OMDEC
OPTIMAL MAINTENANCE DECISIONS INC

560 Burns Road
Godfrey, Ontario
K0H 1T0, Canada
613-273-4366
1-800-787-7961
Fax: 613-273-4367
www.omdec.com

OMDEC Solution Overview

OMDEC's reliability solution has expanded to include some new and important processes and decision support tools.

The purpose of the solution is to provide senior management with the knowledge and comfort level to predict their revenue and protect their ROI from critical equipment and businesses process failure.

The starting point recognises the fundamental importance of business risk. In the world of physical asset management, this is defined as the cost of failure times the probability of failure. The cost of failure must recognise the three main elements of costs and losses:

Cost of Failure =

Cost of Emergency Repair
+
Cost of Lost Revenue, lost opportunity, lost margins during the failure period
+
Penalty Costs of Safety and Environmental violations, Costs of lost Reputation, lost Markets, Fines and Reparations etc

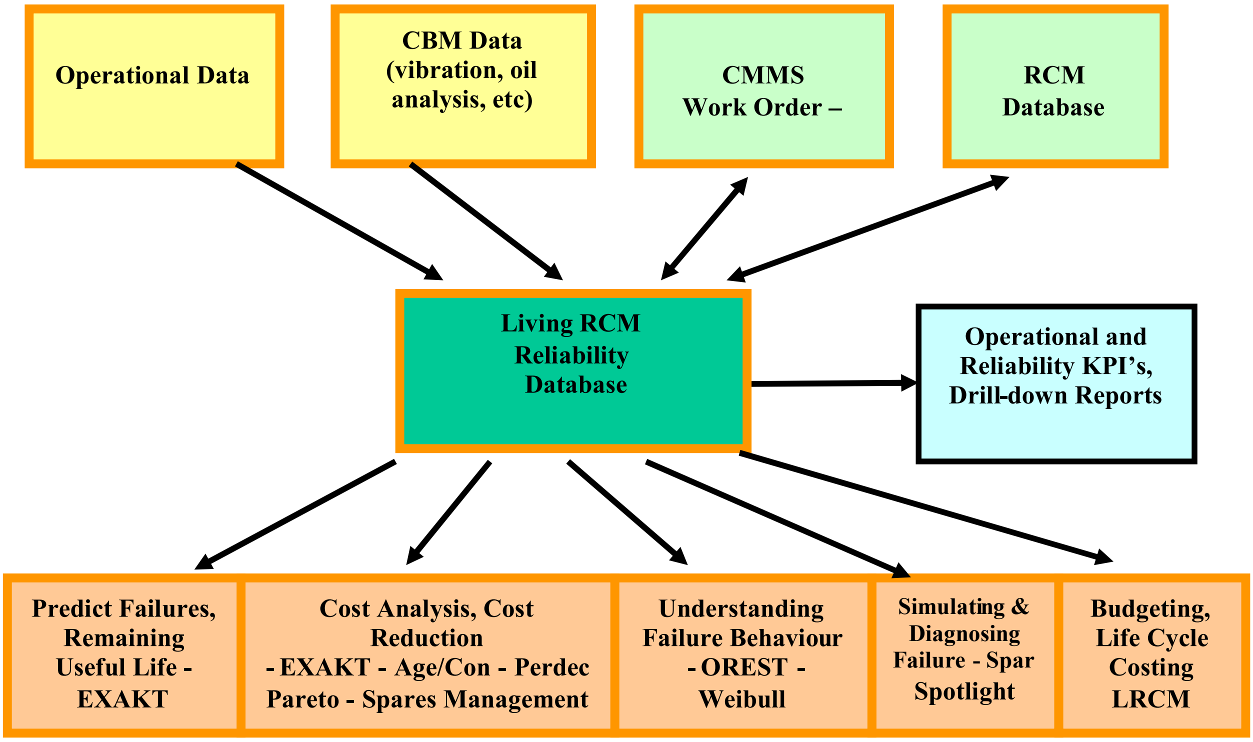
These costs may be many times the cost of preventive or avoidance measures, and should represent a standard output report from any Enterprise Asset Management system (EAM) or Computerized Maintenance Management System (CMMS). Unfortunately they often don't – a special report has to be produced.

On the other hand, probability of failure – the other key criterion of risk – requires a **specialist prediction system**. These systems are available and operate with a high degree of effectiveness, but are reliant on good data. In summary:

Data Sources for Reliable Failure Predictions:

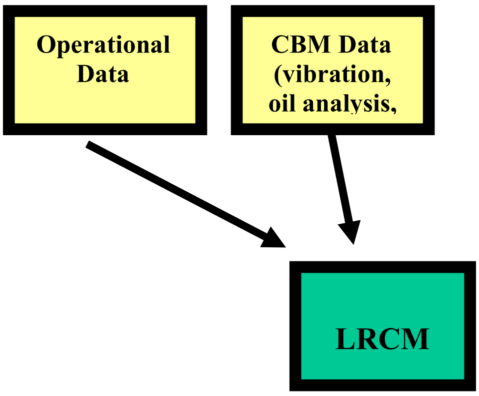
Knowledge of what has happened (= IFS = key events)
+
Knowledge of what is happening (= CBM = current status)
+
Knowledge of what "ought" to happen (= RCM = failure modes)

Typically, Physical Asset Management (PAM) users have access to most of this data, but each database usually exists in isolation of the others. The issue then becomes – how can we tie these pieces together, and what is the value of doing so? OMDEC's answer is **LRCM (Living RCM).** It builds a reliability database which can then act as the basis for the decision support tools – as follows:



The principle here is quite simple – if we can amalgamate key items of data from our core Asset Management databases, then not only can we provide accurate failure analyses, but also perform many other types of valuable analyses to provide better insights into our business, such as focused cost reductions and optimum economic equipment replacement periods for assets.

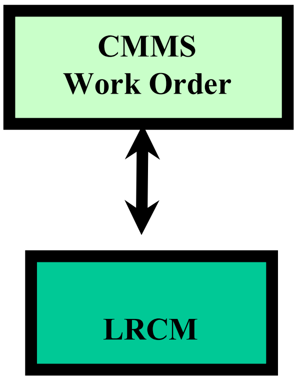
Let's look at some of the key components of the data flow chart.



1. Operational and CBM data to Living RCM – the operational and condition monitoring data that is available in most maintenance departments provides a very fertile basis for tracking the current status and current health of the equipment. As will be seen later, we will want to use **selected parts** of this data for failure prediction. In the meanwhile, we will note that because the ability to collect this data has far outstripped our ability to analyse it, too much data has become a chronic problem. *The concern should turn to the relationship between the data that is collected and its ability to be used for maintenance improvement and failure prediction purposes.* In short, if there is a useful purpose to be served from the analysis, then we should collect the data; if not, then stop collecting it. (In the later discussion of **EXAKT**, we will see that it does indeed identify data that has no predictive value, and which therefore can be ignored for this purpose.) **LRCM's** task is to identify key data, validate it and store it for later access by our analytical tools. The data can come in many forms – representing conditions such as vibration, oil sediment analysis, pipe corrosion measurements, temperatures and so on.

2. CMMS data interchange with LRCM - for analysis purposes, good prediction needs to have access to historical data that is (typically) stored in the CMMS system. However, it is rare that the CMMS data contains all the data elements needed for the analysis. In particular, data related to the "as found" condition is rarely included. To rectify this an additional field is required in the CMMS Work Order; namely whether the fault corrected in the Work Order is :

- A Functional Failure – which compromises the equipment's ability to perform the desired function; or
- A Potential Failure – which if uncorrected will lead to a Functional Failure; or
- A Suspension – which records a unit taken out of service for reasons unrelated to failure.



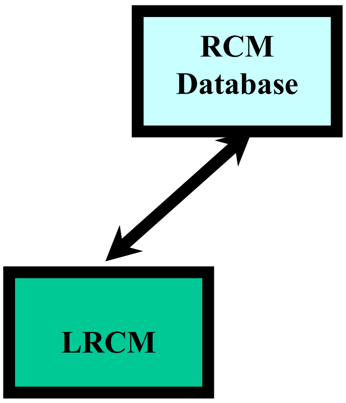
These items provide us with the basis for building the reliability database required for later analysis. In addition, one other key item of information is needed – the record reference number in the RCM database of the RCM analysis that corresponds to the fault that is recorded on the Work Order. This critical analysis of what is (and what is not) critical data is a core part of the OMDEC reliability service.

LRCM's proven integration capability with CMMS, EAM and ERP systems such as SAP, Maximo, Ellipse, Datastream and others means that the transfer of data is performed reliably, consistently and on-line. The architecture and methodology are based on data warehousing ETL (extract, transform, and load) and OLAP (on-line analytical processing) technologies. We unify relevant data sources to enable *fact-based decision making*. Good decisions require knowledge derived from the analysis of valid data. A continuously improving knowledge process supports confident decisions.

In short, **LRCM** extracts experiential data from SAP PM, Maximo etc to build a reliability database for interrogation by powerful analysis tools, for the purposes of failure prediction, cost analysis, economic annual cost calculations, problem diagnosis etc.

3. RCM data interchange with LRCM - This clearly introduces a new concept – that of linking the CMMS and the RCM databases through **LRCM.** The fundamental reason is so that the knowledge and experience from the two can be combined to the advantage of the user. Historically, CMMS and RCM have at best been seen as parallel but unconnected (and, at worst, often competitive). RCM contains information about what we expect to happen; CMMS contains information about what has happened. Our expectations should help us to better record what has happened; and our experience should help to improve our expectations of what will happen.

In linking the two, we will see several different situations arising:



- RCM already has a record of the Equipment – Function - Failure Mode that corresponds exactly to the identified fault in CMMS. In this case, the RCM reference number (RCMREF) is returned to the CMMS and recorded in the Work Order field provided. This linking of the RCMREF to the Work Order means that any future analysis can access both records to provide full knowledge of what has taken place. Note that **LRCM** provides a very effective Google-style search engine that will ease the finding of the relevant RCM record.

- RCM does not have a record of an equivalent Equipment – Function - Failure Mode – ie this is a new failure that was not included in the original RCM analysis; in this case the appropriate information is taken from CMMS and a temporary RCM record is created by LRCM. This can be later validated using the regular rigorous RCM methodology.

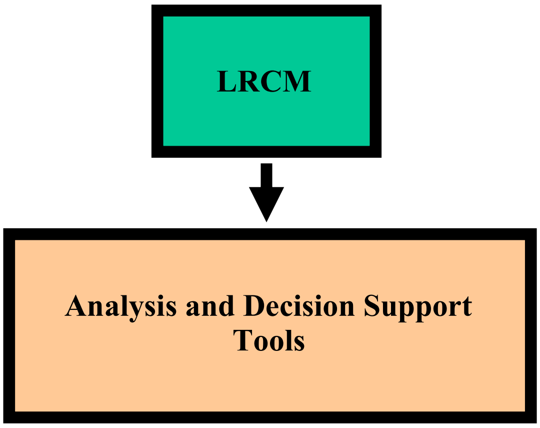
- RCM contains a similar record but different data is recorded – this is normal, as the RCM database is built from expectations of what will happen, while we are matching with what actually has happened. Again, a temporary record is created by **LRCM** for later validation and consolidation.

This interchange between the two previously isolated databases has many practical advantages – example, the knowledge of the maintenance function (through the CMMS) is now pooled with the knowledge of the reliability function (through the RCM), and each can validate and update the other. This removes two serious drawbacks:

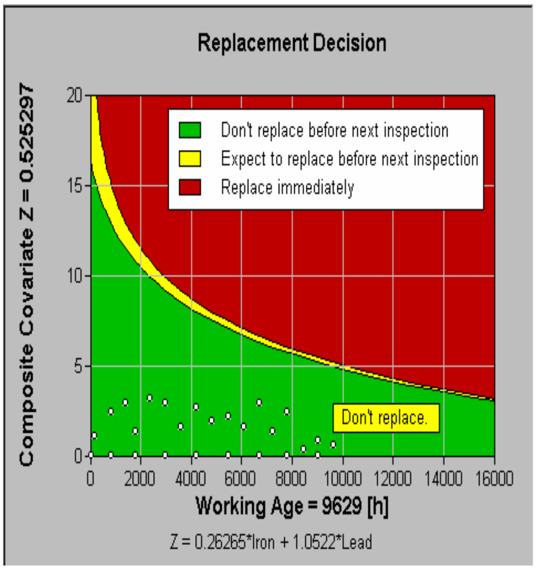
1. Fault codes – long collected in the WO and long ignored as rarely providing any reliable data – can now be the same as the (RCM) failure mode of the equipment.

2. The RCM database can now be regularly updated with actual experience; critical failure frequencies can be easily tracked, the ability of the potential failure to avoid the functional failure can be measured, and costs per task can be monitored.

This in turn leads to a very valuable and practical result – namely that the Maintenance and Reliability specialists are now talking the same failure language. Problems become more quickly identified and much more quickly resolved. Simultaneously, if a critical failure does occur, then if the same RCM logic was applied to other equipments in the same or a similar class, this can be quickly tracked and rectified.



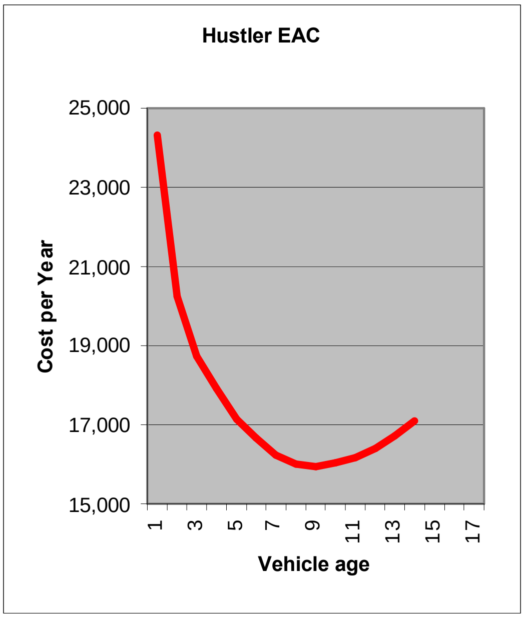
The highly valuable net result of these data interchanges, is that **LRCM** constructs a reliability knowledge base that is tailor-made for use by a wide variety of analytical tools. One of the foremost of these tools is **EXAKT**. Developed by Professor Andrew Jardine of the Department of Mechanical and Industrial Engineering at the University of Toronto, it is designed specifically to predict equipment failure. **EXAKT** works by establishing the predictive impact of condition variables on failures and failure modes and correlating it with the working age of the equipment. Depending on the application, the working age can be the number of working hours of the unit or it can integrate load or stress. The condition variables are extracted from the **LRCM** data base, or they input directly into **LRCM.** In recent years, the capability of the condition monitoring industry to collect data has far outstripped the ability of the users to analyse that data. **EXAKT** solves that problem by using proportional hazards modelling – a complex procedure (but easily managed within **EXAKT**) for determining which of many variables have failure predicting capability. The result is a monitored formula which than tracks the equipment status on a familiar and easy to read traffic light graph.



Here, the dotted line traces actual readings from the formula and provides a "Don't Replace" conclusion in relation to the next planned inspection or end of the production run etc. **EXAKT** balances Preventive Replacements against Run to Failure, using cost or reliability as the optimiser. Built-in statistical tests advise whether data accuracy and consistency is sufficient to predict the accuracy of failure with high levels of confidence. By applying **EXAKT** to historical data, the costs savings are determined.

The use of **EXAKT** to determine the probability of failure within a given period, provides the capability to assure output and therefore revenue – thus materially increasing Senior Management's confidence in their ability to meet customer demand and maintain their return on investment.

The reliability knowledge base built into LRCM also transfers data into other analytical tools. Prominent among these are two other OMDEC tools - **Age/Con and Perdec**. These are designed to easily solve the complex financial equation surrounding the point at which equipment should be replaced – not simply for wear-out reasons, but for overall cost reasons.



Using data originating primarily in the CMMS, Age/con and Perdec show the minimum Economic Annual Cost (EAC) of an equipment. Trading or replacing a unit at a point other than the point of minimum EAC, wastes the organization's money. A quick look at the EAC graph shows the extent of the financial wastage. Drawing data from the CMMS, the EAC calculation includes purchase and replacement costs, trade-in values, operating, maintenance and financial costs as well as the usage profile of the unit. The EAC chart graphically shows the extent of the financial wastage. A delay of a couple of years (and a rise of $1000) beyond the minimum cost point wastes that thousand dollars per year of the unit's life for each unit.

Other OMDEC tools will assist in defining the failure model that is applicable to a specific equipment (**OREST**), prioritising among the acute and chronic problems (Jack-knife) showing the frequency of failure (Pareto) and preparing life cycle costing and budgeting information **(LRCM).**

In addition, two important **LRCM** output capabilities present the user with a powerful insight to their maintenance operations. The KPI module has both the templates and the calculations for almost 50 of the most commonly used maintenance performance indicators. Because of the full integration of **LRCM** with the core PAM databases, the KPI's are now able to be updated automatically and on-line.

Consistent with this concept of open data availability is the drilldown report writer. Here, the output of an analysis may be a graph or a pie-chart. Clicking on the graph or chart will successively drill down through the intermediate level analysis to the original data records – thus helping the user to validate specific initial readings.

Central to reliability improvement, is the use of the knowledge and practical experience of the most senior technicians to bring complex problem solving within the scope of their less experienced colleagues. This knowledge-sharing approach is employed by Spotlight – an expert diagnostic system. Using a Q&A methodology, Spotlight drills down into the symptoms encountered by the technician, and matches them against prior experience. Advanced case-based reasoning evaluates the match with the prior history, and through a probability score, shows the level of confidence that we have identified the correct diagnosis. This in turn can trigger the release of the best practice work order. This type of expert system is becoming a core solution to record and retain key corporate knowledge before the senior technicians retire.

SPAR'S advanced simulation methodology provides yet another dimension in the quest for improved reliability. Here we use the computer simulation of different types of failure to predict the impact on equipment reliability and plant performance. As the managers of critical physical assets seek to optimize the maintenance and use of their equipment, this must be matched by their ability to use techniques to forecast the resulting impact of different policy decisions without the risk of trial and error.

Conclusions: OMDEC's reliability suite takes the issues that have traditionally been confined to the Maintenance function, and opens them to the senior executive. Introducing risk measurement indices and using failure prediction methods, the impact of failure and failure prevention are now directly linked to the revenues, ROI and customer satisfaction of the organization. Top management can now promise delivery with confidence of success.

Ben Stevens
1 October 2008