

RELIABILITY CENTERED MAINTENANCE: 40 YEARS YOUNG AND AS RELEVANT AS EVER

Tara Holwegner, CPLP, CMRP, PMP

Introduction

Reliability Centered Maintenance (RCM) is turning 40, but it isn't "over the hill." In fact, RCM is just as relevant and strong an approach today as it was when Nowlan and Heap published "Reliability Centered Maintenance" in 1978. The RCM studies, initially developed and applied for the civil aviation industry, revolutionized the maintenance mindset and initiated an evolution in maintenance technology.

Thirty-six years later, in January 2014, the ISO 55000 series of asset management standards cemented asset management as integral to business strategy and performance. The evolution in maintenance technology continues with increased adoption of ISO 55000 principles, improvements in condition-based and predictive technologies, analytics, asset intelligence, and efforts to empower a multi-skilled workforce to support asset availability.

Here are four reasons why RCM isn't "over the hill":

- A risk-based RCM approach is strategic to the business
- RCM is an expression of ISO 55000 "thinking"
- RCM favors efficient and feasible proactive tasks
- RCM has published standards, program guides, tools, software, and systems to support planning and implementation

RCM is good business

RCM is a study in how to balance different business dynamics and address the most critical potential or probable risks to operations. RCM takes a logical, sequential approach to preserve a system's function by identifying how it can fail (functional failures), the consequences of a failure, and the "failure mode" or the manner in which the failure reveals itself. From there, RCM aims to assign the right maintenance tasks at the right time to sustain reliability and availability and optimize life cycle costs.

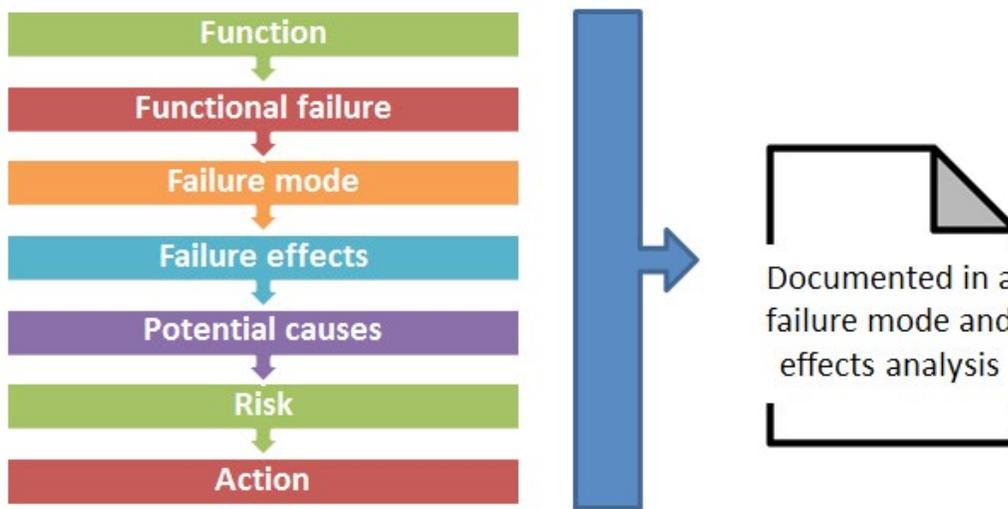
This table of RCM benefits shows why it is a good choice for any operation.

Safety	RCM uses analysis, monitoring, early and decisive action, and documentation to make sure people, property, and places remain healthy, uninjured, and undamaged.
Cost	Costs decrease as RCM prevents failures and replaces maintenance tasks with condition monitoring. After initial program investments, the returns are significant.
Reliability	A key emphasis of RCM is improving equipment reliability by providing feedback. Planners, engineers, operators, and others can make equipment more reliable with the feedback they receive about the maintenance experience and equipment condition.
Work Management	RCM forecasts maintenance needs based on risk calculations, creating time to plan and obtain parts while reducing unnecessary maintenance.
Program Efficiency	RCM aligns priority to cost, ensuring the proper type of maintenance is performed on equipment when it is necessary. RCM identifies existing maintenance that is not effective and eliminates it. Critical spares are identified and obsolescence plans can be developed to maximize productive time and build reliable budgets.
Reliability-driven Workforce	Employees are more engaged when they know their work is meaningful and adding value. RCM provides a line of sight between maintenance tasks and the equipment failures they prevent. This line of sight allows employees to realize how their work contributes to increased availability and successful operation.

Table 1: RCM Benefits

Complaints about RCM include its data burden, time consumption and laborious/tedious nature. This may very well be the case if an organization does not take a strategic approach to implementing RCM. As an example of a strategic approach to RCM, Life Cycle Engineering has trademarked the Risk-Based Asset Management (RBAM®) methodology, which bookends traditional RCM practices with business risk and program optimization.

Classical RCM is expressed in seven steps. The image below shows these steps and how they are documented in a tool called an FMEA (failure mode and effects analysis).



In a risk-based RCM approach - like that espoused in LCE's Risk-Based Asset Management - an asset hierarchy is created (or validated) and an asset criticality assessment is performed to identify candidates for an RCM study. After the FMEA is developed, an equipment maintenance plan is created to organize maintenance tasks. Finally, a healthy PM optimization program can ensure that your preventive maintenance program is as efficient as possible. Taking the RBAM approach of "wrapping" RCM in a larger risk-based approach can provide focus and business rationale before embarking on an RCM journey, because it considers scope, efficient execution and justification for the analysis.

RCM is an expression of ISO 55000 "thinking"

In his article titled "RCM Providing the Line of Sight for ISO 55000 Compliance", Tim Allen muses "ISO 55000 is silent to the words reliability centered maintenance and its acronym RCM. However, if RCM didn't already exist, wouldn't we now have to invent it to comply with the standard?"

RCM is an expression of asset management "thinking" and can provide a roadmap to reach the standard's objectives. Some themes from ISO 55000 for physical asset management related to RCM include:

- Assets should be framed in the context of the value they bring to the organization and how they help achieve business objectives
- Decisions and actions we make to manage our assets should be based on risk and opportunities
- There should be a direct line of sight between asset management activities, resources provided, and the organization's policy, strategy and business objectives.

Using a risk-based approach to RCM requires analysts to assess the risk and value of an asset to operations (its criticality), then methodically determine and document the functions and functional failures of that system, quantify the risk of those failures, and prescribe maintenance tasks or other actions to prevent or mitigate failures that are most risky to the business (the FMEA). Part of the risk-based RCM process is determining a common, numerical definition of risk categories and levels. Defining these levels allows the team to quantify a risk using factors important to each operation. With a common definition of risk, the team can determine a risk threshold number above which an action must be put in place to address the risk.

To further connect ISO 55000 and risk-based RCM methodology, if we create an equipment maintenance plan based on FMEA recommendations we have a direct line of sight on how each maintenance task is targeted at addressing a failure – solving a problem for the organization and contributing to operational performance.

The table below, from Life Cycle Engineering’s eRCM education and LCE’s Risk-based Asset Management course, summarizes the connection between risk-based RCM and ISO 55000.

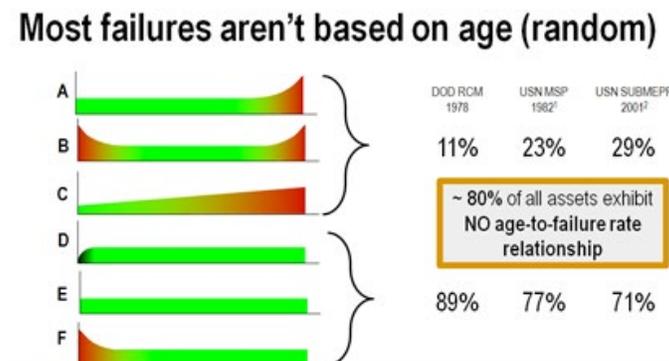
Risk-based RCM Methodology	ISO55000 Standard Requirements
Create an asset hierarchy to show relationships, track history, and make decisions about asset management.	Assets should be framed in terms of the value they bring to the organization and how they help achieve business objectives
Conduct an asset criticality review to identify the most critical assets based on strategic risk criteria calculations.	
Complete an RCM analysis and failure mode and effects analysis (FMEA) to document functions and functional failures, assess risks, and prescribe equipment maintenance tasks in an equipment maintenance plan (EMP).	Decisions and actions we make to manage our assets should be based on risk and opportunities
Use an EMP and monitor progress using PM optimization to evaluate and improve maintenance processes.	Direct line of sight between asset management activities, priorities and the organization’s strategy and business objectives

Table 2: Connection between Risk-based RCM and ISO 55000

So, if you haven’t considered using the RCM methodology as part of your maintenance program, are you ready to consider it now?

RCM favors efficient and feasible proactive tasks

The original RCM studies revealed six basic failure profiles and the predominance of random failures vs. wear-out failures. Random failures were five times more prevalent than wear-out type failures. The image below summarizes three RCM studies showing that approximate 80% of failures have no age-to-failure rate correlation.



1: Navy Mach Sweep Program (aviation); 2: Navy Submarine Maintenance Engineering, Planning and Procurement

Figure 1: RCM studies failure curve frequency

RCM espouses that because most failures are random, it doesn't make sense to execute maintenance only on a strictly defined time schedule. Programs based solely on time-based preventive maintenance may prevent some failures but are not actively pursuing 80% of the failures that can occur. RCM teaches us to analyze the failure and its behavior to choose the most feasible and efficient maintenance (or other) task to prevent or mitigate the failure. During an RCM analysis, teams are prompted to consider tasks that will identify and address failure modes, which normally require assessment of the system's condition.

Technological advancements in the areas of condition monitoring and predictive technologies discover equipment condition and performance irregularities that can signal a pending failure. Early failure detection lowers risk because action can be taken to avoid or at least prolong the time before impending failure. During the FMEA process, teams consider if a condition-based inspection or predictive task is feasible to detect the system's condition and lower the risk of a failure mode. RCM can be considered a proponent of condition-based maintenance. In SMRP's Best Practices 5th Edition, they define proactive work as "maintenance work that is completed to avoid failures or to identify defects that could lead to failures. Includes routine preventive and predictive maintenance activities and corrective work tasks identified from them" (pg. 173). SMRP's benchmark for this measure is greater than 80% of all work should be targeted at preventing failures. How could this benchmark be reached without the failure-based analysis that RCM facilitates?

RCM Training and Resources

There are many RCM training, program resources and tools publicly available. RCM training and software are available from many vendors. The Life Cycle Institute (the learning division of Life Cycle Engineering) has classroom courses on Risk-based Asset Management (RBAM) and is building a RCM eLearning solution called eRCM.

The resources below can provide guidance on how to institutionalize and manage RCM:

- SAE standard JA1011
- IEC's standard #60812 on FMEA
- NASA's RCM Program Guide
- Naval Aviation Reliability-Centered Maintenance Process
- Reliability Centered Maintenance Project Manager's Guide (ReliabilityWeb.com)
- RCM II – 2nd Edition by John Moubray (Aladon Network)
- FMEA: The Heart of Equipment Maintenance (LCE.com)

Summary

RCM isn't "over the hill". On the contrary, by employing a risk-based approach to managing physical assets an organization can achieve far-reaching effects that go beyond the benefits of improved overall equipment effectiveness and optimal life cycle costs. Using the RCM methodology in a strategic Risk-Based Asset Management program to evaluate the most critical equipment, with an eye towards efficiently mitigating the most damaging failure modes, makes smart business sense in terms of safety, cost, reliability, work management, program efficiency and employee engagement.

Citations:

Allen, Tim. RCM Providing the Line of Sight for ISO 55000 Compliance. ReliabilityWeb.com, 2015.

https://reliabilityweb.com/articles/entry/rcm_providing_the

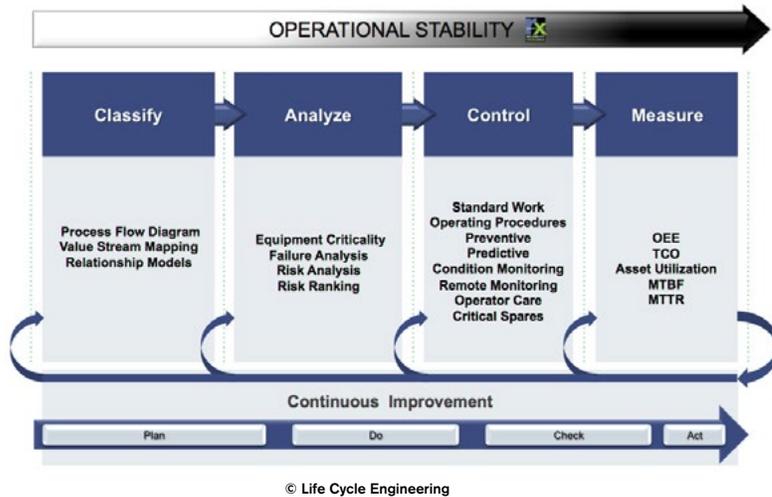
Society for Maintenance and Reliability Professionals. *SMRP Best Practices, 5th Edition, Maintenance and Reliability Body of Knowledge*. SMRP Press: 2017.

About the Writer



Tara Holwegner, CPLP, CMRP, PMP is a Learning and Performance SME with Life Cycle Engineering. Tara builds reliability competence-building solutions for commercial and government entities. You can reach Tara at tholwegner@LCE.com.

Risk-Based Asset Management Model:



Explore how to improve asset availability and meet reliability goals by applying a risk-based approach to asset maintenance and operations. In the Risk-Based Asset Management (RBAM®) course, you practice how to prioritize reliability efforts on critical equipment and failures that impact your operation. RBAM incorporates reliability-centered maintenance (RCM) principles and continuous improvement practices like PDCA to position your program for decreased downtime, lower maintenance expenditures, and an acceptable total cost of ownership.

During the course, participants classify and analyze assets and failures to rank equipment criticality and draft a risk plan. Next, learners build a failure mode and effects analysis (FMEA) to define control strategies and populate an equipment maintenance plan. Group activities in the class include examining how life cycle cost influences investment and choosing key performance indicators to manage a reliability program. Specific emphasis will be placed on the resources needed to create an asset management plan - a risk, maintenance and asset operations plan - that can manage the entire life cycle of an asset.

Learn How To:

- Draft components of an asset management plan: risk and maintenance plan
- Describe what an asset management organization needs to know to manage risk and improve performance
- Describe the four phases in a risk-based asset management model
- List ways to extend the life of assets and evaluate their effectiveness
- Use a failure mode and effects analysis (FMEA) to analyze risks and map control strategies to failure modes
- Describe how audits, reviews and key performance indicators drive continuous improvement
- Practice applying a standard process for preventive maintenance optimization
- Select the optimal strategy for renewal or disposal based on asset management strategy

Who Should Attend:

People responsible for installation, commissioning, operation or maintenance of capital assets and auxiliary equipment. This includes Project Engineers, Reliability Engineers, Maintenance Managers, Operations Managers, and Engineering Technicians.

Coming Soon: Reliability Centered Maintenance Online!

eRCM integrates content from our Risk Based Asset Management course with the prevailing Reliability Centered Maintenance standards and decades of best-practice benchmarking into a performance-driven, self-paced online solution.

- Create a set of standard processes and tools
- Onboard new Reliability Engineers faster
- Reach geographically dispersed teams
- Validate competency

To learn more, contact us at:
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Course Information:

Each course includes a comprehensive active learning manual, morning and afternoon refreshments and lunch. Classes are held on Tuesday through Thursday. All students completing a class at Life Cycle Institute will receive a certificate of completion awarding 2.1 CEUs.

Life Cycle Institute is different because:

- Facilitators who practice what they teach and teach what they practice
- Course content that is constantly updated with the latest proven tools and methods
- Adult learning methods that minimize lecture and emphasize learning by doing
- Classrooms that are specifically designed to facilitate learning

Registration:

Download our class schedule for the latest class dates and course costs or contact Life Cycle Institute at:
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This course is one of the four courses that lead to the Reliability Engineering Certification program.



This course is one of six courses that can be applied to the Maintenance Management Certification program.



This course has been approved for continuing education credit for Certified Reliability Leaders.

