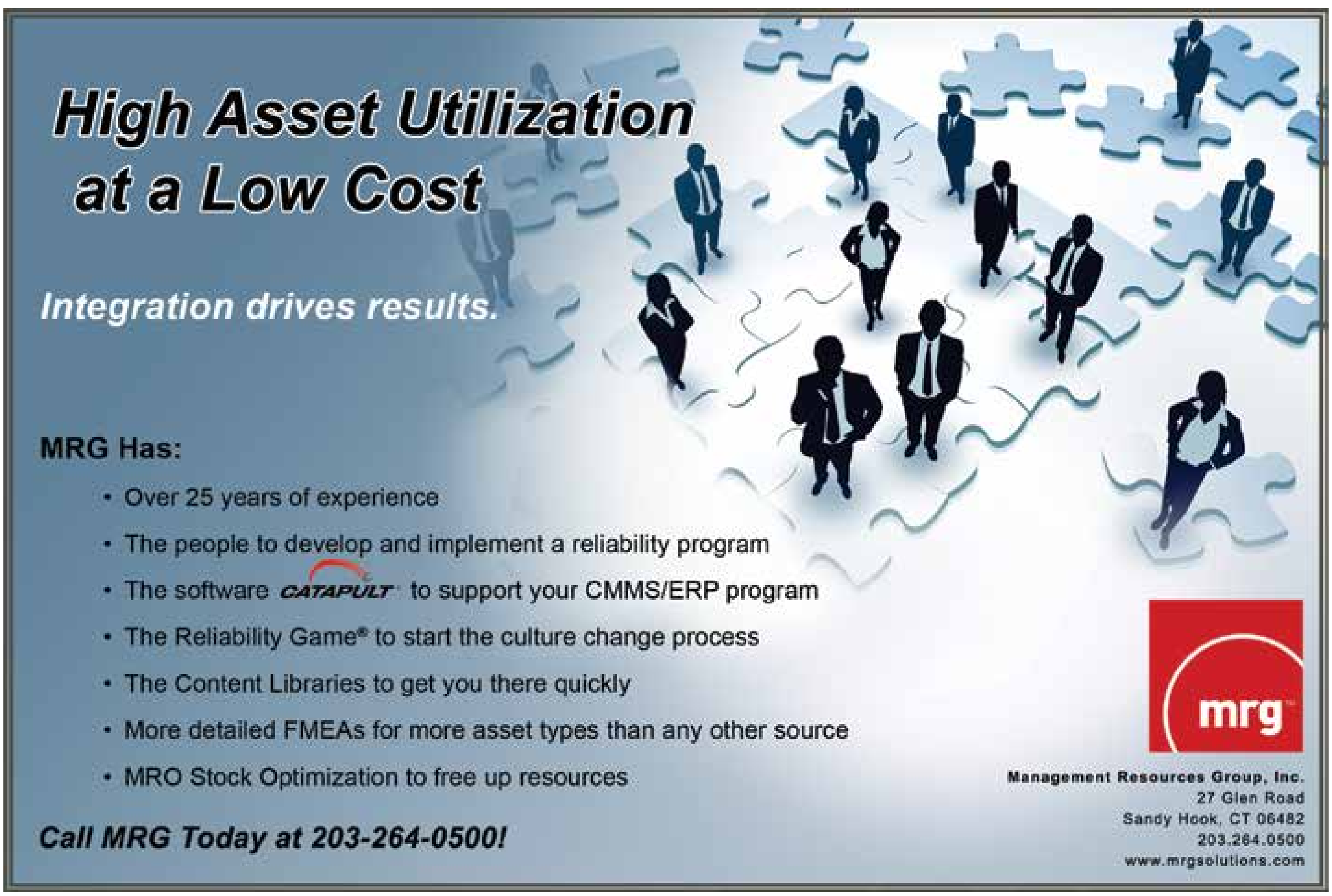
cause! However, what an accurate estimate of failure causes can do for us is provide the information for a design or operating procedure change if we wish to undertake capital improvement projects, which of course many of us exactly do. Elimination or mitigation of failure cause is essentially a *design* issue—while elimination or mitigation of a failure mode is essentially a *maintenance* issue.

If we mix up the two terms, I find it difficult, if not impossible to define what maintenance action we can take versus what design change action we should consider!

The fourth topic I want to briefly address is the business of selling RCM and the related challenge of gaining an organization to buy in to an RCM program.

I don't think that it will come as a surprise to anyone in this audience, that the single most important consideration to selling RCM is money, or perhaps more specifically, return on investment (ROI). Introducing RCM into the O&M side of a plant or facility organization requires their top management team must decide to commit some of their staff resources, mainly the O&M supervisors and technicians, to the job of performing the RCM studies, and then taking the necessary actions to implement the findings. The biggest hurdle in my experience is to get their okay to do a pilot project to see just how it will work within their plant and



culture. They will be considering the cost of resources needed to do this—both from consultants and their own staff—versus what they can expect in terms of ROI. Based on the outcome of that pilot project experience, they will eventually decide on go or no go for more extensive RCM applications in their plant. Using the 80/20 approach, I have not found it too difficult to convince the O&M management to initially try the pilot study. But whether or not they will further commit to more extensive use of RCM will rest almost totally on the outcome of that pilot project. So if you find yourself in the position of "chief salesperson" with a client or within your company, it behooves you to play a key role in selecting both the system for the pilot project as well as the staff personnel who will play the active role in supplying the data and information for the RCM analysis. For example, don't be swayed to let the system selection go to a "simple" (20/80) non-critical system because this sets you up to fail the ROI test (by definition, there is not much potential for an eye-catching ROI with one of those non-critical systems. Go for the one that is eating your lunch). Also, don't be swayed to let the crucial team player selections be the second string because chances are they are not the ones who will produce the depth of equipment and plant knowledge needed to accurately fill in the blanks during the analysis. And, make no mistake, the proper data base for the RCM analysis will be the "A" team of craft technicians.

Now, if you succeed in meeting the ROI test, your next challenge will be to gain the buy-in from the larger O&M population. You now have a small handful of converts from the successful pilot project, but to make this become a plant wide program, a majority of their peer technicians must be brought on board. And no matter what you try, it will not happen overnight. Let me suggest three factors that can be pursued to help change the organization mind-set from "preserve equipment" to "preserve function."

A. Embark on a steady program of E&T about RCM and its potential benefits to everyone in the plant who could have any possible interface with the RCM analysis and implementation phases. People tend to automatically resist change in their current modus operandi and will dig in their heels if they do not have the slightest idea what this RCM thing is all about. You should count on your people who have actually experienced the successful pilot project to be key participants in your E&T efforts. Buy-in at the grass roots level is now the important path to pursue to maintain the sustainability of your successful pilot project.

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B. Maintain program visibility at the management level on what is happening and what is planned. Define KPIs, which should be religiously tracked and frequently reviewed with management. You must keep management on your side and not let them lose track of the fact that ROI is continuing to trend in the right direction.

C. Seriously consider designating a key person into the position of "RCM Champion" who will be responsible for assuring that the above two points will be done.

You may have heard some statistics on success vs. failure with RCM projects. Here is the track record with my classical RCM experience of 30 years: About 60% succeed, and 40% either never get off the ground or stall after the pilot project. The failures can be traced to one or more of the above three factors not being done.

Shifting to our fifth topic, I will now suggest at least one approach to a maintenance strategy for the so-called 20/80 or better-behaved systems. This concern for the 20/80 systems was first expressed to me by the USAF management at the Arnold Engineering Center at Tullahoma, Tenn. in the late 1980s, and came after three years of multiple classical RCM pojects on 80/20 systems, which were very successful. The response, which also proved to be a very successful exercise, was to use our development of the ECM or experience-centered maintenance analysis methodology. The ECM is *not* RCM—but unlike RCM, which is function-driven, ECM is data-driven. The data used is twofold: First, is the existing PM tasks that are analyzed on a spreadsheet to review what they were supposed to be doing for the equipment, and questioning if these tasks were in fact performing as expected. If not, what should be changed, including a possible decision to RTF as the most effective action to take. Secondly are the recent corrective maintenance events for the past 12 to 18 months, and questioning why these unexpected failures occurred. Was there a PM task in place that did not work, and what might be changed to make it work, or if no PM task was present, could there be one introduced to avoid the unexpected failure mode occurrence. The ECM process takes about 25% of the time required to do a full-blown classical RCM study. Caveat: Do *not* use ECM on the 80/20 systems because the problems there go far beyond making minor corrections to the existing PM task structure. It does not explore the functional failures.

My final topic is what is the future of RCM? The answer is really self-evident: U.S. industry is still predominantly in the mode of reactive maintenance, and for the most part does not even recognize the application of the 80/20 rule. RCM can change that unfortunate situation to a shift to proactive maintenance. The opportunity is there for those who choose to seize upon it. S

Anthony M. (Mac) Smith's engineering career has spanned 57 years, including 24 years with GE's missile and space, jet engine, and nuclear operations. Mac is recognized for his pioneering work in bringing RCM applications to over 50 industrial and government facilities and plants.