COLLEGE OF ENVIRONMENTAL DESIGN

ARE 524
Facilities Maintenance Management

2nd, 7th and 9th December 2003

Reliability Centered Maintenance
Section 7

Uptime
Strategies for Excellence in
Maintenance Management

By: John Dixon Campbell

Prepared By:
Bakr F. AlHajri # 773470

Instructor
Dr. ABDULMOHSEN AL-HAMMAD

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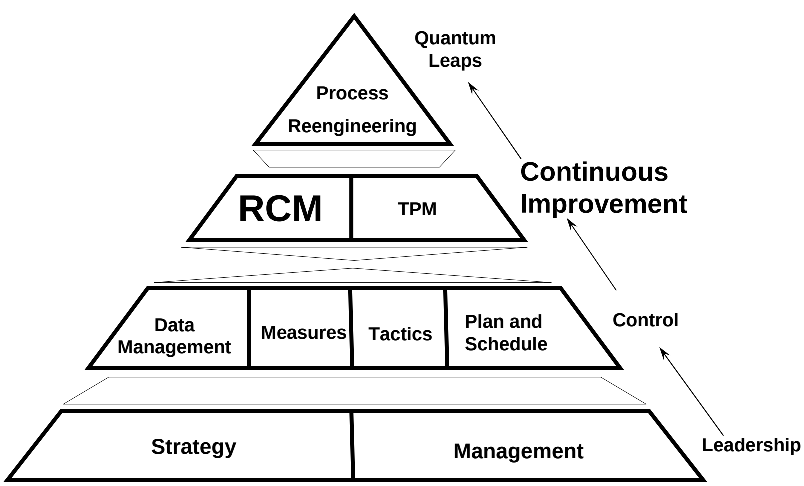

World Class Maintenance

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OUTLINE

- ❖ INTRODUCTION
- ❖ CREATING VALUES FOR CUSTOMERS
- ❖ RCM ELEMENTS: PHILOSOPHY TO PRACTICE
  - ❖ STEP 1: SELECT PLANT AREAS THAT MATTERS
  - ❖ STEP 2: DETERMINE KEY FUNCTIONS AND PRODUCTIVITY GOALS
  - ❖ STEP 3: DETERMINE PLAUSIBLE FUNCTIONAL FAILURES
  - ❖ STEP 4: DETERMINE LIKELY FAILURE MODES AND THEIR EFFECT
  - ❖ STEP 5: SELECT FEASIBLE AND EFFECTIVE MAINTENANCE TACTICS
  - ❖ STEP 6: IMPLEMENT SELECTED TACTICS
  - ❖ STEP 7: OPTIMIZE TACTICS AND PROGRAM
- ❖ IMPLEMENTING RCM

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INTRODUCTION - 1/9

- ❖ To be competitive, industry must continually improve.
- ❖ Companies are embracing, like never before, efficiency methods such as just-in-time and total quality management.
- ❖ These structured, step-by-step systems can both identify and help implement ways to enhance the business.
- ❖ They are tools to build on and make better use of employees' operating abilities and technology know–how .
- ❖ Maintenance, too, is being changed by the competitive pressures in the marketplace.
- ❖ It also has much to learn from the new techniques that are transforming business practice.
- ❖ And those who use them properly are finding that better maintenance can mean bigger profits.

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INTRODUCTION - 2/9

- There are several techniques that apply to maintenance performance.
- Their common goal is to continually improve that performance by
  - Dealing with each type of failure most appropriately, in the most cost – effective way.
  - Enhancing productivity with a more proactive and a planned approach.
  - Ensuring active support and cooperation of people for maintenance, materials, operations, technical, and administrative functions.

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INTRODUCTION - 3/9

- One of the most notable techniques is reliability centered maintenance (RCM).
- By providing a strategic framework and using the knowledge and expertise of people in the organization, it can accomplish two important goals.
- First, it identifies the maintenance requirements of a physical asset that meets the operational or production goals.
- Then it optimize the performance, with the results.

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INTRODUCTION - 4/9

- RCM works in a progression of related steps.
- First, it examines the functions and associated to productivity goals of the assets.
- Second, it assesses the ways those goals can fall short and the effects of failing .
- Finally, RCM\s detective work deduces the most feasible and effective ways to eliminate or reduce the consequences of failure.

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INTRODUCTION - 5/9

- RCM was launched in the U.S. commercial airline industry during the early 1960s.
- It developed In response to rapidly increasing maintenance costs, poor availability, and concern over the effectiveness of traditional time – based preventive maintenance.
- The problems were obvious, so was the need – more reliable maintenance programs.

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INTRODUCTION - 6/9

- ❖ Studies were conducted of existing engineering techniques and preventive maintenance practices, which we discussed in chapter 4 under maintenance tactics.
- ❖ The results are in the right to a surprising fact about the traditional, time – based, preventive maintenance approach:
  1. Scheduled all overhaul has little effect on the overall reliability of a complex item, and this failure is frequent.
  2. There are many items for which there is not effective form of scheduled maintenance.

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INTRODUCTION - 7/9

- ❖ The results of these initial studies have extended far beyond the airlines.
- ❖ They were used to develop the basis of a logical preventive maintenance program that can apply throughout industry.
- ❖ This approach has since become known as the reliability centered maintenance .

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INTRODUCTION - 8/9

- RCM was first applied on a large scale to develop the maintenance program of the Boeing 747.
- Later, it was used for the L–011 and DC–10.
- The results have been impressive .
- These aircraft a cheap significant reductions in schedule and or time-based maintenance , with no decrease in reliability.
- For example only 66,000 labor hours of structural inspections were required before first heavy inspection at 20,000 flying hours on the Boeing 747, as compared to 4,000,000 labor hours over same period on the smaller DC–8.
- And the DC-10, only seven items were subject to scheduled overhaul, in comparison with the schedule and overhaul of the 339 items on the DC–8.

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INTRODUCTION - 9/9

- RCM (or MSG-3 as it is known in the aerospace industry) is now used to develop the maintenance programs for all major types of aircraft.
- Other applications include the navy, utilities, the offshore oil industry, and manufacturing processes.
- RCM is particularly suitable where large, complex equipment is used and where equipment failure pose significant economic, safety, or environmental risks.

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CREATING VALUES FOR CUSTOMERS - 1/2

- As desirable as it may be to have a comprehensive, logically based maintenance program, it is of little use unless it helps maintenance, and the company as a whole, create value for its customers and shareholders.
- Typical benefits of RCM are outlined in figure 7-1.
- That advantages of instituting an RCM program depend on the nature of the business, the risks posed by equipment failures, and the state of the existing maintenance program.

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CREATING VALUES FOR CUSTOMERS - 2/2

Quality	Service	Cost	Time	Risk
Increased plant availability (2-10%)	Better teamwork and communication	Optimized maintenance program	Shorter repair times	Safety and environmental integrity a priority
Elimination of chronic failures and inherent reliability problems	Improved understanding of "customer" requirements	Reduced levels of scheduled maintenance (10–50%)	Reduced duration of scheduled overhauls	Failures with unacceptable consequences must be dealt with
Flexibility to accommodate production requirements	Less disruption of production processes due to unplanned breakdowns	Better maintenance contract administration	Extended periods between overhauls (60–300%)	Reduced likelihood of multiple failures
Documented basis for maintenance program		Clear guidelines for application of new maintenance technology		Reduced numbers of routine, invasive tasks
in proved ownership for maintenance program		Longer life of expensive equipment		Was used risk to plant maintenance workers
		Reduction in secondary damage		

Figure 7-1: Benefits of Reliability Centered Maintenance

RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 1/38

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- RCM is based on the philosophy that maintenance is a key functions of the company .
- It is crucial for the expected functional performance and productivity goals to be achieved.
- Further, maintenance requirements are best it developed by multidisciplinary teams from production, materials, maintenance, and technical departments, and should be founded on a logical, structural, and engineered approach.
- Some of the key precepts of RCM are that equipment redundancy should be eliminated, where appropriate; condition–based or predictive maintenance tactics are favored over traditional time–based methods; and run–to–failure is acceptable, where warranted

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 2/38

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- To develop an RCM–based maintenance program for physical resources, we need to answer the following questions:
  1. What assets are owned and operated by the company and to which of these should RCM be applied ?
  2. What are the functions and performance expectations of a selected asset ?
  3. In what ways can it fail to perform these functions?
  4. What causes it to fail?
  5. What are the consequences of each failure?
  6. What should be done to prevent each failure , and what steps should be taken if effective preventive measures can't be found?

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 3/38

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- This questions are answered through a logical , seven-step review process, illustrated in figure 7-2.
- The process begins with an understanding of the business requirements and objective.
- This ensures that the maintenance program meets the productivity goals and the physical resource under review.
- The maintenance agenda is then undefined .
- Once that happens, an ongoing monitoring and review process is established to make the most of the program.
- The major steps in the RCM review process are described below .

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 4/38

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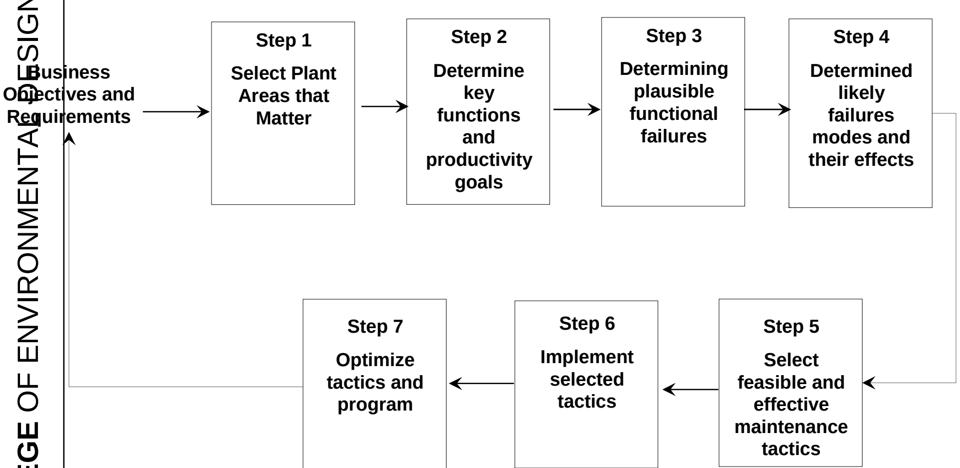

Figure 7-2: RCM Review Process

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We will stop here. RCM Review Process will be discussed next Sunday

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 5/38

Step 1: Select Plant Area that Matter

- **Businesses typically have thousands of pieces of machinery and equipment.**
- **These can range from pumps and valves to process systems, rolling mills, fleets of load-haul-dump (LHD) trucks, ships, or buildings .**
- **They may be fixed or mobile.**
- **Each asset will benefit from RCM in varying degrees.**
- **Therefore, the first step in the RCM process is to identify and prioritize the physical resources owned or operated by the enterprise.**
- **Only then can they be reviewed properly .**

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 6/38

Step 1: Select Plant Area that Matter

- **This is a national stage involves :**
  - **Establishing a structured , comprehensive list of all physical assets owned or used by the organization that require some form of maintenance or engineering attention. This list is referred to as the plants register, plant inventory, or equipment family tree.**
  - **Assessing the Impact of the physical resources of the key business performance areas. These may include availability, process capability, quality, cost, and safety or environmental risks . This ensures that the review focuses on the areas or equipment in the plant that benefit most from RCM. Although several complimentary methods can be used in assessment, the precise method is not critical. Of more Importance is selecting a method, documenting it and its results, and then proceeding with the review. Simplicity is the key . Usually, the highest and lowest priority systems would be obvious. It's not worth the added effort to figure out the exact order of importance of those between the two.**

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 7/38

Step 1: Select Plant Area that Matter

  - **Establishing the boundaries between equipment systems. Boundaries include everything necessary for the physical resource to do its job. This helps define the scope of the review and organizes it into manageable pieces.**
- **One company selected its environmental control and monitoring equipment, including dust collectors and effluent samplers.**
- **They concluded that this category represented the greatest long–term risk.**

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 8/38

Step 2: Determine Key Functions and Productivity Goals

- **Once the physical resource selected, its functions and the associated productivity goals are determined. This is a key step.**
- **The purpose of a maintenance tactic is to make sure the equipment is working properly and producing on schedule.**
- **Every physical assets has a function – usually several.**
- **This can be categorized as:**
  - **Primary**
  - **Secondary**
  - **Protective**

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 9/38

Step 2: Determine Key Functions and Productivity Goals

- ***Primary*** **-** this is why the equipment exist that all . It is usually evident from its name, as well as form the interfaces that are supported between physical assets. An example of a conveyor's primary function, for instance, is to transfer rock from hopper to crusher at a minimum rate of 10 tons/hour.
- ***Secondary*** **-** in addition to it's a primary purpose, a physical assets usually has a number of secondary functions. These are sometimes less obvious, but the consequences of failure may be no less severe. Examples of secondary functions include maintaining a pressure boundary, relying local or control room indications, supplying structural support, or providing isolation.

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Step 2: Determine Key Functions and Productivity Goals

- ***Proactive*** **-** As processes and equipment increase in complexity, so do the ways in which they can fail dramatically. Likewise, the consequences of failure. To mitigate these dire results, protective devices are used. The job of these devices must be defined before adequate maintenance program can be developed. Typical protective functions Include warning operators of abnormal conditions, automatically shutting down a piece of equipment, and taking over a function that has failed.

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Step 2: Determine Key Functions and Productivity Goals

- In addition to defining the functions, this process highlights the expected level of performance or the productivity goals.
- This can include capacity, reliability, availability, product quality, and safety and environmental standards.
- While this may sound relatively straightforward, technical and maintenance performance are typically judged differently.
- Thus, performance can be defined as:
  - *Built-in or inherent* – what it can do.
  - *Required* – what we want it to do.
  - *Actual* – what it is doing .

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Step 2: Determine Key Functions and Productivity Goals

- ❖ In many instances, the equipment can deliver what is required of it with proper maintenance.
- ❖ Situations can arise, though, where what's required exceeds what physical resource is capable of.
- ❖ In these cases, maintenance cannot meet the performance events.
- ❖ If there is a big gap between the performance needed and the built–in ability or the performance currently being achieved, the equipment assets needs to be modified.
- ❖ Either it should be replaced with a more capable item, or operating changes must be made to reduce expectations.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 13/38

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Step 2: Determine Key Functions and Productivity Goals

- ❖ Again , the purpose of the RCM review is to define the maintenance requirements for a physical assets that are necessary to meet the business objectives.
- ❖ The level of performance, then, reflects what is required or wanted from the asset.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 14/38

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Step 3: Determine Plausible Functional Failures

- ❖ The third step is to address all plausible ways in which equipment can perform below expectations.
- ❖ Partial and total shortcomings are considered, as well as an inadvertent function.
- ❖ Usually, we tend to think of an item failing when it stops working –- a go/no go situation.
- ❖ For example, the car doesn't start or a compressor doesn't provide high pressure air.
- ❖ While some equipment is like this, notably electronic machinery, in other cases what constitutes a failure is less clear.
- ❖ Your car may start and run, but its acceleration is poor and it uses too much gas .
- ❖ To compress may run but does it provide enough air pressure of volume?

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 15/38

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Step 3: Determine Plausible Functional Failures

- ❖ Obviously , an idea of the boundary between acceptable and unacceptable performance is needed to determine when failure occurs . This bounty in the expected level of performance.
- ❖ The definition of functional failure is the inability of the physical assets to deliver its expected level of performance.
- ❖ This definition suggests that the function could fail in numerous ways, each with its own (usually different) modes and effects.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 16/38

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Step 3: Determine Plausible Functional Failures

- This happen speak or is there may be :
  - A total loss of function, where the Item stops working altogether. For example, a pumping system fails to provide any flow .
  - A partial loss of function, where the item works but fails to achieve expected level of performance. For example, a pumping system fails to provide an adequate flow.
  - Multiple levels of performance expected of from an individual function.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 17/38

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Step 3: Determine Plausible Functional Failures

- The expected level of performance defines not only what is considered a failure, but the amount of maintenance needed to avoid that failure .
- As illustrated in figure 7-3, this frequently creates conflict between various departments.
- It's essential then, that all concerned – the technical, operations, and maintenance departments – play a part in drafting the performance levels.
- The joint seal of approval is essential before proceeding.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 18/38

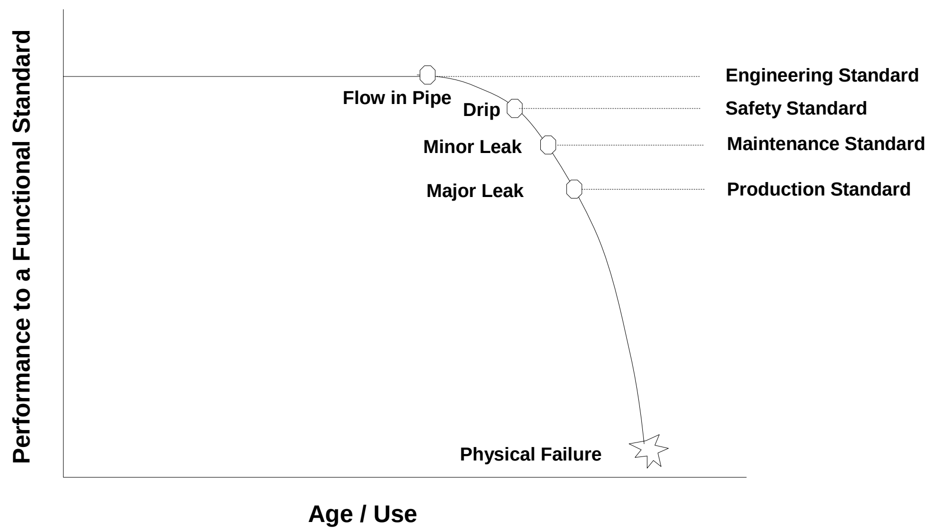

Figure 7-3: Performance Standards and Functional Failure

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 19/38

Step 4: Determine Likely Failure Modes and Their Effects

- ❖ The next task is to set forth the likely failure modes and their cause and effect.
- ❖ The failure mode describes what can or has happened as opposed to what caused it to happen.
- ❖ For example, one failure mode of a pump could a seized bearing that halts any flow.
- ❖ Failure modes of spelled out because the process anticipating, preventing, detecting, and correcting failures is applied to any number of different examples.
- ❖ While many potential failures modes can be listed, only those that are fairly likely need be considered.

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Step 4: Determine Likely Failure Modes and Their Effects

- These include:
  - Failure modes that have occurred on the same or similar equipment. This is determined through a review in of maintenance work order history and experience.
  - Failure modes that are already the subject of preventive maintenance tasks.
  - Other failure modes that have not happened but are considered possible because of experience or vendor/manufacturer recommendations. The extent to which these less--than–likely failure modes are included with depend on their consequences. The greater the potential setback, the more these “what if “scenarios count.

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Step 4: Determine Likely Failure Modes and Their Effects

- Possible causes of the particular failure are also identified since they have a direct bearing on the maintenance tactics used.
- In the example of the seized bearing, the cause of this failure could be a lack of lubrication.
- Other typical reasons are wear, erosion, corrosion, fatigue, dirt, incorrect operation, or faulty assembly.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 22/38

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Step 4: Determine Likely Failure Modes and Their Effects

- What actually happens when each failure mode occurs is next identified .
- The effects are described fully, as if nothing were done to prevent the failure. This way, the consequences can be judged fairly .
- To do so, the following are described :
  - The evidence of failure to the operating crew under normal conditions.
  - The hazards the failure may pose to worker safety, public safety, process stability, or the environment.
  - The effect on production output and maintenance.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 23/38

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Step 5: Select Feasible and Effective Maintenance Tactics

- Failures of the physical resources owned or used by a company can very enormously.
- Their results may be potentially catastrophic or trivial.
- How great the Impact influences the way the company views the failure and the steps deemed necessary to prevent it, such as adding a backup systems.
- In some cases, it may not be worth the effort and expense.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 24/38

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Step 5: Select Feasible and Effective Maintenance Tactics

- To successfully manage a failure, the preventive maintenance tactic must be:
  - *Technically feasible* - dealing effectively with the technical characteristics of the failure.
  - *Cost – effective* – reducing or avoiding pitfalls in line with dollar and operating constraints.
- Tactical options are discussed more for the inch up to four in.
- Whether a particular approach is technically appropriate to solve the failure depends not only on the kind of help, but the nature of the problem.
- Technically feasible tactics for condition – based and time – based maintenance satisfy the following criteria .

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Step 5: Select Feasible and Effective Maintenance Tactics

1. *Condition – based*
   - It's possible to in detect the physical resource's degraded condition of performance.
   - The failure is predictable as it progress from first instance to complete breakdown.
   - It is practical to monitor the physical resource in less time than it takes for the problem to develop completely.
   - The time between incipient and functional failure is long enough to be of some use – that is, action can be taken to avoid the failure.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 26/38

Step 5: Select Feasible and Effective Maintenance Tactics

2. *Time – based*
   - ❖ There is an identifiable point at which the physical asset shows a rapid increase in failure rate.
   - ❖ Most assets survived to that age. For failures were significant safety or environmental risks, there should be no failures before this point.
   - ❖ The task restores the assets condition. (This might mean partially restoration if the asset is overhauled, for example, or complete restoration if the item is discarded and replaced.)

❖ To be costs – effective, preventive maintenance must reduce the likelihood and/or consequences of failure to acceptable levels , be readily implemented, and stay within budget.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 27/38

Step 5: Select Feasible and Effective Maintenance Tactics

❖ Within these limits, that maintenance tactic is considered cost-effective if :

- ❖ For legal problems, it cuts the chance of a multiple failure to an acceptable level.
- ❖ For failures with safety and environmental effects, the risks are kept to a comfortable minimum.
- ❖ For failures with production setbacks, the cost of the tactic is, over time, less than the production losses. Also, it must be cheaper than repairing the problem it is meant to prevent .
- ❖ For failures with maintenance consequences, the cost of prevention measures is, over time, less than repairing the failure that would otherwise results.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 28/38

Step 5: Select Feasible and Effective Maintenance Tactics

- If maintenance measures are neither technically feasible nor cost–effective, then, depending on the risk of failure, one of the following default action is selected:
  - For hidden failures, the failure – finding tactic to reduce the likelihood of multiple failures . An example is testing the readiness of standby equipment.
  - Four failures with unacceptable safety or environmental risks, redesign or modification .
  - For failures with production or maintenance consequences, run – to – failure or corrective maintenance.
- At logic tree diagram is used to integrate the consequences of failure with technically feasible and cost – effective maintenance tactics . A simplified version of this diagram is illustrated in figure 7 – 4.

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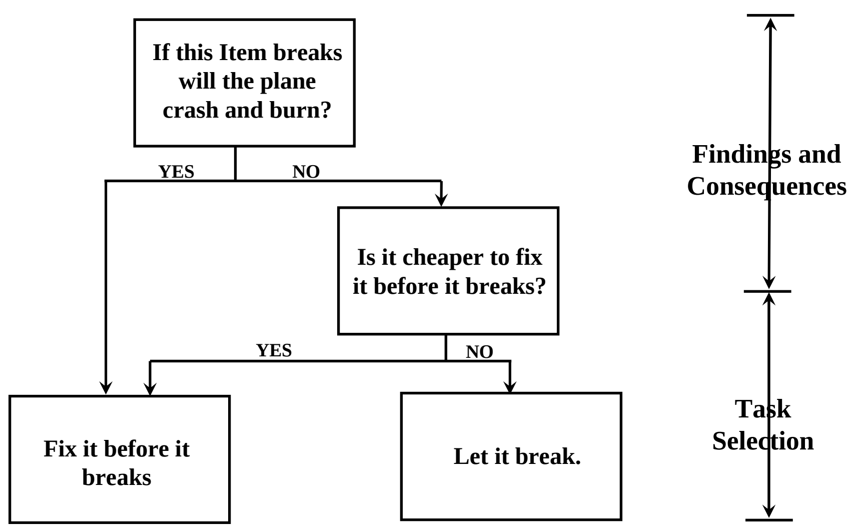

Figure 7-4: Simplified Maintenance Selection Logic Diagram

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 30/38

Step 5: Select Feasible and Effective Maintenance Tactics

- In general , tactics to prevent failures for this order:
  - *Condition – based maintenance (CBM) tactics* – These generally have the least impact on production, help focus corrective actions, and get the most of the economic life of the equipment.
  - *Time – based repair / restoration tactics* – These may work for failures that presents a significant safety, environmental, or economic risk to the organization. However, this approach is less preferable than the CBM for a number of reasons. It usually effects production or operations, the age limit can mean premature removals, and the additional shop work required increases the cost of maintenance.
  - *Time – based discard tactics* – These are generally that least coast – effective preventive maintenance measures. The tend to be used, though, where repair or restoration is impossible or ineffective, such as for components like filter elements, o–rings, and, in some cases, integrated circuit boards.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 31/38

Step 5: Select Feasible and Effective Maintenance

- *Combinations* – in some cases a combination of tactics may be necessary to reduce the safety and environmental risks to an acceptable level. In general, this involves a condition – based maintenance method along with some form of time – based maintenance. An example would be the in – place inspection of an aircraft engine by borescope every 50 flying hours, combined with time – based inspection and overhaul in a shop every 200 hours.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 32/38

Step 5: Select Feasible and Effective Maintenance

- ❖ Once the maintenance tactics have been chosen, next comes deciding how often they are performed initially.
- ❖ For condition -- based tactics, the frequency is linked to the technical characteristics of the failure and the specific monitoring technique.
- ❖ Depending on these factors, the time can vary from weeks to months.
- ❖ Generally, the more sophisticated (and expensive) the technique, the more Infrequent .

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 33/38

Step 5: Select Feasible and Effective Maintenance

- ❖ Time – base tactics are applied according to the expected useful life of the physical assets.
- ❖ That is determined by the age at which wear – out begins, when the chance of failure greatly increases.
- ❖ How often the failure -- finding tactic is needed depends on how available it is and how likely a breakdown in the system.
- ❖ Figure 7—5 gives an example of how the first five steps might look on a worksheet

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COLLEGE OF ENVIRONMENTAL DESIGN

RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 34/38

Equipment : Family Car
Assembly : Braking
Component : Front Disc Brakes

Function	Failure	Cause	Effect	Criticality			
1- To stop car smoothly within 20m from speed of 60kph on dry pavement on brake pedal application of 3cm 2 ------ 3 ------ 4 ------	1.1 ----- 1.2 ----- 1.3 ----- 1.4 brakes pedal moves to more than 3cm to stop	1.4.1 ----- 1.4.2 ----- 1.4.3 Hydraulic fluid level low, caused by leakage in system, which causes pedal to move 5 to 8 cm before braking action.	1.4.3 Stopping becomes increasingly difficult with more pressure application of brake pedal required; fluid continues to leak until the pedal pressure has no effect on calipers to close disc pedal. Car fails to stop, resulting In Severe safety hazard.	Severity	Frequency	Ease of Finding	Overall Factor
				High (5)	Low (1)	Medium (3)	Moderate (15)
Maintenance Task	**Scheduler**	**Responsibility**	**Comments**				
1.4.3 *Monitor brake pedal movement *Monitor brake fluid level and top up *Check breaking hydraulic system for signs of wear , corrosion, leaks	• Measure quarterly • 15,000km intervals • 30,000km intervals	• Operator • Operator • Mechanic	•Family car has a few operators. Small changes likely to be detected. • if stopped off twice in one year , refer to Mechanic. • check pads and rotor at the same time.				

Figure 7-5: RCM Worksheet

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 35/38

Step 6: Implement Selected Tactics

- ❖ It often requires as much effort – and more coordination to put the results of the RCM in motion than the review itself.
- ❖ The recommendations are compared with the tasks already included in the maintenance program.
- ❖ The question is whether to add new tasks, change the existing ones (scope or frequency), and/or delete any.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 36/38

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Step 6: Implement Selected Tactics

- Next on the agenda are the actions needed to put the maintenance tactics into effect . These may include:
  - Tweaking maintenance schedules.
  - Developing or revising task instructions.
  - Specifying spare parts and adjusting inventory levels.
  - Acquiring diagnostic or test equipment.
  - Revising operation and maintenance procedures.
  - Specifying the need for repair or restoration procedures.
  - Most significantly, conducting training in the new procedures.
- To ensure all this is coordinated smoothly, an integrated plan is developed.
- This plan underscores the actions required and assigns the responsibilities and target dates for their completion.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 37/38

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Step 7: Optimize Tactics and Program

- Once the RCM review is complete and the maintenance work identified, periodic adjustments are made.
- The process is responsive to change in plant design, operating conditions, maintenance history, and discovered condition.
- In particular, the frequency of the tactics is adjusted to reflect the operating and maintenance history of the physical resource.
- The objectives of this ongoing activity are to reduce equipment failure improved preventive maintenance effectiveness and the use of the sources, identify the need to expand the review, and react to changing industry or economic conditions.

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RCM ELEMENTS: PHILOSOPHY TO PRACTICE - 38/38

Step 7: Optimize Tactics and Program

- To achieve these goals, two complimentary activities are integrated into a " living program."
  1. The periodic re-assessment and revision of the RCM review results. The frequency of the re-assessment depends to some degree on the equipment age but is usually conducted in the tool to five years.
  2. A continuous process of monitoring, feedback, and adaptation. This process analyses and assesses the data produced by production and maintenance activities for failure rates, causes, and trends. It includes variances between actual and target performance. Corrective actions can then be taken. These may include changing the task type, scope, or frequency; revising procedures; providing additional training; or changing the design.
- Continually reviewing and improving the initial maintenance program is akin to a quality management process that continuously improves product quality.

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We will stop here. Implementing RCM will be discussed next Tuesday

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IMPLEMENTING RCM - 1/11

- Some of the key success factors in previous RCM programs are listed In figure 7-6.
- To achieve such success and manage change effectively, the RCM program must be phased in and constantly improved.
- The continuous improvement strategy is long-term, involving people from production, materials, maintenance, and technical functions in the RCM review process.
- The program involves the use. of a part–time review team, under the direction of a full–time facilitator.
- As a result, it can take a few years to review the critical physical resources in a company.

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IMPLEMENTING RCM - 2/11

- **Clear project goals**
- **Management support and a commitment to introduce a controlled maintenance environment**
- **Union involvement**
- **Good understanding of RCM philosophy by plant staff**
- **Pilots RCM applications to demonstrate success and build support**
- **Sufficient resources for both the review and subsequent implementation of recommendations**
- **Clear documentation of results to facilitate acceptance of recommendations**
- **Integration with condition-based maintenance capability**

Figure 7-6: RCM Program Key Success Factors

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IMPLEMENTING RCM - 3/11

- This approach complements other improvements initiatives, such as just in time (JIT) and total quality management (TQM). It provides :
  - A high degree of support from people in production, materials, maintenance, and technical departments for RCM, ensuring acceptance of change.
  - Many part-time review teams under the direction of full–time facilitator to review important plant areas. Thus, it is easier to obtain the right people to conduct the review.
  - Flexibility and cost-effectiveness, minimizing the need for full-time staff.

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IMPLEMENTING RCM - 4/11

- The basic building block of this strategy is the cross functional RCM review team of company employees.
- The RCM review process addresses six questions about a physical asset (see page 106).
- To answer these questions, input is required not only from maintenance but also the production , material , and technical departments.
- As a result, the RCM review is best conducted by small teams (five to seven members), with at least one member from each of the above functions who is knowledgeable about the physical resource under consideration .
- The other key member of the review team is that facilitator who provides expertise in the RCM methodology and guides the review process.

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IMPLEMENTING RCM - 5/11

- The RCM review team meets on a part–time basis.
- Typically, this involves one to two meetings per week of about three hours duration each.
- Team members also spend about three to four hours per meeting on individual preparatory to follow – up work.
- The RCM review process takes about ten to fifteen meetings to complete.
- The physical resource chosen may be studied in sections, by subgroups, so that that if you can be accomplished in this time.
- The RCM review team also coordinates how the commendations are carried out.
- Team meetings during this phase are of similar duration but less frequent.

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IMPLEMENTING RCM – 6/11

- In addition, the phased–in approach is used to manage change successfully. This approach is employed to :
  - Establish the need for RCM and build support for its implementation.
  - Establish a vision of excellence .
  - Customize RCM methods to meld with existing structures and systems.
  - Promote technology transfer and commitment to RCM through an initial cadre of people trained and experienced in its methods.
  - Achieve immediate results to build credibility .
- The major phases in this implementation approach and general tasks are illustrated in figure 7-7.

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IMPLEMENTING RCM – 7/11

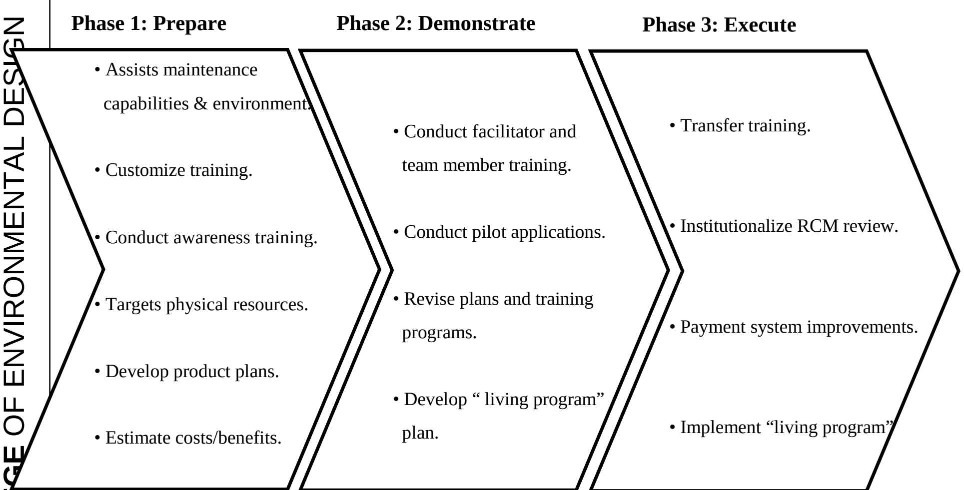

Figure 7-7: RCM Implementation Phases

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IMPLEMENTING RCM – 8/11

- The following is an example of the use of RCM in manufacturing
- One mining company with a fleet of 240 ton trucks in continuous operation wanted to reduce unplanned downtime.
- They analyze the data in the truck dispatch system to determine the highest delay causes, and selected an assembly that was both significant and reasonably straightforward.
- Their choice was the hydraulic box dump assembly.
- With a team of in-pit and shop maintainers led by a facilitator with RCM expertise, they met for about two to three hours every week over thirteen weeks.

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IMPLEMENTING RCM – 9/11

- The primary function was defined as: "provide hydraulic power to smoothly and symmetrically raise and lower a loaded (240t) dump tray. The maximum overall cycle is 47 seconds for an empty tray at the regulated pressure of 2400psi ± 50psi with the prime mover at 1910 rpm."
- The function is a stated crisply, with several standards of performance that make the definition of a function failure clear:
  - Fails to raise the dump tray at all with a regulated pressure of 2400psi ± 50psi.
  - Tray is raised too slowly (overall cycle time >47s empty) at a pressure of less than 2350psi.
  - Tray is raised too slowly (overall cycle time >47s empty) at a pressure of less than 2400psi but with the engine<1910rpm.
  - Try is raised erratically.
  - Try cannot be raised to full height.
  - Try is lowered too slowly.

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IMPLEMENTING RCM – 10/11

- About 150 modes of failure were determined using cause – effect diagram and then transcribed to worksheets using terse phrases such as "Hoist control valve spool jammed by foreign material or wear and tear ."
- The failure effects were classed as to degree of severity using a frequency and severity matrix, with a bias toward frequency, on the assumption that if you care of the chronic problems, the acute ones will take care of themselves.
- The effect corresponding to the Jammed spool above is "Sufficient pilot pressure not available to move dump control valve spool and so tray cannot be lifted. The pilots valve is changed, which requires two labor hours and the truck is down for less than four hours."

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IMPLEMENTING RCM – 11/11

- The cost – effectiveness of this RCM example is clear.
- Downtime cost about 500 tons/hour and is worth $20,000 in lost production, or $480,000 in a one – day period.
- They were able to find the root causes of all critical failures, change both maintenance and operating procedures to reduce the incidence of some causes, and make some simple modifications in hydraulic system design to eliminate others.
- Today challenging maintenance environment demands continuous improvement. RCM Provides a strategic framework to do just that. If properly applied, its benefits can be seen in better service and products.
- RCM is a logical and structural approach to balancing resources with equipment reliability requirements . Although it clearly involves the help of several functions in the organization, it is very much “top – down” and engineering oriented.

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Thank You

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