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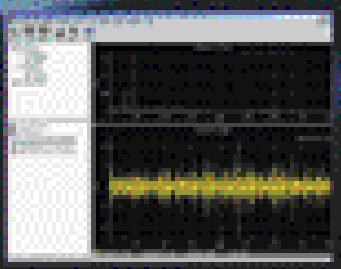

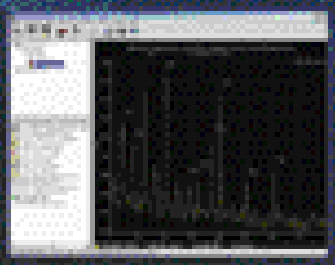

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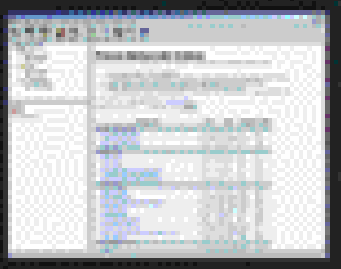

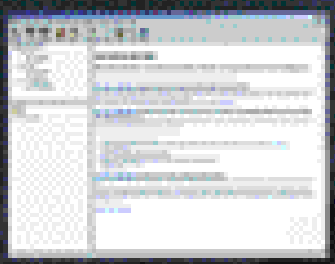

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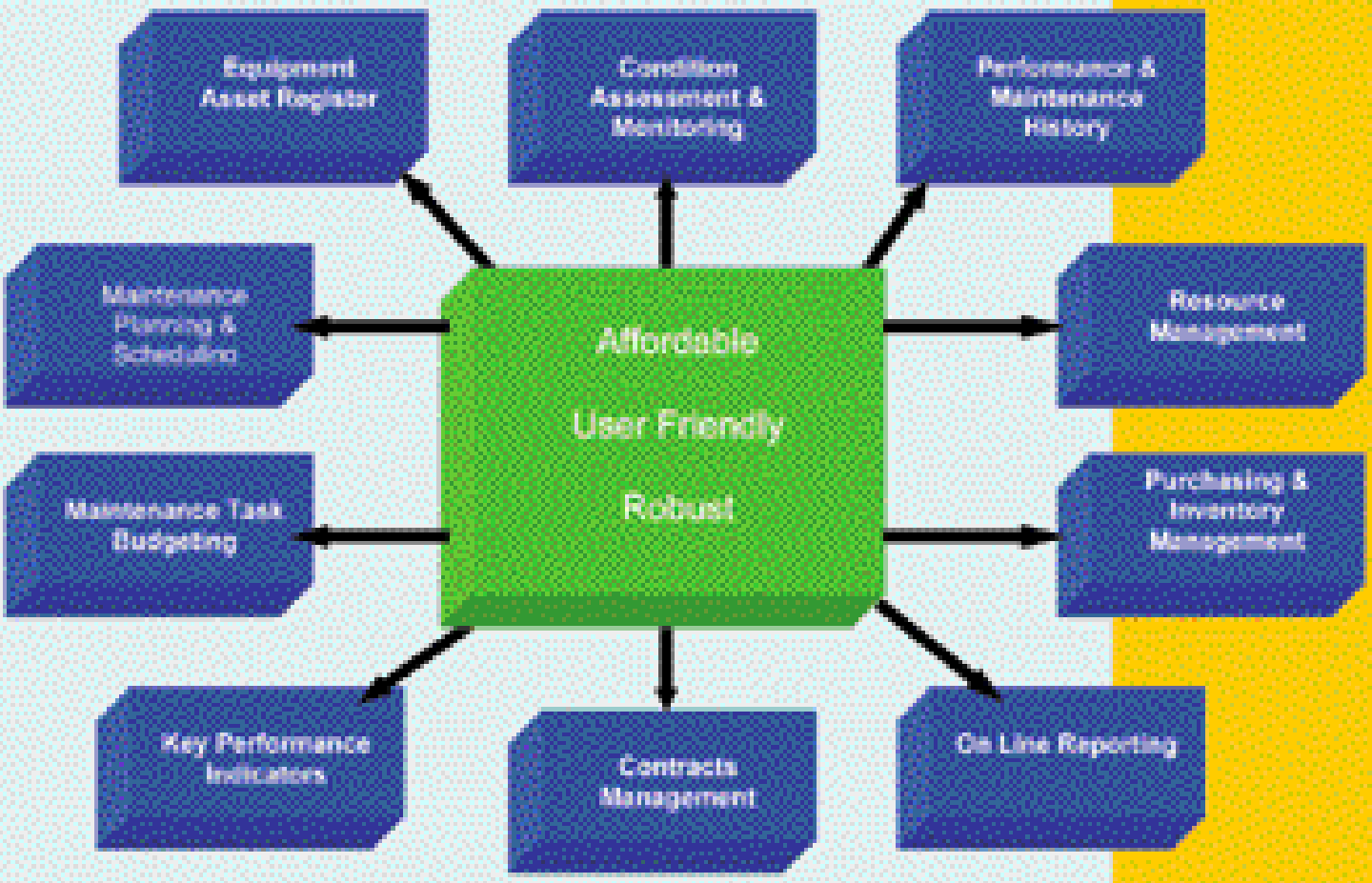

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MJ Maintenance Journal

May 2004

Contents

A journal for all those interested in the maintenance, monitoring, servicing and management of plant, equipment, buildings and facilities.

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For all Enquiries Contact:
Engineering Information Transfer Pty Ltd
PO Box 703, Mornington,
Victoria 3931, Australia
Phone: (03) 5975 0083,
Fax: (03) 5975 5735,
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Accelerometers connected to the end bearing of one of Malabar Sewage Treatment Plant's centrifuges measure vibration in three directions. See Maintenance News for details.

Regular Features

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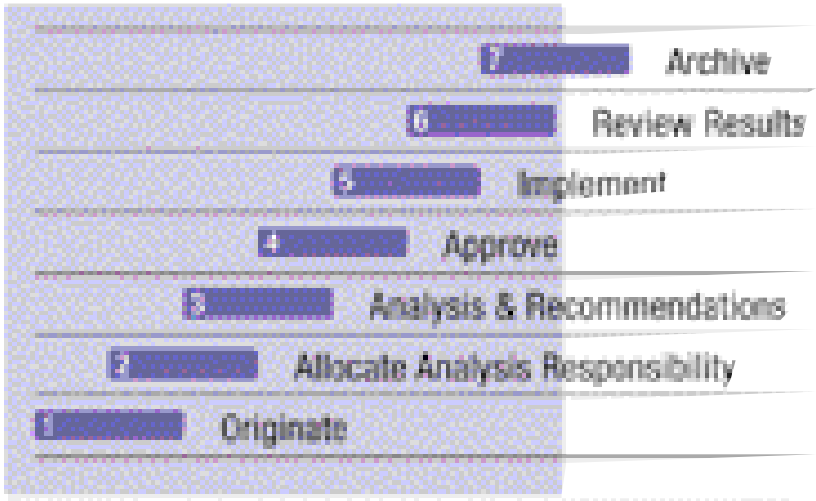

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May

Editorial

The annual survey of Computerised Maintenance Management Systems (CMMS) has generated almost 50 responses. The systems include small to large, with costs of $2000 to millions of dollars. There has to be at least one of those systems that meets most of your CMMS requirements.

One article in this issue is by your MJ editor. In my 20 years of examining, implementing and using CMMS I have seen dramatic changes in their ease of use, flexibility and functionality. My article touches on some of those improvements of recent years. However I have observed in the past that the best users of CMMS did not necessarily use the best CMMS systems. So what factors do help create the best users of CMMS systems?

There are two articles on how we may better display maintenance related data via Jack-Knife Diagrams (with Mining Plant examples) and Honeycomb Maps (US Marine Corps). One allows the display of multiple parameter maintenance performance data for an asset. The other uses a single image to display the state of readiness for use and significance of multiple asset types.

I also have a particular interest in John Wilson's article on the Post-Construction Maintenance of Infrastructure Assets - or the lack of it. I spent many years on various aid projects in developing countries. Big budgets for the construction phase but little for ongoing maintenance.

In the first quarter of 2004 Philip Higgs conducted a Survey of Condition Monitoring Systems in Industry. A summary report on the results of that Survey are included in this issue.

A new regular feature has been added to the Maintenance Journal - the "Planned Maintenance Corner". Each issue will include a Condition Monitoring routine for a particular plant type, this issue features a CM routine for a Screw Conveyor.

SURVEY FEATURE
in the October
2004 issue
Survey of Special Maintenance Applications Software

The SMAS survey provides a listing and details of Maintenance software products such as for RCM, Failure Analysis. FMEA, LCC, Simulation, PM Optimisation, Weibull Analysis, Parts Optimisation, Plant Replacement software, etc.

If your organisation wishes to be included in the SMAS survey for 2004, then you may obtain the appropriate survey form by contacting Ian Bradshaw at

mail@maintenancejournal.com

The completed survey forms must be returned by 2nd July 2004.

Improved CMMS and Asset Management Systems - But Do They Lead to Success?

By Len Bradshaw,

Editor, The Maintenance Journal

Part 1

Improved CMMS And Asset Management Systems

Computerised Maintenance Management Systems (CMMS) evolved in the 70's and 80's as a means of managing maintenance activities. In particular they were created to help manage all aspects of managing, planning, controlling, requesting, recording, reporting, and analysing maintenance activities.

The Basic Modules of a CMMS

The basic requirements of Computerised Maintenance Management Systems (CMMS) are as follows:

- A means of establishing a data base for the maintenence asset.
- A means of requesting the assistance of a maintenence section.
- A means of establishing the prioity of incoming work.
- A means of checking the available resources of material, tools, personnel, etc.
- A means of storing and retrieving appropriate description of maintenance activities.
- A means of issuing maintenance work instructions.
- A means of recording work preformed, additional work identified, and resources actually used.
- A means of establishing appropriate historical records for each asset, sub-assets, or groupings of assets.
- A means of analysis of historical data to to produce reports on the efficiency and effectiveness of the maintenance activities performed.
- A means of generating information flow for other special applications such as Statutory Maintenance Activities, Permit to Work Systems, etc.

In addition to the above the latest CMMS's will provide a vast range of capabilities/modules. They are large complex software packages but are now relatively easy to use, provided that appropriate training in the system usage has been given.

More Than a Computerised Maintenance Management System

There have been dramatic improvements in the ease of use, speed, and functionality of Computerised Maintenance Management Systems. CMMS's now provide much more than a basic Maintenance Management system. They have improved capabilities such as:

Intergration / Interfacing

- Direct linkage to Stores, Purchasing, Costing and Production Management Systems. Such interlinked systems go beyond being simply CMMS to Enterprise Asset Management Systems (EAMS).
- Linkage to other specialist systems such as Project Management, Energy Management, and Analytical software, etc
- Ability to access and disseminate Diagrams and pictures, CAD/CAM, videos, etc.
- Direct linkage to Condition Monitoring Systems. Providing if required condition data from a plant item to anywhere in the World.
- Direct linkage to control systems / production control data, etc.

Communication / Data Collection / Data Transfer

- Portable Data Collection and Data Transfer Systems, etc
- Bar coding, Stick on data Buttons, Transponders, Electronic tagging, etc.
- Radio paging, Data transmission, Telemetry Systems.
- Internet, Intranet, Web based capabilities.
- Links to Global Positioning Systems (GPS)
- Geographic Information Systems (GIS)

Intergration/ Interfacing of CMMS

A CMMS is a mechanism for communication not just within the maintenance department but also with other departments and possibly even other organisations.

This 'integration' or 'interfacing' of the CMMS with other systems is shown in Figure 1.

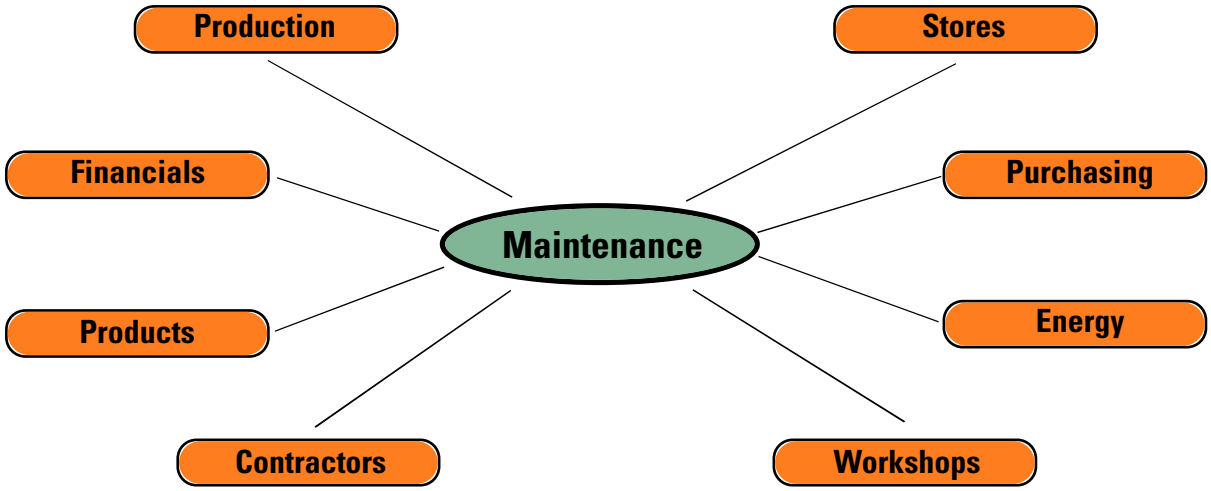


Figure 1: Intergrated Maintenance Management

Chris Cooper[1] suggests:

- A true EAMS is one that provides maintenance functionality but is also a fully integrated module of an enterprise system. The integration will then be part of the overall software design and immediate updating of files takes place rather than data being passed between system modules.
- A third-party EAMS will usually require data to be passed between systems and is therefore interfaced not integrated.

The benefits achievable by a computerised maintenance management system are very much dependent on the extent of the integration of the maintenance management system and other sections of the organisation. The selected system must not only satisfy the planning, control and information needs of the maintenance department, but must also provide the data/information flow to and from the other sections of the organisation.

Quotes on the extended use of CMMS / EAMS

Information Engineering - The Search for Business Intelligence

By Tom Singer[2], Principal, Tompkins Associates

"While our ability to control specific transactions and work flows through information technology continues to increase, how effective are we at making tactical decisions based on the mounds of data we collect? Information may be an asset, but in copious quantities it can literally choke the decision-making process. We might be impressed by the number of reports and inquiries within our enterprise applications, but can we effectively use these tools? Despite all their underlying data, do our applications present the information we really need in a manner that we can effectively use in our decision-making processes?'

Towards Predictive Maintenance - Listen to the Factory-Floor

Rockwell Automation

"What if the loop could be closed - what if your factory-floor could "talk back" to your CMMS in real time? This is the essence of predictive maintenance or condition-based monitoring, and the future of asset management and CMMS.

Using the data inherent in almost all plant-floor automation and control systems, coupled with advanced Condition-Based Monitoring [CBM] technologies you can transform the CMMS into a truly responsive predictive maintenance system.

- Computerisation of maintenance scheduling, spares procurement, plant equipment databases and so on, using leading CMMS technologies.
- Automated data collection: Reducing laborious and costly routine data collation by drawing in data straight from its factory-floor source.
- Condition-based monitoring: Applying advanced Condition Based Monitoring schemes to protect investment in major plant items.'

The Impact of Computer Technology on Maintenance

By Philip Taylor[3], Commercial Director, Engica Technology Systems.

"Internet companies are investing millions of pounds and dollars building virtual market places called portals. There are industry specific portals and general portals but they all operate in much the same way. If you wish to send out a tender to a number of suppliers then all you need do is send the tender to a portal you subscribe to and they will circulate it to appropriate suppliers. The suppliers reply to the portal operator who forwards the responses to you for consideration. When you decide on the best supply contract, you place your order through the portal operator and this in theory cuts down the time and effort you spend in tracking down the most competitive deal.'

Communication / Data Collection / Data Transfer

Barcoding - Barcoding of parts, work instructions, personnel, equipment and tools. This allows less paperwork and data entry workload, provides more accurate reporting, and can be used to verify the time/date of the activity

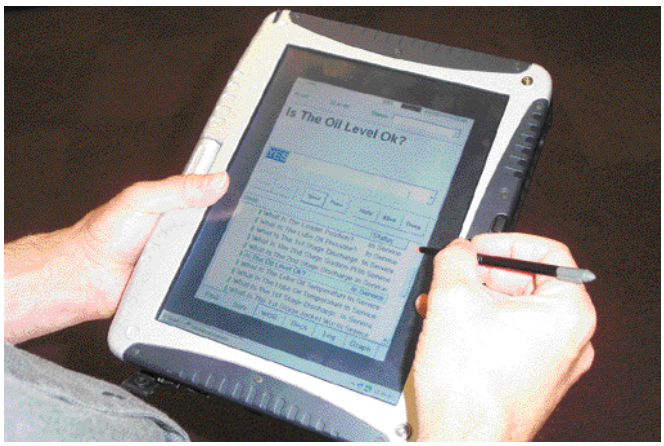
Stick-On Memory Buttons - Button sized stainless steel encased electronic buttons provide an alternative to Barcoding that are able to be used in wet and dirty environments [just needs electrical contact with the hand held data collector]. These buttons are also available that measure temperature, and have the ability to store maintenance data [ie maintenance instructions can be transferred to the data logger when contact is made with the button].

Transponders - Similar function to the 'Buttons' but do not require direct electrical contact. The data-logger sends a radio signal, that energises the transponder, and which allows transfer of data to or from the transponder.

Hand Held Data Loggers/Palm Devices

Hand Held Data Loggers/Palm Devices are small computers that are transportable, often pocket sized, and able to be used in most maintenance environments.

- The ability to programme the data logger for PM Routines or



IntelaTrac DAPR Toughbook XP OS

IntelaTrac running on Symbol hand held

IntelaTracb Safety Inspection Using RFID Tags

RFID Tags and Transponders

Inspections, which provides to the tradesman/technician the asset details and maintenance work details.

- The inspection person can respond to each prompted task by using a Bar-code Reader or keying into the data-logger numbered codes from fault or response lists.
- Some data loggers can be fitted with measurement probes for temperature, pressure, vibration levels or electrical measurements.
- At the conclusion of a day of inspection activities the information can be transmitted to the main Computerised Maintenance Management System by direct line, radio or telephone.
- Data loggers may also be used in conjunction with Global Positioning Systems (GPS), which for widely distributed assets (roads, power poles, etc), or for mobile assets (long distance haulage vehicles, etc), may be a very useful facility. It allows accurate location of the point at which maintenance is being performed or the point at which a fault is being reported.

  There are also Palm devices that link to Geographic Information Systems (GIS) and provide GIS displays/maps.
- Plant operators may use Machine or Wall Mounted Data Loggers to improve the quality of data, and the speed of data collection (ie for Downtime data collection).
- Data loggers with bar-code reading facilities as a means of used by the tradesman as a means of recording his arrival at a particular asset and linking that asset to a maintenance activity.

Part 2

We now have the greatest sytems but where are the great results?

Even with modern CMMS and EAM's we still find that there are implementation failures or perhaps that the system's impressive range of functions are under utilized (the expensive electronic filing cabinet). These improved CMMS/EAM systems, whilst perhaps helping to create satisfactory performance in managing maintenance, do not necessarily lead to your organisation becoming amongst the 'Best' of maintenance organisations. What leads to dissatisfaction, satisfaction or success in managing maintenance?

Motivational Theory

Let us examine one of the better known theories on motivation, Herzberg's Motivation and Hygiene Theory[4], using Figure 2a and 2b. Hertzberg considered that the factors shown in Figure 2a Achievement, Recognition, Work Itself, Responsibility, Advancement and Growth are the true motivators.

Factors shown in Figure 2b are the Hygiene factors which if not up to a certain level or standard cause significant dissatisfaction. Once

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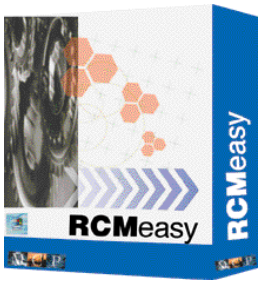

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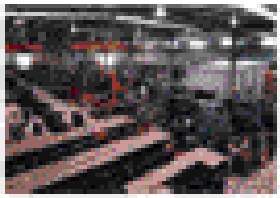

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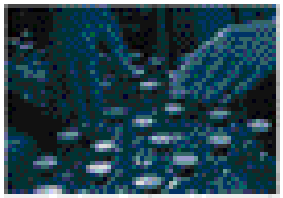
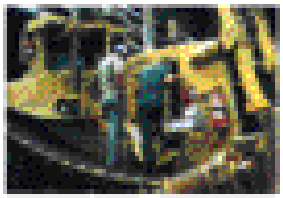
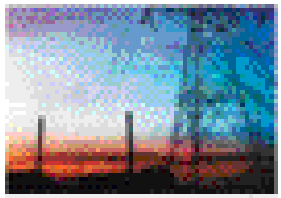


PHARMACEUTICALS
McNeils Pharmaceuticals, Puerto Rico



MINING
Western Mining Corporation, Gunpowder



ENERGY
Stanwell Power Station, Queensland

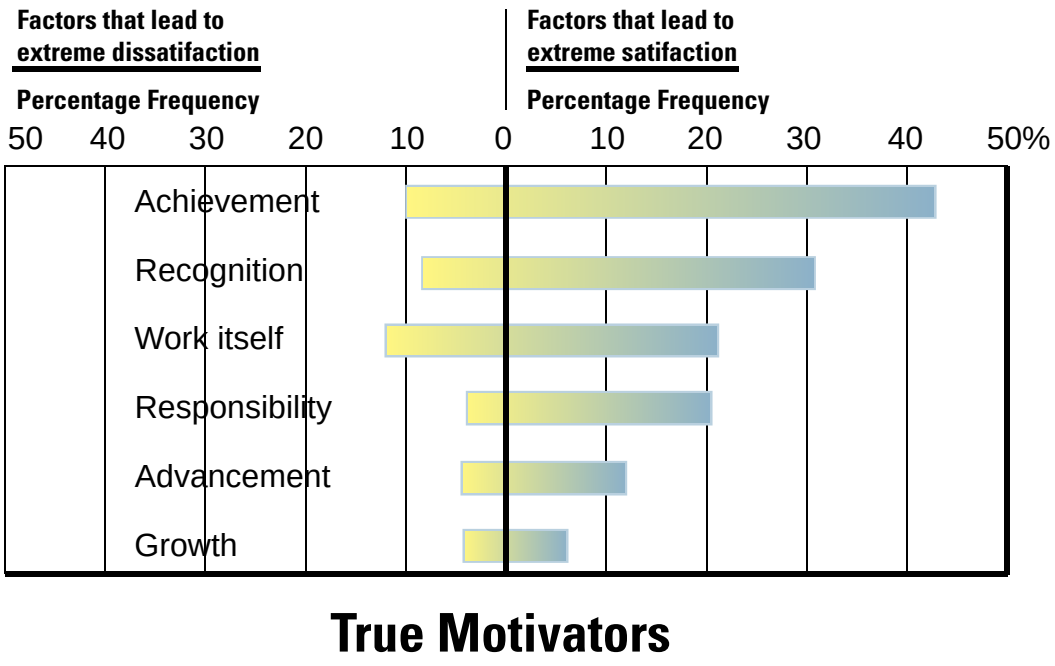


Figure 2a: Herzbergs Motivation and Hygiene Theory

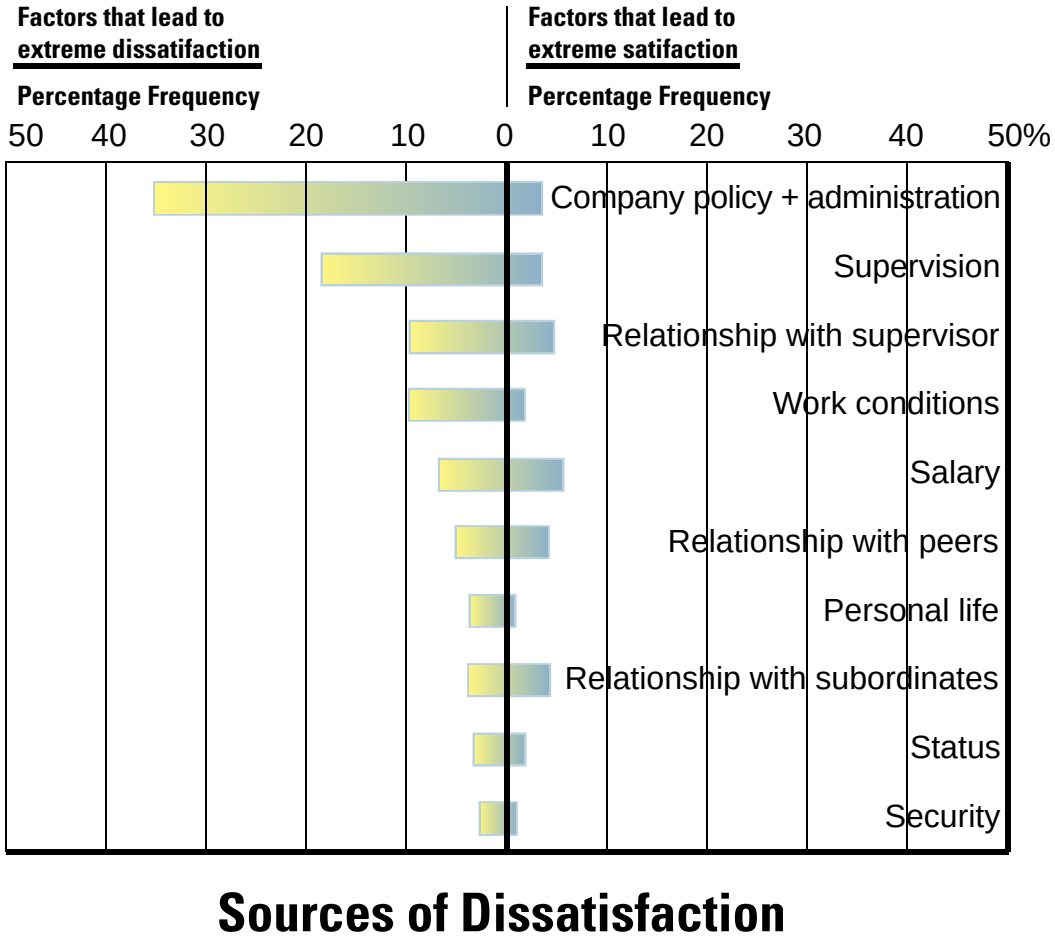


Figure 2b: Herzbergs Motivation and Hygiene Theoty

those basic needs or standards are reached further improvements to these hygiene factors will not on its own create significant or sustainable levels of motivation in the workforce.

So if we create an interesting and varied work environment, where we are proud of what our work group is able to achieve then this is a situation in which the workforce is likely to be motivated.

One of the Hygiene factors 'Salary' often generates questions motivator. If our salary is already at a reasonable level (therefore not a source of major dissatisfaction) and we receive a big increase in salary it may generate motivation for a short period but we quickly accept the new salary level as the expected norm and it then is no longer a motivator.

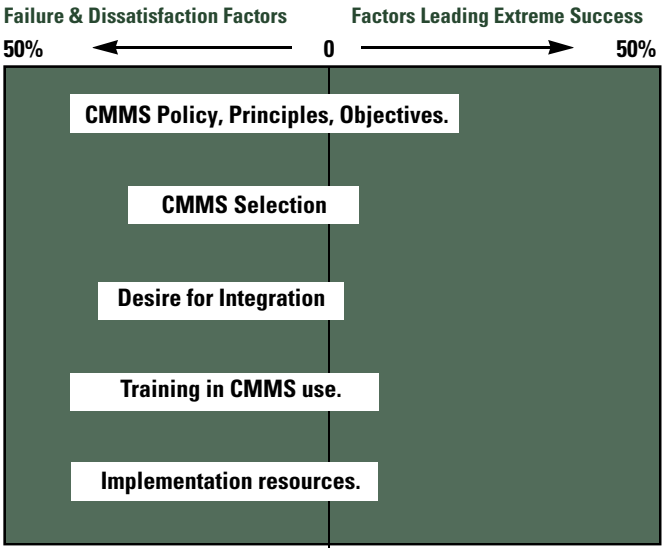
Applying motivational theory to the use of CMMS and EAM's

Let us try to apply Hezberg's approach to Motivational theory to the use of CMMS and EAM systems.

Selection and Implementation of Maintenance Management Systems

The failure to properly select and implement a Computerised Maintenance Management System is often caused by insufficient attention to Human Factors in the selection and implementation process.

Figure 3 Selection And Implementation of a CMMS



In Figure 3 is shown that the way we select and implement a CMMS or EAM can be a major source of dissatisfaction.

As an example consider the following extract from Labib's paper[5]:

'It appears that there is a new breed of CMMSs that are complicated and lack basic aspects of user-friendliness. Although they emphasise integration and logistics capabilities, they tend to ignore the fundamental reason for implementing CMMSs that is reducing breakdowns. These systems are difficult to handle by either production or maintenance. They are more accounting and/or IT oriented rather than engineering based.'

- Is the above CMMS chosen to meet maintenance objectives and to meet the needs of maintenance personnel - NO
- Where maintenance personnel actively involved in the selection process - NOT VERY LIKELY
- Is the training on these difficult to use systems going to be easily achieved - NO
- Are your maintenance personnel going to be motivated towards the implementation process of this imposed system - NOT VERY LIKELY
- Is this system going to be a source of dissatisfaction - VERY LIKELY

Such systems will tend to be a major source of dissatisfaction within your maintenance workforce.

In one organization's successful implementation of a computerised maintenance management system the reasons given for their success were as follows:

- Forward planning which meant that the project was not going to be forced on the people concerned.
- The people were asked for opinions and ideas and at all times were involved in the introduction.
- Section Heads were kept well informed of progress.
- Training was conducted in a manner which helped people accept the change
- Training was conducted on 'home ground' and people were more involved.
- Management had continually shown its support and desire to meet where possible the individual need of everyone who used the system eg design for individual problems.
- Problems were diagnosed and corrected as soon as possible.

It is clear that successful implementation of a Computerised Maintenance Management System is heavily dependent on the following issues:

- Adequate consideration of human factors.
- Involvement of persons affected by the new system in the design, specification and implementation process.
- The provision of adequate training for all levels of personnel in the system objectives and system operation.

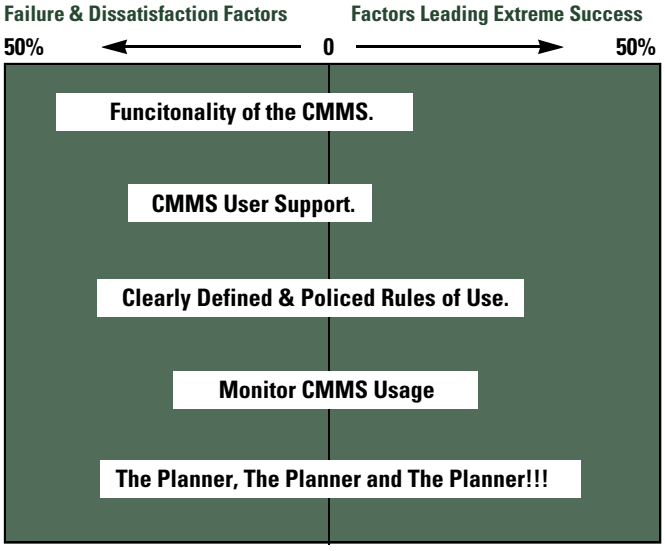
Using The CMMS or EAM

Functionality and Support for the CMMS:

As with the Selection and Implementation process the poor Functionality of the CMMS/EAM and poor support for the CMMS/EAM can be a major source of dissatisfaction. However as long as the functionality and support are reasonable the dissatisfaction will generally be overcome. Very good functionality and support can start to contribute to motivation but does not play a major part. It will not necessarily lead you to excellence in maintenance.

Consider one of the most recognised sites in the world for excellence in maintenance planning and maintenance management. Their CMMS system for more than 10 years was adequate but far from the best in terms of functionality and ease of use. You can be the best even if you do not have the best CMMS or EAM. Their path to being the best is by using the remaining factors of Figure 4 and those factors given in Figure 5.

Figure 4 : Using the CMMS



Clearly Defined & Policed Rules Of Use:

Involving as many people as possible in defining the structures, systems, use and responsibilities and then sticking with the chosen methodologies. For example:

- All maintenance requests must be documented before job start. Even urgent work will require the creation of a 'quick work order' prior to work on such jobs.
- This production area will have a maintenance coordination meeting each Wednesday, in this room, involving these people. The group will discuss planned preventive and corrective work for the following week. The production department cannot at any point beyond that meeting refuse access for agreed planned work except in the case of clear emergencies and only then if such refusal of plant access is in writing from production management.

Set the rules and make sure those rules are followed.

Monitor and Review:

Ensure there is a system in place to monitor CMMS usage and the results or achievements made via the CMMS. Set a regular review process and review period. Set performance parameters for the CMMS relative to its use and outcomes. For example:

- Ratios of work issued to work completed
- Access rates to the various CMMS modules by maintenance personnel
- Quality standards for maintenance history data

The Maintenance Planner

I may be old fashioned but I still believe that in medium to large maintenance groups the key to success is a full time dedicated and motivated planner. A poor quality planner will be a major source of dissatisfaction where as a good planner should be a salesman for the CMMS/EAM and a key motivator for others to work with the system rather than against it. If you speak with the planner and he or she is winging and complaining about the CMMS you have no hope of higher level success.

People Issues:

The final and most important set of Factors are shown in Figure 5. 'The People Issues' may contribute to great success in using CMMS/EAM's or conversely create great dissatisfaction.

The first two factors 'Recruitment' and 'People Resourse Levels' require little comment. If your organisation has recruited well then your group of motivated team players will make your system work well (even if it is a pig of a system).

If your organisation has recruited badly (poor work culture and 'don't give a dam' mentality) then even if you have the best CMMS/EAM in the World it will never be successful.

Figure 5 : People Issues

Similarly if you have insufficient maintenance personnel the people are pulled off PM's to attend to failures, which lead to more failures and fewer PM's - the downward spiral to fire fighting. The CMMS/EAM will help make better use of your few people resources. It will also help to identify the extent of the problem (incomplete PM's, backlog levels, etc).

Teams:

I am a fan of Teams whether they are Maintenance Teams dedicated to a particular area, or mixed Maintenance/Production Teams. Teams that are created in the right way and made up of motivated team players are great. They can bring together all of those true Motivating Factors of Hertzberg's (Figure 2a). In high level teams it is very much the team members who not only collect history for the CMMS but will also be using the history for improvement strategies. They recognise the value of the CMMS as a management and decision making tool that they interact with every day.

A U.S. Company 'Advanced Software Design' stated the following:

'For a product to be fully and willingly utilised, it must offer value to the person who must enter data; satisfying management's information needs is not adequate reason to ensure diligent usage of the product. Value to the technician/craftsman invariably falls into one of several areas:

- It makes their job easier.
- It allows them to do their job better
- It reduces tedious tasks.
- It makes their job more interesting.
- It increases their value and therefore their probability of future higher earnings'.

A good Maintenance Team utilising a good CMMS/EAM can get close to achieving the above conditions.

Trust:

How much time and money is wasted because of the lack of trust?

- Are CMMS, and particularly EAM's, there as effective maintenance and asset management tools? Or are they there to check on each employee as to the value of his work and the dollars he costs?
- As an employee do you trust your managers and accountants to use the information you input to the system in a fair and reasonable manner?
- As an employee how often do you fear reporting the truth to your CMMS.

Without trust, when in an atmosphere of blame and penalties, we use the CMMS/EAM to play games.

- Under worked - you must be joking. Just look at my daily job sheets - I have been busy every hour of every day for the last 20 years, (must be great planning!).
- I am pleased to announce that this team has reached its new Performance targets' (but nothing actually changed! Hey what % do you want, we will supply the data that will produce that % for you!)
- Last quarter this team recorded the lowest backlog figures for this company. Unfortunately management used this as evidence our team is over resourced and has moved two of our guys to another team. (I wonder just how high those backlog figures will be in the future!)

Leadership:

For your organisation to be the best at Maintaining, Managing and Using you company's assets requires good Leadership. In terms of a CMMS or EAM's this means you need someone at the top of your organisation who will champion the selection, implementation and on going use of the CMMS/EAM.

Hugh Blackwood[6] of Alcoa's Mt Holly plant good Leaders:

- **Create** a sense of urgency - this is not 'program of the month'
- **Understand** the plan so you can share with others
- **Communicate** with the folks you work with (walk the talk)
- **Encourage** folks for broad based action
- **Focus** - begin generating short-term results
- **Lead** - our success depends on it!

Blackwood also defined the difference between a Leader and a manager:

Leaders

- Establish Direction
- Align People
- Energize the Organization

Managers

- Plan, Budget
- Organize, Staff
- Control, Problem Solve

To be the Best it is Leaders that are required and not just a Manager. It is clear that successful implementation of a Computerised Maintenance Management Systems an Enterprise Asset Management Systems is heavily dependent on People Issues:

Quote on the Basics

(Editorial Letter - Maintenance Technology/October 2000)

"Working in a continuous flow manufacturing environment, I have witnessed tens of millions of dollars in capital investment at our facility over the past four years. We are now dutifully equipped with all the latest bells and whistles, from automation to expanded PLC control and process monitoring. However, we still cannot track downtime causes, perform root cause problem solving, locate spare parts, or follow standard work practices. Because of this, we continue to flounder. We have been given a Corvette but have yet to get our driver's license!"

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Downtime Priorities, Jack-knife Diagrams, and the Business Cycle

Peter F. Knights

Associate Professor, Mining Centre, Faculty of Engineering, Catholic University of Chile,
e-mail: knights@ing.puc.cl

Abstract

Pareto histograms are commonly used to determine maintenance priorities by ranking equipment failure codes according to their relative downtime contribution. However, these histograms do not readily identify the dominant variables influencing equipment downtime, namely the failure frequency and mean time to restore service (MTTR) associated with each failure code. This paper advances an alternative method for analysing equipment downtime using logarithmic (log) scatterplots. Log scatterplots preserve the ranking scheme of Pareto histograms, but provide additional information content regarding failure frequencies and MTTR. By applying limit values, log scatterplots can be divided into four quadrants enabling failures to be classified according to acute or chronic characteristics and facilitating root cause analysis. In addition, the graphs readily permit the identification of problems affecting system reliability, availability, and maintainability. Depending on the relative importance of maintenance and repair costs to the economic consequences of failures (including lost production costs), a V-shaped limit can be established for determining downtime priorities. These graphs have been christened "jack-knife" diagrams after the shape of the V-shaped limit. As prices vary over the business cycle, the jack-knife limit can change orientation, re-focusing downtime priorities to reflect changes in business priorities. By graphing the trend of failure data over successive time periods, log scatterplots provide a useful visual means of evaluating the performance of maintenance improvement initiatives. Since their introduction in 1999, log scatterplots and jack-knife diagrams have been profitably employed by a number of mining companies and mining equipment suppliers world-wide.

1. Introduction

In the late 19th Century, the Italian Engineer Vilfredo Pareto (1842-1923) constructed histograms of the distribution of wealth in Italy and concluded that 80 percent of the country's wealth was owned by 20 percent of the nation's population. This trend was later found to be representative of the distribution of other data populations. The 80:20 rule, and variations such as ABC analysis that uses an 80:15:5 classification rule, or "top ten" list generation, are now routinely used in many fields of study. As applied to the field of maintenance engineering, Pareto analysis is commonly used for identifying those failure codes responsible for the majority of equipment maintenance cost or downtime. Based on the failure codes identified, action plans can be elaborated to lower maintenance costs or improve equipment availability and reliability.

However, Pareto Analysis suffers from a number of deficiencies:

Firstly, maintenance costs and downtime are the product of two factors; the number of failures that occurred in a particular time frame and the average associated repair cost, or mean time to restore service (MTTR). A Pareto histogram based on downtime (or cost) alone cannot determine which factor, or factors, are dominant in contributing to the downtime or cost associated with particular failure codes.

Secondly, Pareto histograms prepared for failure codes ranked according to repair cost, equipment downtime, failure frequency and MTTR will generate four quite distinct lists of failure code priorities. These four lists must be combined in some way to generate a reduced, manageable set of downtime priorities. Which failures should be selected in order to best improve business performance? A graphical means for simultaneously visualizing equipment availability, reliability and maintainability problems as a function of equipment failure codes would be extremely useful to this process.

Thirdly, Pareto analysis of equipment downtime may miss identifying: (i) individual events having high associated downtime or (ii) frequently occurring failures that consume relatively little downtime yet cause frequent operational disturbances. An example of the former is the failure of the transmission in a mechanical mining truck. An example of the latter are repairs to the truck's driving lights. Failures that frequently re-occur often have significant hidden costs. For example, if the truck has to return to the truck shop to have a light replaced, the time lost travelling to and from the shop may dramatically increase the opportunity costs associated with lost production.

Fourthly, when there is a lot of data to analyse we commonly use data stratification or hierarchical decomposition techniques. A Pareto histogram is prepared for downtime data grouped by major equipment or functional failure type. More detailed Pareto graphs are prepared for the downtime associated with those components or functional failures judged to be the most significant contributors of downtime. There are two potential problems with the use of stratified Pareto analyses: (i) because hierarchical Pareto graphs are only prepared for the significant contributors of system downtime, failures associated with less significant components or functional failures will not be explored. It is possible that we may miss identifying a component, or failure mode that offers significant potential for reliability improvement. (ii) The same failure mode may appear in several of the lower level Pareto histograms. We may fail to identify or underestimate the relative importance of these common cause failure modes.

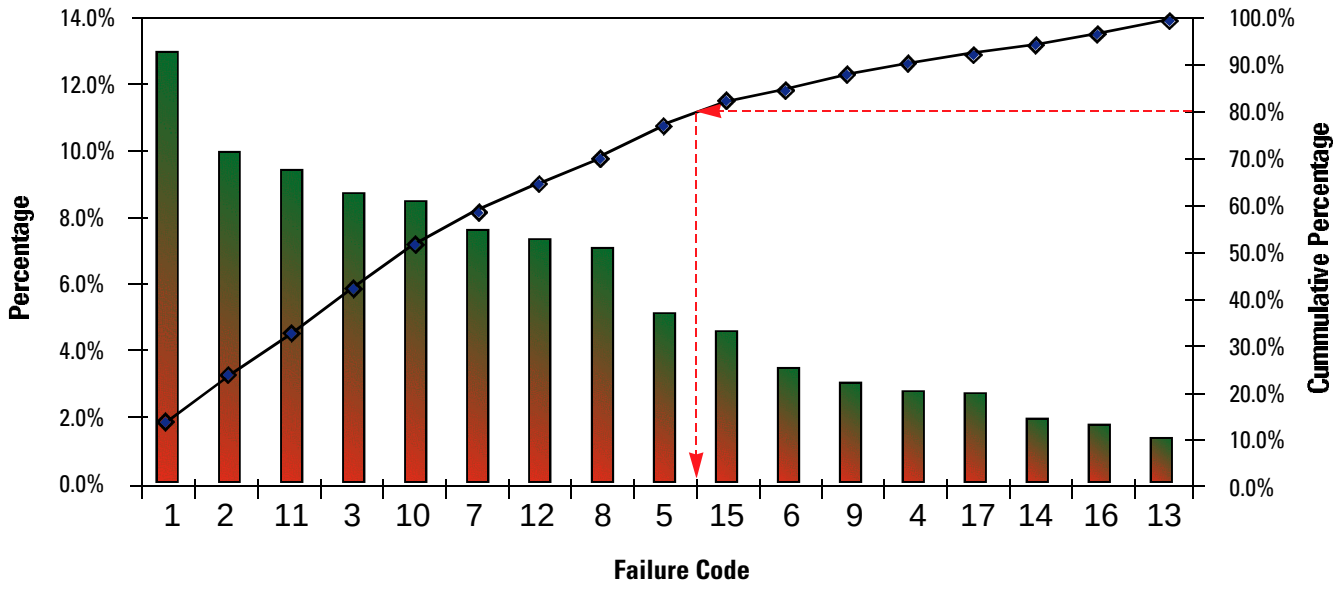

Figure 1: Pareto hisogram of unplanned shovel electrical downtime

Code	Description	Quantity (min)	Duration	% Time	% Cum.
1	Electrical inspections	30	1015	13.0	13.0
2	Damaged feeder cable	15	785	10.1	23.1
11	Motor over temperature	36	745	9.6	32.6
3	Change of substation or shovel move	27	690	8.8	41.5
10	Overload relay	23	685	8.8	50.3
7	Auxiliary motors	13	600	7.7	58.0
12	Earth faults	7	575	7.4	65.3
8	Main motors	12	555	7.1	72.5
5	Power cuts to substations	21	395	5.1	77.5
15	Air compressor	8	355	4.6	82.1
6	Rope limit protection	10	277	3.6	85.6
9	Lighting system	26	240	3.1	88.7
4	Coupling repairs or checks	15	225	2.9	91.6
17	Over current faults	6	220	2.8	94.4
14	Control system	7	165	2.1	96.5
16	Operator controls	5	155	2.0	98.5
13	Miscellaneous	9	115	1.5	100
	TOTAL	270	7797	100	

Table 1: Unplanned shovel electrical downtime.

Finally, Pareto histograms are not generally useful for trending comparisons. It can be difficult to directly compare ranked histograms of costs or downtime for two different time periods since the relative position of failure codes can change from one period to the other.

This paper outlines a simple, but powerful way of analysing data in order to address these shortcomings. The paper builds on and updates earlier work published by Knights (2001, and 1999).

2. Logarithmic Scatterplots

The most convenient way of introducing the new methodology is via an example. Table 1 lists the unplanned downtime recorded for electrical failures in a fleet of 13 cable shovels at an open pit copper mine located in northern Chile. The data was collected over a one-month period. Figure 1 shows the Pareto histogram for the unplanned electrical failures, with failure codes ranked in descending order according to their downtime contribution. Applying the 80:20 rule, it is evident that priority should be given to failure codes 1, 2, 11, 3, 10, 7, 12, 8 and 5 (failure code 1, electrical inspections, is associated with unscheduled call-outs). Of these, maintenance can do little to reduce the downtime associated with failures codes 3 (substation changes or shovel moves) and 5 (substation power cuts).

Maintenance downtime can be represented by the equation:

$$\textbf{Downtime}_i = n_i \times \textbf{MTTR}_i \qquad (1)$$

where Downtime_i is the downtime associated with the $_i$th failure code and n_i and MTTR_i represent the number of failures, and the mean-time-to-restore service respectively.

Figure 2 shows an alternative means of presenting the failure data listed in Table 1. An x-y scatterplot is used to plot mean downtime against the number of unplanned failures for each failure code. Curves of constant downtime are represented by a family of hyperbolae as shown. It can be seen that the failures that consume most downtime are those associated with failure codes 1, 2 and 11. Thus the order of priority observed in the Pareto analysis is preserved, however a clearer picture is available as to which factor - failure frequency or MTTR - is dominant.

A disadvantage of Figure 2 is that the curves of constant downtime are hyperbolae and can be difficult to plot. A solution to this is to take the logarithm of equations (1) and (2). Thus:

$$\log(\text{Downtime}_i) = \log(n_i) + \log(\text{MTTR}_i) \qquad (2)$$

where log refers to $\log_{10}$. If an x-y graph is prepared of $\log(n_i)$ against $\log(\text{MTTR}_i)$, the curves of constant downtime now appear as straight lines with uniform negative gradient (see Figure 3). These logarithmic (or "log") scatterplots can be very simply prepared using commercial spreadsheet software such as Excel™ by positioning the mouse over the axes of the x-y graph such as that shown in Figure 2 and then using the right-hand mouse button to select logarithmic scales for the axes. Log scatterplots simplify the identification of those failures which contribute most to total equipment downtime, whilst continuing to permit the visualisation of the influence of failure frequency and MTTR.

Repairs that require lengthy downtime can be considered *acute* problems. Those failures that frequently reoccur (i.e. high n) can be considered *chronic* problems. By determining threshold limits, the log scatterplot can be divided into four quadrants, as shown in Figure 4. The upper quadrants denote acute failures, whilst the right-hand quadrants denote chronic failures. The upper right-hand quadrant is a region of acute and chronic failures

3. Limit Determination

Thresholds can either be absolute values determined by company policy, or relative values that depend on the relative magnitudes and quantity of data. One approach for determining relative values is to use average values as follows.

The total downtime, D, consumed by unplanned failures is given by:

$$D = \sum_i \text{Downtime}_i \qquad (3)$$

The total number of failures is:

$$N = \sum_i n_i \qquad (4)$$

Letting Q be the number of distinct failure codes used to categorise the downtime data, the threshold limit for acute failures can be defined as:

$$\textit{or} \qquad \text{Limit}_{\text{MTTR}} = \frac{D}{N} \qquad (5)$$

and the threshold limit for chronic failures can be determined as:

$$\text{Limit}_n = \frac{N}{Q} \qquad (6)$$

In the case of the unplanned electrical failures for the fleet of shovels, D=7797 minutes, N=270 and Q=17. Therefore, the limit value for acute failures is 7977/270 =28.9 minutes and the limit value for chronic failures is 270/17=15.9 repairs.

4. Identifying Reliability, Availability and Maintainability Problems

Having identified the threshold limits, logarithmic scatterplots provide an easy means for identifying reliability, availability and maintainability problems. Strictly speaking, reliability is a probability of survival and a function of time. A common industry practice is to use the mean time between failures (MTBF) as a measure of reliability. The MTBF is defined as;

$$\textit{MTBF} = \frac{\textit{Operating time}}{N} \qquad (7)$$

Shovel availability, reliability and maintainability are interrelated by the approximation;

$$\textit{Availability} \approx \frac{\textit{MTBF}}{\textit{MTBF} + \textit{MTTR}} \qquad (8)$$

The relationship shows that shovel availability can be enhanced by increasing MTBF, decreasing MTTR, or a combination of both.

Returning to the logarithmic scatterplot, the chronic failures are those that contribute most to the number of observed failures, N. These are the electrical failures that most affect the reliability from the shovel fleet under examination (see Figure 5). Finding solutions to the root causes of these failures will most increase shovel MTBF.

Similarly, Figure 6 shows those failures that most affect shovel fleet availability. In this case, the position of the diagonal downtime limit was determined from the Pareto analysis as the line defining 80% of fleet downtime. Finding solutions to the root causes of these failures will most increase shovel fleet electrical availability. The failure code 9 (lighting system) is an interesting case. It was identified in Figure 5 as a reliability problem; solving this problem would increase MTBF and could therefore be expected to also increase fleet electrical availability. In fact, on average repairs to the lighting system require very little time. If it were possible to eliminate these failures, the MTTR for the remaining electrical failures would actually increase. Referring to equation (8), the effect of increased MTBF is largely negated by the increase in MTTR and comparatively little availability gain can be expected by eliminating shovel lighting failures.

Figure 7 shows the acute failures that most affect shovel electrical maintainability, and Figure 8 shows the combined effect of the reliability, availability and maintainability limits. From these it can be seen that, if the root causes of failure codes 15, 16 and 17 are addressed, although MTTR will be somewhat reduced, fleet availability will not be significantly affected. The reason for this is that failure codes 15, 16 and 17 occur infrequently and their elimination will not significantly affect fleet MTBF.

There is another motive besides fleet availability for addressing

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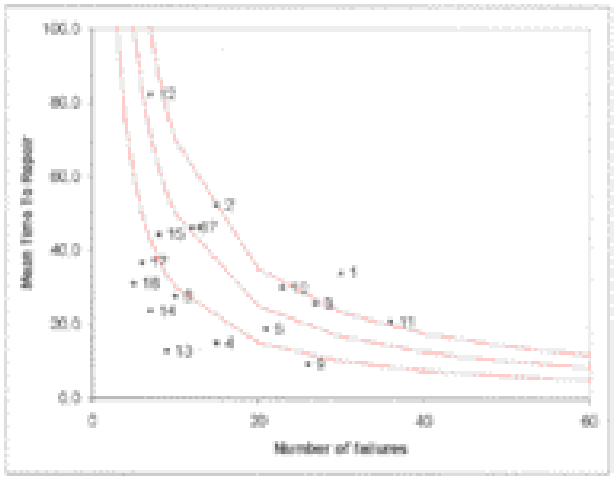

Figure 2: X-Y dispersion plot of mean repair times versus number of failures

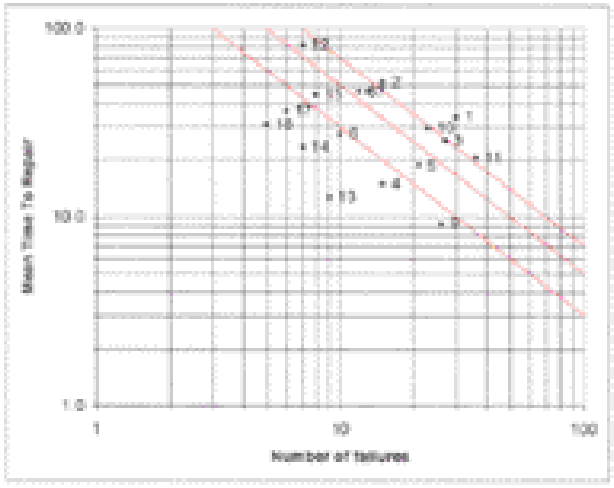

Figure 3: Log Scatterplot of mean repair times versus number of failures

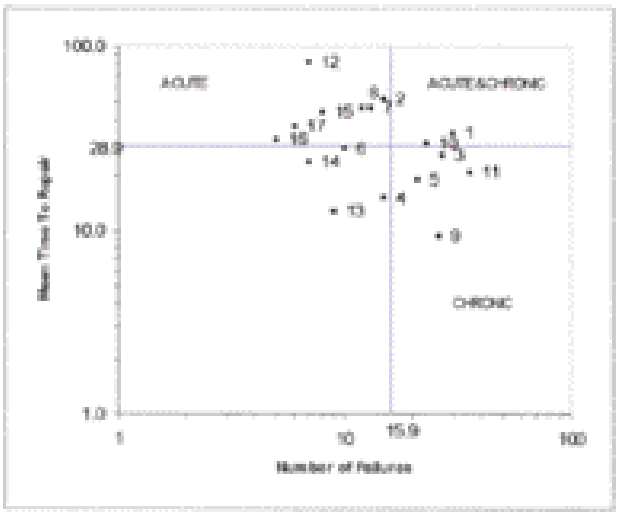

Figure 4: Log Scatterplot showing limit values

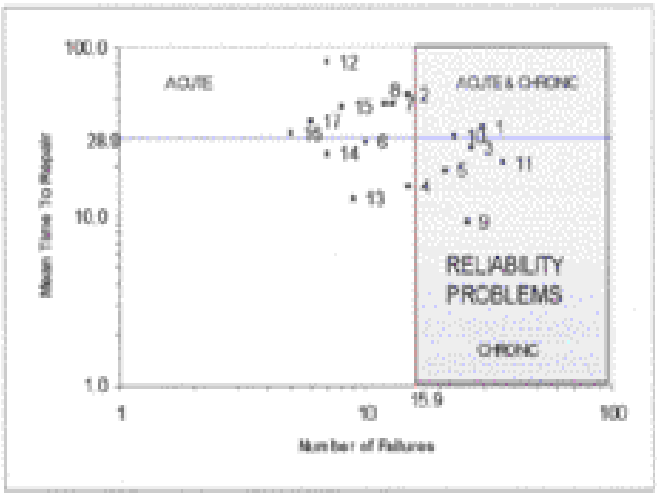

Figure 5. Shovel Fleet Reliability Problems

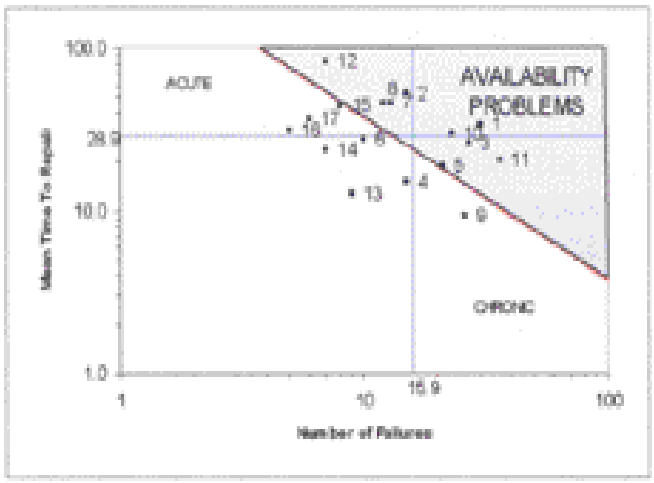

Figure 6. Shovel Fleet Availability Problems

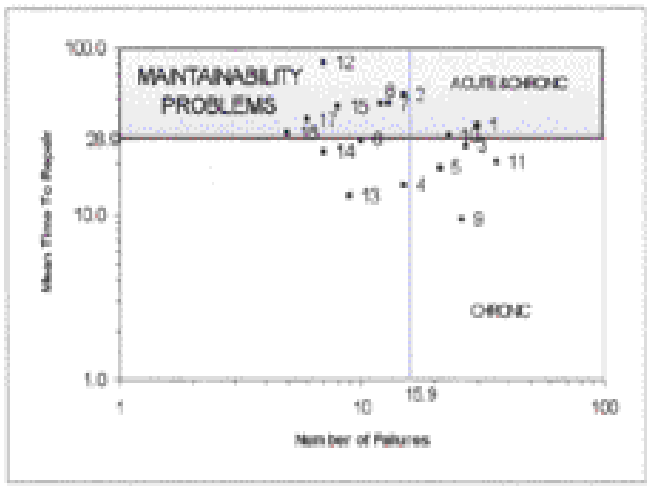

Figure 7. Shovel Fleet Maintainability Problems

acute failures; repair costs for these failures are frequently more expensive. Not only are direct costs higher (repairs may require more labour hours, specialist services or the costly expediting of spares), but the opportunity cost of lost production per failure is higher. With this in mind, we are now ready to answer the question as to which failures should be prioritizing in order to best improve business performance.

5. Downtime Priorities and the Business Cycle

The discussion so far has assumed that the electrical failures causing unplanned downtime of the shovel fleet are (i) evident to the operators and (ii) do not cause significant safety or environmental hazard. Hidden and potentially hazardous failure modes should be addressed and can be identified by applying Reliability-Centred Maintenance (RCM) decision logic such as that developed by Moubray (1997).

Assuming that the hidden and hazardous failure modes have already been filtered from the shovel electrical downtime data, maintenance priorities will be determined solely on the basis of the economic consequences of failures and their associated repair costs. The economic consequence of a failure includes the opportunity cost of lost production, the extension of fixed costs such as operator salaries which must be paid irrespective of equipment downtime, the cost of maintaining an increased number of spares as a result of the failure and the cost of maintaining redundant equipment capacity in order to mitigate the effects of lost production.

In some industries, the economic consequences of plant or equipment downtime for critical equipment far outweigh repair and maintenance costs. For example, the mining industry is subject to highly cyclical commodity prices. With copper prices currently at five-year highs, the opportunity cost of lost production will significantly exceed the direct cost of repair and maintenance. In such circumstances, it is desirable to prioritize production, hence equipment availability and reliability, over repair costs.

However, when copper prices fall, the cost of production becomes more significant. Thus in commodity price troughs, controlling and reducing maintenance and repair costs will be as important as maintaining equipment availability and reliability.

Figures 9 and 10 illustrate these two scenarios. Figure 9 corresponds to a scenario where the opportunity cost of lost production far exceeds shovel repair and maintenance costs. Figure 10 corresponds to the scenario of a commodity price squeeze causing production cost concern.

For ease of construction, the availability limit has been defined as the line of constant downtime equal to the product of the two threshold limits calculated in equations (5) and (6). Note that the availability limit effectively separates the acute and chronic quadrants into two areas: acute A and B and chronic A and B respectively. The expression for the availability limit is:

$$\begin{cases} n_i X MTTR_i = \frac{D}{Q} & \text{where } 0 \leq n_i < Limit_n \\ n_i = Limit_n & \text{where } n_i > Limit_n \end{cases} \quad (9)$$

in the case of Figure 9 and:

$$\begin{cases} MTTR_i = Limit_{MTTR} & \text{where } 0 \leq n_i < Limit_n \\ n_i X MTTR_i = \frac{D}{Q} & \text{where } n_i > Limit_n \end{cases} \quad (10)$$

in the case of Figure 10. The resulting graphs have been christened "jack-knife" diagrams because of the inverted V shape of the limits.

Because the analysis of unplanned shovel downtime due to electrical failures was undertaken during a time of very low copper prices, the jack-knife limits shown in Figure 10 were used to establish downtime priorities (see Table 2).

It is valid to question the decision not to include all of the events affecting shovel reliability in the prioritized list. In effect, this means adding those events classified as "Chronic type B" to priority list.

Code	Description	Quantity	Duration	% Time	Av. Time
ACUTE & CHRONIC FAILURES					
1	Electrical inspections	30	1015	13.0	33.8
10	Overload relay	23	685	8.8	29.8
Sub total				21.8	63.3
ACUTE FAILURES					
2	Damaged feeder cable	15	785	10.1	52.3
7	Auxiliary motors	13	600	7.7	46.2
12	Earth Faults	7	575	7.4	82.1
8	Main motors	12	555	7.1	46.3
15	Air compressor	8	355	4.6	44.4
17	Over current faults	6	220	2.8	36.7
16	Operator controls	5	155	2.0	31.0
Sub Total				41.7	339
CHRONIC FAILURES - TYPE A					
11	Motor over temperature	36	745	9.6	20.7
3	Change of substation or shovel move	27	690	8.8	25.6
Sub total				18.4	46.3
CHRONIC FAILURES - TYPE B					
5	Power cuts to substations	21	395	5.1	18.8
9	Shovel lights	26	240	3.1	9.2
Sub total				8.2	28

Table 2: Electrical maintenance problems prioritised according to Jack-Knife Principles.

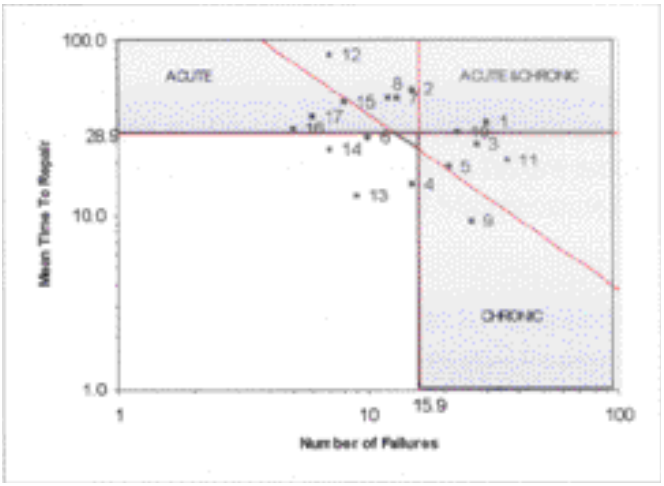

Figure 8. Combined Reliability, Availability and Maintainability Limits

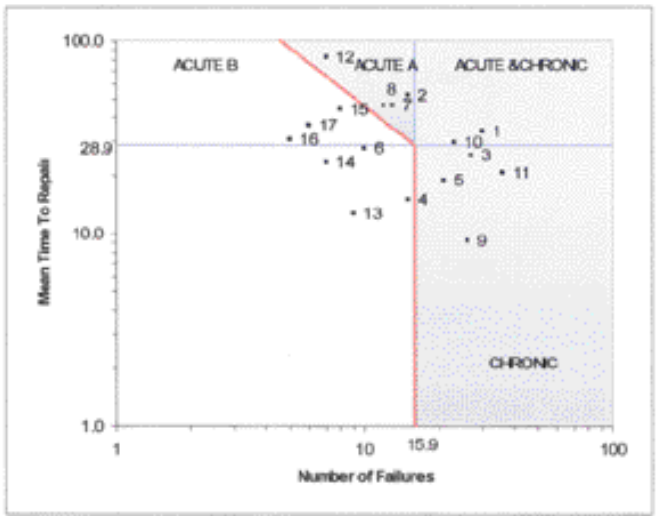

Figure 9: Jack-knife diagram for commodity price cycle peaks

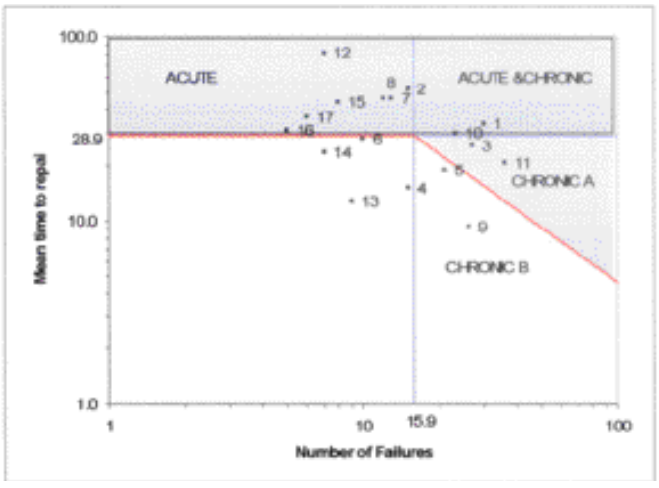

Figure 10: Jack-knife diagram for commodity price cycle troughs

Experience with analysing larger sets of downtime data has shown that the priority list simply grows too large. To this extent, it is desirable to focus on only those chronic failures that have highest availability impact.

6. Root Cause Analysis and Remedial Action

Once a prioritised list of failure codes has been identified, hypotheses can be made about the possible cause (or causes) of each problem. Experienced maintenance and operating personnel are indispensable to this process, since familiarity with the machine, the operating environment and with maintenance and operating practices is required.

The root causes of equipment downtime are associated with the following broad categories; equipment design, purchase, storage, installation or start-up, operation or maintenance (Moore, 2002). Each of these categories can be further subdivided; for example, root causes associated with maintenance include: planning and scheduling problems; resource availability problems (labour, tools, documentation, shop space); inadequate inspection or PM practices; and poor work quality.

Chronic repairs are often associated with design problems (material quality defects or design inadequacies), inappropriate operator practices or poor quality control in upstream processes. Two good examples of chronic repairs are provided by the data:

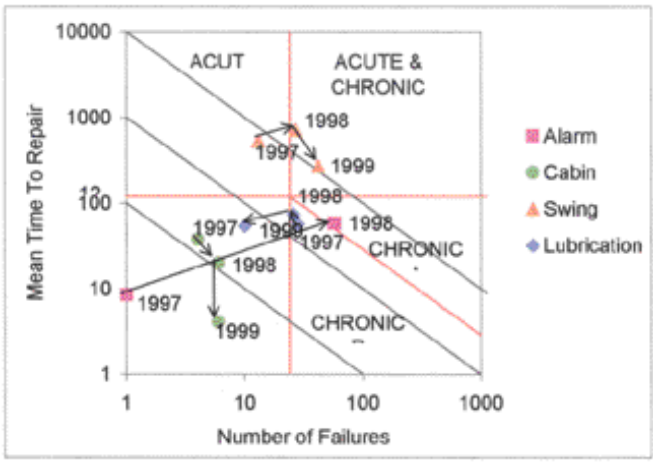

Figure 11: Trends in unplanned failures for BE 495-B Cable Shovel

Motor over-temperature alarms (failure code 11) can result from poor blast fragmentation, shovel abuse or high ambient temperatures. In the former two cases, corrective action should be directed at mine operations.

Outages to the shovel lighting system (failure code 9) typically result from wiring damage due to structural vibration or poor filament reliability. Redesign of the wiring harness may be one way of tackling this problem.

Following the identification of the factors contributing to the root causes to each failure code, a set of corrective actions should be formulated to eliminate or mitigate the factors causing unplanned downtime. Some maintenance actions may necessitate investment on the part of the mine. An estimation of the expected reduction in downtime allows the Maintenance Department to undertake a cost/benefit evaluation of implementing the maintenance action plan. If the cost savings are projected over say, a 3-year period, an NPV can be calculated for the maintenance project. The advantage of this approach is that it permits executive management to evaluate maintenance projects alongside competing project alternatives. Maintenance need no longer be perceived as a costly overhead, but as a strategic tool to maximise asset utilisation.

7. Trend Plots

A further benefit of logarithmic scatterplots is that they provide a useful means of visualising trends in maintenance performance. For example, Figure 11 shows the evolution of four failure codes from a BE 495-B cable shovel working at an open pit copper mine in Chile. Unplanned failures were analysed for a period of three years, 1997 to 1999 inclusive. The threshold limits used in the graph were calculated relative to the total unplanned failure data set for the three year period.

It can be seen that significant improvement has been made with respect to two of the failure codes over the period of the study. Unplanned failures to the shovel lubrication system were chronic in 1997 and 1998, and not classified in 1999. Similarly, the total downtime due to failures of controls in the operator cabin has decreased. However, unplanned failures to the swing system (comprising the two swing motors, spur gears and main ring gear) are obviously an area of concern, increasing from acute in 1997 to chronic and acute in 1999. Likewise, unplanned stoppages due to motor over-temperature alarms (alarms) also increased in both frequency and duration (data was not available for the 1999 period to confirm this tendency).

Jack-knife trend plots provide a very useful visual means of analysing and controlling maintenance performance. It is easy to see the "wins and losses" of the maintenance department. Another potential application of jack-knife trend diagrams is to the preparation of maintenance budgets. A log scatterplot of the repair costs incurred during the most recent time period could assist a maintenance manager to fix performance targets for forthcoming periods. It is postulated that windows-based software could be developed to help automate this procedure. Using a mouse, the points representing failure codes in the log scatterplot could be selected and dragged to desired target positions. The software could then automatically calculate the resulting cost and downtime reductions, as well as display the corresponding operating budget for the maintenance department.

8. Conclusions

The use of logarithmic (log) scatterplots overcomes many of the shortcomings of Pareto analysis for generating lists of equipment downtime priorities. Log scatterplots preserve the ranking scheme of Pareto histograms, but provide additional information content regarding failure frequencies and mean time to restore service. A methodology is provided for calculating thresholds for classifying failures according to acute or chronic characteristics. The graphs readily permit the identification of problems affecting system reliability, availability, and maintainability. Jack-knife limits can be established for determining failure priorities. The orientation of the jack-knife limit depends on the relative importance of repair costs to the economic consequences of downtime, which in turn is affected by changes in the business cycle.

Log scatterplots are not necessarily intended to replace traditional Pareto analysis techniques. The two techniques can be beneficially used in parallel. In addition, elements of the methodology outline in the paper, such as the classification of acute and chronic failures, can be usefully adapted for use in conventional Pareto analysis.

Since their inception in 1999, log scatterplots and jack-knife diagrams have been profitably employed by a number of mining companies and mining equipment suppliers. In Chile, a large maintenance service provider now regularly used jack-knife diagrams to monitor equipment downtime for controlling maintenance and repair (MARC) contracts.

9. Acknowledgements

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INFRASTRUCTURE PROJECTS: POST-CONSTRUCTION OPERATIONS AND MAINTENANCE. WHO CARES?

John Wilson

John Wilson has worked in Malaysia in Facility Management positions as a Team Leader - Facilities, General Manager and Consultant with international/local Joint Venture companies.

Introduction

There is generally great motivation and interest in the funding and design of infrastructure projects, especially for developing countries. These projects include power stations, roads, bridges, ports, airports, dams, hospitals, housing and other projects related to economic growth and development. Such projects typically involve multi-million, or multi-billion dollar investments and are the pride of the financier and the recipient.

Infrastructure projects for developing countries are often funded by world bodies such as the UN, ADB, World Bank or other International Aid Agencies and are provided to those that are in need but do not have sufficient internal resources for self-development. These projects are often more of a political or economic investment rather than based on hard loan financing as would apply to businesses or individuals. In some cases the funding for the project is really a gift - with an understanding that 're-payment' is in the form of economic or political co-operation rather than cash. In most cases the debt repayment scheme is clouded in the prevailing or future economic situation and rarely directly attributable to or reliant upon the returns from the project itself.

Once a concept is framed, usually after laborious studies and reports, and once funding approval is obtained, some of the world's best Architects and Engineers are engaged to design the asset using the latest technologies and envisaging cost efficient construction practices. In reality the construction may involve inferior local materials, unskilled or inexperienced labour and generally lack rigid quality control and competent supervision.

Somewhere along the concept/acquisition/ownership chain there is a fundamental oversight - the recipient's ability, or indeed desire, to adequately operate and maintain the finished product. This oversight is probably due to several factors, not the least being the political and financial imperatives that become elevated and tend to take precedence over the whole-of-life engineering requirements. There is a tendency for the focus to remain on the economic/political/financial showcase agenda and the functional requirements tend to be left on the designer's drawing board or in the technical specifications.

In essence, many of the huge investments in infrastructure projects are not protected by an insistence by the sponsors on sound post-construction management and engineering maintenance; there is often just a hope that the project will fulfil its needs and that it will remain functional throughout its designed life. In terms of resources - both financial and material - this leads to significant and costly waste.

This Paper discusses some of the shortcomings of large infrastructure financing in terms of 'ownership' management and investment protection. It attempts to raise the awareness of this critical need.

The Problem - Design Life

Every infrastructure project has a design life, or more precisely, every physical element in the project has a lifespan related to its usage, location, materials and construction - and its care. For instance, a concrete column located on a tropical shoreline may deteriorate within five years due to its location whereas the same column situated in a hot desert environment may last many decades and perhaps centuries longer.

In the example, the columns would be designed to withstand the weather, loadings and other assumed conditions for a pre-determined lifespan, based on materials and engineering sciences. If say the lifespan selected was 50 years in both cases then the columns may not be physically the same. The column in the tropical environment may be larger with a greater cover of concrete over the embedded reinforcing steel or it may be coated with a protective shield to keep out deleterious salts and chemicals. The column in the desert may be shielded with a tough coating to resist the eroding effects of wind-driven sand. These factors usually emanate from the designer's drawing board and are written into the construction specification that is aimed at satisfying the design intent and design life of the columns. A static element such as a concrete column may have its design life compromised or considerably shortened if say the protective coating is damaged or if it is overloaded. The design life is a theoretical factor only. On the other hand if the column is not loaded as intended and its protective barrier is maintained or improved then its actual life may be extended well beyond its design life; this is related to the care it receives.

There are usually provisions or notations in the accompanying documentation, such as the Operations and Maintenance Manuals handed to the user post-construction, that prescribe some care or maintenance criteria, or even replacement, for individual items during the design life of the asset. Not all elements have the same reliability and maintainability nor require the same care - some must be repaired or replaced many times due to factors such as wear and deterioration as a result of use and abuse. Often the maintenance documentation is merely a product catalogue rather than a maintenance guidebook, inserted to bulk up the handover documentation.

Almost everyone appreciates that expensive infrastructure projects will not reach a productive design life without due care and attention. The meaning of care in this context may include reducing abuse, such as operating beyond design capacity, and providing adequate maintenance. Over the design life of the asset, the cost of this care may be many times the acquisition cost. Failing to adequately care for the infrastructure will result in premature failure, reduced capacity or even the need for untimely replacement.

Although recognised, few appear to apply the concept of care for infrastructure projects - unless lack of care results in exceptional adversity such as unforeseen breakdowns, power outages, traffic

congestion, accidents, injuries or damage. Most will agree that care is necessary but as the responsibilities for providing the care filter down there is usually a related dissolution of the funding. There is rarely a specific fund created for providing the care (i.e. maintenance) and, although its value may be recognised during the euphoria of acquisition, it soon becomes diluted or forgotten after a year or two of ownership.

On some large power station projects there has been a recent trend for the key equipment supplier to offer a long-term maintenance contract to supplement or sweeten the deal. Such contracts are based around technology transfer concepts and are commendable for caring for the main equipment under specialist guidance. However, these deals are usually very specific and do not cover the maintenance care needed for all of the other civil, structural, mechanical and electrical assets associated with the total project. It is a narrow view to consider having a well-maintained turbine-generator, cited as an achievement when it is relying on under-maintained support infrastructure. The care of the infrastructure in total should be viewed in terms of systems engineering in a holistic manner to ensure that the project meets the desired level of performance - not just one element.

Deferred Maintenance - The Financial Factor

The deferral of maintenance is an insidious cancer. When an asset is new it tends to function remarkably well with little or no care. It is also a fact that if certain items do not receive care (maintenance) then they will gradually, or even catastrophically, deteriorate or fail. This is common sense but it is ignored more often than acknowledged, particularly by those with responsibilities for financing the care.

The problem is exacerbated by modern financial axioms where quarterly indicators are the measure of financial acumen and good management. It is relatively simple to keep cutting the maintenance budget to improve the balance sheet and this can be done for years - certainly beyond the quarterly terms that Finance Officers use for judgement periods. When the catastrophe finally occurs it is often regarded as bad luck rather than bad management.

A classic case was highlighted in the US Congress in early 2001. The Smithsonian Museums now require US$1.5 billion worth of restoration because maintenance and repairs were neglected over recent decades. In the damming NAPA Report the management of the Smithsonian was found wanting for not adequately addressing the annual maintenance requirements. It would be fair to assume that had regular maintenance been carried out over the deterioration period the present value would be significantly less than the US$1.5b (probably around US$1.0b). This blunt realisation of massive expenditure injection for a prestigious asset cannot be attributed to bad luck. There is little doubt that over the period many managers were recognised and perhaps rewarded for their financial skills in achieving savings as a result of deferring maintenance.

This isolated example can no doubt be accompanied by countless others where future costs for restoration of infrastructure can be directly attributed to lack of funding, and perhaps awareness, to ensure adequate care; funding if provided regularly would have been appreciably less than the restoration costs.

Deferred Maintenance - The Engineering Factor

Designers of infrastructure have a good grasp of the materials sciences with which they work. They know the stress, strain characteristics and some of the limitations of applicability; even the limitations of minor elements such as paints and sealants. Generally, the more sophisticated the materials the more is known about their behaviour and qualities. Aeroplanes are designed with a very low factor of safety because the materials of construction are exhaustively tested to determine their characteristics and limitations.

Unless the owner of the infrastructure asset has the desire to understand the design limitations or has the requisite knowledge and

experience, the care of the asset will be in jeopardy, probably under-funded and inadequately maintained. Inadequate maintenance may not be in terms of effort but in terms of appropriateness. For example it takes the same effort to put the wrong lubricant in a gearbox.

This problem is brought about by several factors:

- Lack of trained technicians to care for the asset
- Lack of comprehensive maintenance documentation
- Importation of technology without corresponding technology transfer or skills development
- Lack of appreciation of life cycle costing (cost of ownership)
- Pride and acclamation in acquisition but lower appreciation of ongoing care needs (life cycle costing)
- Lack of long-term interest in ensuring the success of the asset (eg acquisition for immediate political advantage)
- Changing priorities - usually political/economic.

However, the lack of experience, knowledge and trained personnel is often a major factor for premature infrastructure degradation, whether a power station, road, airport or other works with a significant technology component. Much of this is related to a lack of awareness, by the user, of the need for care.

In developed countries, the technology applications and their subsequent usage and care develop along a closely aligned research/skills education timeline; evolution rather than the revolution that occurs when modern technology is deposited in a less developed region. It is relatively common that the beneficiaries of infrastructure grants, loans or aid do not have the corresponding skilled workforce to provide adequate care to their new acquisition. If the asset is a power station then it is usual that a training component for operations is included in the project but maintenance training is usually only linked to the major items such as turbines or control systems. Skills transfer is usually at the higher end of operations and maintenance. Civil projects, for instance a bridge, would come with less skills transfer for maintenance activities, yet the techniques for proper care and repair may be vital to ensure that the asset maintains its design integrity. Patching a failed runway on an international airport is not the same as filling a hole in a garden; a fact appreciated by the designer and probably the constructor but less likely understood by the person who is asked to perform the repair work, usually devoid of related maintenance documentation.

In infrastructure projects for developing countries the transfer of technical knowledge remains a major gap, particularly transfer beyond the construction phase into the care phase. Considering that the care phase, in terms of ownership really does not commence until after the year of defects liability period (held accountable to the contractor), and considering that the care needs increase with age and usage of the asset, there can be a significant time gap between when the skills or knowledge are transferred and when they need to be applied. In this time gap, which may be up to five years, numerous things may occur which effect the quality of care - such as funding reductions, staffing transfers, new management priorities, etc.

It should also be noted that in both developed and developing countries there is more professional kudos in the engineering design and construction sectors than in maintenance. This could be because maintenance is regarded as a money-spending enterprise, usually fixing someone else's mistakes, with less glorification and recognition than creating or building something modern and new. Nevertheless, infrastructure must be maintained and appropriate care over the life of the asset is part of the ownership equation.

The replacement cost of infrastructure is often much more than the (theoretical) sinking fund model predictions. Over time, new and unforeseen requirements emerge - such as environmental or political constraints that leverage up the cost. With cost escalations and ROI considerations Governments or agencies often prefer to extend the life of an infrastructure asset rather than replace. This can be accomplished much more cost effectively if the asset has received good care and maintenance. It is not unusual for owners to refurbish power stations, or roads and bridges that are in reasonable condition although they have exceeded their design life. There are many factors such as heritage considerations, changes in demographics, economic woes, etc. that influence refurbishment/replacement decisions but it is fair to claim that an asset that has not received adequate care will deteriorate quicker and cost more to refurbish than a well maintained asset - in which case replacement becomes the main option.

Deferred Maintenance - The Investor

When an asset is on 'loan', as it could be considered until it is fully repaid, then the investor, or de facto owner, should have some interest in how that asset is used or abused.

In the realm of large infrastructure acquisition projects, inhabited by financiers, politicians and economists, it is not surprising that the awe of the scheme overshadows the life cycle costing aspects - and that a major consideration such as caring for the asset to ensure its longevity and function gets lost in the ether. This is probably due to the lack of a direct link relating repayments of the loan to income from the asset.

Indeed, this link to return on investment (ROI) for say a flood mitigation dam or a toll-free bridge would be difficult to define in accounting terms. Nevertheless a principle should apply - to ensure optimum preservation of the asset rather than ignore its care after acquisition - which could and should be considered as a waste of resources. The real cost of this 'waste' can only be estimated but for a major acquisition the waste could be equivalent to say funding health care facilities or education programs. The waste on a multi-million dollar project, deteriorating due to lack of care, may indeed exceed the replacement value if all direct and indirect costs could be summarised.

It could be argued that the responsibility for ensuring that the proper care of the asset lies with the new user. However, the provider or funding agency has a duty to ensure that the new user is not only aware of the requirements for proper use and care but should insist that the asset receives adequate care. Such an attitude is sounder financially, morally and ethically than having only an interest in the repayment processes. The recipient, if not aware of the on-going maintenance commitments should be informed and if there is awareness then the recipient should demand associated funding aid to cover the needs.

Maintenance Funding

In developed countries the issue of infrastructure care, particularly government- funded assets, is usually not spotlighted nor receives adequate funding until crises develop. Acquisition, as in developing countries, is more prestigious than maintenance and easier to fund. In an attempt to pass the burden of care to others many infrastructure projects are privatised, usually with good intentions. However, the assets are not usually better maintained or even adequately maintained under different owners because of the age-old problem; maintenance is recognised but can be deferred until a crisis develops. The power, transportation, water infrastructures in several developed nations are in turmoil as a result of short-term visions and lack of adequate investments in maintenance, whether government owned or privately controlled. The recent expose of the rail system in the UK, the Smithsonian Museums funding needs and the campaign that the Institution of Engineers, Australia has launched to influence the Government to fund infrastructure maintenance or replacement throughout Australia, illustrate the problems. By extrapolation, the problems in maintaining infrastructure in developing countries are significantly magnified.

It is a political and economic falsehood to expect that acquisition of infrastructure will somehow attract the funding for adequate care, particularly in developing countries. The problems are often exacerbated by inferior materials, poor quality control during construction, short-cuts due to lack of qualified labour and supervision, or even corrupt practices, which result in the need for relatively higher levels of maintenance effort and funding.

The process of obtaining maintenance funding should commence

with the detailed life cycle costing of the project. This process often pays little attention to the real maintenance needs because the annualised sums are relatively low compared to the prime costs of acquisition and operations (eg fuel for a power station). However, the accumulated maintenance costs taken over the life of the project become significant, sometimes more than the acquisition cost. A minor treatment of maintenance requirements at this stage will usually lead to major shortcomings in the future. Financiers, designers and many Engineers are not well versed in recognising and prescribing maintenance needs in a holistic approach and often revert to flawed historical data rather than derivations from first principles.

Following the identification of maintenance costs there needs to be a serious commitment to allocating and applying the funds. This requires not only better informed sponsors and recipients but some formal agreements or commitments that protect the interests of the parties by ensuring that maintenance funding is adequate and cannot be easily dispersed for other more immediate or unrelated uses. One of the best methods of ensuring on-going maintenance funding for a project is to incorporate it into firm budgetary policy that cannot be diluted or diverted by a few zealous managers or politicians without a larger consensus, including incorporation into Law.

Funding for maintenance should be seen as a vital element in any infrastructure project and as such its importance requires greater magnification and recognition than it currently receives. It is analogous to looking at the maintenance requirements through the wrong end of binoculars when viewing a project proposal - it is visible but appears inconsequential.

Finally, much can be done at the design stage to optimise the maintenance needs by designing out maintenance, say with galvanised rather than painted surfaces, and designing in features that support greater maintenance efficiency and effectiveness, such as signage, walkways, platforms and accessibility. While this may increase the initial acquisition of the project it should lead to an overall reduction in life cycle costs and avoidance or reduction of some of the main issues that have been highlighted - securing on-going maintenance funding, shortage of skilled maintenance personnel and proper care of the asset.

Recommendations

Funding for infrastructure projects should have conditions that relate to post-construction care and maintenance.

Those providing the infrastructure, or funding, should ensure that there are resources dedicated to adequately care for the asset for its design or 'economic' life. This should form part of a technology transfer agreement for all major infrastructure acquisition projects.

Those receiving the project should insist that appropriate funding for care is factored into the acquisition deal.

Designers need to have a familiarity with the construction and labour capabilities at the operational site and an awareness of the after-construction care likely to be available. Maintenance strategies should be considered at the design phase.

Operations and maintenance documentation should cover the design life of the project and detail the requirements for adequate care and repair for all significant elements, not just key M&E equipment.

Financiers, politicians, economists need to appreciate the engineering (and financial) requirements for proper post-construction care of infrastructure and factor those requirements into the acquisition processes.

Experienced, professional Facility Managers should be engaged during the design, acquisition and operational phases of infrastructure projects to ensure that asset care is fully documented and optimised.

johnwilson@bintai.com.my www.bintai.com.my

New Generation Of Reliability Tools Give Asset Managers Real Decision Making Power.

Mick Drew

Director
ARMS Reliability Engineers

Asset managers are now able to take advantage of the latest reliability engineering methods and easy to use computer simulation packages to make informed decisions on managing their assets to achieve their business goals.

Improved reliability is all about reducing the business cost of failure. Businesses competing at a global level can no longer rely on over design and heavy maintenance regimes in order to meet the requirements of today's lean manufacturing environment. Asset managers need to be in control of their business performance and ensure maximum capacity is achieved for minimal capital invested. Unfortunately, maintenance is an area where traditional thinking is firmly entrenched and often the activities are fixed or overhauled using other static or unwieldy slow to respond programs. There is now available a new generation of decision making tools that ensures that one of the largest areas in the operator's budget is optimized, that is the contribution of assets to the business and the maintenance program required to ensure assets continue to contribute at a high level.

Key features of the new generation of reliability tools are:

- Simulated decision making to take control of assets that are capable of meeting the performance needs of the business replaces the traditional approach of assuming the maintenance of equipment is required to meet fixed standards or that the function of equipment is fixed and once defined remains the same throughout the asset life. The needs of a modern organization competing in the global market place are ever-changing. Costs, uptime, interruptions, safety compliance issues, environmental impacts have significant impact on the bottom line of a business and may well determine the level of profitability. Simulation provides a dynamic approach to decision making and replace the older static methods.
- The "What if" capability of the new generation allows new ideas to be tried in a low cost simulated environment. Rapid feedback of results is now possible in minutes or hours instead of years typically involved in the field trials of old. Today's design engineer or asset manager can utilise the knowledge of past performance, workshops, field repair teams, operators, inspectors, supervisors and engineers in electronic format. Simulation provides the means for this knowledge to accumulate and grow. It's application can ensure all the knowledge of today is used in forecasting future behaviour. Innovation and new ideas challenge the status quo and allow the organisation to bust existing paradigms and develop new levels of asset contribution and reduction of failure costs.
- Streamline use of resources through using forward looking predictions. Different business scenarios modeled in a simulated environment ensure the likely critical areas are addressed through either of the following improvement scenarios- improved design, redundancy, repair plans including spares holdings, preventive actions, predictive actions, monitoring or alarms, or planned retirement.
- Use of "dirty data" often upsets purists who want more failure data to be statistically significant. Reliability engineers want to avoid failure data, and so make intelligent use of the meager data on offer- looking for any source of previous failure, inspection, or experience, in order to make a failure forecast. Data driven models allow quantification of future expectations. Some models are built solely from shop floor knowledge, but once captured as failure parameters, the models can be enhanced as future data becomes available. Some models for new designs are built solely on the basis of predictions from sources such as MIL217 for electronic components. In this case stress levels and parameters can be varied to reflect expected conditions, and the standard reflects these changes in the failure rate prediction.
- Use of Weibull parameters to reflect ageing modes in equipment, allows ready use of performance data to update predictions. Deterministic methods applied to in-service failures allows the

root causes to be identified and reliable predictions updated, and asset management plans to be improved.

- Use of Monte Carlo simulation allows mixed modes, random, wear-out, and the interdependencies between multiple failure modes to be assessed over a lifetime.
- Overall system performance measured through metrics such as MTBF can be better understood by drilling down to dominant modes of equipment deterioration. Preventive maintenance regimes can be quickly reviewed to ensure fixed time actions are effective in reducing the cost of failures or extending the failure free period. Similarly, condition monitoring programs can be targeted at optimum frequencies ensuring effective warning to avoid the detrimental effects of failure.
- New technologies can be quickly evaluated to gauge the impact and cost benefit of the latest in diagnostic methods
- In summary I can harvest existing knowledge and build a data model. Using this model I can rapidly simulate real world behaviour- like throwing the dice a thousand times but biased to reflect my failure distribution- and try out my best decisions. I can challenge existing paradigms with creative ideas, way out methods, latest advances in technology, and be able to compare their "worth" to my business. I can adopt the model that best suits me and use the data collected in my CMMS to update and keep pace with the "real world" and continue forecasting to the future.
- Models can be also to improve the performance of individual pieces of equipment or System models allow me to model complex systems. Modeling of complex systems simplifies decision making. The simulation engine (Monte carol generator) will model the interdependencies so I can evaluate my individual decisions against the impact of the whole system. Multiple levels of redundancies, long series and parallel systems with long logistics supply chains, different modes of failure including random, burn in, wear out- can be daunting if performance is poor. Where do I start? What is the critical factor? Simulation using a systems availability simulation tool answers these questions in minutes, as well as providing a vehicle to prove the desired improvement mechanism.

Maintenance Optimization of Individual Equipment

Developing an Optimized Maintenance plan for an individual piece of equipment is a Simple Four Step Process

- Define the objectives
- Predict the behaviour
- Identify maintenance solutions
- Implement

Phase 1.

In the first phase we are concerned with defining the asset contribution to the business goals and the impact of interruptions due to failures and equipment downtime. The consequences of failure will be assessed according to the severity of the impact on the business goals and objectives. A Corporate Risk matrix is often used to assist decision making regarding acceptable risks levels associated with failure events. An example of a business risk matrix is shown in Table 1.

Table 1 - Business Risk Matrix

Severity Ranking	Safety		Community		Environmental		Target Rate
1	S1	Risk of Minor Cuts, Bruises or sickness.	COM1	Risk of incident creating adverse localized site awareness.	ENV 1	Risk of Minor Environmental Event	<100/yr
2	S2	Risk of Medical Treatment Injury	COM 2	Risk of incident creating adverse general site awareness.	ENV 2	Risk of Incident with Off site Emission but no damage	<10/yr
3	S3	Risk of Serious Non-Permanent Injury (chosen as benchmark to assist with other targets)	COM 3	Risk of incident creating adverse local media impact	ENV 3	Risk of Incident with adverse effect on environment.	<1/yr
4	S4	Risk of Serious Permanent Injury	COM 4	Risk of incident creating adverse state media impact	ENV 4	Risk of incident with non permanent damage to environment	<1/10yrs
5	S5	Risk of fatality	COM 5	Risk of incident creating adverse national media impact	ENV 5	Risk of incident causing permanent local environmental damage.	<1/100yrs

In an RCM Study a failure effect table is developed so that each a failure mode can be assigned a consequence level. The use of Severity numbers differentiates each level as shown in Table 2 for Safety.

Table 2 - Failure Effort Table

Effects (based on Orica risk matrix)	Definition	Target Rate	Severity	Target Safety Criticality	Threshold No. of Events in 100 yrs
S1	Risk of Notable safety event/ minor injury	<100/yr	87.6	1	10000
S2	Risk of MTI	<10/yr	876	1	1000
S3.1	Risk of LWC	<1yr	8760	1	100
S3.2	Risk of Permanent Disability	<1/10yrs	87600	1	10
S4.1	Risk of Single fatality (chosen as benchmark to assist with other targets)	<1/100yrs	876000	1	1
S4.2	Risk of Multiple fatalities	<1/1000yrs	9E+06	1	0.1

A simulation run will determine how many events will occur per hour, and report a criticality number which will be severity per hour. So if a S3.2 failure effect is predicted to occur in a 10 year (87600 hours) simulation run, the resulting criticality will be 1 as given by the severity number divided by the number of hours (8760/8760=1). So a target criticality of 1 for each of the failure effect levels corresponds to the threshold rate of each Safety level. As can be seen in this approach the risk of 1 Lost Work injury in a year is an equivalent level of safety performance as the risk of 1 fatality in 100 years, or similarly 100 S3.1 in 100 years is equivalent to 1 S4.2 event. The results of the simulation can be used to evaluate the alignment of equipment reliability with the risk management objectives for Safety, Environment and Operational events. The benefit of simulating performance in a computer environment of course, is that the simulated results does not require 100 years of plant operation nor is an actual fatality required in order to assess the Reliability of the equipment.

Cost Effects

In the field of simulation a direct contribution to the business can be measured in the dollars per occurrence of a failure event or dollars per hour of downtime. The dollar impact may be a reflection of direct costs such as contract penalties or fines, waste, poor quality or the cost of damage to other equipment, or indirect losses such as lost

Equipment Damage		Production Loss	
Dam $5k	Risk of Equipment Damage to $5,000	LOSS 100K	Risk of Incident causing losses $100,000 per incident.
Dam $50k	Risk of Equipment Damage to $50,000	Loss 500K	Significant Production Deviation outside control limits. Pot loss up to $500,000.
Dam $100k	Risk of Equipment Damage to $100,000	Loss 1 mil	Large Production Deviation outside control limits. Pot Loss up to $1,000,000.
Dam to $500k	Risk of Equipment Damage to $500,000	Loss 2 mil	High Product out of specification. Pot Loss up to $2,000,000.
Dam over $500k	Risk of Equipment Damage over $500,000	Loss 5 mil	High On going out of Specification. Pot Loss to $5,000,000.

Table 3 - Financial loss per incident effects

profit contribution, efficiency impact under utilized capital, waste, penalties, and cost of poor quality or the cost of damage to other equipment. A typical cost matrix is shown in Table 3.

Downtime	$4,000 per hour.

Table 4 - Financial loss per hour effects

A simulation run can forecast the expected cost of failure effects over any lifetime.

Phase 2

In the second phase an asset hierarchy is built that assembles equipment into subsystems to reflect a logical drilldown from the plant to subsystem to individual pieces of equipment. The Subsystems consist of equipment where there is a common purpose that contributes to the performance of the subsystem; the performance of the plant is then a result of each of the subsystems working in combination. The lowest level in the hierarchy is the asset whose function you are trying to preserve by making various decisions regarding maintenance activities to preserve function or manage the consequences of functional failures. An FMEA is the next level of drilldown whereby for each asset the functions required, the possible functional failures, and the likely modes of failure are listed. It is at the mode level that decisions are made regarding the type and frequency of maintenance actions, so a failure effect level is assigned to each mode.

Failure parameters are assigned to each mode. These failure parameters describe the likelihood the failure mode will occur over the lifetime. There are six types of characteristic failure behaviors that can be described using the Eta, Beta and Gamma Parameters of the Weibull distribution.

Weibull Analysis:

- Traditional maintenance programs use MTBF to base their maintenance strategy, Reliability Engineering uses Weibull analysis.
- Traditional approaches define reliability using the following formula:

  $R(t) = e\text{-}t / MTBF$
- This assumes random failures with constant failure rate. In a Weibull analysis, this is where ß = 1. Of course, no two types of component fail in the same way.
- RCM recognizes six different failure modes, they are:

  Type A - Bathtub: ß = combination (system)

  Type B - Worst Old: ß >4

  Type C - Slow aging: ß = 2

  Type D - Best New: ß = 1.5

  Type E - Constant: ß = 1 (traditional approach using MTBF)

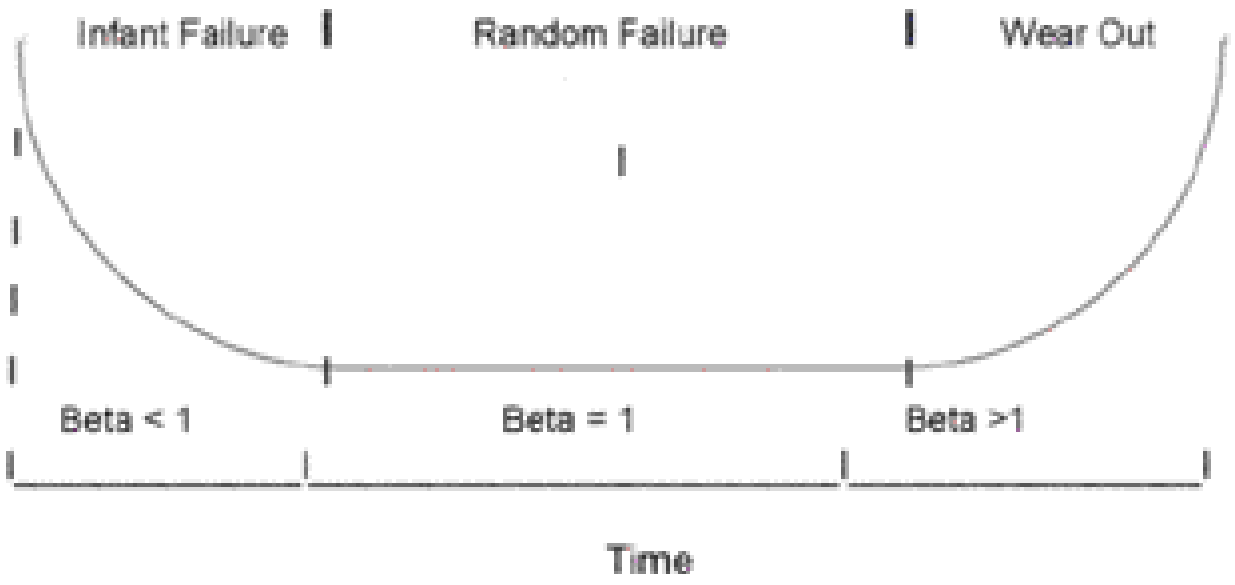
  Type F - Worst New: ß < 1
- Each has a particular Beta (ß), or failure curve shape. Reliability in this context is defined using the following formula:

  $R(T) = e\text{-}(T/\eta)ß$
- Note that the formula is similar to the "official" definition of reliability, but MTBF has been replaced by η (Eta) which is the "Characteristic Life" and is raised to the ß power. When solving for R(T), η & ß must now be considered.

Understanding failure behaviour allows lifecycle performance to be predicted over any lifetime using simulation packages with a Monte Carlo simulation engine such as RCMCost or Avsim Plus from Isograph.

Assigning the details of how long to repair the failures for each failure mode and the resources required, allows a simulation of a run to failure strategy. Simulation results will indicate the cost of failures and the cost repairs over the system lifecycle. Criticality of safety issues, environmental issues and operational issues is also predicted in the run to failure simulation of RCMCost.

Figure 1
Weibull Failure Curves: ***(Type A - Bathtub) R(T) = e*** $^{-T/\eta)^{\beta}}$



Phase 3

Identifying a maintenance solution that can reduce the effects of failure comes from understanding the root causes of the failure mode. A Root Cause Analysis may be performed at this stage in order to identify viable solutions. The Maintenance solutions are identified to challenge the causes and so reduce the likelihood of failure, or have sufficient warning of a failure condition in order to take corrective action without incurring the effects of failure.

Maintenance solutions can take the form of :

- Run to failure where the predicted costs of failure are so low as to not warrant action to be taken.
- Preventive actions that extend the useful life and prevent the failure mode occurring.
- Predictive actions that monitor the onset of a potential failure condition at a frequency to give sufficient warning of a failure so that restoration action can be taken. This is often called Just in time maintenance or Condition based maintenance.
- Condition monitoring where a hard wired system is installed to indicate an undesirable condition or state.
- Redundancy is added.
- Redesign the equipment to achieve a more favorable level of reliability in the period.

Selection of each maintenance action is based on a cost benefit, safety benefit or operational benefit. Often these tasks are then grouped to a convenient window to achieve least disruption to operations or greater efficiency in execution.

Phase 4

The decisions made on the optimum task, frequency and grouping require input to Maintenance Work Managements system to ensure effective implementation. The chosen tasks, the spares and resource requirements are adopted in the maintenance plan so that work orders for the regular tasks are performed at the optimum frequency. The output may be grouped into a work instruction, or maintenance documentation, or be included in routine checklists.

As work is executed, the opportunity to do things better, cheaper, differently can be fed back for improvement of future plans. Similarly, remaining life estimates, the presence of failure modes, of any equipment parts can be recorded and fed back with likely causes so that models are dynamic and firmly linked with reality. A periodic review of "Times to Failure" information allows the parameters to be updated and the model to be continuously improved.

Optimization of System Availability

System analysis recognizes that pieces of equipment belong to systems and the system performance is dependent on the interrelationships between equipment.

For example if the reliability of an individual piece of equipment over a year is say 0.9, it has a 90% chance of not failing in the year. But if I have 3 pieces of equipment in series whereby failure of either one can cause the system to fail then there is only a 73% chance of not failing in a year. Other complexities arise when resources are required. Do you plan resources for 1 repair, what about when all 3 fail together?. So modern generation tools for availability modeling uses both Monte Carlo simulation for predicting likelihood of failure as well as queuing theory for predicting the impact of logistics plans on system performance.

There are 4 steps to building an Availability model.

I Define the success path

II.Set the logistics

III.Check system performance meets goals

IV.Implement

Defining the success path requires consideration of all equipment items in the system that can impact the availability of the system. Consideration is given to any parallel relationships or levels of redundancy where perhaps only 3 out of 4 equipment items are required in service for the system to be available. Equipment is represented by a block which carries its failure parameters, corrective maintenance details including spares, and any planned maintenance activities. Any Logistic delays are defined for spares and crew resources.

Simulation over a lifetime provides an estimate of the system failures that can be expected, the level of downtime expected, the costs, and resources likely to be needed. Comparison to performance goals allows the analyst to change intervals, optimize spares levels, and assess the impact of changes in the configuration or redundancy.

Importance Analysis ensures the analyst can focus on those areas which are important - downtime, safety, costs, environment or operational.

RAM modeling (Reliability, Availability, Maintainability) of new or existing projects allows engineers to optimize the availability and

reliability of production systems in a computer environment, allowing design and operational scenarios to be evaluated in short periods of time, with no adverse impact on the bottom line.

RAMS Targets are an essential component of the requirements specifications for any project. Contracts typically require demonstration of performance following commissioning and ramp up. Use of RAMS modeling techniques combined with Monte Carlo simulation engines provides:

- An early indication of a system's potential to meet the design availability and reliability requirements.
- Enables assessment of lifecycle costs to be carried out.
- An early indication of which components or areas contribute to the major portion of capacity loss.
- Enables trade offs to be made between reliability, maintainability, and redundancy and buffer capacity.
- Provides early assessment of Safety and Environmental compliance.

Application of RAMS modeling to existing facilities by inputting actual Times to Failure can also assist identifying weak areas of performance, identify Availability bottlenecks, allow alternative maintenance regimes to be evaluated or simply understand the criticality ranking of equipment as they impact site production.

AvSim+ from Isograph is a powerful availability and reliability simulator capable of analyzing complex and dependent systems efficiently and accurately. AvSim+ capabilities extend far beyond analyzing the availability and reliability of complex systems. The program's Weibull, spares tracking (through multiple echelon levels) and task management functions allow users to implement a Reliability-Centered Maintenance (RCM) strategy aimed at reducing costs, optimizing availability and managing planned maintenance tasks.

RAM modeling includes modeling the effect of:

- Labor availability,
- Spares availability,
- Maintenance strategies
- Equipment failure behaviour including infant mortality, random failures and aging.
- Production capacity,
- Size of intermediate buffers such as stockpiles or surge tanks,
- Standby equipment,
- Shutdown intervals,
- System configuration changes.
- Phased changes over time.

The Monte Carlo simulator engine enables AvSim+ to model complex redundancies, common failures and component dependencies that cannot be modeled using standard analytical techniques including those listed below.

- Warm and cold standby arrangements
- Queuing for labor
- Queuing for spares from site, depot and factory
- Hold for repair
- Opportunistic maintenance

AvSim+ will then analyze your system using efficient Monte Carlo simulation algorithms to provide availability and reliability parameters, life cycle costs, importance rankings etc. You may also optimize spare holdings and planned maintenance intervals.

ARMS Reliability Engineers distribute Isographs RAMS tools in Australia, Canada and USA and provide training and project services to companies in mining, refining, power, manufacturing and defense.

www.reliability.com.au

Equipment Readiness and Visibility Using Honeycomb Maps

James M. Reeve

William and Sara Clark Professor of Accounting and Business
University of Tennessee
Knoxville, TN
jreeve@utk.edu

Michael Williamson

Deputy Director, Studies and Analysis Department
US Marine Corps Logistics Command
Albany, GA
The opinions expressed in this article to not necessarily represent that of the United States Marine Corps.

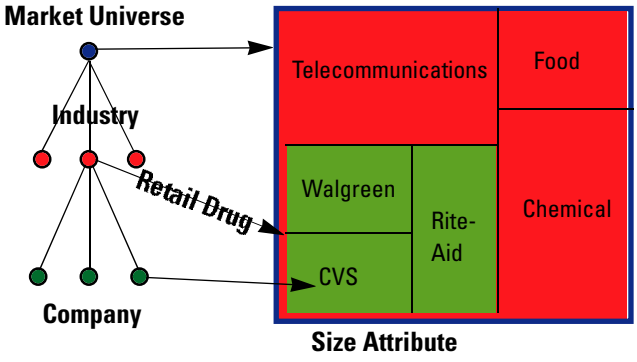
The U.S. Marine Corp describes their mission as a "Total Force in Readiness". The concept of "total force" includes all the elements of an expeditionary force, including troops, support personnel, and equipment. The concept of "readiness" is the availability of all elements at the required time and in the required place. Thus, when a tank goes down, the commander must know when it went down, why it went down, and when it will again be available. If the elements are not ready, then the mission is not ready. Not surprisingly, a culture that is built around these requirements must also manage a maintenance system for fast response.

Recently, a new tool has been developed and deployed to assist the Marines in planning and evaluating equipment readiness. This tool, termed MERIT (Marine Corps Readiness Information Tool), is providing the Marines with near real-time readiness information to support strategic deployment, planning, and management of equipment maintenance status and underlying parts. Already, the results of MERIT are receiving wide interest both inside and outside the military. For example, Congressman Mutha recently stated, "the MERIT system is an exciting new tool that is providing a great advancement in our ability to maintain the readiness of the Marine Corps. Ö This system provides a near real-time visual display of everything we need to carry out our mission from tanks to spare parts."[1] In this article we will describe MERIT and show how it was developed to support equipment readiness performance and repair cycle visibility.

Honeycomb Maps

The tool is a graphical analysis layer based on a new technology, termed "honeycomb" maps. Honeycomb maps are developed and marketed by the Hive Group (hivegroup.com), based on the theoretical work of Ben Shneiderman.[2] The honeycomb map expresses an information hierarchy into a two dimensional mapping. Exhibit 1 expresses the honeycomb concept. The highest "blue" level of the tree hierarchy is expressed in the honeycomb as the outer dimension. Lower tree levels (red and green) within the tree hierarchy are expressed by the inner dimensions of the honeycomb.

Exhibit 1. Tree Visualization with Honeycomb Maps



For example, one of the most celebrated uses of this technology is in the investment sphere (see smartmoney.com maps). The market universe is the outer dimension of the honeycomb (blue level), as shown in Exhibit 1. The highest level inner dimension is the industry dimension (red level), while the smallest squares within the industry are the individual companies (green level). In addition, attributes at any level within the honeycomb can be expressed by size, color and location of the honeycomb cells. In the investment example, location represents an attribute such as market capitalization. For example, telecommunications has the highest market capitalization of all industries, which is indicated by its upper-left position on the map. Likewise, one level down, Walgreen's has the highest market capitalization in the retail drug sector. Additionally, the area of the honeycomb cell visually represents a second attribute, such as trading volume (i.e. the larger the cell, the higher the volume). Finally, a third data attribute could be captured by the fill color of the cells (not shown). In the investment sphere, the color codes would indicate the change in market price over a designated period of time. Red cells would indicate price declines, yellow cells would indicate minimal price changes, and green cells would indicate price increases. Thus, the honeycomb map is able to convey both data hierarchy and up to three data attributes within a single plane view. In more sophisticated applications, the individual cells can be linked to underlying data to provide drill down capability from the individual data elements (cells) to underlying cause factors. Such a visual display can be applied to a wide variety of scenarios as we will illustrate with MERIT.

MERIT's honeycomb layer resides over existing data providing dynamic information on equipment readiness (performance) and underlying supply chain status (visibility).[3] The MERIT front screen is shown in Exhibit 2. The hierarchy tree for MERIT is built around equipment groups and types. The equipment groups include Marine expeditionary equipment such as radios, trucks, light armored vehicles, and the like. These equipment groups (or Functional Areas, FA's) are visible on the MERIT screen as the larger boxes in white outline. Each cell within the equipment group includes a particular piece of equipment. For example, the upper left-hand cell labeled A2171 is a vehicular radio set. This hierarchy configuration can be changed by selecting alternative hierarchy definitions on the tabbed drop down list. That is, users can change the honeycomb hierarchy by changing the group from equipment functional definitions to alternatives, such as commodity codes.

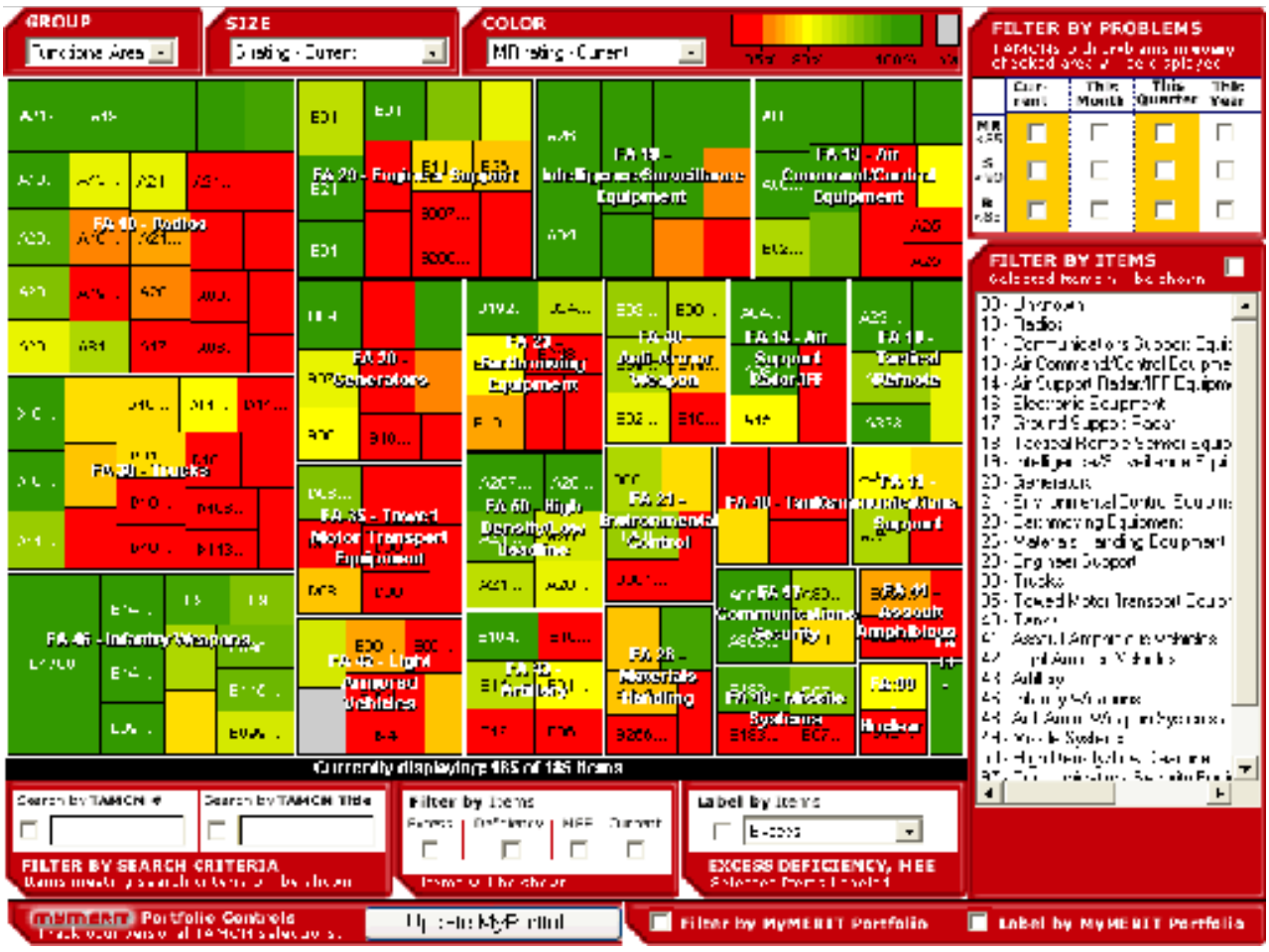
The cells of the honeycomb are sized and color coded according to two attributes, or performance metrics, which can be defined from the "size" and "color" drop down menus at the top of the screen. MERIT uses the size and color dimensions to capture readiness characteristics of their equipment according to three measures, as follows:

$$\text{S-Rating} = \frac{\text{Number on-hand (including pieces in maintenance)}}{\text{Number Authorized}}$$

$$\text{R-Rating} = \frac{\text{Number of units deployment ready}}{\text{Number available (including pieces in maintenance)}}$$

$$\text{MR-Rating} = \text{S} \times \text{R}$$

Exhibit 2. MERIT front screen



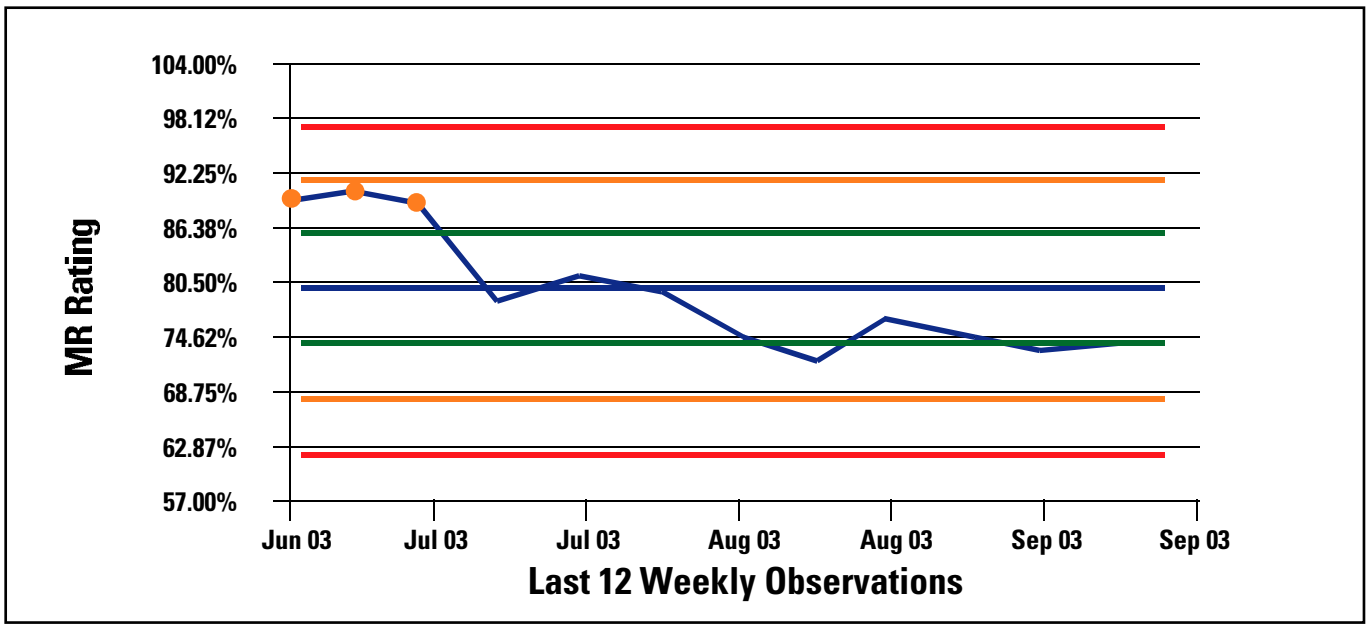


Exhibit 3. Performance Control Chart

MR Ratings for Light Tactical Vehicle

- Data
- A(+/-) line indicating three standard deviations from the historical mean MR rating.
- B(+/-) line indicating two standard deviations from the historical mean MR rating.
- C(+/-) line indicating one standard deviation from the historical mean MR rating.
- The historical mean MR rating.

The S-rating measures the number of equipment items on-hand (both available and in maintenance) against the planned authorizations. While the S-rating provides information on the number of units on hand relative to that which is authorized, the R-rating, or maintenance rating, evaluates the amount of equipment that is combat ready relative to the amount available. The MR-rating is summary rating that is the product of the S and R ratings. Thus, if a Marine Corps unit has 125 units, but only 100 are authorized, then the S-rating would be 125%, indicating that there are pieces of equipment in excess to that which was authorized. These excess units can be located by Marine organizational units through MERIT view changes. However, if 50 units were under repair, then the R-rating would only be 60% (75/125). The MR-rating would be the product of these measures, or 75%. The MR is the percent of combat ready pieces to authorization. These measures are very consistent with the broader class of equipment availability measures suggested in the Total Productive Maintenance literature.

These measures can now be incorporated into the size and color characteristics of the honeycomb map. The Exhibit 2 view shows the honeycomb cell size to be the current S-rating and the color to be the current MR-rating. The S, R, or MR ratings for different time periods can be selected from the drop-down list to prepare different honeycomb views. Functional Area (FA) cells are one level higher in the hierarchy. Each of these cells are positioned on the map according to equipment density. To illustrate, FA-10 Radios has the highest density of equipment in the Marine Corps, and thus is displayed upper-left on the view. The colors designate the current MR-rating. Green colors indicate MR-ratings above 92%, yellow colors indicate MR-ratings from 85-92% while red colors are MR-ratings below 85%. Among the radios the A1955 (radio terminal set) has an MR rating below 85%, which would indicate the need for additional management oversight.

In this example, because the S Rating sets sizing, the individual pieces of equipment are arrayed within their functional groups so that the highest S-rated equipment is positioned in the upper left-hand corner (green corner) and the lowest rated weapon systems are positioned in the lower right-had corner of the group box (red corner). Thus, among the radios, the A2171 radio has the largest cell area, which represents the highest S-Rating among the radios. A click on the box will show the actual S, R, and MR performance attributes over designated time periods. Thus, users have a quick visual display of the multiple dimensions of equipment availability. Naturally, the honeycomb can be filtered along any of the equipment or performance metric dimensions to focus on a particular class of equipment or readiness issue. While viewing the maps from an equipment perspective is important, MERIT also arrays the data from an organizational perspective which allows analysts to quickly focus on organizations that are experiencing problems.

In addition, the system archives historical S, R, and MR ratings by equipment type for control charting. Thus, an analyst can click on an equipment cell and request the system to prepare a control chart of the maintenance performance for variable timeframes such as the last 24 months. Exhibit 3 provides an example for a Light Tactical Vehicle using assumed data. Over the last 12 weeks it has been experiencing declining MR performance.

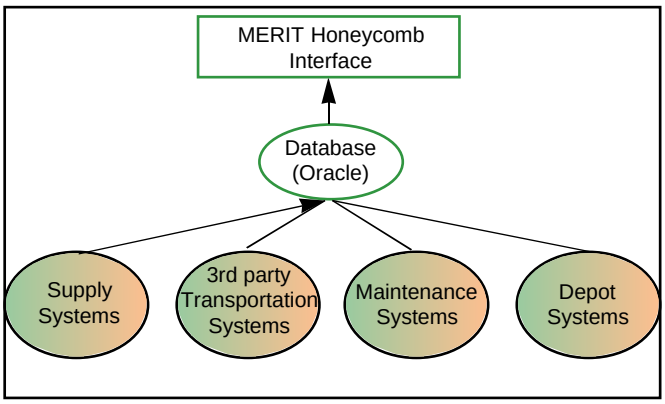
The resulting honeycomb maps have allowed Corps personnel to move energy and time away from data gathering, accumulation, and reporting; towards solving and preventing critical readiness problems. Force Commanders are given clear visibility of readiness trends, revealing potential problems and associated causes.

System Structure and Development Methodology

The honeycomb map by itself provides a multi-dimensional view of performance, but does not provide the management information needed to influence the causes of the performance. In order to accomplish this objective, supply chain variables must be connected to the honeycomb items (equipment). In this way, performance, underlying causes, and associated responses can be linked. MERIT accomplishes this linkage.

MERIT draws data from the Marine's maintenance, supply, logistics, and distribution systems as well as 3rd party suppliers and transportation systems as shown in Exhibit 4. The technology behind MERIT is an open-source Java-based programming technique. The common delivery method is through a web browser using a Java Applet processed on the server and connected to a data source such as Oracle, XML or delimited text. The graphical results are embedded in HTML and displayed by the user's web browser. The final product is a small, flexible file that runs on virtually any platform and handles a large number of users simultaneously.

Exhibit 4. Integrated Data Sources



The integration of these data sources and the adaptation to MERIT was done under a rapid application development (RAD) methodology. Under this methodology requirements identification, commercial off-the-shelf (COTS) integration, and database integration were accomplished in a compressed time frame. Such a flexible, responsive, and entrepreneurial development approach was well suited to an environment characterized by rapid changes in IT policy combined with multiple system modernization objectives. Exhibit 5 illustrates a rapid application development framework.

Traditional IT development approaches are similar to the rigid design and development process within the construction industry. Requirements are turned into a building through a slow sequential process. Such an approach is reasonable with a building, since the final product is costly to change or repair once built. However, this is not the case with software. Software can be developed and designed iteratively. A working "bare bones" version of the software can be developed rapidly, and then improved and tested under the strain of use. As the software is used, another round of requirements and improvements are then initiated. RAD places working software in the hands of users much more rapidly than the traditional approach. More importantly, iterative design methods will provide more realistic and useful design inputs from users. The user's imagination is able to function more creatively within the context of use, than in the context of planning (hypothetical use).

Thus, the cornerstone of a successful rapid development process is the production of a useful, working application at the end of each development cycle. We were able to integrate the data into the first MERIT prototype in less than three months because business processes had been defined and requirements existed. Consistent with rapid prototyping protocol, the users were co-opted into the process as beta testers. A web site was established where users evaluated the new tool, responded to enhancements, and contributed ideas for new improvements. This process lead to an evolving tool that provided more and more of what the users wanted.

In the next section, we'll see how weapon systems and program managers, maintainers, and analysts can access detailed information to initiate readiness responses.

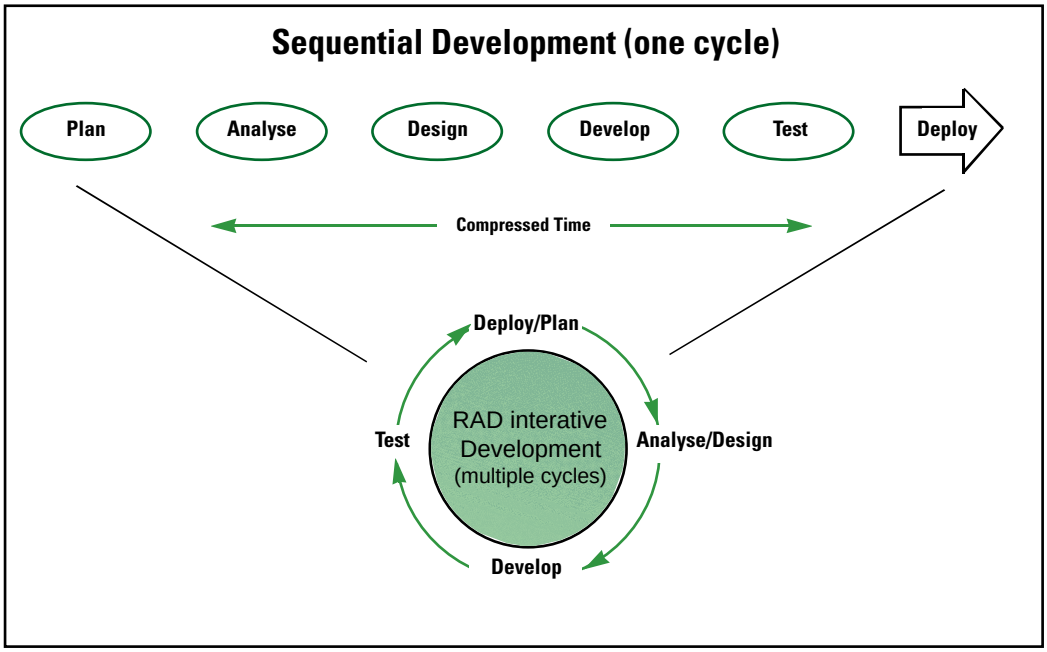
MERIT Repair Cycle Visibility

Exhibit 6 illustrates the system's repair cycle management capability. This illustration simplifies the actual system, by reducing both the number of data elements and levels within the system.

Assume a light armored vehicle (LAV-25) is in the red zone on the honeycomb display. Assume the LAV-25 has 15 vehicles authorized and three are in the maintenance shop, yielding a MR-rating of 80% (12/15) as of September 15th. Thus, in this example the LAV-25 is in the "red zone" and requires further analyst attention.

The analyst can click on the LAV-25 cell of the honeycomb map and connect directly into the equipment maintenance system to evaluate maintenance status of the LAV-25's. The equipment level

Exhibit 5. Rapid Application Development (RAD)[4]



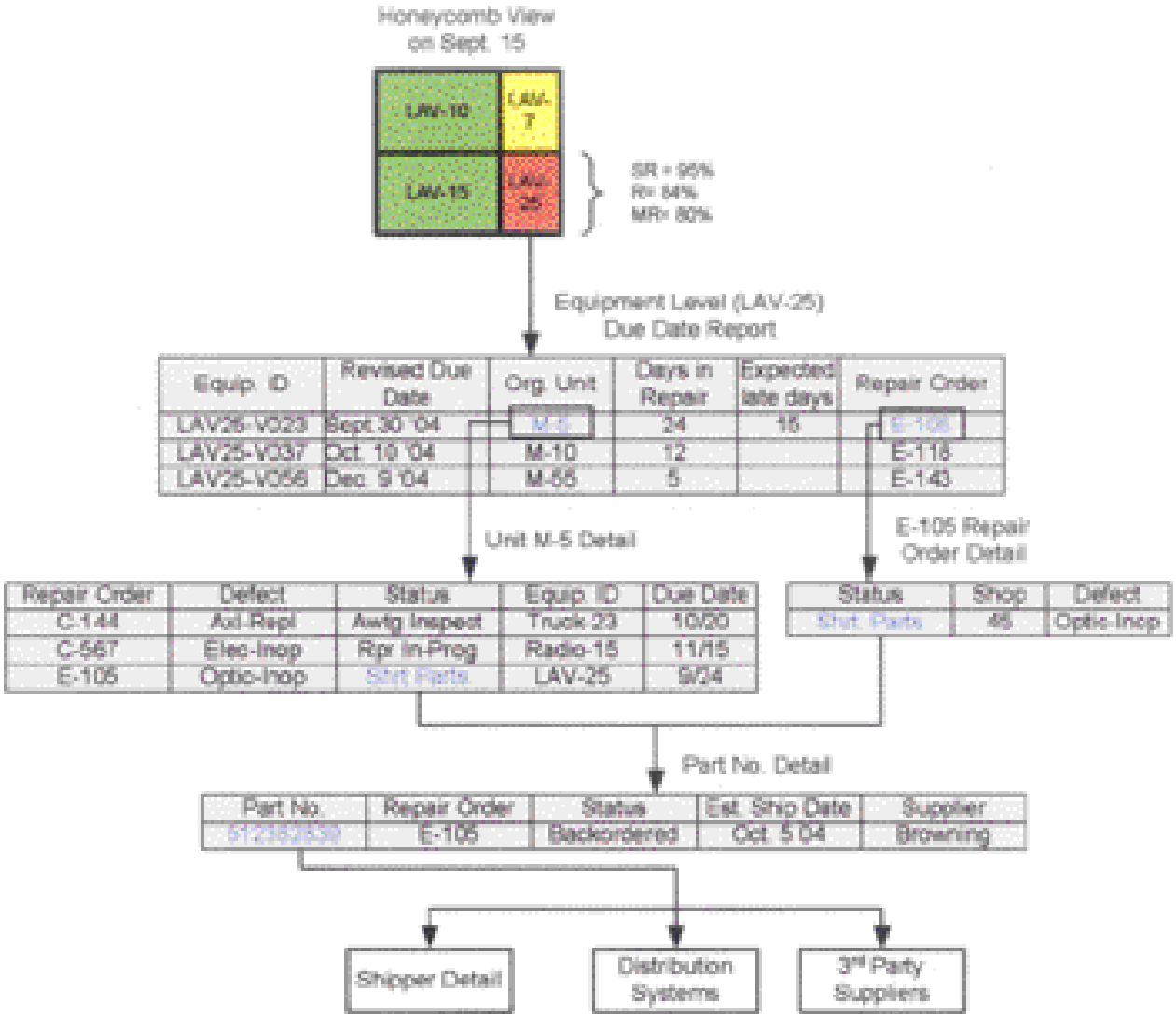


Exhibit 6. Repair Cycle Visibility

view shows the maintenance status for the three LAV-25's under repair, as shown in Exhibit 5. Vehicle number V023 had a due date of September 15th, but is now expected to be available on September 30th, or 15 days after the original due date. Since this vehicle was not released from the shop on the scheduled due date, the MR-rating has dropped below 85%.

At this point the analyst can evaluate maintenance either from an organizational perspective (left-hand branch) or from a specific repair order perspective (right-hand branch). The organizational perspective provides the analyst the complete detail of repair work orders, their status, associated equipment, due dates, and late status for a particular organizational unit. Naturally, this information can be queried and sorted using simple database tools. The organizational view allows the analyst or Commander to evaluate the readiness detail of the entire Marine Corps and/or down to the smallest unit by evaluating the complete repair status of all pieces of equipment assigned to the unit. This view will reveal the underlying causes for the readiness status for a particular unit. For example, the unit readiness analyst could evaluate all the equipment in maintenance and reassign resources to accomplish the most important tasks or to reduce bottlenecks. Commanders at higher levels could evaluate maintenance conditions and redistribute resources across subordinate units to increase the overall readiness of the command. For example, the commander may be waiting on a different but specific part for trucks. By reprioritizing the parts that are actually possessed, the trucks may be repaired more quickly than if left as an unattended process.

Alternatively, the analyst can drill into the repair order view, as shown in right-hand pathway in Exhibit 5. This view explains why the LAV25-V023 is past due, by indicating the reason for the repair and the timeline status of the repair. Many delayed repairs are due to part shortages. In order to evaluate the part shortage the analyst needs to access the material supply system. MERIT makes this access transparent. The analyst can click on the "Shrt Parts" label in either the organizational listing or repair order listing to move into the supply system. The supply system provides the analyst the ordered part detail. This would include the part number, due date, status, expected ship date, and other pieces of relevant part number information. From this detail the analyst can determine if the expected equipment due date is reasonable. As can be seen in this example, there is a

discrepancy. The short part is due on October 5, while the equipment is expected to be repaired on a revised due date of Sept 30 (from the equipment maintenance screen). Thus, the analyst is now aware that the equipment will not likely be ready on September 30th, as in the revised plan, but will more likely be available some time after October 5, after the short part is shipped. The analyst can either change the equipment expected due date or attempt to accelerate the shipment of the short part. To facilitate the latter action, the system provides capabilities to support inquiries to the purchasing agent, or directly with the supplier.

The part number can also link to transportation provider tracking details if the part has been shipped, so that exact arrival status can be determined. In addition, the part number inventory information can be accessed from the part number hot link.

Exception-Based Feedback

One of the objectives of near-real-time management support systems, such as MERIT, is to build in feedback loops so that exceptions can be identified and monitored without the need for excessive database search and query. MERIT accomplishes this objective in two ways. The first feature is a screening mechanism that allows the analyst to segment the full database into a MyMerit view. MyMerit filters the database so that organizational units or equipment items are isolated. This provides focused analyst control at appropriate levels of responsibility. This feature is like establishing and tracking a stock portfolio. The second feedback approach is an email alert feature. The user can configure the system to provide email alerts when performance ratings drop below or improve beyond established thresholds. Finally, because tools like MERIT draw data from many different transactional systems it highlights many disparities between and among them. Accordingly, many reconciliation features were included, such as the following frequent conditions:

- parts are not on order in the supply system even though the maintenance system indicates they are.
- parts have been delivered to the requestor's facility even though his system indicates they are still due in.

Features such as these can be used to actively manage the maintenance and supply system to overcome equipment repair delays.

Conclusion

MERIT is a new tool that is receiving wide interest both inside and outside the Department of Defense community. The tool provides managers at various levels a "honeycomb" visual representation of maintenance performance along a number of different performance characteristics, within a number of different data hierarchy alternatives. The tool links the visual display with underlying repair cycle detail, indicating equipment level and part number level status. Such information can be used to follow-up and focus on particular problems, identify potential solutions, monitor ongoing efforts, and identify responsible persons or organizations.

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1 May 30, 2003, Johnstown, PA.

2 Shneiderman, B. "Tree Visualization with Treemaps: a 2-d space-filling approach," ACM Transactions on Graphics, Vol. 11 (Jan. 1992), pp. 92-99.

3 The MERIT application was developed as a collaboration between Concurrent Technologies Corporation (CTC), U.S. Marine Corps, and Defense Logistics Agency.

4 See Steve C. McConnell , "Rapid Development: Taming Wild Software Schedules" (http://www.credata.com/research/rad.html).

Developing Suppliers That Provide Reliability and Maintainability

by Ron Moore

First Published in Plant Engineering, December 2003

Introduction

Companies frequently ask suppliers of critical equipment about the reliability and maintainability of their equipment. The questions cover a number of topics and often include queries about Mean Time Between Failure (MTBF), recommended spares, PM requirements, the role of reliability and maintainability in the design of equipment, and so on. My experience has been that the answers, while pretty standard, are often little more than sales-speak, and perhaps more importantly, the questions are often not sufficiently specific to solicit an adequate response. These observations are not intended to be overly critical, but rather to observe what has been traditional in the supplier-buyer relationship. Below are some common examples of questions put forth by the buyers, and typical answers from the suppliers of critical equipment. Many times these answers are less than satisfying. To help achieve a greater sense of partnership, below are also several additional questions and suggestions that are proposed to foster a greater sense of partnership between the buyer and supplier, and ultimately assure better reliability and maintainability, and lower costs.

Specifications for Reliability and Maintainability

A common question included in a request for proposal might be something to the effect of 'What roles do reliability and maintainability play in the design of the equipment which you are quoting?' A typical answer might be something to the effect of 'We've designed this equipment many times and work with many plants to make our equipment reliable.' Of course, I'm summarizing, but this seems to be the gist of the questions and answers, and they aren't very satisfying. Let's be more specific, and use the following kind of language:

We're currently experiencing some ____% maintenance downtime with equipment similar to that which you are quoting. This is considered at least in part to be due to poor reliability and maintainability. Likewise, the lack of ease of changeovers is also affecting our ability to provide for rapid setup and reduced changeover and transition losses. We estimate this at some ____%. This totals over ___% of our production losses. We find this unacceptable for new equipment, and will make the purchase of this new equipment untenable. (Note: you might also consider their initial reply as non-responsive to your question.). In order to more fully address these issues, please provide or respond to the following:

A. Provide your definition, criteria, and standards for reliability and maintainability of the equipment being supplied, e.g., SAE, SMRP, etc.

B. Provide a description of the most common failure modes, and each's consequence, for this type of equipment. Also provide a description of those failure modes that are infrequent, but have severe negative consequence for this type equipment. The description of consequences should include a discussion of the potential downtime (or mean time to repair), and repair costs, that are typically experienced for each of these failure modes.

C. Provide the key operating and maintenance practices required to mitigate and minimize these failure modes.

D. Describe the critical spares that are needed in light of these common failure modes. What is the risk or consequence without these spares?

E. Describe the methodologies being used for analyzing the reliability of the equipment, e.g., RCM, RCFA, FMEA, Pareto, etc. Give a specific example of each method being used for the equipment proposed.

F. Where and how is this data collected for applying the methodologies described in paragraph E. above, and how does the proposed equipment compare to the baseline equipment for which the data was collected?

Designing for Reliability and Maintainability

A typical question might be 'How can future downtime be prevented during the design and engineering phase of the equipment procurement? And what can be done to facilitate future trouble-shooting and problem solving efforts? A typical answer might be something to the effect of 'We'll let you review the drawings for your approval, and/or our processes are highly automated for ease of troubleshooting.' Or, they might say 'We spend considerable time in plants working with operators and maintainers, understanding their

problems, and getting their ideas on how we can improve the design'. Certainly these are important, but not likely to be sufficient. Let's ask the following:

A. In light of the failure modes analysis described above, how will you modify the design of your equipment to eliminate, mitigate or better manage (through condition monitoring methods that allow early detection of problems) these failure modes? If condition monitoring technologies or methods are applied, please describe those that apply, including their potential costs and benefits. Include in your discussion a review of the application of continuous monitoring.

B. Describe 3 or 4 design changes that have been made as a result of working with your customers, and why. What additional efforts are currently on-going for improved reliability and maintainability in the equipment?

C. Attached is a listing of several problems that we have had in reliability and maintainability. Please provide us with a description as to how you will address and resolve these problems in the design to assure improved reliability and maintainability.

D. Will approval of your drawings be permitted, and if so, in sufficient time to allow for equipment modifications and still meet the project schedule? Please outline your plans.

Experience with Reliability and Maintainability

When asked about their specific experience in providing reliable, readily maintainable equipment, or more to the point, when asked about the reliability of the equipment being procured, a typical reply from the supplier might be 'This equipment has been installed in many places throughout the world, and has operated very reliably. In particular, this equipment was installed at the First-Up plant, and had few difficulties during commissioning, and is currently running reliably. It's also been installed at the Next-Other plant. Let's ask the following:

At the First-Up and Next-Other plants, please respond to the following for each plant:

A. What has been the historical average % unplanned maintenance downtime?

B. What is the mean time between repair?

C. What is the mean time to repair?

D. What are the five most common failure modes?

E. What is being done in the design to mitigate or eliminate these reliability and maintainability issues?

F. How long did the commissioning process take to achieve full, sustainable production rates? How many failures and of what duration occurred during that period? Did any supplied parts exceed the guaranteed failure rate?

G. What were the major problems encountered during commissioning?

H. What design changes have been made to minimize these commissioning problems?

I. What is the standard commissioning process? We desire that the equipment run at least one full production cycle while maintaining full production requirements. We also desire that this same test be repeatable within 6 months of initial ⁞ your process for meeting these requirements.

J. We desire a mean time between failure (MTBF) of not less than _____ hours. For our purpose, a failure is defined as anything that occurs with the equipment that results in any downtime, production rate reduction, or quality loss. For example, at a ____% confidence level, this requires that we have no more than ____ failures during a ____hour period. Please affirm your commitment to running a commissioning test over the period stated with these specific confidence limits, and predetermined number of failures, or offer your alternative that will meet this need.

K. Could you arrange for our engineers and purchasing people to visit these two plants, and perhaps other plants, to review their practices and performance?

PM and Spares Requirements

When asked about PM and spares requirements, and how they are developed, vendor responses vary considerably. A typical answer might be 'Spares recommendations are based on our experience and on feedback from our customers, separated into capital spares and routine wear parts, with expected lifetimes.' What this means is not very clear. To add greater clarity, let's ask the following:

A. What statistical methods and other techniques were used to convert your experience and feedback into spares recommendations and PM intervals? In light of the failure modes described above, and assuming the failure modes cannot be entirely eliminated in the design, describe how these PM will assure mitigation and/or early detection of these failure modes. Describe how the spares recommended are to be used for better managing these failure modes.

B. Please provide one example of each major component analysis, wherein techniques such as RCM, FMEA, PM Optimization were used in conjunction with statistical failure and wear data to determine PM requirements and intervals and spare parts requirements.

Training

Training is critical for the proper startup, operation and maintenance of new equipment. A typical question might be 'What level of training is required for operators and maintainers for equipment of this type?' A typical answer might be 'We do good training, and much of the equipment is automated, minimizing the need for training.'

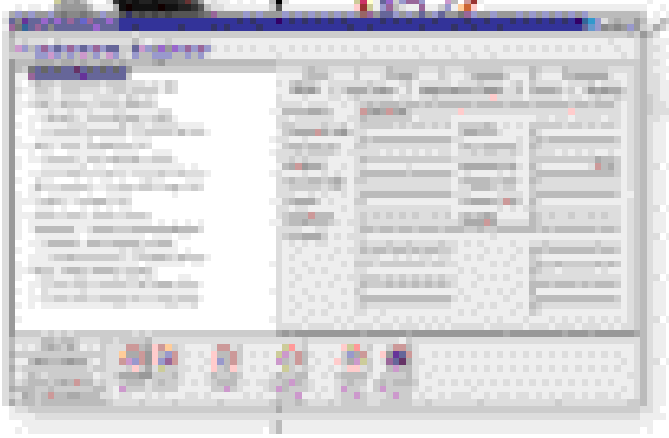
Increased automation is more likely to increase the complexity of the equipment, resulting in a need for greater skill and competency in our staff, not less, particularly during problem analysis and corrective action. With this in mind:

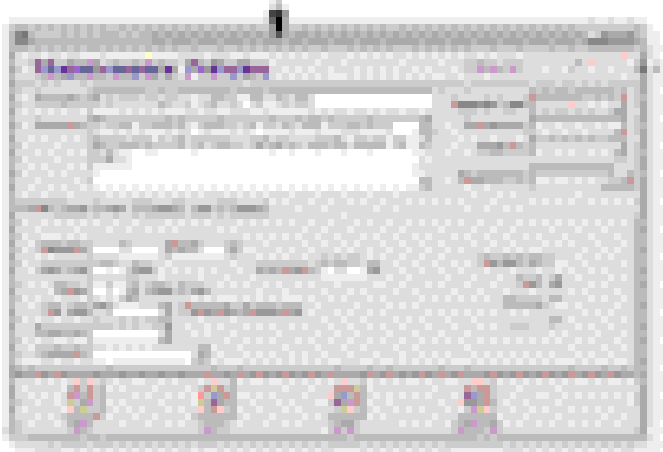
A. Describe the operator training, as well as mechanical and electrical maintenance training required to assure world-class practice, including a detailed outline of all training and support requirements that will be necessary for supporting the reliable operation and maintenance of the equipment.

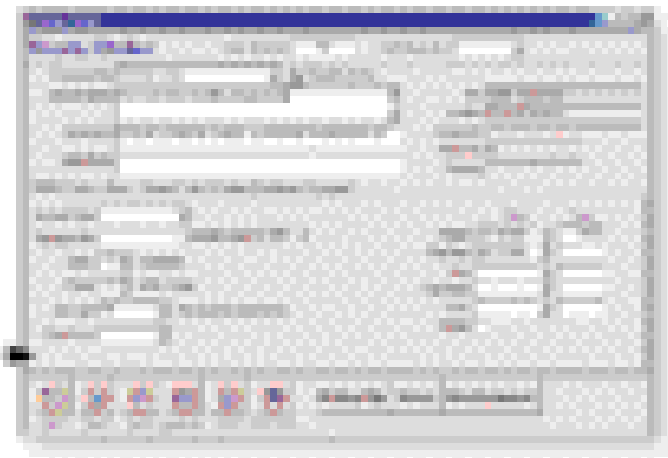
Summary

Using the model outlined above should be an integral part of an overall strategy for minimizing the total cost of ownership for major capital equipment. The key to using this approach is having a good understanding of your current operating results and problem areas, the failure modes most likely to result in lost production, downtime, or high costs; or that may have the most severe consequence to your overall operation. Having a good understanding of these issues will assure that you can work with your supplier to eliminate, mitigate, and manage these risks; and that you can minimize your total cost of ownership, and be more profitable. Many of you may be far along the path for this and have more detailed processes to achieve the above requirements. No doubt others would consider these requirements beyond the scope of many of your procurement efforts. Somewhere in the middle are many of you who could use this model to more fully develop your requirements for improving reliability and maintainability. Hopefully the suggestions above will help you in that effort.

Ron Moore is Managing Partner of The RM Group, Inc., Knoxville, TN, and author of *Making Common Sense Common Practice: Models for Manufacturing Excellence* from Butterworth-Heinemann. He can be contacted by telephone at 865-675-7647; or by email at *RonsRMGp@aol.com.*







MEX operates on all current Windows platforms including '95 '98 '00 NT & XP. It also allows the user to report directly into Word, Excel and Access. It is recommended that you have at least 32 Mb Ram, 152 Mb Hard Disk space and an 800 x 600 display option with 256 colours.

Other solutions available from Maintenance Experts include: FLEETMEX, MEX OPS, MEX STORES, EASYTIME, FUEL MEX, MEX LINKS & MEX INSPECTIONS.

Your Maintenance - Our Expertise. Over 2400 Users Worldwide

MEX | MAINTENANCE MANAGEMENT SOFTWARE

Reduce Costs, Improve efficiency and help harness the full potential of your maintenance operation. MEX gives companies all the power to take control of their maintenance operation. Whether you are managing the maintenance of a Processing Plant, Factory, Building Facility or even providing Contract Maintenance services, MEX has the flexibility to accommodate any situation. Let MEX launch your operation towards significant improvements in efficiency and productivity.

MEX'S Powerful Features Include:

Equipment Register
A complete asset register, accurately tracking the value and status of all of your equipment.

Work Orders
Increase efficiency and profits, know who did what work, what it cost and when it was completed. Schedule and utilize your resources effectively.

Equipment Usage/Performance
Condition reporting. Record and monitor readings by any type including hours used, Kpa, km etc

Maintenance Policies
Reduce breakdowns and control routine preventive maintenance with automatic work orders and standard jobs.

Reporting
Essential and accurate information immediately. Customise your reports and graphs, and export to third party applications.

History
All your equipment history for performance and comparative analysis and life cycle costing.

Stores
Complete inventory management from issuing spares to vital information on parts availability and consumption.

Invoicing
Simple invoicing for customer maintenance work completed direct from your work orders.

Inspections
Utilise MEX and hand held devices to address risk management and safety obligations. Perform routine inspections and upload results into MEX with a press of a button.

Work Requests
Save time and eliminate paperwork. Remote requesting module to accurately track, approve, and monitor work requests.

MEX FROM $2178*

FREE CD DEMONSTRATION COPY OF MEX

MEX

www.mex.com.au

Just fax this form to Maintenance Experts +61 7 3392 4888 or mail to:
MEX Maintenance Experts PO BOX 6118 Buranda Qld Australia 4102

Name/Position:

Company:

Address:

Phone: **Fax:**

Equipment Register
- View add and update all details from within a selected record
- Record and report on details of supplier, costs, purchases date etc
- Equipment movement tracking
- Location hierarchy to any branch of equipment
- Region/department hierarchy
- Inclusion of all equipment details including graphics/pictures
- Security and User access levels

Work Orders
- Multiple jobs for a work order
- Resource and plan Labour, Materials and time
- Prioritise, report on and control work in progress
- Estimated and actual job costs
- Internet and Intranet Work Requesting
- Graphical schedules & tracking of work

Readings
- Monitor plant readings
- Track plant usage times
- Graph results

Equipment usage/Performance
- Record and report on any reading type
- Calculate average usage rates for equipment
- Report on equipment performance

Maintenance Policies
- Schedule work by conditions, hours used, km, months etc
- Automatic work order creation
- Standard jobs
- Allocation and management of job spares, people and costs
- Attach files to Policies

Invoicing
- Invoicing of work completed
- Create invoices directly from Work Orders
- Complete breakdown of costs, labour and parts
- Invoice matching to line item level
- Customer specific pricing

Drawings
- Complete Drawings register
- Store equipment listing for each drawing

History
- Life cycle of costing and comparative analysis
- Failure analysis codes
- Full work details including description, labour parts
- Account code charges
- Down time/Repair time

Reports
- Ease of data capture
- User customizable reports
- Export data quickly and accurately

www.mex.com.au

2004 Survey of Computerised Maintenance Management Systems

Compiled by Ian Bradshaw , March 2004
The data given in this May 2004 CMMS Survey is extracted, as received, from the respondents. The Maintenance Journal does not therefore accept any liability for actions taken as a result of information given in this Survey.

2 Maintain

Contact: George.T.Hamilton
Phone: 630-455-0959 EXT 2
Fax: 630-455-0960
Email: ghamilton@2maintain.com
Web: 2maintain.com

In Country support : USA

Typical cost of the CMMS software:

Small site: $1500 USD
Medium Site: $3500 USD
Large Site: $6500+

Available as a stand-alone system.

CMMS DETAILS - Technical

Windows environment. All versions fully can be upgraded with no loss of data. Export/import into other MS Windows programs (Word/Excel). System operates on run-time version of MS Access (included). All versions can be loaded on stand-alone PC or on server/network. Designed by facility managers for facility managers.

CMMS DETAILS - Functionality

Schedule PM on 52 work week calendar. Annual/Semi-annual/Quarterly/Monthly/Tri-weekly/Bi-weekly/Weekly. Complete work order modules included. Inventory of repair/maintenance items. Re-order feature. Complete PM/Repair History at the touch of a button. Payback period for replacement based upon repair costs calculated automatically. Detailed worksteps for PM includes lubricants, instruments. Completely user friendly.

AMMS

Company: MicroWest Software Systems, Inc
Address: 10981 San Diego Mission Road, Ste 210 San Diego, CA 92108 USA
Contact: John (JR) Ruta / James Henry
Phone: 619 280-0440
Fax: 619 280-0467
Email: sales@microwestsoftware.com
Web: www.microwestsoftware.com

In country support: USA and Canada

Typical cost of the CMMS software:

Small site: US$3,000-US$12,500
Medium Site: US$12,500-US$25,000
Large Site: US$25,000-US$75,000

Available as a stand-alone system.

CMMS DETAILS-Technical

AMMS has served the needs of serious maintenance and purchasing professionals since 1984, with Ease of Use a Top Priority. Many CMMS look alike, but one feature that makes AMMS better is our User Customization Option (UCS). UCS lets anyone easily tailor screens to your liking, create custom reports and forms and even populate databases on-the fly. Imaging allows viewing and printing of scanned drawings, diagrams, or procedures from Work Orders or Purchase Orders.

CMMS DETAILS - Functionality

AMMS is an easily customizable, comprehensive, no-nonsense Maintenance, Inventory and Labor management PC-program. AMMS is PALM and WEB enabled, with Network, Barcode, Imaging, Email, Audit Trail, Calibration, Fleet and other options. Microwest offers expert training, implementation, custom software and interfaces.

MicroWest takes pride in our outstanding Customer Support. With our annually-renewable Maintenance & Support service we provide a real person, not automated messages or Web sites to help you with a question or problem fast. Our customers agree Maintenance & Support is one of the most important ingredients in a successful implementation.

AMPRO

Company: Third City Solutions Pty Ltd
Address: 52Hill Pde Clontarf ,4019 Queensland Australia
Contact: David Powell
Phone: 61 7 3885 2019
Fax: 61 7 3885 2099
Email: info@thirdcitysolutions.com
Web: www.thirdcitysolutions.com

In country support: Australia

CMMS Designed for group:

Marine, Facilities, Factory and Fleet

Typical cost of the CMMS software:

Small site: AUS$2,390.00
Medium Site: AUS$5,425.00
Large Site: POA

Available as a stand-alone system.

CMMS DETAILS - Technical

AMPRO is a Windows based application, developed in Microsoft Visual Basic, which utilises Client/Server methodologies to increase

system performance and efficiency. AMPRO can be installed stand-alone or on a network with the database installed on a network server or client computer.

AMPRO is available with a choice of database engines, being MSDE (Microsoft SQL Server 2000 Desktop Engine), a data engine built and based on core SQL Server technology or Microsoft Access 2000/XP, utilizing Microsoft's Jet database engine, a file-based data management system.

AMPRO uses Crystal Reports as its main reporting engine and enables you to export your reports into many different formats. AMPRO allows you to use Crystal Reports and/or Microsoft Access 2000/XP to develop your own custom reports which can be seamlessly integrated into AMPRO

CMMS DETAILS - Functionality

AMPRO - Developed from the ground up by people who took the time to develop a robust, intuitive and user friendly system based on the familiar interface, to ensure you get what you need to maintain all your plant and equipment.

Features of AMPRO

1. Modules are seamlessly integrated with each other.
2. Colour coded modules and the same 'look and feel' throughout makes the application intuitive for users.
3. Post messages, so users of AMPRO can see.
4. Roaming user profiles. Log on to AMPRO using your user name at any computer and your AMPRO personal settings will follow you.
5. Option to use up to six (6) levels In Asset Register.
6. Track costs incurred against an individual Asset or track costs incurred against a Cost Centres
7. Contact hierarchy 2 levels. (Create Companies at level 1 and the contact for those companies at level 2)
8. Create your own Reports and view them in AMPRO.
9. The ability to export reports in many common formats
10. Each user can have their own favorite's folder for frequently run reports and graphs.
11. Save the report to provide you with a snap shot of the data at that point in time.
12. Filter and Format the Listings and then print them out gives you power and flexibility to customise your own reports.
13. Comprehensive and easy to understand on-line Help and electronic User Guide

AMPRO - Job Requests

Company: Third City Solutions Pty Ltd
Address: 52 Hill Pde Clontarf, 4019
Queensland Australia
Contact: David Powell
Phone: 61 7 3885 2019
Fax: 61 7 3885 2099
Email: info@thirdcitysolutions.com
Web: www.thirdcitysolutions.com

In country support: Australia

CMMS Designed for :
Marine, Facilities, Factory and Fleet

Cost for the CMMS software: AUS$2,390

This CMMS works in conjunction with AMPRO

CMMS DETAILS - Technical

Job Requests is a Windows based application, developed in Microsoft Visual Basic, which utilises Client/Server methodologies to increase system performance and efficiency. Job Requests can be installed over a network on any number of client computers with the AMPRO database installed on a network server or client computer.

Job Requests integrates with AMPRO, which is available with a choice of database engines, being MSDE (Microsoft SQL Server 2000 Desktop Engine), a data engine built and based on core SQL Server technology or Microsoft Access 2000/XP, utilizing Microsoft's Jet database engine, a file-based data management system.

Job Requests uses Crystal Reports as its reporting engine and enables you to export your reports into many different formats. Job Requests allows you to use Crystal Reports to develop your own custom reports which can be seamlessly integrated into Job Requests.

CMMS DETAILS - Functionality

Job - Requests is the module that allows your operators around your company to request jobs directly into the AMPRO program, where Engineering / Maintenance will create Jobs if applicable. Remove the worry and drama with the paper based system where they go missing or just forgotten about, or the "I phoned them yesterday with that problem" syndrome. AMPRO - Job Requests is quick and direct. Follow the status of all requests from the easy to use

interface. Make notes and / or comments about the Job, these are then added to the Journals of this Job.

This easy to use powerful and functional application makes quick work of organizing the day to day job requests for any industry by getting the request directly into the Maintenance Department.

AMPRO - Job Requests is developed for site wide use with no additional expense if more users come on line

Features include -

Filtered Listings -View department's requests, the requests you enter, or all requests

Reports - Ability to report on requests, Print, Export to most common formats (PDF, Excel, etc) Run reports showing your own requests or the departments.

Email Notification - Have AMPRO Email you when changes are made to your request. All correspondence between AMPRO and requests are recorded in the Job Journals section.

Documentation - Comprehensive and easy to understand on-line Help and electronic User Guide

API Pro V5

Company: Apt Management Solutions,
Address: Suite 22, 450 Elizabeth Street
Surry Hills NSW 2010
Contact: Ian Jones
Phone: 02 9318 0213
Fax: 02 9318 0776
Email: info@aptgroup.com.au
Web: www.apipro.com (www.aptgroup.com)

In country support: 40 conuntries

Cost for CMMS software:

Small site: $6,000
Medium Site: $35,000
Large Site: $100.000+

currency used for the above costs: Australia

Available as a stand-alone system.

IS THIS CMMS part of larger

management/corporate system: APIPro can be Integarted with most company systems.

CMMS DETAILS - Technical

API is designed to be installed within today's industry IT systems and major database structures.

Interfacing to:

- Condition Monitoring
- Palm Pilot
- Bar Code
- Data Loggers
- ERP systems
- Financial systems

System & Technology:

System Security: Each API user will have their own individual log in structure.

Server Structure:

Progress is the current run time licence that supports API Pro; it provides for advanced reporting and analysis.

CMMS DETAILS - Functionality

API Pro OverviewV5:

API Pro is used within 500 leading companies worldwide in a variety of industries to maintain high-value capital assets such as plant, facilities, building & equipment.

API's mission is to assist our customers achieve decisive improvements.

Example of Modules:

Plant Documentation & Information Searching

Maintenance, Inspection

Stock Control

Purchase Management

Job Ordering

Internal Purchase Requests

Drawing and Documents and Graphical Navigator

Production Calendar

Project Management

Resource Planning

WEB Enabling

Purchase Agreement

Analysis & Performance

Palm Pilot

Industrial Interface, ABB/Alstom, SKF @ptitude

Change Logging FDA validation.

Standard BAPI interface to SAP, MFG/Pro + others

BEIMS

Company: Mercury Computer Systems (Aust) Pty Ltd.
Address: Level 5, 501 La Trobe StreetMelbourne VIC 3000 Australia
Contact: Garry Busowsky
Phone: +61 3 9602 2255
Fax: +61 3 9602 2595
Email: sales@beims.com
Web: www.beims.com

In country support:

South East Asia and China

CMMS Designed for group:

Buildings and large facilities

Typical cost of theCMMS software:

Small site: AUS$12,000 (ex GST)
Medium Site: AUS$24,000 (ex GST)
Large Site: AUS$50,000 (ex GST)

Available as a stand-alone system

CMMS DETAILS - Technical

Software/Hardware details:

BEIMSÆ operates on WIN9X, NT, 2000 and XP supporting SQL Server, Oracle and Access databases.

Graphics Capabilities: Visual planned maintenance calendars. Links photos, CAD drawings, Word and EXCEL documents to Work Orders, Assets, Buildings, etc.

Ability to interface: Links with Building Management and Financial Systems.

Reporting: Multi-parameter reporting, exports to Word, Excel, etc.

GIS: BEIMS SISfm links to CAD drawings, maps, etc.

Web Based capabilities: ContractorWebÆ - contractors access jobs online.

WEB Remote Request System - online requests and responses.

CMMS DETAILS - Functionality

BEIMS is purpose designed software for managing & maintaining buildings and assets.

Core Components:

Asset Management, Planned/Preventative Maintenance, Work Orders, Cost Control, Crystal Report Writer, Document Linking & Auto Manager View.

Optional Components:

ContractorWebÆ, WEB & LAN Remote Request System, Help Desk, Wireless Mobile Work Orders, Materials Management, Interfaces to Building Management & Finance Systems, Fax/Print/Pager/SMS Agents, Task Library and DOMAIN (Virtual Databases).

Special Features:

- Wireless and WEB capabilities
- KPIs and Corporate Reporting
- Deployable over multiple sites, while keeping data separate
- Electronic document filing
- High level of consulting and support services.

CHAMPS CMMS

Company: CHAMPS Software, Inc.
Address: 1255 N. Vantage Point Drive
Crystal River, FL 34429 USA
Contact: Debbie FieldsPhone: (352) 795-2362, Ext. 221
Fax: (352) 795-9100
Email: dfields@champsinc.com
Web: www.champsinc.com

In country support:

United States, Japan, India, France

CMMS Designed for group:

NO. CHAMPS Software, Inc. provides software and services to various industry groups including Government (Federal, State and local), facilities, utilities, manufacturing (discreet and process), pharmaceuticals, pulp and paper, mining and petroleum, hospitals and universities.

Typical cost of the CMMS software:

Medium Site: US$27,000
Large Site: US$54,000

Available as a stand-alone system.

CMMS DETAILS - Technical

CHAMPS is a state-of-the-art, fully integrated Computerized Maintenance Management System developed to take full advantage of Microsoft Windows '95, NT, '98, '2000 and XP operating systems and Microsoft SQL Server 7.0, '2000 or ORACLE 8i databases. The proposed system is developed using the Object Oriented development architecture. Industry standard CASE tools were used throughout the development process, from the creation of business process flow diagrams, through quality assurance testing. The programming language is PowerBuilder, with future project development in .Net.

CMMS DETAILS - Functionality CHAMPS enables large enterprises to optimize the life cycles of their capital assets. These assets include work force, equipment, facilities, vehicles, tools and spare parts. Efficient acquisition, maintenance, repairs, and replacement or salvaging of these critical assets result in operational excellence, leading to decreased cost and increased profits. CHAMPS modules include:

- Work Force Management
- Equipment
- Bill of Material
- Preventive Maintenance
- Web Work Request
- Work Order
- Financials:
- Inventory
- Purchasing
- Accounts Payable

Optional:

- Microsoft Project Baseline Interface
- Lockout / Tagout
- Project Tracking

COGZ

Company: COGZ Systems, LLC
Address: 58 Steeple View Lane Woodbury, CT 06798 USA
Phome: 203-263-7882
Fax: 203-263-7885
Contac: Jay Ambrose
Phone: 203-263-788
Fax: 203-263-7882
Email: jay@cogz.com
Web: www.cogz.com

Typical cost of the CMMS software:

Small site: US$995.00
Medium Site: US$2,995
Large Site: US$9,995

Available as a stand-alone system.

CMMS DETAILS - Functionality

COGZ is an integrated maintenance system consisting of:

- Equipment Management
- Work Order Management
- Preventive Maintenance
- Inventory Management
- Purchasing

As data is entered in one part of the system all related data is updated automatically. You never have to enter data twice since all the modules of COGZ are fully integrated.

Additional modules available are:

- Customization/Translation Module
- Properties/Multiple Database Module
- Downtime Tracker Module
- Work Order Request Module
- Email Reports Module
- Report Writer (allows user to create custom reports)
- Cad View and Print Module
- Bar Code Software Module
- ODBC Data driver

Coswin 7i

Company: Siveco Group BP 41
Address: 78185 ST Quentin En Yvelines Cedex, France
Contact: Mrs Stephanie Moret
Phone: 33.1 30 45 98 80
Fax: 33. 1 30 45 98 88
Email: contact@siveco.com
Web: www.siveco.com

In country support:

Brazil, Canada, Mexico, Algeria, Benin, Burkina Faso, Ivory Coast, Morocco, Reunion Island, South Africa, Tunisia, Italy, United Kingdom, Italy, Portugal, Romania, Greece, Luxembourg, Belgium, Switzerland, Poland, Bulgaria, Serbia and Macedonia, Germany, Spain, Turkey, China, Korea, Saudi Arabia

Typical cost of the CMMS software

Medium Site: ard 5000 the seat
Large Site: ard 5000 the seat

State currency used for the above costs: euros

Available as a stand-alone system.

Is this CMMS part of larger management/corporate system: yes

CMMS DETAILS - Technical

-fully configurable according to the user profile: graphical indicators, change of vocabulary, simplification of screen layouts, addition of fields, links to external applications amongst others thus allowing contextual navigation.

- the latest leading edge technologies through the Oracle capabilities, Java and Html version (COSWIN 7i) & a Client/Server architecture

Compatible with the principal ERPs in the market, COSWIN interfaces also with various production control software applications, with condition monitoring systems, and EDMS solutions (Electronic Documents Management System).

CMMS DETAILS - Functionality

COSWIN 7i helps companies to increase their profitability - by improving the management of corporate assets, improving employee productivity and reducing costs. COSWIN 7i provides a central register of corporate facilities and assets: managing and optimising all the maintenance activities and recording a full history of work completed - including spares, tools, resources and costs. For a full picture COSWIN 7i integrates the management of, and purchasing of spare parts and services.

Creative Maintenance Management System (CMMS)

Company: Creative Software Solutions Pty Ltd
Address: 9 Clegg Place, Glenhaven NSW 2156 Australia
Contact: Steve Ransome
Phone: 02 9680 7595
Fax: 02 9899 2642
Email: sransome@creativesoftware.com.au
Web: www.creativesoftware.com.au

In country support: Australia, New Zealand, China, Singapore, India, Malaysia.

Typical cost of the CMMS software

Small site:	AUS$2,000
Medium Site:	AUS$5,000
Large Site:	AUS$10,000+

Available as a stand-alone system.

CMMS DETAILS - Technical

Powerful, yet easy to use maintenance management tool designed for the maintenance practioner. Drill-down features and graphical displays make it easy to navigate between models with Microsoft style commands and functions.

Navigate through the CMMS modules and setup your operations using the user-friendly Tree View or Workorder Calendar. The Tree view is used to define relationships between the Equipment, Sub-assemblies and Locations. View and adjust the Workorder schedule using a simple drag-and-drop Gannt style calendar. MS Access , MS SQL Server, Windows 95/98/2000/XP

CMMS DETAILS - Functionality

Comprehensive equipment database includes also includes full history of equipment status, location history for shared mobile, rotatable equipment or assemblies and an unlimited number of user customised specification sheets with up to 20 fields.

Parts Inventory multiple locations is maintained according to receipts of parts and parts used to complete work orders. Other information includes price, order quantity, re-order levels, lead time and specifications for multiple suppliers. Includes purchasing module.

Scheduling handles complex schedules based on date/time, or meter readings, or both, at the same time as preferentially scheduling or not scheduling on defined days. The schedule is easily adjusted using a simple gannt style calendar.

Datastream 7i

Company: Datastream
Address: Brisbane Office 240 Queen St. Level 17 Brisbane 4000 Australia
Corporate Headquarters: Datastream 50 Datastream Plaza, Greenville, SC 29605 USA
Contact: Lynda Kadlec
Phone: 864-422-5001
Fax: 864-422-5001
Email: info@datastream.net
Web: www.datastream.net

In country support: Most countries in the World

Available as a stand-alone system.

CMMS DETAILS - Technical

Datastream 7i is a three-tier application, comprised of the client, application server, and database server, completely designed and built using standard Internet protocols and technologies. Datastream 7i supports S-HTTP, incorporates VeriSign digital certificates and 128-bit SSL encryption, offers electronic record generation and storage, electronic signature, back-end tamper monitoring, preventive maintenance and inspection revision control, and an auditing and reporting suite. Datastream 7i integrates with third-party systems via standard integration tools; it supports Java, J2EE 1.3, Forms, Web services, XML, and SOAP.

CMMS DETAILS - Functionality

Datastream 7i combines Internet architecture with broad enterprise asset management functionality, integrated procurement, advanced analytics and multi-site capability for complete Asset Performance Management infrastructure. Datastream 7i Extended easily integrates with other enterprise systems, delivering an easy-to-use, easy-to-configure, zero-footprint HTML interface. Through Datastream 7i Mobile, customers interface with the software via portable input devices. Datastream 7i Analytics provides in-depth, flexible reporting and graphing capabilities to help users analyze key metrics, forecast performance issues, and take preventive measures to optimize asset performance. Datastream 7i is offered through hosting, eliminating hardware and software concerns by loading and storing data at a secure remote location.

Dimple Software Pty Ltd

Address: 20 Keating Street Maroubra NSW 2035
Contact: Stuart Frumar
Phone: 02 8300 1585
Fax:: 02 8336 4108
Email: dimpsoft@bigfoot.com
Web: www.dimple.com.au

In country support: Australia
Designed for group: Building Services

Typical cost of the CMMS software

Small site:	$10,000
Medium Site:	$15,000
Large Site	$40,000:$AU

Available as a stand-alone system

CMMS DETAILS - Technical

DIMPLE sets a new standard for client/server Asset & Maintenance Management systems with an easy to use GUI interface. The front end client application is a true cross platform product which can be operated concurrently on any combination of Windows 95/98/XP or Windows NT/2000 Workstation.

The database may be the native database supplied for stand alone or multi user operation on a LAN with small to medium size installations. For large installations, particularly when remote access over a WAN is required, an industry standard SQL back end such as Oracle, Sybase, SQL Server, or DB2 is recommended.

It comes with a large range of standard reports together with a report writer which enables users to develop an unlimited range of customised reports. Other report writers (such as Crystal Reports) can be used for report interfacing. With an SQL back end relational database such as Oracle, Sybase or Microsoft SQL Server, any industry standard SQL report writer may be used to create reports.

CMMS DETAILS

DIMPLE is a Maintenance Management software program designed to maintain equipment history, schedule maintenance and repairs, fully document equipment specifications and maintenance procedures and to extend the life cycle of equipment and ultimately deliver maximum value from it. DIMPLE ensures that the Total Cost of Ownership is minimised.

It will provide the additional features of:-

- Asset Management
- Contract/Contractor Management
- Budget & Accounts Control
- Resource Scheduling
- Essential & OH & S Services Documentation
- Due Diligence
- Financial & Management Reporting
- Capital Equipment expenditure management
- Financial Interface for Purchase, Disposal and Depreciation

DIMPLE is a wholly Australian developed and supported software product which has gained wide acceptance in the areas of asset, contract and maintenance management since its release in 1992.

DirectLine Service - Advanced MPC

Company: MegaMation Systems Inc,
Address: 114 Lakeshore Road East, Oakville (Toronto), ON L6J 6N2 Canada
Contact: Merilyn Cudmore, Sales Specialist
Phone: (905) 844-9947 Ext 237

Fax: (905) 844-0347
Email: mcudmore@megamationsystems.com
WebPage: www.megamationsystems.com

In country support: USA, Canada, UK with Regional Distributors in Latin America and South America

CMMS Designed for group:

Manufacturing / Universities, Colleges & Private Schools / Healthcare / Municipalities / School Boards / Service Management / Facilities

Typical cost of the CMMS software

Our DirectLine Service starts at $495.00 CDN per month, which provides a full robust 20 module facilities software program, unlimited telephone support and internet training and all upgrades included in the monthly rate.

CMMS DETAILS - Technical

Megamation DirectLine is a service-based CMMS Computerized Maintenance & Facilities Management System. Our DirectLine Service provides our clients with a fully functional "State of the Art" CMMS system. Included in the service is unlimited phone-in help and support, unlimited internet training, free software upgrades - the support commitment and services that will ensure a continuous successful solution. Megamation's DirectLine Service helps you to meet ISO 9000, QS 9000 and other major quality standards.

CMMS DETAILS - Functionality

Megamation utilizes the power of the internet to give clients, access to over 20 modules to assist them in the management of their facility:

- Equipment •Maintenance Work Orders
- PM's • Procedures • Analysis
- Inventory • Purchasing • Timecards
- Document Manager •Quality Management
- Calibration • Tooling • Readings
- Project Control • Work Schedules
- Bar Codes • Contracts •Fleet
- Vouchering

Healthcare: • Wheelchair • Safety Alert
Educational: •Lock & Key

- Hazardous Materials •Budgeting
- Chargebacks • Space Planning
- Capital Planning / Reserve Fund

Municipalities: • Building Entry

Ellipse

Company: Mincom Limited
Address: 198 Turbot Street, Brisbane, Australia
Contact: Rebecca Hall
Phone: 07 33033034
Fax: 07 33033048
Email: rebecca.hall@mincom.com
Web: www.mincom.com

In country support:
Many countries supported

CMMS Designed for group: Mining, utilities, transport, defense and government

Typical cost of the CMMS software

Small site: AUD $100,000:
Medium Site: AUD $120,000:
Large Site: AUD $280,000:

Available as a stand-alone system.

IS THIS CMMS part of larger management/corporate system: yes

CMMS DETAILS - Technical

Mincom Ellipse is a system that has been architected to be independent of hardware, operating system or database. As such it is currently available on operating systems from IBM (AIX and O/S 390), HP (HPUX and Tru 64) Microsoft and Sun, and databases from IBM, Oracle and Microsoft.

The system can be deployed in a Windows or Web environment and is readily interfaced to corporate systems. Interfaces to GIS, Data Collection and Condition Monitoring systems are also available.

CMMS DETAILS - Functionality

Mincom Ellipse Asset & Works Management delivers optimum asset performance through the use of improved management tools, and by streamlining communication across the entire organization. Integrating with other Mincom Ellipse systems, Asset & Works Management provides details about service performance against schedules, vendor performance, stock number/part number performance, value-based procurement decisions, real-time grant expenditures, employee utilization and training needs, recruiting needs, as well as many other functions.

Mincom's flexible solution can be tailored to suit an organizations maintenance strategy. Mincom provides analysis of strategic maintenance

requirements within each industry and establishes the drivers and the parameters for an effective asset lifecycle management.

eMaint X3

Company: eMaint Enterprises, LLC
Address: 7 Chester Ave. Medford, NJ 08055 USA
Contact: Hannelore Fineman
Phone: 609-714-1689
Fax: 253-323-6353
Email: info@emaint.com
Web: www.emaint.com

In country support: United States, Guam

Typical cost of the CMMS software:

$480.00 per user per year

Small site: Under $1,000.00 Medium Site: Under $5,000.00 Large Site: Under $15,000.00

State currency used for the above costs: USD

Available as a stand-alone system.

CMMS DETAILS - Technical

eMaint X3 is a100% HTML, thin-client system designed to be accessed via standard Internet browser. It can be deployed on client's corporate servers or via eMaint's hosting service. The system's Web architecture minimizes expensive hardware requirements by reducing network traffic over modern LANs and WANs. Options for data collection, condition monitoring, and mobile access via handheld PDAs. Able to link and display graphics/multi-media files. System is brandable and highly configurable to meet requirements of internal business processes and workflow.

CMMS DETAILS - Functionality

eMaint X3 helps clients reduce costs, schedule and plan maintenance, control inventory, track work orders and work requests, manage assets and PMs, and measure the performance of labor and equipment effectiveness. System is full-featured, low-cost (as low as $40 per month) and easy to implement. System features digital dashboard and complete reporting tools, automated e-mail and PM options, and requestor user-packs. Built-in tools enable user to easily configure screens, fields, lists, reports, security access, and color schemes. Training, system configuration, and data conversion services are available. Sign up for a free 30-day trial, with support included, at www.emaint.com.

ExpressMaintenance

Company: Express Technology Inc.
Address: P.O. Box 372 Fairhope, AL 36532, USA
Contact: Bob Tucker
Phone: 888-565-0127
Fax: 251-929-3211
Email: btucker@ExpressTechnology.com
Web: www.ExpressTechnology.com

In country support:

USA, Australia, Canada, Malaysia, Nigeria, Norway, Panama, Venezuela

Typical cost of the CMMS software

Small site: $1,295
Medium Site: $2,890
Large Site: $4,890 US

Available as a stand-alone system.,

CMMS DETAILS - Technical

ExpressMaintenance & ExpressRequest create a complete SQL based maintenance management system. It is multi-user, client server software that can also be used as a single user system. It requires the use of a Windows based computer and / or network. It supports asset management of any type of equipment as well as parts PMs, breakdowns, parts inventory, work orders and purchase orders.

CMMS DETAILS - Functionality

Discover the way maintenance should be! ExpressMaintenance is premium maintenance management software (CMMS). Designed for rugged multi-user environments, it's also affordable and easy to use. ExpressMaintenance automates preventative and non-scheduled maintenance on any type of equipment. From the built-in report builder and powerful MS SQL database to user definable fields, you will find ExpressMaintenance to be flexible and powerful. Request you free evaluation copy at www.ExpressTechnology.com .

FaciliWorks

Company: Technisyst
Address: Level 4 / 175 Eagle St Brisbane, QLD, 4000 Australia
Contact: Carolyn Gaskell
Phone: 07 3229 3150
Fax: 07 3229 3702
Email: cgaskell@technisyst.com.au
Web: www.technisyst.com.au

In country support:

Australia; United States

Typical cost of the CMMS software

Small site: <$2000/user
Medium Site: $8000
Large Site: Can be negotiated

currency Australian Dollars

Available as a stand-alone system.

CMMS DETAILS - Technical

Both client and web-based versions of FaciliWorks are available. It can be deployed on your choice of Access, SQL or Oracle databases. Security Manager lets administrators control access to the database as well as monitoring events. Support for PDA devices is also available utilizing either upload / download, or wireless components, while the simple Microsoft Outlook style interface is easy to learn and use. Comprehensive flexibility is provided with the completely customizable text allowing the familiarity of company terminology.

CMMS DETAILS - Functionality

FaciliWorks is a program designed for companies that need a convenient, easy-to-use, easy-to-learn, flexible system. In addition to helping prevent breakdowns FaciliWorks will reduce your costs and improve your productivity. It will also assure compliance to numerous industry and government organisation standards. FaciliWorks CMMS includes tracking and scheduling of maintenance tasks; personnel; equipment; tools; parts and supplies. It also provides for Task Shadowing; Equipment Schedule; Job Calendars; Fleet Management; Unlimited Component Hierarchies; E-Mail Notification; Record Cloning; Key Performance Indicators; Custom Report Creation; Internet Capabilities and PDA Software.

FastMaint

Company: SMGlobal Inc.
Address: 2911 Waterford Forest Circle Cary, NC 27513, USA
Contact: Sales Team
Phone: 1-919-434-5146
Email: sales@smglobal.com
Web: http://www.smglobal.com

Typical cost of the CMMS software

Small site: < 5000$
Medium Site: < 10,000$ USD

Available as a stand-alone system.

CMMS DETAILS - Technical

Supports Windows 95/ 98/ Me/ 2000/ XP. Available in single or multi-user versions. Choice of supplied Microsoft Jet database (Access 2000) or an external Microsoft SQL Server database. Can import/ export data to text files and Excel spreadsheets. Ability to restrict users rights to view or modify data.

CMMS DETAILS - Functionality

FastMaint CMMS software is preventive maintenance software for small to mid-size maintenance teams. It can be used for enterprise asset maintenance, plant maintenance, facility maintenance, fleet maintenance and many other types of maintenance tasks. It is designed to be easy to install and use. Major features - manage inventory, track labor and material costs; support for meters and alarms; plan work for the week, month, quarter, year or other period you specify; identify pending tasks; import/ export data; review problem patterns and more. Visit http://www.smglobal.com for a free trial. A web based maintenance request module also available.

FLEETMEX

Company: Maintenance Experts
Address: PO Box 6118 Buranda QLD 4102 Australia
Contact: Matthew Ward
Phone: 07 3392 4777
Fax: 07 3392 4888
Email: mattw@mex.com.au
Web: www.mex.com.au

In country support:

Australia, New Zealand, Indonesia, China, Malaysia, Thailand, Canada

CMMS Designed for group:

FLEETMEX is utilised in a number of industry sectors including bus and transport companies, local councils and heavy machinery operators.

Typical cost of the CMMS software

Small site: $3000.00

Medium Site: $8000.00

Large Site: $30 000+

currency used for the above costs: Australian

Available as a stand-alone system.

CMMS DETAILS - Technical

FLEETMEX Version 3.x System Requirements

Operating Systems

- Windows 95 or later, or
- Windows NT Server/Workstation 4.0 or later

Hardware Requirements

- Pentium 166 System recommended
- 64 MB of Memory (RAM)
- 152 MB of available hard disk space
- CD-ROM drive or access to a CD-ROM drive over a computer network
- Display adapter capable of 800x600-screen resolution.
- Mouse

MEX Ops - Web Enabled Job Requests System

- Internet Information Server (IIS) V 4.0
- Or Personnel Web Server (PWS)

CMMS DETAILS - Functionality

FLEETMEX is a Microsoft compatible maintenance management system designed for companies looking to improve the efficiency and effectiveness of their vehicle performance. FLEETMEX is particularly effective in implementing preventative maintenance strategies.

FLEETMEX is utilised in a number of industry sectors including bus and transport companies, local councils and heavy machinery operators.

Basic functions of FLEETMEX include the Equipment Register; Work Orders; Maintenance Policies; History; Reports; Invoicing and Readings.

Equipment Register - record all of your equipment in this register. Include details such as suppliers, costs, purchase dates, warranty dates, dimensions and much more.

Work Orders - create Work Orders for work to be done. Include start dates, departments, tradespeople, costs, parts, tasks, safety information etc.

Maintenance Policies - create preventative maintenance work to be carried out on equipment. Schedule the work based on conditions, hours used, km, month's etc.

History - access a complete history on all works ever carried out on a piece of equipment.

Reports - accurately measure and analyse your equipment and operation performance.

Invoicing - invoice for all work completed including a complete breakdown of costs, labor and parts.

The modular configuration of FLEETMEX enables companies to implement additional functionality as required. These modules provide an extra level of system integration including requests, mobile palm applications and stores.

Stores adds to FLEETMEX the capability of Inventory Management. The module enables you to maintain an appropriate balance between having what you need on hand, while keeping the capital tied up in stores to a minimum.

Other additional functionality available includes:

MEX Ops is a Web enabled job requesting system. It allows requests to be made anywhere at anytime and maintenance staff can easily prioritise and schedule work. It also allows the requestee to track their job.

FuelMEX allows you to integrate your Fuel Data system with FLEETMEX. With FuelMEX, data from fuel charge cards is electronically transferred into the FLEETMEX system. Fuel data is automatically allocated to the correct vehicle, with odometer readings, date, fuel type and other relevant information.

Facilities Maintenance Management System (FMMS)

Company: KDR Creative Software Pty Ltd
Address: Suite 15, 85 Turner St.,
Port Melbourne, Victoria 3207 Australia
Contact: Geoff Montgomery
Phone: 03 96461788
Fax: 03 9646 9680
Email: gmontgomery@kdrinc.com
Web: www.kdr.com.au

In country support:

Australia South Africa USA Italy

Singapore New Zealand

CMMS Designed for group:

No. ExistingFMMS customers represent a very broad industrial cross-section. However FMMS has specific functionality which makes is very

attractive to Mining, Utilities, Transport including Rail, Defense and Manufacturing including Hi-Tech organizations.

Typical cost of the CMMS software

Small site:	$2,000
Medium Site:	$25,000
Large Site:	$100,000

State currency used for the above costs: AUD$

Available as a stand-alone system.

However FMMS has been seamlessly interfaced to several corporate ERPs for those customers unwilling to accept compromise.

CMMS DETAILS - Technical

The following diagram depicts the product architecture and the various methods of deployment that are available:

FMMS compliments Corporate ERP Systems by utilizing a library of interface procedures in order to access data that resides outside of the core application. A number of such interface libraries have already been built by KDR for existing customers with the predominant ones enabling bi-directional access with ERPS such as SAP, Oracle Financials and Mincom.

In addition, this approach has been adopted to interface to in-house products built by FMMS customers and to a wide range of external product types, including Condition Monitoring, SCADA, Configuration Management, GIS, Supply Logistics and Project Management.

CMMS DETAILS - Functionality

FMMS has been designed and purpose-built to accommodate the following key functional areas of Asset Management:

- Definition and Navigation of Asset Hierarchy
- Preparation of Standard Activity Libraries
- Initiation, Monitoring, Feedback and Recording of Maintenance Activities
- Maintenance Planning, including Resource Capacity, Prioritization and Criticality Indicators
- Business Metrics via on-line inquiries, report writing and user-defined Key Performance Indicators
- Serial Number Tracking of Essential Components and Certified Items
- Spare Parts Cataloguing, Purchasing, and Inventory Management
- Contracts and Project Management
- Timesheet Recording
- Budget/Forecast Preparation, Review and Monitoring
- Workflow Definition and Management
- Field Deployment via Mobile Devices
- Real-time Wireless access
- Work Packaging
- Certified Items

Does your Organisation have geographically dispersed Workshops?

Working closely with Australian blue chip railway operators, KDR solved the problem of effectively maintaining mobile assets over geographically dispersed workshops.

Are Linear Assets difficult to identify and maintain?

FMMS boasts a unique solution to asset identification in relation to linear assets like railway lines, channels and power-lines. Visual display of GPS locations for linear assets has resulted in economic benefits hereto unheard of for owners of such assets.

Are you concerned about Eliminating Materials Losses?

The FMMS bar-coding functionality manages uncontrolled, unmanned materials stores. The easy to use, wireless, bar-code based stores issuing system, enhances materials tracking, thereby eliminating materials losses.

Are Safety Issues Important to you?

Modifications to Assets for test purposes can lead to safety issues should the maintainer not be aware of the modification. FMMS Facility Alert notifies the maintainer of any modification previously applied to the asset.

GURU CMMS

Company: Contine Systems, Inc.
Address: 6562 S. Gold metal drive
Taylorsville, Utah 84084 USA
Contact: Brian Smith
Phone: 801-243-5847
Email: brian@contine.com
Web: www.contine.com
www.chipshooters.com

In country support: U.S.A., India, Zambia

Typical cost of the CMMS software

Small site:	$794.90 USD
Medium Site:	$1,800 USD
Large Site:	$2,500 USD

Available as a stand-alone system.

CMMS DETAILS - Technical

- PC with at least a Pentium I or compatible processor running at 233 MHz or higher.
- Microsoft Windows 95/98/ME/2000 operating system -or- Windows NT operating system version 4.0 with Service Pack 3 or later.
- 16 MB of RAM for Windows (32 MB recommended); 24 MB for Windows NT 4.0 (32 MB recommended.)
- Microsoft Internet Explorer 4.01 Service Pack 1.
- VGA Video Card which supports High-Color (16-Bit) color depth. (24-Bit or 32-Bit True Color capability is highly recommended.) This is not your regular bland-looking CMMS.

CMMS DETAILS - Functionality

Introducing Guru, the modular-based CMMS that provides the tools you need to effectively manage your contacts, assets, inventory, maintenance, and so much more. Guru is designed with maximum flexibility and scalability in mind. We created a system that's capable of supporting your current and future requirements. It's modular design uses the latest in COM/ActiveX technology which provides never-ending capabilities. New features can be installed and working in seconds, by you, not some technical expert from the supplier. No matter what your requirements are, Guru is capable of supporting it. Many systems today provide you and your users a bit to be desired when it comes to interface design. Whether it's a poor layout, a bland color-scheme, too many buttons, or a 'buggy' interface, Guru understands you spend a lot of time using your CMMS, so why not spend it with an interface that is easy, unique, and simple to use?

Hardcat

Company: Hardcat Pty Ltd
Address: 253 Park Street, South Melbourne, 3205, Vic Australia
Contact: Dan Drum
Phone: +61-3-9695-5400
Fax: +61-3-9695-5499
Email: ddrum@hardcat.com.au
Web: www.hardcat.com

In country support:

UK, USA, Canada, Australia, New Zealand, Malaysia, Indonesia, Hong Kong, Pakistan, Maldives, UAE,

Typical cost of the CMMS software

Small site:	$3000
Medium Site:	$15,000
Large Site:	$50,000

Australian $

Available as a stand-alone system.

THIS CMMS is part of larger management/corporate system.

CMMS DETAILS - Technical

Clent/Server application supporting Web access. Databases`supported are MS SQL, Sybase, IBM DB2, Oracle 9i. Data Collection & Monitoring via PDA, both Palm & Pocket PC. Barcoding, GPS, RFID. API to integrate directly into other systems. Windows front end supporting graphics.

CMMS DETAILS - Functionality

Hardcat is a complete asset management CMMS system catering for Preventative Maintenance, Stock Control, Help Desk, Purchasing, Depreciation, Barcoding, E-Procurement. The system is simple to use & fast to setup.

IFS Maintenance

Company: IFS Australia Pty Ltd
Address: 86 Denmark Street, Kew 3101, Melbourne, Australia
Address 2: Level 6, 280 Pitt Street, Sydney 2000, Australia
Contact: Mr. Rob Simmons
Phone: +61-3-9854 9600
Fax: +61-3-9854 9699
Email: rob.simmons@ifs.aust.com
Web: www.ifsworld.com

In country support:

Many countries around the World

Typical cost of the CMMS software

Medium Site:	150,000
Large Site:	250,000

US Dollars

Available as a stand-alone system.

IS THIS CMMS part of larger management/corporate system: Yes

CMMS DETAILS - Technical

Software •Web-based

- Using J2EE, J2ME and .Net
- Non-platform dependent
- Oracle database

Hardware •No specific hardware as long as it supports Oracle database

- Non-OS dependent

Links

- Can be easily linked to external systems using IFS Connect
- OPC compliance, with links to major SCADA and DCS eg. fully integrated to ABB's Operate IT system.

CMMS DETAILS - Functionality

IFS Maintenanceô components make up a complete maintenance system that provides the proactivity, openness and flexibility to develop and adapt to keep pace with the rapidly changing demands of the world. Easy to work with and access, it contains a depth of functionality that provides comprehensive support for day-to-day maintenance requirements, as well as continuous development and improvement.

Key functionalities included in the latest 2004 version are:

- Equipment
- Equipment Monitoring
- Equipment Performance
- Equipment Metering
- Work Order
- Preventive Maintenance
- Scheduling
- Process Automation Integration
- Vehicle Information Management
- Complex MRO

iMaint

Company: DPSI
Address: 4905 Koger Blvd., Suite 101
Greensboro, NC 27407, USA
Contact: Marion Seaman
Phone: 336-854-7700
Fax: 336-854-5972
Email: marion.seaman@dpsi.com
Web: www.dpsi.com

Typical cost of the CMMS software

Small site:	$10,000
Medium Site:	$30,000
Large Site:	$80,000

US dollars

Available as a stand-alone system.

CMMS DETAILS - Technical

iMaint is an n-tier client/server, Web-enabled solution. iMaint requires a Windows 2000 server (plus IIS 5.0 for iMaint Web), or can be remotely hosted; clients may be Windows 98, NT/2000/XP rich-GUI (Web module uses IE 4.0 or later, or Netscape Navigator 6.1 or later); databases supported are Microsoft SQL Server 2000 or 7.0 and Oracle 8i or 9i. iMaint systems range from single-sites on a LAN to global installations across the Web.

CMMS DETAILS - Functionality

iMaint enterprise asset management (EAM) software combines state-of-the-art maintenance practices with state-of-the-art technology to plan, control, and monitor all maintenance activities. This EAM system provides accurate and timely maintenance tracking, cost-effective inventory control, and thorough and in-depth reporting and analysis. Major capabilities include asset management, maintenance scheduling, labor and craft management, work order management, cost tracking and containment, parts inventory management, and purchasing. iMaint integrates with Crystal Reports and Microsoft Great Plains. iMaint has a bar code interface and Web interface, and a mobile PDA option. FDA compliance check for 21 CFR Part 11 is also available.

IMPACTxp

Company: Matrix Australia Pty. Ltd.
Address: 38 Pearse Street
North Fremantle, WA
Australia 6159
Contact: Bill Shanklin
Phone: +61 (08) 9430 7819
Fax: +61 (08) 9430 7809
Email: sales@matrixoz.com.au
Web: matrixoz.com.au

Company: SoftSols (Asia/Pacific) Pty Address:Ltd,
5 Park Road Glen Iris Vic 3146 Australia
Contact: David Gillard
Phone: +61 (0)3 98094566
Fax: +61 (0)3 98094566
Email: asia@impactxp.com
Web: www.impactxp.com

In country support:

Australia, UK, USA, Canada, Netherlands, Spain, Portugal, Italy, Czech Republic, Poland, Russia, South Africa, India, Sri Lanka, Indonesia, Philippines, Malaysia, Thailand, Singapore, Hong Kong, Mexico, Colombia, Costa Rica

CMMS Designed for group:

No but major markets in Manufacturing, Pulp & Paper, Facilities Management, Engineering Contracting

Typical cost of the CMMS software

Small site: 5 users - AUS$ 15,0000

Medium Site: 20 - 40 users AUS$65-90,000
Large Site: AUS$250000 Australian Dollars

Available as a stand-alone system.

Provides a standard ODBC compliant interface to allow for integration into the corporate reporting structure

CMMS DETAILS - Technical

Impactxp is a windows based , modular maintenance and supply system comprising a core Base Module with a range of modules to suit different industry needs and maintenance strategies. Impactxp scalability and flexibility have been proven around the world in installations sizes ranging up to Wide Area Networks with over 200 users, with typical installations being 10-35 users. Standard interface modules are available for leading ERP, Manufacturing, Financial and GIS systems .The Generic Interface tool provides a simple interface to systems such as Process Control, Building Management Systems whilst providing communication facilities to Hand Held Computers. Multiple deployment options include browser based Internet operation. Impactxp offers a choice of operating on Oracle, Progress or SQL server databases. Impactxp is designed for rapid, low cost data uptake and implementation. Hardware independence, proven stability and ease of use ensure an exceedingly low ongoing cost of ownership.

CMMS DETAILS - Functionality

Impactxp is an Asset Maintenance Management system with an excellent ROI. It manages work very well and provides comprehensive reporting capabilities to measure effectiveness A modular system, Impactxp provides a tightly integrated solution with specific strengths in a multi company environment. Impactxp is fully configurable including the Asset Records, menus and reports allowing users to format the system to their requirements. It is an "easy to use " system. Modules are implemented as required. Impactxp will manage reactive, calendar based, usage based, condition based and project based maintenance. It includes an Inventory Management module, containing Stock Control, Purchasing, Invoice Matching and Cataloguing to ensure optimum availability of spares. Impactxp integrates Tool Control, Calibration, Cad Viewer, and Document Viewer. Impactxp controls repairable spares It can manage Essential Services and incorporates a Portable Appliance Testing module .It provides comprehensive graphical management reporting with multi-level drill down providing effective performance management, fault analysis etc. This has been enhanced by developing the integration with CORVU and Crystal Reports. Impactxp contains an on-screen scheduling facility, using "drag and drop" techniques, to manage work by resource and by asset with a Knowledge Base module to assist with diagnostics. The Generic Interface provides a seamless link to MFG/PRO, Sun Accounts, SAP, PeopleSoft and others and provides the link to Data Collection devices including Hand Helds, BMS and Machine Monitoring systems. Help Desk Module combined with the Contractor Billing provides a strong offering for Engineering Services companies. The Help Desk is both Web enabled and integrates to email systems to effectively manage the CRM aspects of Facilities Management

Offering more than 20 standard modules and a high degree of user defined parameters, screens, etc. to accommodate widely varying needs and maintenance strategies. IMPACTxp is designed for use by owners and contractors. IMPACTxp design for rapid implementation and low ongoing cost ensure an excellent Return On Investment.

InSite Extended Edition (EE)

Company: Indus International
Address: L7, 220 Mary St
Brisbane, QLD, 4001 Australia
Contact: Patricia Cassis
Phone: 07. 3815 0930
Fax: 07.3815 0999
Email: patricia.cassis@indus.com
Web: www.indus.com

In country support:

Direct sales in North America, Europe, Japan, Australia and New Zealand. Reselling partners in Malaysia, Singapore, India and China

CMMS Designed for group:

Utilities and Process Industries

Available as a stand-alone system..

IS THIS CMMS part of larger management/corporate system: Yes.

CMMS DETAILS - Technical

InSite EE combines both a windows client server and a J2EE Web client server.

The Windows Client of InSite EE provides a robust EAM/CMMS for enterprise power users. The windows client can be deployed using a standard server, Citrix or a Terminal Server and is an Application/Business logic server based on Oracles 9i platform.

The J2EE web Client of InSite EE provides an EAM/CMMS for self service users. The web client package is delivered in J2EE compliant archives such as EAR, WAR and JAR.

CMMS DETAILS - Functionality

The three key functions of InSite EE include; Real-time Performance Management, Push Maintenance and Connecting to everything.

Real-time Performance Management (RPM): InSite EE empowers organizations to manage their operation proactively by delivering information and real-time analytics to the right user at the right time.

Push Maintenance: InSite EE enables proactive maintenance strategies that lower maintenance costs and reduce production stoppages. Online condition monitoring provides early warnings of impending failures and can update asset meter readings automatically.

Connect To Everything: InSite EE's integration framework facilitates efficient systems integration to lower the cost of information sharing with diverse operation systems

INTERAL PlanPro

Company: Conception INTERAL inc.
Address: 400, Jean-Lesage, suite 530
Quebec, Qc Canada, G1K 8W1
Contact: Yves Gagnon
Phone: (418) 529-5730
Fax: (418) 529-6734
Email: sales@interal.ca
Web: www.interal.ca

In country support:

Canada, USA, Belgium, Tunisia

Typical cost of the CMMS software

Small site:	$5 000
Medium Site:	$25 000
Large Site:	$75 000

currency used for the above costs: $ canadian

Available as a stand-alone system.

IS THIS CMMS part of larger management/corporate system: In design

CMMS DETAILS - Technical

INTERAL PlanPro is a client/server application designed using the latest technologies which can greatly improve equipment reliability and availability. It is built with graphic capabilities to help track the workload and generate powerful statistical reports on maintenance activities.

Data collection systems can be linked to this CMMS to gather precious information on the assets which will be used to generate preventive maintenance plans based on schedules, totalisers, events, etc. PlanPro can also be linked to other external systems.

CMMS DETAILS - Functionality

INTERAL PlanPro is a powerful tool designed for asset, procurement and store management. Many functions are available for optimal (corrective / preventive) maintenance scheduling, costs tracking, downtime minimization.

The information is organized to facilitate strategic and operational decisions based on complete intervention and asset histories, to maximize savings and for extended asset life. Many statistical reports can be generated from the database.

Replacement parts are also tracked and all the needed functionalities for inventory control and procurement are built into the system. Suppliers history, equivalent parts, bid management, replenishment and many other functionalities are part of INTERAL PlanPro.

Ivara EAM

Company: Ivara Corporation
Address: 935 Sheldon Court, Burlington, Ontario, Canada L7L 5K6
Contact: Ann Christie
Phone: 905-632-8000 ext 249
Fax: 905-632-5129
Email: ann.christie@ivara.com
Web: www.ivara.com

In country support:

North America and Europe

CMMS Designed for group:

Comprehensive offering for any capital-intensive industry with strong emphasis on the following industries: Utilities, Food and Beverage, Pulp and Paper, Metals and Mining, Oil and Gas, Chemical and Petro Chemical

Typical cost of the CMMS software

Approximately $5,000 USD per user

Available as a stand-alone system.

CMMS DETAILS - Technical

Ivara's robust architecture uses C++, COM, Active Server Pages, and ODBC. Web and desktop user interfaces included.

Ivara collects condition data from any online source, consolidates data from Predictive technologies like Doble, SKF, and data historians like OSIsoft Pi.

Ivara analyzes condition data from single or multiple points, and has built-in rules and calculations for a true picture of equipment health, identifying potential failures (flashing alarms and trending graphs) and triggering the right work at the right time.

CMMS DETAILS - Functionality

Ivara EAM helps increase asset reliability by providing a higher return on asset investment, increased output and profitability, reduced costs and downtime, and improved safety and environmental performance.

Ivara EAM ensures that you are executing the right work at the right time to optimize asset performance and extend asset life. Features:

- asset hierarchy, criticality
- condition monitoring
- reliability analysis
- RCM analysis and implementation
- asset maintenance program development
- work planning, scheduling
- inventory
- purchasing
- invoicing
- key performance indicators

Ivara software is known for its ease of use, particularly in navigation, definability and integration.

JOB Cal

Company: OPS Systems, Inc USA
Contact: Melanie Hazlett
Phone: 800-677-0067
Fax: 505-994-3574
Email: sales@opssys.com
Web: www.opssys.com

In country support:

USA, Singapore, Malaysia, Israel

CMMS Designed for group:

Water & Wastewater

Typical cost of the CMMS software:

$800 Single User license

CMMS DETAILS - Technical

Windows 98/ME/NT4/2000/XP

The program is a calendar displaying all due and completed jobs. Jobs will be color coded to show when they are due, when they are late and when they are done. The calendar shall be able to scroll back 4 weeks and forward 52. When a job is selected its detail (instructions, hours worked, cost accrued, and notes) shall be automatically displayed. The calendar shall be able to:filter, DRAG & DROP, and close jobs with a single button.

CMMS DETAILS - Functionality

JOB Cal is a computerized maintenance management program that assists you in your maintenance operations. The Calendar is the heart of the JOB Cal system. It displays all the work to be done, completed work, and overdue work for a 52-week period. Jobs can be closed, rescheduled, deleted, skipped, and created using the calendar.

The system automatically generates work orders and updates the calendar. The closed job information is placed in a history file and can be accessed at any time. You can produce reports from this data to give you historical information.

M1 - Maintenance One

Company: Q2 Solutions Pty Ltd
Adress: PO Box 1122
Milton Qld 4064 Australia
Contact: Zane Knight
Phone: 07 3368 2623
Fax: 07 3368 2284
Email: info@q2solutions.com.au
Web: www.q2solutions.com.au

In country support: Australia

Typical cost of the CMMS software

Small site:	$7k
Medium Site:	$14k
Large Site:	$20k AUD

Available as a stand-alone system.

CMMS DETAILS - Technical

32bit Windows application using SQL database developed in Brisbane Australia. M1 is an off-the-shelf solution that can be customized specifically for each client via our unique Customisation module. Some web interfaces also exist.

CMMS DETAILS - Functionality

Asset Register (including sub-registers for easy searching) covers warranty, insurance, registration, all name plate details and other specific information. Requests for work (optional authorization), work orders including contractors, spares and materials, tasks, trades, documents, instructions, correspondence records, FMEA, delay details and costs. Automatic PM routine reminders and forecasts for any date range. Utility usage and readings including graphical analysis. Contractors management with public liability renewal reports, future financial commitments with historical analysis.

Includes 2 days on-site training and implementation.

Mainpac

Company: Mainpac Pty Ltd
Address: Suite 201, 10 - 12 Clarke St, Crows Nest, NSW, 2065 Australia
Contact: John McInerney
Phone: 0412 668 096
Fax: 02 9436 2423
Email: johnm@mainpac.com.au
Web: www.mainpac.com.au

In country support:
Australia, United Kingdom, New Zealand, South Africa & Indonesia

CMMS Designed for group:

Manufacturing, Mining & Mineral resources, Power Generation, Gas/Water/Sewage Utilities, Transport/Road/Railway, Air Shipping, Buildings/Hospitals/Local Govt, General Process Industry.

Typical cost of the CMMS software

Small site:	$9,000
Medium Site:	$25,000
Large Site:	POA

Available as a stand-alone system.

CMMS DETAILS - Technical

Software: Mainpac for Windows is a true 32 bit application designed to run on the latest 32 bit operating systems. It is Written in Borland Delphi using Paradox or MS SQL MSDE databases.

Operating Systems supported include: MS Windows, 98, ME, 2000, XP & NT

Hardware: Pentium class PC (recommend 233MHz), 32Mb RAM (recommend 64Mb) 50Mb Hard disk space, CD ROM & MS Windows compatible printer.

A major development into the Microsoft? .NET environment is well advanced. This exercise will coincide with the release of Version 7, our Multi-Site, Multi-Warehouse Enterprise Solution.

Mainpac is also well suited to PDA's and bar-coding hardware & software.

CMMS DETAILS - Functionality

Mainpac is a functionally rich, easy to use asset management solution. Modular by design, Mainpac for Windows includes maintenance management, inventory control, purchasing, asset management, remote job entry, document register, rotables, tyre management, and import/export utilities.

Mainpac provides all the functionality required for comprehensive asset and maintenance management. Mainpac can be configured to meet the specific requirements and workflows of different industry types. Screens can be fully

customised to reflect local terminology and data entry requirements. Powerful search and mass update functions enable efficient scheduling and planning of all maintenance activities.

Mainpac's usage and condition based functions make it particularly well suited for fleet and other non-calendar based maintenance applications. Integration with SCADA, barcode scanners and field service applications is available to increase maintenance responsiveness and optimise staff efficiency.

Web-based functions provide access for remote users to request maintenance work, raise and close Jobs.

The Mainpac Asset module provides a Total Asset Management view of an asset or group of assets. Combining maintenance costs with financial costs and KPI's, such as condition, downtime, utilisation and production, enable analysis of asset contribution and life-cycle planning.

MainView is a key performance indicator (KPI) based approach to asset and maintenance management. Drawing data from Mainpac, it offers an executive analysis and easy to use visual reporting system with which to assess maintenance performance.

The Worksafe module is a comprehensive work safety instruction and hazardous equipment isolation facility which has been integrated with the core Mainpac Job Management System.

Interfaces allow Mainpac to communicate with MRP, ERP and Financial systems. Mainpac also Interfaces to other software systems such as GIS, Project Planning (MS Project) and CAD systems.

Inventory and Purchasing modules can operate independently or integrated with Maintenance module.

MainPlan

Company: Dbase Developments
Address: 1 Neptune Street
Sandringham Vic 3191
Contact: Tracey Francis
Phone: 03 9502 0250
Fax: 03 9502 0250
Email: tracey@mainplan.com
Web: www.mainplan.com

In country support: Australia

Designed for group:

Manufacturing and Facilities Management

Typical cost of the CMMS software:

Small site: $1,000Std, $3,000Gold
Medium Site: $2,500Std, $6,000Gold
Large Site: $10,000+
State currency used for the above costs: $AU

Available as a stand-alone system

CMMS DETAILS - Technical

MainPlan allows small to medium operations to achieve the benefits of computerised maintenance management in a low cost, easy to implement system. Low cost does not mean low performance and this product is being used by some of Australiaís largest companies.

MainPlan is written in various Microsoft Visual Studio tools using one of the fastest PC database products available. It is a fully visual (GUI) application and is fully integrated with the MS Office suite. MainPlan has been thoroughly tested on Windows Terminal Server and Citrix Metaframe and this is the recommended installation for Wide Area Network (WAN) use. A Wide Area Network reporter allows concise reports across widely distributed data.

MainPlan Standard is aimed at the first time CMMS user. MainPlan Gold is a fully featured product that incorporates advanced purchasing and stock control modules. JobRequest is an integrated module that facilitates work request entry and tracking.

CMMS DETAILS - Functionality

MainPlan is a mature Windows-based asset and maintenance management system for manufacturing, engineering, facilities maintenance, equipment service and similar operations.

MainPlan Standard is aimed at the first-time CMMS user and organisations with modest requirements. It provides standard CMMS functionality including automated scheduling of preventative maintenance by fixed calendar intervals and plant condition, asset register, labour register, suppliers register, work and safety procedures registers and full access to all maintenance history. Fixed and user defined reports are available. A graphical report writer is included so there is nothing more to pay once the system has been purchased.

MainPlan Gold provides all the features of Standard plus spare parts purchasing, receival and inventory control. Barcodes are available for spares tracking and work order closeout. Faults and Remedies registers are included together with additional databases for Motors, Drawings and Rotables.

Reports

A powerful graphical report writing and editing facility is included with MainPlan and a specialised Crystal Reports management reporting tool is also available.

Job Request (for both Standard and Gold) makes the requesting of work a completely paperless function. Job Request can also be used as a Help Desk front end for logging of work requests and tracking repair progress.

Control Panel is an add-on component that provides an asset based front end to MainPlan. All maintenance information such as routines, backlog, history and spares can be displayed for each item in the Plant/Asset register.

Support and Training

Workshops are held throughout the year. Contact User Support on 0500 595955 for details.

MAINSAVER

Company: MAINSAVER
Address: 30 Maitland Avenue
Kingsford NSW 2032 Australia
Contact: John Kedzier
Phone: (02) 9663 2318
Fax: (02) 9662 2193
Email: kedzier@compuserve.com
Web: mainsaver.com

In country support:

Australia, USA, Mexico, Canada, UK, Germany, Malaysia, India

Typical cost of the CMMS software

Small site: $20,000
Medium Site: $50,000
Large Site: $100,000 Aus

Available as a stand-alone system.

IS THIS CMMS part of larger management/corporate system:

MAINSAVER has been integrated to a variety of corporate systems including SAP, Oracle, Peoplesoft QAD and Epicor to name a few.

CMMS DETAILS - Technical

MAINSAVER will enable you to carry out Work order processing , Purchasing management, Inventory and material control, Real-time status reporting, Accurate labour and material cost tracking, Corrective, preventive maintenance and on-demand work scheduling, Advanced scheduling tools, Accurate maintenance histories, Bar code and light pen data collection options, Internet- and intranet-enabled work management, Available route management capability, Runs on Windows PCs and your choice of SQL, Oracle, Sybase, or DB/200 database servers

MAINSAVER provides seamless integration with Oracle Financials ERP Applications. Languages include English, German, Spanish, French and Chinese.

CMMS DETAILS - Functionality

MAINSAVER is Modular to match your unique requirements.

Three vital areas determine the effectiveness of any maintenance operation. These are Work Orders, Inventory and Purchasing. If things are running well in these areas, then the entire operation is likely flowing quite smoothly. Not surprisingly, Mainsaver's mastery of these three functions is unsurpassed. Once a solid footing is established with these three core modulesówhich can be installed in any combination or orderóyou can add to Mainsaver's remarkable functionality with optional modules that extend the power and capabilities of your maintenance solution to fill your exact requirements. Additional modules include Dispatch, Data Collection, Internet Work Management, Imaging

Maintelligence

Company: Design Maintenance Systems Inc. USA
Contact: Steve Reilly
Phone: 604-984-3674
Fax: 604-984-4108
Email: sales@desmaint.com
Web: www.desmaint.com

In country support:

Canada, US, Korea, Norway, UK, South Africa, Australia, New Zealand, Taiwan, India, Egypt, Holland, Mexico, Iran

CMMS Designed for group:

Specifically designed for industries focused on Inspections and/or Condition Monitoring.

Typical cost of the CMMS software

Small site:	$3,000
Medium Site:	$40,000
Large Site:	$75,000 USD

Available as a stand-alone system.

CMMS DETAILS - Technical

Windows based system built modular to allow additions later, one shared database, scalable from workstation to client/server, extensive data access capabilities as it links to ERP, MRP, DCS, PLC's, extensive drivers to interface with other software and data collection hardware, advanced condition monitoring software module.

CMMS DETAILS - Functionality

The CMMS section of MAINTelligence has all standard capabilities. Where it differs from other CMMS's is that MAINTelligence is specifically designed from a maintenance perspective. It has the capacity to automatically generate work orders based on PM data that is derived from its advanced Condition Monitoring module that handles vibration, lubrication, infrared and ultrasound. It is expandable to include handheld Windows CE units for mobile inspections and work orders. MAINTelligence functions to finally enable maintenance people to gain full benefits from their regular data collection efforts.

MaintScape

Company: Advanced Software Designs
Address: 18203 Lakepoint Cove
Lago Vista, TX 78645 USA
Contact: Bill Selph
Phone: 1-512-267-9377 ext. 1
Fax: 1-512-267-9380
Email: info@asd-info.com
Web: www.asd-info.com

In country support:

all of Middle East, All of Far East and Pacific Rim China through Australia, Mexico, Canada, all of South and Central America, all of Africa

Typical cost of the CMMS software

Small site:	$999 +
Medium Site:	$1495+
Large Site:	$3995+ USA

Available as a stand-alone system.

CMMS DETAILS - Technical

Windows based Asset, Facility and Plant Maintenance, all modules including Purchasing, Service Requests, Predictive Maintenance /Condition Monitoring, Bar Coding, PDA hand held computer. Easy Drag and Drop and Point and Click. Superb customer support. Single PC or Networked. All network operating systems.

CMMS DETAILS - Functionality

Offers all modules - base maintenance, calibration, parts inventory control, purchasing, service requests, bar coding, PDA hand held computer support, drag and drop graphical labor scheduling and balancing. Supports email, pager and fax. All modules are fully integrated. Powerful navigation and shotcuts. Pricing for small, medium and large organizations. Standard version and Professional version.

MaintSmart

Address: 216 S. Fairmont Ave., Lodi, CA 95240, USA
Contact: Daniel Cook
Phone: 209-367-0450
Fax: 209-369-9396
Email: sales@maintsmart.com
Web: http://www.maintsmart.com

In country support: USA, Malaysia, Singapore, Taiwan, South Africa, Philippines

Typical cost of the CMMS software

Small site:	$1295.00
Medium Site:	$1295.00
Large Site:	$4995.00

Available as a stand-alone system. @ $995.00

CMMS DETAILS - Technical

Windows 32 bit application. No extra modules, programs to buy. Optionally uses OPC server (example: RSLinx) to increment meter data. Access or SQL Server 2000 backend database. Reports Crystal Reports 8.5, direct Excel export or data grid-print. System requirements: any 32-bit windows OS, 80 MB disk space, 64 MB RAM

CMMS DETAILS - Functionality

Work orders, PMs (separate from work orders), equipment failure, inventory, purchasing, reliability analysis (military standard), skills. Heavy on reporting and analysis. Designed to improve your maintenance operation. Save reports as Excel, MS Word, HTML, .pdf and

more. Up to 2 billion equipment items.

Uses reliability analysis MTBF (average time between failures) to guide user to optimized PM task lists.

Four user-defined equipment hierarchies with fully functional equipment tree-view makes locating problem equipment (and remedy) quick and easy.

Automatically create work through OPC/DDE linked meters. Up to six units per meter. No programs required (Access version).

MAXIMO

Company: MRO Software
Address: Level 3, 76 Berry Street, North Sydney NSW 2060 Australia
Contact: Rochelle Vincent
Phone: 02 9463 7734
Fax: 02 9957 2669
Email: Rochelle.Vincent@mro.com
Web: www.mro.com.au

In country support:

Australia, New Zealand, Hong Kong, Singapore, China, Japan, Malaysia, Phillipines, Korea,

CMMS Designed for group: No, however specialist MAXIMO Industry solutions are available for the Pharmaceutical, Transportation, Transmission & Distribution and Nuclear industries.

Available as a stand-alone system.

CMMS DETAILS - Technical

MAXIMO is one of the few commercial applications to be verified by Sun Microsystems as a J2EE compliant application. As such it can be deployed in a true 'n' tier environment with application processing performed on a server, with the presentation layer displayed in a client browser. No code (plug-ins or downloads) is executed on the client. MAXIMO is truly 'architected' for the internet and as such is suitable for deployment from small to very large scale user bases.

CMMS DETAILS - Functionality

MAXIMO is a comprehensive asset management system designed to be intuitive and flexible for all levels of users. MAXIMO's capabilities are both wide and deep. MAXIMO offers functionality for specific industries and situations along with coverage of a broad range of assets. MAXIMO can manages fleet, facilities, production and IT related assets.

MAXIMO transforms maintenance workers' knowledge into enterprise-wide intellectual capital. Organisations can automate activities, and "push" proper procedures out to the field. Document management capabilities streamline maintenance and regulatory functions while workflow helps organizations synchronise operations. MAXIMO also allows the fine tuning of applications, to suit specific work processes.

MEX

Company: Maintenance Experts
Address: PO Box 6118 Buranda QLD 4102 Australia
Contact: Matthew Ward
Phone: 61 7 3392 4777
Fax: 61 7 3392 4888
Email: matt.ward@mex.com.au
Web: www.mex.com.au

In country support:

Australia, New Zealand, Indonesia, China, Malaysia, Thailand

CMMS Designed for group:

MEX is utilised in a large number of industry sectors including manufacturing plants; building facilities; local governments and maintenance contractors.

Typical cost of the CMMS software

Small site:	$3000.00
Medium Site:	$8000.00
Large Site:	$30 000+ Aus

Available as a stand-alone system.

CMMS DETAILS - Technical

System Requirements
OPERATING SYSTEM

- Windows 95 or later, or Windows NT Server/Workstation 4.0 or later
- MS SQL Server version 2000
- To modify MEX reports and/or create your own reports for MEX a copy of Microsoft Access 2000 is required.

HARDWARE REQUIRMENTS

- Pentium 166 System minimum recommendation
- 64 MB of Memory (RAM)
- 152 MB of available hard disk space
- CD-ROM drive or access to a CD-ROM drive over a computer network
- Display adapter capable of 800x600-screen resolution.
- Mouse

MEX Ops - Web Enabled Job Requests System

- As above •Internet Information Server (IIS) V 4.0 or above
- Or Personnel Web Server (PWS)

Specialised Hand-held Device Applications

- Windows 95, 98, 2000, XP
- Palm Operating System 3, 4, & 5
- Pocket PC

CMMS DETAILS - Functionality

MEX is a Microsoft compatible maintenance management system designed for companies looking to improve the efficiency and effectiveness of their maintenance operation. MEX is particularly effective in implementing preventative maintenance strategies.

The modular configuration of MEX enables companies to implement additional functionality as required. These modules provide an extra level of system integration including requests, mobile palm applications and stores.

Equipment Register - record all of your plant and equipment in this register. Include details such as suppliers, costs, purchase dates, warranty dates, dimensions and much more.

Work Orders - create Work Orders for work to be done. Include start dates, departments, tradespeople, costs, parts, tasks, safety information etc.

Maintenance Policies - create preventative maintenance work to be carried out on equipment. Schedule the work based on conditions, hours used, km, month's etc.

History - access a complete history on all works ever carried out on a piece of equipment.

Reports - accurately measure and analyse your equipment and operation performance.

Invoicing - invoice for all work completed including a complete breakdown of costs, labor and parts.

Readings - monitor plant readings and track usage.

Stores adds to MEX the capability of Inventory Management. The module enables you to maintain an appropriate balance between having what you need on hand, while keeping the capital tied up in stores to a minimum.

MEX Ops

MEX Ops is a Web enabled job requesting system. It allows requests to be made anywhere at anytime and maintenance staff can easily prioritise and schedule work. It also allows the requestee to track their job.

Hand-held Device Applications

Specialised applications that eliminate time spent on data entry with automatic uploading of information into MEX. Applications available include:

- HandiWork Orders
- Ad Hoc Work Orders .
- Store Issues / Returns
- Stocktake
- Equipment Readings

With MEX you control your maintenance with knowledge. Whether you require detailed information on every aspect of your operation or simply an overview of department efficiency or work scheduled and completed, MEX delivers.

MicroMain XM

Company: MicroMain Corporation
Address: 5100 Bee Caves Road, Austin TX 78746 USA
Contact: Joe Brummer
Phone: 512-328-3235
Fax: 512-328-5942
Email: joeb@micromain.com
Web: www.micromain.com

In country support:

United States, Canada, Mexico, China, Lebanon, South Africa, Switzerland (serves Europe), Germany

Typical cost of the CMMS software

Small site:	$2,995
Medium Site:	$9,000
Large Site:	$80,000

State currency used for the above costs: U.S.

Available as a stand-alone system.

IS THIS CMMS part of larger management/corporate system:

MicroMain XM can be integrated with enterprise resource planning (ERP) systems and other corporate software

CMMS DETAILS - Technical

MicroMain's CMMS and modules are based on the latest industry standards, including Microsoft Accessô and Microsoft SQL Serverô. All products are being ported to Microsoft .NET.

Standard Pentium class server and client computers are sufficient hardware. MicroMain's PDA-based software runs on any Palm-based PDA; the mobile module is also available for Pocket PC. In addition to stand-alone installations, MicroMain XM is available via ASP (application service provider).

Data collection, condition monitoring, web-based capabilities are included, with integrations to corporate systems.

CMMS DETAILS - Functionality

MicroMain XM gives organizations worldwide the tools for comprehensive asset and maintenance management. This CMMS provides automated work orders, preventive maintenance scheduling, asset tracking, inventory control, fleet management and hundreds of standard and customizable reports.

Optional modules extend functionality. Modules utilizing handheld devices for Palm OS and Pocket PC enable mobile work orders and inspections; PDA-based, barcode-enabled modules provide asset tracking and inventory control; modules for work request submission utilize the Internet and networks; additional modules provide work order time entry, tool management, key control, and executive management by importing maintenance data from multiple sites into a master database.

Miquest

Company: Miquest Limited.
Address: Dammas House. Old Town.
Swindon. Wilitshire SN1 3EJ UK
Contact: Don Prater
Phone: 0870 7741555
Fax: 01793 618129
Email: don@Miquest.co.uk
Web: www.miquest.co.uk

In country support:

UK. Middle East. Scandinavia. Far East.

CMMS Designed for group:

Miquest can be used by any sector for Maintenance, Facilities, Fleet and Service Management. The system is fully scaleable for all levels of operation.

Typical cost of the CMMS software

Small site:	£7-10K
Medium Site:	£10-20K
Large Site:	£20K -75K

Available as a stand-alone system.

CMMS DETAILS - Technical

Miquest is a complete and Totally Integrated solution for any Asset Management application including Maintenance, Facilities, Fleet and Service Management. Developed in Powerbuilder Miquest ports to Sybase, MS-SQL Server and Oracle databases. Miquest will operate on any network, Intranet or the Internet using Citrix or similar or Thin Client options. Open connectivity allows interfaces to other systems including Process Control/Monitoring devices, PDA's for Bar Code, RFID and mobile computing using Cognito GPRS networks as well as facilitating direct data transfer.

CMMS DETAILS - Functionality

Miquest Software is a totally integrated solution with comprehensive modules that include: Asset/Location Register & Central Data Repository, Help Desk and Defect Reporting, Planned/Unplanned Work, Resources, Work Management, Calibration, Document Management, Purchasing, Stock Control, Costs and Budgets, Quotations, Sales Orders and Invoicing. Security Management with Full User Group Functionality, Links to external systems GIS, Mobile applications and hardware. Comprehensive Analysis and Reporting. Miquest is fully scaleable for all levels of operation from single to multi-site user operations without any data or system limitations. Miquest is a genuine "Future Proof" solution and is available with full range of implementation and support service options.

Intentia MOVEX

Company: Intentia Australia Pty Limited
Address: 33 Herbert StreetSt Leonards
Sydney NSW 2065
Contact: Mike Tonks
Phone: 02 84375661
0416298514
Fax: 02 84375699
Email: mike.tonks@intentia.com.au
Web: www.intentia.com

In country support:

Australia, New Zealand, Northern Europe, NW Europe, Central Europe, Southern Europe, Canada, Mexico, USA, Asean, Japan, Greater China, South East Asia.

CMMS Designed for group:

Discrete manufacturing, process manufacturing, power generation, mining, ports, infrastructure, telecom.

Typical cost of the CMMS software

Medium site:	+$100k
Large site:	+100k Aus

Available as a stand-alone system.

IS THIS CMMS PART OF LARGER MANAGEMENT/CORPORATE SYSTEM:

Yes and also stand alone

CMMS DETAILS - Technical

Movex Version 12 is available in JAVA on NT, Windows 2000 or SUN, Solaris or on IBM -i Series, OS400. Client requires Microsoft Internet Explorer 6 + SP1

Databases

DB2 on OS400 and NT as well as SQL Server on NT. Oracle RDBMS on SUN Solaris.

Hardware

Currently, IBM i-Series, IBM Netfinity as certified NT servers, SUN servers. Other platforms to be announced as certified.

CMMS DETAILS - Functionality

Intentia's Enterprise Asset Management (EAM) solution supports the plant maintenance process in its goal to reduce equipment downtime and maximize production output.

Intentia's EAM can be supplied as a cost-effective stand-alone solution integrated to other applications or fully integrated with Intentia's financial management, inventory, e-procurement, manufacturing, human resource, project management and production planning.

Intentia's EAM covers:

- Asset Registration
- Preventive Maintenance
- Work Planning
- Defining maintenance strategy
- Controlling maintenance costs
- Optimising production
- Project Planning
- Measuring performance
- Controlling spare parts
- Efficient purchasing
- Management of safe working practices
- Management of maintenance skills

OPRA (Order Processing & Requisition Accelerator)

Company: Package Products & Services, Inc.
Address: 520 Washington Blvd., #661
Marina del Rey, CA 90292 USA
Contact: Warren Wagner
Phone: 310-822-5988
Email: sales@opras.net
Web: opras.com

In country support:

USA - Australia

CMMS Designed for group:

Education - Municipalities - Private sector

Typical cost of the CMMS software

Small site:	$300 month
Medium Site:	$850 month
Large Site:	(quoted) USA$

Available as a stand-alone system. - Internet based - can run on client's server.

CMMS DETAILS - Technical

Originally deployed in 1996 the Work Order Module is the flagship module of the growing suite of OPRA's 100% Internet based tools. OPRA provides the quickest pathway to implementing an eloquent and intuitive CMMS solution for you without going through weeks, months or years of frustration and analysis. Our philosophy is: "If a system is not easy to use - it's not worth using".

CMMS DETAILS - Functionality

Using the OPRA "fuse box", OPRA can be adjusted to conform to just about any government or corporate environment. You need site level approvals, great - you're done, need service department level approvals - no problem, want OPRA to send a text message to your cell phone or email when an emergency order is placed - OK, want to track fixed assets and maintenance records on those assets - bada-bing

bada-boom. These are just a few examples of the hundreds of customized features available within the OPRA's 100% Internet/Intranet application.

Paradigm Business System 5

Company: Paradigm Designs Software, Mitcham, Victoria.
Address: The Rylson Group, PO Box 455 Maroochydore, QLD, 4558 Australia
Contact: Joseph Bernard
Phone: 03 9872 3533
Fax: 03 9872 6135
Email: paradigm@parasoft.com.au
Web: www.parasoft.com.au

In country support:

Australia, America, Canada and Asia.

CMMS Designed for group:

Is currently used in Steel, Mining, Paper, Packaging, Process Food, Vineyards, Utilities, Auto, and Fleet management industries. PBS5 is suited to any civil, electrical or mechanical facilities or production.

Typical cost of the CMMS software

Medium Site: $100k

Large Site: On Application

currency used : Australian Dollar

IS THIS CMMS part of larger management/corporate system: Yes

CMMS DETAILS - Technical

PBS5 unique graphical interface creates a totally visual asset register, which when combined with its advanced query engine creates a powerful easy to use workflow engine - visual capability allows linking of graphical objects to data or documents. PBS5's internal browser enables document linking to any object or record - supports file or internet documents. PBS5 can be connected to real time systems and includes predictive maintenance information. PBS5's user definable reports and windows are driven by a unique wizard query engine which drives workflow providing a high degree of flexibility. PBS5 operates within Windows Variants, Solaris, Linux and Mac OSX. PBS5 is provided as thin (inter/intra net) or Traditional Client Server installation. PBS5 supports most ANSI 96+ compliant SQL databases and is developed in a fifth generation development system that guarantees the highest level of quality, reliability and extendibility.

CMMS DETAILS - Functionality

Paradigm Business System ver.5 (PBS5) is an Enterprise Facilities and Production Management system designed to optimize business which provides a demonstrable return on investment and is suited to any large multi-national enterprise requiring production and facilities management for civil, electrical or mechanical assets. PBS5 has two unique features, a graphical asset register (HyperGraphica) and a trans-lingual capacity. The graphical asset register reduces training, is language independent, and assures the quality of the data - this is a critical success factor in implementation and end user adoption. The trans-lingual capacity means that people from different lingual backgrounds can view the same data, but in their native language - a real multi-national solution.

PBS5 is simple to use yet offers the depth and complexity to deal with any enterprise problem. PBS5's interface reduces training via user definable computer generated standardized forms of the highest quality and consistency.

PBS5's multi-national capable modules include HyperGraphica, Linguistica (dynamic trans-lingual capability), scheduled and unscheduled work management and workflow, production recording and reporting, inventory, purchasing, safety and risk mitigation, document management, preventative maintenance reporting and business structure backbone. Field and label level security creates profiles that control the look, feel and validation of all functions and objects within PBS5.

PBS5 should be evaluated by enterprises looking for a forefront solution to large-scale complex facilities and production environments. We welcome the opportunity to demonstrate PBS5, its return on investment, implementation methodology and forefront technology.

PCMAINT

Company: Dbase Developments
Address: 1 Neptune Street Sandringham Vic 3191
Contact: Tracey Francis
Phone: 03 9502 0250
Fax: 03 9502 0250
Email: tracey@pcmstore.com
Web Page: www.pcmstore.com

In country support: Australia

Designed for group:

Manufacturing and Facilities Management

Designed for site:

Small site: Yes

Medium Site: Yes

Typical cost of the CMMS software:

Small site: $1,000Std, $3,000Gold

Medium Site: $2,500Std, $6,000Gold

Large Site: $10,000+

State currency used for the above costs: $AU

Available as a stand-alone system

CMMS DETAILS - Technical

PCMAINT allows small to medium operations to achieve higher yields and better reliability of equipment through better asset management. PCMAINT provides formalised maintenance management in a low-cost, easy to implement system.

PCMAINT has been thoroughly tested on all Windows platforms including Windows Terminal Server and Citrix Metaframe and this is the recommended installation for Wide Area Network (WAN) use.

PCMAINT Standard is specifically aimed at companies that might be "getting by" with no maintenance system or rudimentary hours-based preventative maintenance. It is easy to learn, easy to operate and low in cost.

PCMAINT Gold is a fully featured product that will benefit industries which until now have had to spend many tens of thousands of dollars purchasing large systems to obtain the advanced purchasing and stock control systems offered by this system.

JobRequest is an integrated module (for both Standard and Gold) that facilitates paperless work request entry and tracking.

CMMS DETAILS - Functionality

PCMAINT is a Windows-based, asset and maintenance management system for plant maintenance, facilities maintenance, equipment service and similar operations.

PCMAINT Standard provides all the CMMS functionality required by an organisation implementing its first system including automated scheduling of routine preventative maintenance by both fixed calendar intervals and plant condition, asset register, labour register, suppliers register, work procedures and safety procedures registers and full access to all maintenance history. Fixed and user defined reports are available.

PCMAINT Gold provides all the features required in a CMMS and is suitable for all but the very largest organisations. Includes all Standard features plus spares purchasing, receival and inventory management. Faults/remedies, drawings and rotables registers are also available.

Job Request is a front end to enable users to enter work requests into PCMAINT without actually running the full PCMAINT system

Reports

A powerful graphical report writing and editing facility is included and a specialised Crystal Reports management reporting tool is also available.

Control Panel provides an asset based front end to PCMAINT. All maintenance information such as routines, backlog, history and spares can be displayed for each item in the Plant/Asset register. The majority of standard reports provided with PCMAINT are used to operate the CMMS. Control Panel incorporates a reporter which provides the information required by management to make decisions on plant replacement, capital works programs and to justify changes to the maintenance department budget.

Support and Training

Workshops are held throughout the year. Contact User Support on 0500 595955 for details.

Pinnacle Enterprise Asset & Maintenance Management System

Company: Pinnacle Software Pty Limited
Address: Level 3, Computer Associates House 10 National Circuit, Barton ACT 2600 Australia
Contact: Andrew Malone
Phone: (02) 6220 9900
Fax: (02) 6220 9999
Email: info@pinnaclesoftware.com.au
Web: www.pinnaclesoftware.com.au

In country support:

Australia, UK, Singapore, Hong Kong, China, Malaysia, New Zealand

Available as a stand-alone system.

CMMS DETAILS - Technical

Pinnacle Enterprise is available as either a client/server or web-architected product that running under Windows or via an Internet browser. Extensive PDA functionality includes data collection, barcode scanning, work orders and condition monitoring. Interfaces can be set up to all FMIS products and data exported to any other windows program. Pinnacle is also available as an ASP hosted service so that the user needs only have internet access - which makes it ideal for widely dispersed locations and mobile workforces.

CMMS DETAILS - Functionality

Pinnacle Enterprise includes functions organized into the following modules:

Assets; Property; Job Requests; Planned Work; Work Orders; Schedules; Finance & Budgets; Contracts; Stock; User Security; PDA for Assets; PDA for Maintenance; Job Requests. All modules have full reporting functions and Pinnacle is compatible with third party report writers to deliver unlimited flexible reporting. Almost every aspect of Pinnacle is able to be customized to meet the needs of the user and reflect the business rules they use.

ProTeus

Company: Eagle Technology, Inc.
Address: 10500 N. Port Washington Road
Mequon, Wisconsin 53092 USA
Contact: Sales Department
Phone: 262-241-3845
Fax: 262-241-5248
Email: sales@eaglecmms.com
Web: www.eaglecmms.com

In country support:

USA, Mexico, UK, South Africa, Thailand, Australia, Hungary, Greece, China, Malaysia, Brazil, India, Nigeria, Bahrain, UAE, Pakistan, Bahamas, Serbia.

Typical cost of the CMMS software

Small site: $2,495 US
Medium Site: $10,000 US
Large Site: $40,000 US

Available as a stand-alone system.

CMMS DETAILS - Technical

ProTeus can operate as a stand-alone, thin-client, or client/server CMMS, supporting an unlimited number of users. ProTeus runs in a MSDE, MS SQL, or Oracle database environment, and supports Windows 2000/XP/NT. ProTeus can be taken mobile on handheld PDAs, and offers an Alarm Manager Interface for true integration with Building Automation Systems. ProTeus allows drawings and PDF files to be attached to each work order. A data import utility streamlines database population and data export options include export to Microsoft Office, Crystal Reports and ERP systems. Web capabilities include: web browser access via LAN/WAN or Internet, work order submission direct to email or to wireless handheld devices.

CMMS DETAILS - Functionality

ProTeus helps streamline maintenance operations in plants and facilities worldwide. It offers asset and equipment tracking, preventive maintenance scheduling, demand maintenance tracking, an extensive list of management reports, inventory tracking over multiple stockrooms, employee/labor craft scheduling, budgeting, purchasing and more. Enhancements include: multi-cycle scheduling, multi-currency handling, time card tracking, and quick-entry screens for one-screen work order entry. Optional modules include: service request, barcode, audit trail, mobile interface, and more. A unique interface to popular Building Automation Systems (BAS) set this CMMS apart from the rest. ProTeus is available in multiple languages, including English, Spanish, German and Chinese.

SMART

Contact: Erica LeBorgne
Phone: 847.713.9135
Fax: 847.842.0321
Email: Erica.leborgne@syclo.com
Web Page: www.syclo.com

In country support:

Worldwide support.

IS THIS CMMS part of larger management/corporate system: Yes, as a mobile computing solution SMART is integrated with existing EAM or CMMS application deployed within an organization.

CMMS DETAILS - Technical

Syclo's SMART Suite is mobile software that automates workflow and replaces paper-based processes, which slow productivity and are responsible for poor reporting. SMART is integrated with existing EAM/CMMS systems and deployed on handheld devices including Pocket PC, Symbol, Intermec, and Palm, among others. SMART contains a server component to manage network connectivity, sessions management, etc; client device software that delivers a customized view depending on the user; and an editor that allows systems administrators to configure application workflow as needed.

CMMS DETAILS - Functionality

With features to benefit every area of a maintenance operation, SMART is proven technology that has increased productivity and maintenance efficiency for hundreds of organizations worldwide. The SMART Suite contains multiple function-specific modules to automate data capture and optimize workflow. Work Manager: View work orders and asset repair history, record time and attendance. Inventory: Speed parts and tools issues, track and monitor bin levels, check receipts against POs, automate cycle counts. Rounds & Readings: Download multiple rounds, record observations, view history, create work orders. Auditor: Record class and asset descriptions, conduct physical counts using barcode scanner, monitor conditions.

SSA EAM (Enterprise Asset Management)

Company: SSA Global
Address: 500 West Madison, Suite 1600,
Chicago, IL 60661, USA
Contact: Joy Hein
Phone: 763.797.8814
Fax: 763.797-8800
Email: joy.hein@ssaglobal.com
Web: www.ssaglobal.com/solutions/products
/index.aspx#eam

In country support:

SSA Global has worldwide resources to support customers .

Typical cost of the CMMS software

There is user-based pricing, for both concurrent and named users, as well as CPU-based pricing. EAM base system price is approximately $2000 times number users.

Available as a stand-alone system.

SSA EAM can be operated independently or interoperably with SSA ERP systems.

IS THIS CMMS part of larger management/corporate system:

SSA EAM is compatible with SSA BPCS, and will be interfaced to other SSA ERP systems (SSA PRMS, SSA Infinium) in 2004.

CMMS DETAILS - Technical

Databases: iSeries relational

Operating Systems (Clients): Windows 95 or higher

Browsers (Clients): Microsoft Internet Explorer 5.0 or higher

Operating Systems (server): OS/400

Integration Technology:
Point to Point using DB Triggers

CMMS DETAILS - Functionality

SSA EAM automates planning and control of equipment/facilities maintenance, calibration and warranty tracking functions. Virtually all capital assets can be managed by SSA EAM, including stationary and mobile equipment, machinery, transportation equipment, vehicle fleets, buildings and grounds.

The business processes and functionality of SSA EAM encompass:

Asset and Component Register

Preventive Care and Condition Monitoring

MRO Parts Stores and Procurement Management

Work Order Planning/Scheduling

Maintenance Cost Tracking

Warranty, Calibration and Tire Tracking

Automated Data Collection (bar code)

System Support Module (configuration)

Integration COGNOS Enterprise Performance Analytics (EPAs)

SSA Global is one of the few CMMS suppliers that offer BI (business intelligence) with matrix to track performance of key indicators, route-based (multi-machine) work orders, quick and easy create/complete work order, and craft/employee assignment to work order.

TabWare

Company: AssetPoint
Address: 770 Pelham Road
Greenville, SC 29615 USA
Contact: Tracy Watson
Phone: 864.458.3333
Fax: 864.458.3301
Email: sales@assetpoint.com
Web: www.AssetPoint.com

In country support:

United Kingdom, Germany, Canada, Indonesia

CMMS Designed for group:

No; But focus markets are Chemicals, Oil/Gas, Petrochemical, Metals/Steel, Food and Beverage, General Manufacturing

Typical cost of the CMMS software

Small site: $500 p/month p/concurrent user online model; $5,000 per seat for one time license

Medium Site: $500 p/month p/concurrent user online model; $6,000 per seat for one time license

Large Site: $500 p/month p/concurrent user online model $5-7,000 per seat for one time license

(US Dollars)

Available as a stand-alone system.

CMMS DETAILS - Technical

Our CMMS/EAM, TabWare, is delivered as a traditional licensed solution called TabWare OnSite or through a fully secure, web-based model called TabWare OnLine. The system relies on the database structures of Oracle and Microsoft SQL Server. Complementary products to TabWare that enhance performance include our SMART KPI web portal that graphically displays performance data; TabLink, our eCommerce functionality that seamlessly connects buyers to online supplier catalogs; TabAnyWare, our mobile maintenance and inventory management hand-held solution.

CMMS DETAILS - Functionality

AssetPoint provides integrated maintenance software and services centered on improving maintenance efficiencies. Our CMMS/EAM, TabWare, is delivered as a traditional licensed solution called TabWare OnSite or through a fully secure, web-based model called TabWare OnLine. The system includes full functionality for work orders, equipment management, resource planning and scheduling, preventive maintenance, predictive maintenance interface, invoice matching and inventory management. Special features for TabWare OnLine include single database capability for all sites; immediate access to system through any web browser and automatic functionality updates. Our fast-track implementation process allows clients to quickly ramp-up use of TabWare.

Workmate

Company: Enterprise Performance Solutions Ltd
Contact: Andrew Willis
Phone: +64 (0) 9 913 4000
Fax: +64 (0) 9 912 1212
Email: info@ep-solutions.co.nz
Web: www.workmate.co.nz

In country support: New Zealand

Typical cost of the CMMS software

Small site: $5,000

Medium Site: $15 - $30,000

Large Site: $100 - $180,000

Available as a stand-alone system.

CMMS DETAILS - Technical

Workmate is a PC based client/server application designed for ease of use and comprehensive reporting.

Workmate is operating successfully in many different industry sectors including dairy, timber, chemical, oil and gas, food, hotel, steel, shipping, plastics, etc. Hardware Minimum: Server PC - 750mhz, 128MB RAM and Client PC - 450mhz, 64MB RAM client running tcpip (recommended) protocol. Exact specs will depend on operating system. Suitable for Windows 98, NT, 2000 and XP. Minimum screen resolution 800 x 600.

CMMS DETAILS - Functionality

Workmate includes asset maintenance with Explorer style tree view for practical navigation. Functions include work orders, planned maintenance, inspections, permits, policy/procedure templates, work order templates, purchase orders, stock and inventory management, invoicing and integration with accounts payable via EPS's TransactionManager data management tools. A comprehensive range of tabular and graphical management reports are provided and links to CAD drawings, documents, scanned images, spreadsheets, and other applications via Workmate's Visualx function. Workmate can also integration with email and fax software for work orders and purchase orders. A web based application will be released in 2004 for centralised data nationally or globally.

Xas (Zas)

Company: EDIS Group Ltd
Contact: Andrew Willis
Phone: +64 (0) 9 571 4200
Fax: +64 (0) 9 571 4207
Email: info@edisgroup.com
Web Page: www.edisgroup.com

In country support:

New Zealand (international distribution during 2004 and 2005)

Typical cost of the CMMS software

Small site: $5,000

Medium Site: $50 - $100,000

Large Site: $250,000 + USD

IS THIS CMMS available as a stand-alone system?: yes

IS THIS CMMS part of larger management/corporate system?: no, Xas is stand alone system that integrates with corporate applications and payments

CMMS DETAILS - Technical

Xas is a Web based application designed for Internet and Intranet operation where reliable and secure centralised data management is essential.

Hardware Minimum: Web Server - 2.4Ghz, 1.0GB RAM, 40GB SCSI drive. Operating system: Windows 2000 Advanced Server and Internet Explorer 5.5+ (IE 6.0 recommended). Exact specifications will depend on database size, length of time connections remain open and number of concurrent connections. Recommended screen resolution 1024 x 768. Can include GIS/GPS/SCADA and automated connectivity with other management/operational applications.

CMMS DETAILS - Functionality

Think Locally and Act Globally with EDIS Group's Web based maintenance application 'Xas'. Xas includes Windows Explorer tree-view navigation and secure, centralised data management. Functions include work orders, date and meter based planned maintenance, permits and standard operating procedures presented in a practical user interface. A comprehensive range of management reports are provided and links to drawings, documents, scanned images, spreadsheets, and other applications. Additional modules will be added to Xas during 2004 including purchasing and inventory management. EDIS will provide custom software development for your organisation's specific requirements.

Next Issue - Aug 2004

Survey of Condition Monitoring Products and Services.

Urgent - If you wish to participate in the above survey please contact Len Bradshaw as soon as possible for the CM Survey form using:

mail@maintenancejournal.com

Towards An Intelligent Holonic Maintenance System

Ashraf W. Labib

Department of Mechanical, Aerospace and Manufacturing Engineering,
University of Manchester Institute of Science and Technology (UMIST), UK
Fax: +44 161 200-3803 email: ashraf.labib@umist.ac.uk

Part 1 of this paper was "CMMS - A Black Hole or Black Box"
Published in the Feb 2004 Issue of The Maintenance Journal

Abstract:

In this paper a proposed model provides a decision analysis capability that is often missing in existing CMMSs. The system is highly adaptive and has been successfully applied in industry. The proposed model employs a hybrid of intelligent approaches; a fuzzy logic control rule based (FLCRB) model and a multiple criteria decision-making technique called the Analytic Hierarchy Process (AHP). This hybrid system is analogous to the Holonic concept in that it provides a combination of flexible strategies and fixed rules as defined by Koestler (1989). The distinction between these two features is important. The rules on function automatically, whereas the strategic choices are aided by higher level of strategic policies. Therefore, using a rule-base approach and the Analytic Hierarchy Process (AHP) technique, the relationship and criteria of the proposed system will be analysed.

Introduction

In this paper, the author proposes to implement the holonic concept in maintenance systems. The main features of the holonic concept are fixed rules and flexible strategies. In this paper the author will attempt to apply these concepts into the maintenance systems for manufacturing. Therefore, using a rule-base approach and the Analytic Hierarchy Process (AHP) technique, the relationship and criteria of the proposed system will be analysed.

This paper is organised as follows. In the next section we discuss the holonic concepts with emphasis on applications in maintenance of manufacturing systems. Relationship analysis among criteria that are governing the proposed maintenance model will be presented in the following section followed by an industrial case study implementation. Finally conclusions are presented.

Holonic Systems

This concept is based on theory developed by Koestler (1989). He defined the word "holon" as a combination of the Greek word "holos" (=whole) and the suffix -on, suggesting a particle or part (as in proton and electron, etc), because of the following observations. Firstly, he noticed that the complex adaptive systems will evolve from simple systems much more rapidly if there are stable intermediate forms than if there are not; the resulting complex system in the former case will be hierarchic. Secondly, while Koestler was analysing hierarchy and stable intermediate forms in living organism and social organisation, he noticed that although -it is easy to identify sub-wholes or part- "wholes" and "parts" in an absolute sense do not exist anywhere. This made Koestler propose the word Holon to describe the hybrid

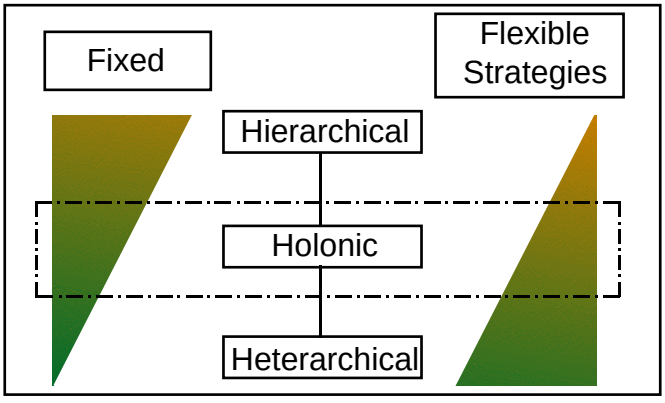


Figure 1. Holonic form: Combination of fixed rules and flexible strategies

nature of sub-wholes/parts in real-life systems; holons simultaneously are self-contained wholes to their subordinated parts, and dependent parts when seen from the inverse direction. The sub-wholes/holons are autonomous self-reliant units, which have a degree of independence and handle contingencies without asking higher authorities for instructions. Simultaneously, holons are subject to control form (multiple) higher authorities. The first property ensures that the holons are stable forms, which survive disturbances. The later property signifies that they are intermediate forms, which provide the proper functionality for the bigger whole (Christensen, 1994). Applying this concept to maintenance of manufacturing systems, a holonic control architecture is to comply with the concept of hierarchy in distributed systems.

In order to have an efficient function in the complex system, every holon has to behave according to fixed rules and flexible strategies. The fixed rules form a pattern of rules governed behaviour, which lends stability and cohesion between holons in the group (complex system). While flexible strategies allow the holon to be autonomous in frame of fixed rules. This flexible strategies enable the holon to determine how it operates and particular how it interacts with other holons in its environment (Bongaerts *et al*, 2000).

Therefore, if each system being maintained is considered as a holon i.e. an independent entity of hierarchical structure and modes of failure which could be prioritised based on different criteria such as severity, frequency, spare parts usage and bottleneck ranking then we can have a better understanding of the systems behaviour. When similar systems are then relatively compared with others based on criteria of importance, we can then apply rules in the form of applicable maintenance policies in an adaptive approach. In a way we combine flexible strategies and fixed rules and end up with an intelligent holonic maintenance system, which is the scope of this paper.

Applying Holonic Concepts in Manufacturing Maintenance

The proposed holonic manufacturing maintenance model is based on the concept of effectiveness and adaptability. Mathematical models have been formulated for many typical situations. These models can be useful in answering questions such as "how much maintenance should be done on this machine? How frequently should this part be replaced? How many spare should be kept in stock? How should the shutdown be scheduled? It generally accepted that the vast majority of maintenance models are aimed at answering efficiency questions, that is questions of the form "how can this particular machine be operated more efficiently?" and not at effectiveness questions, like "which machine should we improve and how?". The latter question is often the one in which practitioners are interested. From this perspective it is not surprising that practitioners are often dissatisfied if a model is directly applied to an isolated problem. This is precisely why in the integrated approach efficiency analysis as proposed by the author (do the things right) is preceded by effectiveness analysis (do the right thing). Hence, two techniques were employed to illustrate the above-mentioned concepts mainly the Fuzzy Logic Rule based Decision Making Grid (DMG) and the Analytic Hierarchy Process (AHP) as proposed by Labib etal (1998). The proposed model is illustrated in figure (2).

The Decision-Making Grid (DMG) acts as a map where the performances of the worst machines are placed based on multiple criteria. The objective is to implement appropriate actions that will lead to the movement of machines towards an improved state with respect to multiple criteria. These criteria are determined through prioritisation based on the Analytic Hierarchy Process (AHP) approach. The AHP is also used to prioritise failure modes and fault details of components of critical machines within the scope of the actions recommended by the DMG.

The model is based on identification of criteria of importance such as downtime and frequency of failures. The DMG then proposes different maintenance policies based on the state in the grid. Each system in the grid is further analyzed in terms of prioritisations and characterisation of different failure types and main contributing components.

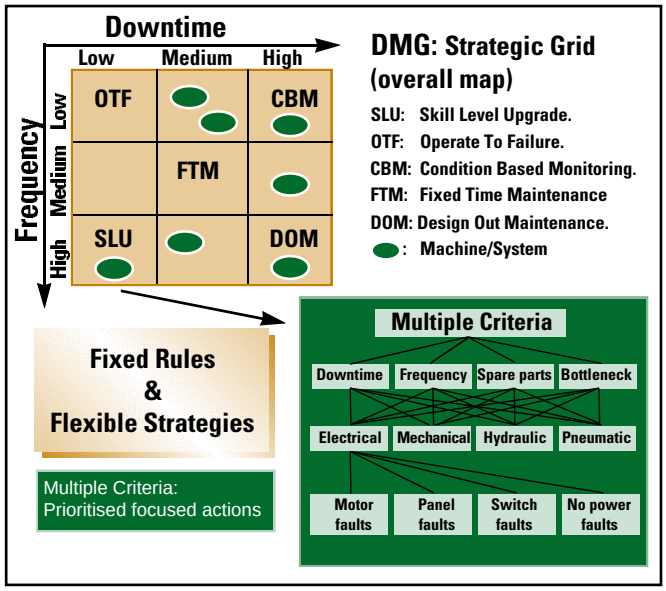


Figure 2: Holonic Maintenance System

Maintenance Policies

Maintenance policies can be broadly categorised into the technology or systems oriented (systems, or engineering), management of human factors oriented and monitoring and inspection oriented. RCM is a technological based concept where reliability of machines is emphasised. Condition Based Maintenance (CBM) - not Condition Based Monitoring - is a sensing technique in which availability based on inspection and follow-up is emphasised. TPM is human based technique in which maintainability is emphasised. The proposed approach in this paper is different from the above mentioned ones in that it offers a decision map adaptive to the collected data where it suggest the appropriate use of RCM, TPM, and CBM.

The DMG through an Industrial Case Study

This case study demonstrates the application of the proposed model and its effect on asset management performance. The application of the model is shown through the experience of a company seeking to achieve World-Class status in asset management. The company has implemented the proposed model which has had the effect of reducing total downtime from an average of 800 hours per month to less than 100 hours per month as shown in figure (3).

Company Background and Methodology

In this particular company there are 130 machines, varying from robots, and machine centres, to manually operated assembly tables. Notice that in this case study, only two criteria are used (frequency, and downtime). However, if more criteria are included such as spare parts cost and scrap rate, the model becomes multi dimensional, with low, medium, and high ranges for each identified criterion. The methodology implemented in this case was to follow three steps. These steps are i. Criteria Analysis, ii. Decision Mapping, and iii. Decision Support.

Step 1: Criteria Analysis

As indicated earlier the aim of this phase is to establish a Pareto analysis of two important criteria Downtime; the main concern of production, and Frequency of Calls; the main concern of asset management. The objective of this phase is to assess how bad are the worst performing machines for a certain period of time, say one month. The worst performers in both criteria are sorted and grouped into High, Medium, and Low sub-groups. These ranges are selected so that machines are distributed evenly among every criterion. This

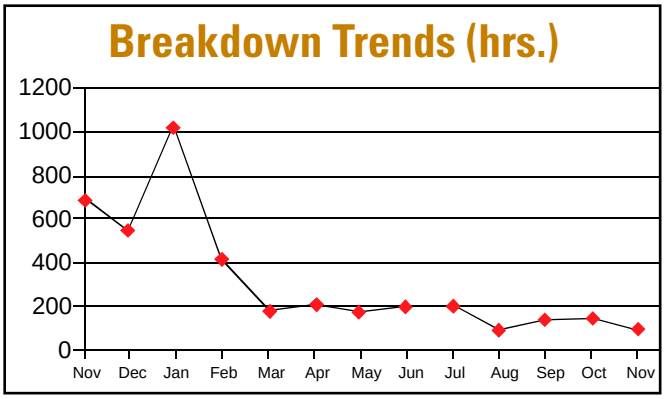


Figure 3 Total breakdown trends per month

is presented in figure (4). In this particular case, the total number of machines is 120. Machines include CNCs, robots, and machine centres.

Step 2: Decision Mapping

The aim of this step is twofold; it scales High, Medium, and Low groups and hence genuine worst machines in both criteria can be monitored on this grid. It also monitors the performance of different machines and suggests appropriate actions. The next step is to place the machines in the "Decision Making Grid" shown in figure (5), and accordingly, to recommend asset management decisions to

Criteria:	Downtime			Frequency		
	Name	Downtime (hrs)		Name	Frequency (No. off)	
HIGH	Machine [A]	30		Machine [G]	27	
	Machine [B]	20		Machine [C]	16	HIGH
	Machine [C]	20		Machine [D]	12	
MEDIUM	Machine [D]	17		Machine [A]	9	
	Machine [E]	16		Machine [I]	8	MEDIUM
	Machine [F]	12		Machine [E]	8	
LOW	Machine [G]	7		Machine [K]	8	
	Machine [H]	6		Machine [F]	4	LOW
	Machine [I]	6		Machine [B]	3	
	Machine [J]	4		Machine [H]	2	
	Sum of Top 10	138		Sum of Top 10	97	
	Sum of All	155		Sum of All	120	
	Percentage	89%		Percentage	81%	

Criteria Evaluation

Figure 4 Step1: Criteria Analysis

management. This grid acts as a map where the performances of the worst machines are placed based on multiple criteria. The objective is to implement appropriate actions that will lead to the movement of machines towards the north - west section of low downtime, and low frequency. In the top-left region, the action to implement, or the rule that applies, is OTF (operate to failure). The rule that applies for the bottom-left region is SLU (skill level upgrade) because data collected from breakdowns - attended by maintenance engineers - indicates that machine [G] has been visited many times (high frequency) for limited periods (low downtime). In other words maintaining this machine is a relatively easy task that can be passed to operators after upgrading their skill levels.

Machines that are located in the top-right region, such as machine [B], is a problematic machine, in maintenance words "a killer". It does not breakdown frequently (low frequency), but when it stops it is usually a big problem that lasts for a long time (high downtime). In this case the appropriate action to take is to analyse the breakdown events and closely monitor its condition, i.e. condition base monitoring (CBM).

A machine that enters the bottom-right region is considered to be one of the worst performing machines based on both criteria. It is a machine that maintenance engineers are used to seeing it not working rather than performing normal operating duty. A machine of this category, such as machine [C], will need to be structurally modified and major design out projects need to be considered, and hence the appropriate rule to implement will be design out maintenance (DOM).

If one of the antecedents is a medium downtime or a medium frequency, then the rule to apply is to carry on with the preventive maintenance schedules. However, not all of the mediums are the same. There are some regions that are near to the top left corner where it is "easy" FTM (Fixed Time Maintenance) because it is near to the OTF region and it requires re-addressing issues regarding who will perform the instruction or when will the instruction be implemented. For example, in case of machines [I] and [J], they are situated in region between OTF and SLU and the question is about who will do the instruction - operator, maintenance engineer, or sub-contractor. Also, a machine such as machine [F] has been shifted from the OTF region due to its relatively higher downtime and hence the timing of instructions needs to be addressed.

Other preventive maintenance schedules need to be addressed in a different manner. The "difficult" FTM issues are the ones related to the contents of the instruction itself. It might be the case that the wrong problem is being solved or the right one is not being solved adequately. In this case machines such as [A] and [D] need to be investigated in terms of the contents of their preventive instructions and an expert advice is needed.

Step 3: Multileveled Decision Support

Once the worst performing machines are identified and the appropriate action is suggested, it is now a case of identifying a focused action to be implemented. In other words, we need to move from the strategic systems level to the operational component level. Using the Analytic Hierarchy Process (AHP), one can model a hierarchy of levels related to objectives, criteria, failure categories,

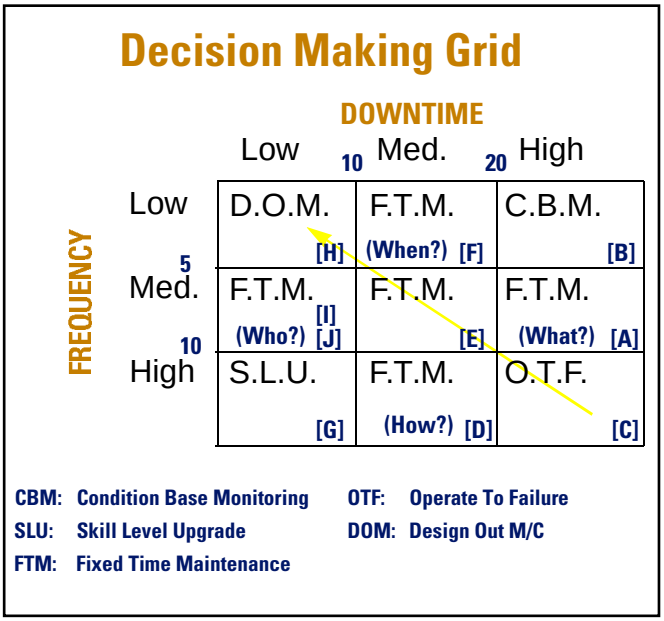


Figure 5: Step2: Decision Mapping

failure details and failed components. This step is shown in figure (6).

The AHP is a mathematical model developed by Saaty (1980) that prioritises every element in the hierarchy relative to other elements in the same level. The prioritization of each element is achieved with respect to all elements in the above level. Therefore, we obtain a global prioritized value for every element in the lowest level. In doing that we can then compare the prioritized Fault Details (Level 4 in figure (6)), with PM signatures (keywords) related to the same machine. PMs can then be varied accordingly in an adaptive manner to shop floor realities.

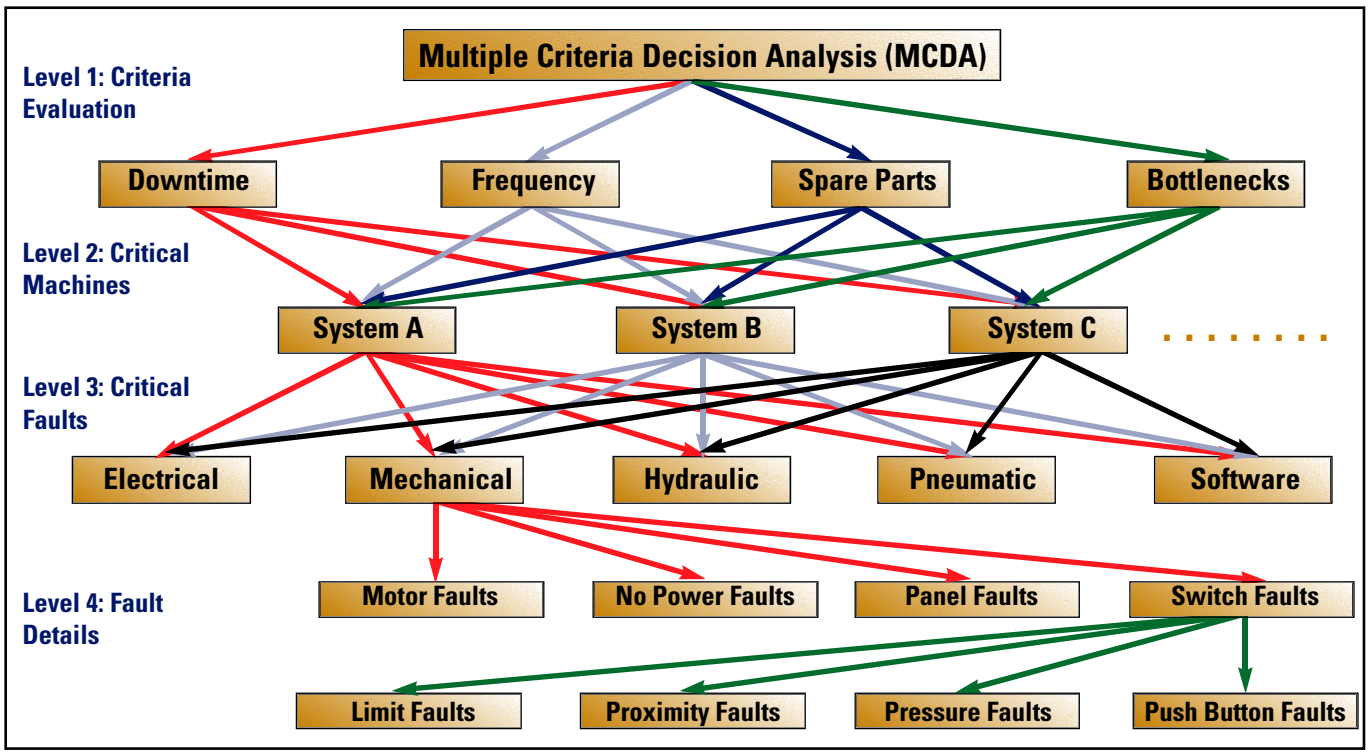


Figure 6: Step3: Decision Support

The proposed holonic maintenance model as shown previously in figure (2) combines both fixed rules and flexible strategies since machines are compared on a relative scale. The scale itself is adaptive to machine performance with respect to identified criteria of importance. Hence flexibility and holonic concepts are embedded in the proposed model.

Fuzzy Logic Rule based Decision Making Grid

In practice, however, there can exist two cases where one needs to refine the model. The first case is when two machines are located near to each other across different sides of a boundary between two policies. In this case we apply two different policies despite a minor performance difference between the two machines. The second case is when two machines are on the extreme sides of a quadrant of a certain policy. In this case we apply the same policy despite the fact they are not near each other. Both cases are illustrated in figure (7). For both cases we can apply the concept of fuzzy logic where boundaries are smoothed and rules are applied simultaneously with varying weights.

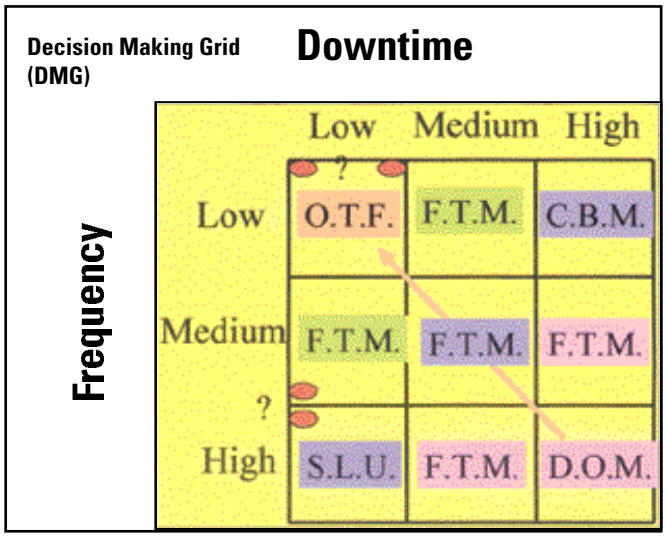


Figure 7: Special cases for the DMG model

In fuzzy logic, one needs to identify membership functions for each controlling factor, in this case: frequency and downtime as shown in Figures (8 a and b). A membership function defines a fuzzy set by mapping crisp inputs from its domain to degrees of membership (0,1). The scope/domain of the membership function is the range over which a membership function is mapped. Here the domain of the fuzzy set Medium Frequency is from 10 to 40 and its scope is 30 (40-10), whereas the domain of the fuzzy set High Downtime is from 300 to 500 and its scope is 200 (500-300) and so on.

The output strategies have a membership function and we have assumed a cost (or benefit) function that is linear and follows the following relationship (DOM > CBM >SLU > FTM > OTF) as shown in Figure (9a).

The rules are then constructed based on the DMG grid where there will be 9 rules. An example of the rules is as follows:

Rules:-

- If Frequency is High and Downtime is Low Then Maintenance Strategy is SLU (Skill Level Upgrade).
- If Frequency is Low and Downtime is High Then Maintenance Strategy is CBM (Condition Based Maintenance).

Rules are shown in Figure (9b).

The fuzzy decision surface is shown in Figure (10). In this figure, given any combination of frequency (x-axis) and downtime (y-axis) one can determine the most appropriate strategy to follow (z axis).

It can be noticed from Figure (11) that the relationship of (DOM > CBM >SLU > FTM > OTF) is maintained. As illustrated in Figure (11), give a 380 hrs of downtime and a 12 times Frequency, the suggested strategy to follow is CBM.

Discussion

The concept of the DMG was originally proposed by (Labib, 1996). It was then implemented in a company that has achieved a World-Class status in Maintenance (Labib (a), 1998). The DMG Model has also been extended to be used as a technique to deal with crisis management in an award winning paper (Labib (b), 1998). It was also presented in the context of crisis management rather than maintenance management (Labib, 1999).

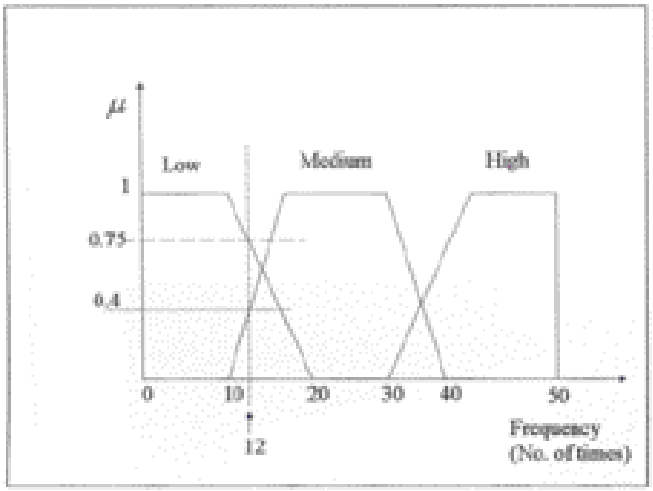


Figure 8a: Membership function of Frequency

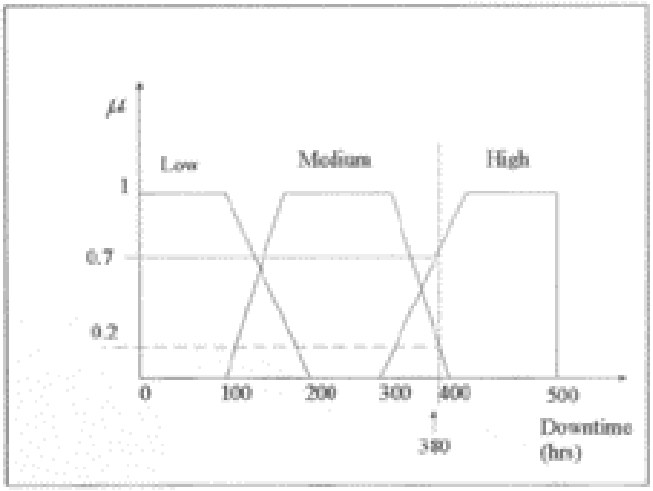


Figure 8b: Membership function of Downtime

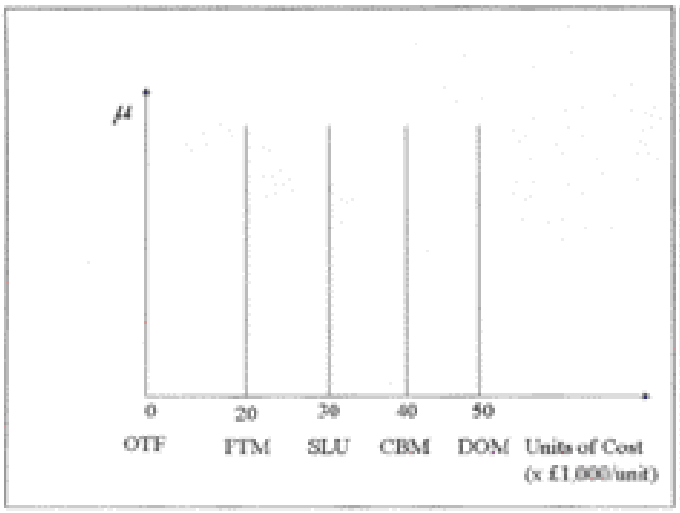


Figure 9a: Output (strategies) membership function

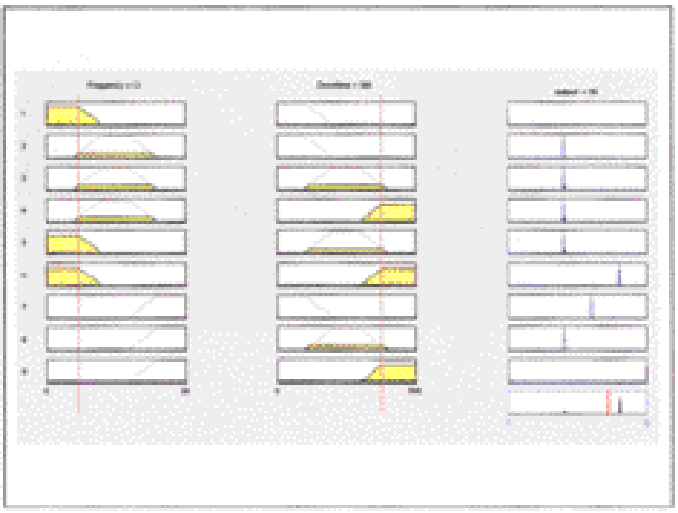


Figure 9b: The nine rules of the DMG.

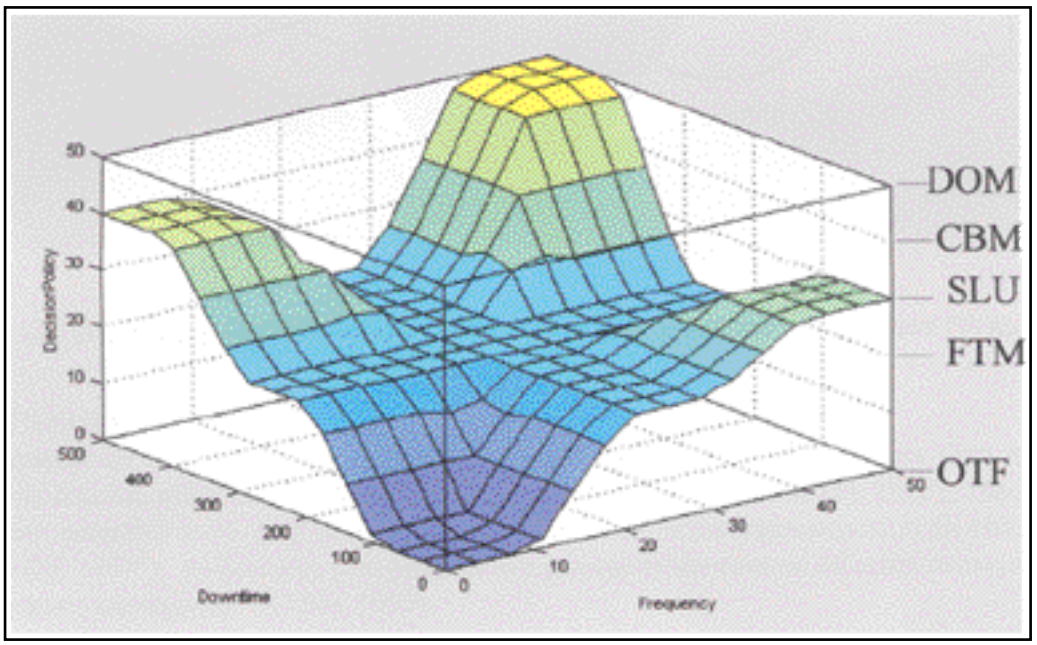


Figure 10: The Fuzzy Decision Surface.

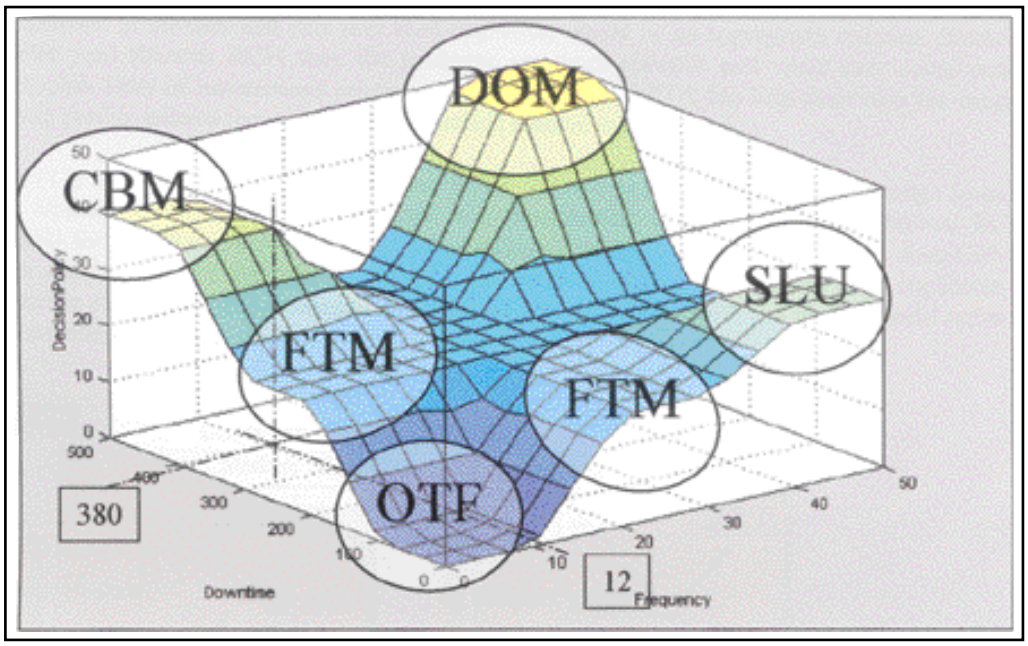


Figure 11: The Fuzzy Decision Surface Showing The Regions of Different Strategies

The DMG could be used for practical continuous improvement process because when machines in the top ten have been addressed, they will then, if and only if, appropriate action has been takes, move down the list of top ten worst machines. When they move down the list, other machines show that they need improvement and then resources can be directed towards the new offenders. If this practice is continuously used then eventually all machines will be running optimally.

If problems are chronic, i.e. regular, minor and usually neglected; some of these could be due to the incompetence of the user and thus skill level upgrading would be an appropriate solution. However, if machines tend towards RCM then the problems are more sporadic and when they occur could be catastrophic. Uses of maintenance schemes such as FMEA and FTA can help determine the cause and may help predict failures thus allowing a prevention scheme to be devised.

Figure (12) shows when to apply TPM and RCM. TPM is appropriate at the SLU range since Skill Level Upgrade of machine tool operators is a fundamental concept of TPM. Whereas, RCM is applicable for machines exhibiting severe failures (high downtime and low frequency). Also CBM and FMEA will be ideal for this kind of machine and hence a RCM policy will be most applicable. The significance of this approach is that in one model we have RCM and TPM in a unified model rather than two competing concepts.

Generally the easy Preventive Maintenance (PM), Fixed Time Maintenance (FTM) questions are Who, and When (efficiency questions). The more difficult ones are What and How (effectiveness questions), as indicated in the figure (13).

Conclusion

The main idea is based on the fact that the 'black hole' or missing functionality in conventional CMMSs is intelligent decision analysis tools. A model has been proposed based on the Analytic Hierarchy Process (AHP) combined with Fuzzy Logic Control (FLC) to render a 'Decision Making Grid'. This combination provides features of both fixed rules and flexible strategies.

This grid supports the decision making process on how assets should be maintained; directing the business to choose to run out to failure, upgrade operator skills, choose fixed time maintenance, or to design out the causes (as examples of such policies). It then gives a prioritised focus within the scope of the suggested policy in order to dynamically adapt maintenance plans through the performance of trade-off comparisons in a consistent approach.

The basic data requirements being simply, for example: the asset register, a fault counter, and timer, and a hierarchical fault tree. The role of each requirement is as follows:

- Asset Register (Machine identifier). This is to identify different machines and plants.
- Counter of Faults (Frequency). This is the first criterion used by the DMG. It could be obtained from any CMMS or using Programmable Logic Controllers (PLCs).
- Timer of Faults (Down-time). This is the second criterion used by the DMG. It could be obtained from any CMMS or using Programmable Logic Controllers (PLCs).
- Level of Faults (Hierarchical). This is important for the AHP model. Here the combination of structured fault codes and flexible description needs to be considered.

These basic requirements are usually easy to find in existing CMMS. It is therefore proposed that such a model could be attached as an intelligent module to existing CMMSs in order to transfer a black hole concept to an intelligent black box that adds value to the business.

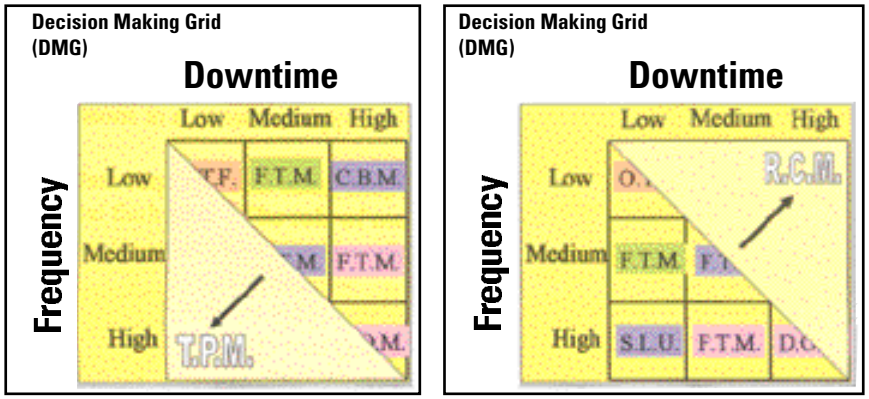


Figure 12: when to apply RCM and TPM in the DMG

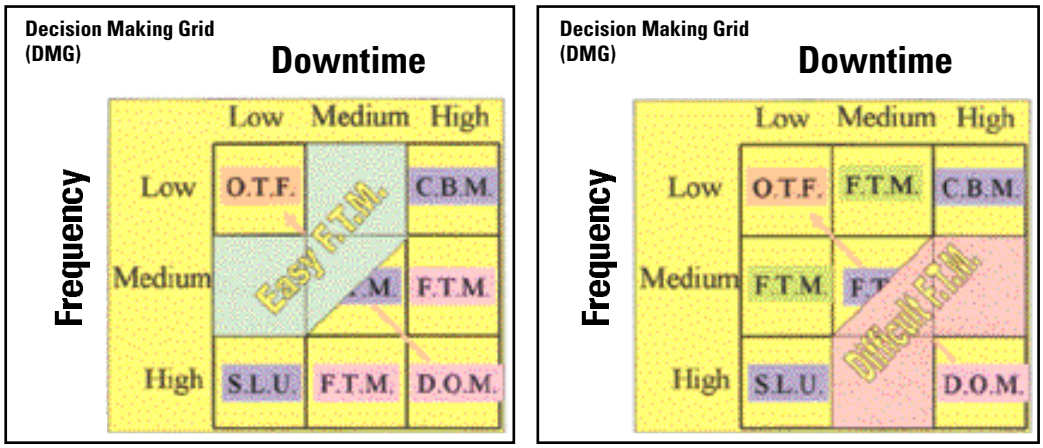


Figure 13: Parts of PM schedules that need to be addressed in the DMG.

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[10]. Swanson, L. (1997) Computerized Maintenance Management Systems: A study of system design and use Production and Inventory Management Journal, Second Quarter pp. 11-14.

1 Received the "Highly Commended Award 1999" from the Literati Club, MCB Press (a publisher of 140 journals), for a paper entitled "A Logistics Approach to Managing the Millennium Information Systems Problem" [Labib, 1998b], Journal of Logistics Information Management, MCB Press, 1998.

CONDITION MONITORING SYSTEMS IN INDUSTRY

Philip A. Higgs, Rob Parkin, Amin Al-Habaibeh, Farbod Zorriassatine, Jo Coy

Loughborough University, Wolfson School of
Mechanical and Manufacturing Engineering, (UK)
Email: phil.higgs@lboro.ac.uk

1. INTRODUCTION

The following paper represents a draft (snippet) of the final paper expected to be released at 7th Biennial ASME Conference Engineering Systems Design and Analysis, July 19-22, 2004 Manchester, UK. Results of a Condition Based Monitoring (CBM) Survey designed to determine present applications of CBM systems within industry are presented. Understanding how industry applies practices such as CBM in the work place offers valuable research results for CBM system providers, consultants and business users alike. Good motivational reasons for conducting a CBM survey. Questions to be addressed fall into six categories: 1) Industrial sector; 2) CBM & NDT techniques; 3) Implementation Incentives; 4) Technology and Integration; 5) Method of implementation; 6) System reliability.

The acronym CBM is also associated with Condition Based Maintenance, a predictive maintenance technique. CBM is the method adopted to monitor and diagnose the condition/s of the process, machinery, or component/s under investigation. CBM therefore links directly with Condition Based Maintenance, a technique of diagnosing failure mechanisms and making a prognosis of the remaining useful life before failure. Enabling corrective maintenance action to be undertaken on the identified failing component/s at a convenient time before anticipated time of failure.

A similar CBM questionnaire with fewer questions and fewer replies was conducted in 2002. [1]. Where similar questions were used, a results comparison is made.

2. SURVEY RESULTS AND DISCUSSION

2.1. Company Information

A broad industrial representation is exhibited in the survey. Demonstrating a wide take up of CBM techniques within industry as a whole. Table 1 identifies Manufacturing-Petroleum refining, chemicals and associated products as being the most popular industrial sector for using CBM systems. The same result was true in a CBM questionnaire undertaken in 2002 [1]. The second most popular industrial group was classified as "other". An indication that a future survey of this nature could include a larger listed selection of industrial and business groups.

Responses were received from over 15 different countries. These include the Americas, Europe, Japan, Australasia, Southeastern Asia, Middle East and Africa. Indicative of the worldwide application of CBM as a maintenance practice, and the effectiveness of questionnaire distribution over the Internet.

2.2. Condition Monitoring and Non Destructive Testing Techniques

Survey findings represented in Table 2 indicate the four most widely used CBM and non destructive testing (NDT) techniques to be: Vibration Analysis, Oil Analysis, Infra-red Thermography, and Human Senses. A similar result to the 2002 CBM survey [1].

All the listed CBM and NDT techniques have been selected.

2.3. Incentives

Table 3 shows a combined 85% of respondents either agree or strongly agree they introduced CBM in order to adopt the practice of predictive maintenance into their company. Less than 3% of respondents showed disagreement.

An underlying message suggests respondents' associate predictive maintenance with CBM. An interesting connotation considering recent discussions questioning the definition of CBM on maintenance forums, as to whether it is a predictive or preventative maintenance practice.

Table 4 shows a combined 95% of respondents either agree or strongly agree they introduced CBM to reduce the number of unscheduled machine breakdowns. Providing a positive indication that in most cases CBM is associated with reducing unscheduled machine breakdowns.

Table 5 shows a combined 83% of respondents either agree or strongly agree their business adopted CBM to save money. Providing a positive indication that in most cases CBM is associated with saving money. Only 2.5% of respondents indicated disagreement.

Table 6 shows a combined 79% of respondents either agree or strongly agree their organisation introduced CBM for competitive reasons. Determining organisations competitiveness is a high level (Director/Chairman) business decision. Because the questionnaire has been randomly distributed, it is quite acceptable to expect a notable 15% of neutral responses.

2.4. Technology & Integration

Survey results shown in Table 7 indicate charts to be the most common method of presenting CBM information to users. All other options (discrete values, alarms, and graphics and animation) received a similar % of replies. Implying CBM graphic user interfaces (GUI) should offer a variety of different mediums in which to present data and information to users.

Table 1

What type of industry does your business belong to?

Petroleum refining, chemicals and assoc. products	39	24.8%
Other	15	9.6%
Manufacturing-other	12	7.6%
Utilities-Electrical Generation	12	7.6%
Oil and Gas-Oil and gas extraction	12	7.6%
Manufacturing-Metal products	11	7.0%
Mining-Metal ore	9	5.7%
Manufacturing-Wood and paper products	9	5.7%
Services-Contact Maintenance/Repairs	8	5.1%
Services-Other	7	4.5%
Services-Business Services/Consulting	6	3.8%
Manufacturing-Food, beverages, tobacco	5	3.2%
Manufacturing-Machinery and equipment	4	2.6%
Services-Education/Academia	3	1.9%
Utilities-Water, sewerage, drainage	2	1.3%
Services-Transport	2	1.3%

Table 2

Respondents Using The Following Condition Based Monitoring and NDT techniques ?

Vibration Analysis	148	94.3%
Oil Analysis	113	72.0%
Infra-red Thermography	99	63.1%
Human Senses	92	58.6%
Motor Current Analysis	77	49.0%
Dye Penetrant Examination	74	47.1%
Ultrasonic Thickness Testing	73	46.5%
Ultrasonic Crack Detection	63	40.1%
Magnetic Particle Inspection	56	35.7%
Acoustic Emission Analysis	39	24.8%
Other	22	14.0%

Table 3

The desire to adopt predictive maintenance techniques motivated our business to adopt Condition Based Monitoring?

Strongly Agree	69	44.0%
Agree	64	40.8%
Neutral	14	8.9%
Does Not Apply or Do Not Know	6	3.8%
Strongly Disagree	3	1.9%
Disagree	1	0.6%

Table 4

We implemented Condition Based Monitoring to reduce the number of unscheduled machine breakdowns?

Strongly Agree	111	70.7%
Agree	39	24.8%
Does Not Apply or Do Not Know	5	3.2%
Neutral	2	1.3%)

Table 5

Our business adopted Condition Based Monitoring to save money?

Strongly Agree	76	48.4%
Agree	55	35.0%
Neutral	16	10.2%
Does Not Apply or Do Not Know	6	3.8%
Disagree	3	1.9%
Strongly Disagree	1	0.6%

Table 6

Our business adopted Condition Based Monitoring to improve the organisations competitiveness?

Strongly Agree	74	47.1%
Agree	51	32.5%
Neutral	24	15.3%
Does Not Apply or Do Not Know	6	3.8%

Table 7

In what medium does your Condition Based Monitoring System present information to user?

Charts	124	78.9%
Alarms	101	64.3%
Discrete values	100	63.7%
Graphics and animation	78	49.7%

Table 8

Is your condition based monitoring system connected to a network for remote access?

No	98	62.4%
Yes	59	37.6%

Of the 403 selections made, 201 or nearly 50% of selections indicated respondents' CBM systems incorporated either charts and graphics and animation. Both options are associated with high visibility graphical prompting aids. Suggesting a preference for representing CBM information through diagrammatic aids.

Additional results (not included in this draft) indicate displaying CBM information to users through written or computerised reports is a common trend. The type of information you'd expect on such reports includes: severity of faults, and trends of individual fault severity, specific repair recommendation and priority.

Table 8 shows a majority of 62% of respondent organisations use stand alone CBM systems as apposed to 38% whose system is networked.

Following in line with results from Table 8, Table 9 shows 63% of respondents indicate their organisations CBM system is not connected to the Internet, as apposed to 38% whose systems do have Internet connectivity.

Table 10 shows 73% of respondents CBM systems do not integrate with a computerised failure diagnostic system, where as 27% do.

Table 11 shows 67% of respondents' organisations maintenance systems link directly with a computerised stock reordering system, as apposed to 33% whose systems don't.

2.5. Implementation

Table 12 shows two comparable results emerge concerning the chosen method for implementing CBM systems. 45% of respondents used a mixture of resources consisting of, internal company expertise and resources, external consultants, and vendors, and 36% used only internal company expertise and resources.

2.6. Reliability

Table 13 shows a combined 77% of respondents agree or strongly agree their CBM system meets expectation. Approximately 3.5% indicated disagreement. A very positive response towards the application of CBM as a maintenance practice.

Table 14 shows a combined 80% of respondents agree or strongly agree operator and engineer awareness of maintenance issues has increased since their companies started using CBM. 3.0% indicate disagreement. A very positive response towards the educational usefulness CBM systems generates towards maintenance within an organisation.

Table 15 shows a combined 46% of respondents disagree or strongly disagree, initial costs of the CBM system exceed the benefits gained, a 14% larger proportion than the combined 32% of candidates who agree or strongly agree to the same question. Not a very clear-cut result either way.

Such a narrow difference of opinion can be expected, because every CBM system implementation is unique and open to different cost critical variables. One organisation may perform a smooth implementation keeping costs down, quickly seeing measurable cost saving, and another may encounter difficulties during implementation, resulting in higher than expected operation costs.

Table 16 shows a combined 76% of respondents agree or strongly agree further maintenance initiatives have resulted following the implementation of a CBM system. Only 1% indicate disagreement.

This matches with the earlier result confirming CBM to have led onto improvements in engineer and operator awareness of maintenance issues. With an increased awareness towards maintenance issues, identification of further maintenance initiatives can be expected.

Table 17 shows a combined 81% of respondents agree or strongly agree, CBM has introduced predictive failure capabilities into their business, improving maintenance scheduling.

An expected result considering the earlier result showing 84% of respondents agreeing or strongly agreeing they introduced CBM in order to adopt the practice of predictive maintenance into their business.

Re-emphasising the fact that respondents' associate predictive maintenance with CBM.

3. CONCLUSION

The survey acts as an application indicator for industrial usage for CBM systems in 2004. A broad selection of industrial and business sectors are represented in this survey, from over 15 different countries.

CBM is most widely used within the Manufacturing-Petroleum refining, chemicals and associated products business sector.

Vibration Analysis is the most widely used CBM and NDT technique. The main incentives for implementing CBM systems are: to adopt predictive maintenance techniques, to reduce unscheduled machine breakdowns, and to save money.

Technological and integration trends present in todays usage of CBM systems indicate a variety of different mediums being readily used for presenting information through GUIs. Popular mediums include: discrete values, charts, alarms, graphics and animation. Presenting CBM information to users through highly visual mediums, such as charts, graphics, and animation are preferred. Further comments suggest written or computerised reports are also commonly used for passing on CBM data and information.

Stand alone CBM systems are presently more wide spread than those with networking and system integration capabilities. At the present time approximately a third of maintenance systems integrate with failure diagnostic systems and / or parts reordering systems

Two similarly popular CBM system implementation approaches emerge: 1). Using internal company expertise and resources; 2). Using a mixture of resources consisting of internal company expertise and resources, external consultants, and vendors.

A strong positive feeling (averaging at 78%) exists towards the reliability of CBM systems following implementation with respects to, meeting expectations, increasing operator and engineer awareness of maintenance issues, creating further maintenance initiatives, and introducing predictive maintenance. A small majority of businesses do not believe CBM implementation costs exceed the resulting benefits.

4. ACKNOWLEDGMENTS

CreateSurvey a subdivision of TB Labs, LLC for providing an online survey management system. Alexander (Sandy) Dunn, Webmaster and creator of Plant Maintenance Resource Center, for advertising the questionnaire on web site:

http://www.plant-maintenance.com/about.shtml

Len Bradshaw, Editor for maintenancejournal.com, for advertising the questionnaire on the web site:

www.maintenancejournal.com

Jim Silvestri, Editor for Plant Engineering Magazine, for advertising the questionnaire on:

http://www.manufacturing.net/ple/

5. REFERENCES

[1] 2002 Condition Monitoring Survey Results, 2002, The Plant Maintenance Resource Center

Table 9

Can your condition based monitoring system be accessed through a company Intranet or over the Internet?

No	99	63.1%
Yes	58	36.9%

Table 10

Does your maintenance system integrate with a computerised failure mode diagnostic system?

No	114	72.6%
Yes	43	27.4%

Table 11

Does your maintenance system link directly with a computerised stock reordering system?

No	105	66.9%
Yes	52	33.1%

Table 12

How did you implement your condition based monitoring system?

Mixture of the below	71	45.2%
Internal expertise & resources	56	35.7%
External consultant was contracted	15	9.6%
Other	9	5.7%
It was supplied and fitted by a vendor	6	3.8%

Table 13

Does your Condition Based Monitoring System meet expectations?

Agree	84	53.5%
Strongly Agree	37	23.6%
Neutral	24	15.3%
Does Not Apply or Do Not Know	6	3.8%
Disagree	4	2.6%
Strongly Disagree	2	1.3%

Table 14

As a result of implementing a Condition Based Monitoring system operator and engineer awareness of maintenance issues has increased?

Agree	74	47.1%
Strongly Agree	52	33.1%
Neutral	22	14.0%
Does Not Apply or Do Not Know	4	2.6%
Disagree	3	1.9%
Strongly Disagree	2	1.3%

Table 15

The initial costs of the Condition Based Monitoring system exceed the benefits gained?

Disagree	45	28.7%
Agree	31	19.8%
Strongly Disagree	27	17.2%
Neutral	25	15.9%
Strongly Agree	20	12.7%
Does Not Apply or Do Not Know	9	5.7%

Table 16

As a result of implementing a Condition Based Monitoring System it has led to further maintenance initiatives?

Agree	83	52.9%
Strongly Agree	37	23.6%
Neutral	25	15.9%
Does Not Apply or Do Not Know	9	5.7%
Strongly Disagree	2	1.3%

Table 17

The Condition Based Monitoring system has introduced predictive failure capabilities into our business, improving maintenance scheduling?

Agree	70	44.6%
Strongly Agree	58	36.9%
Neutral	19	12.1%
Disagree	5	3.2%
Does Not Apply or Do Not Know	3	1.9%
Strongly Disagree	2	1.3%

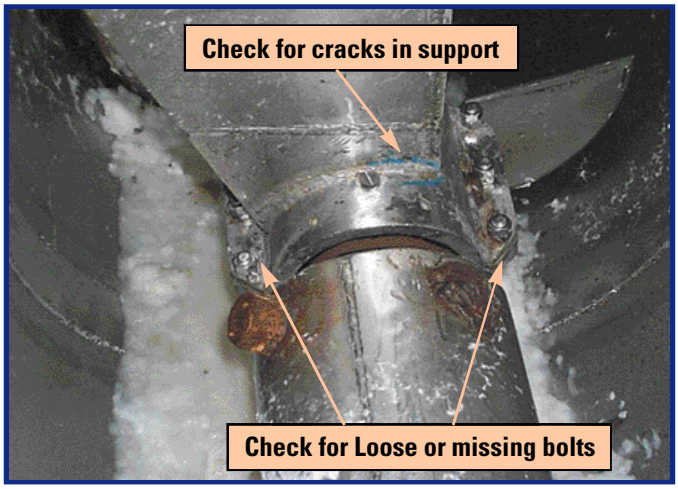
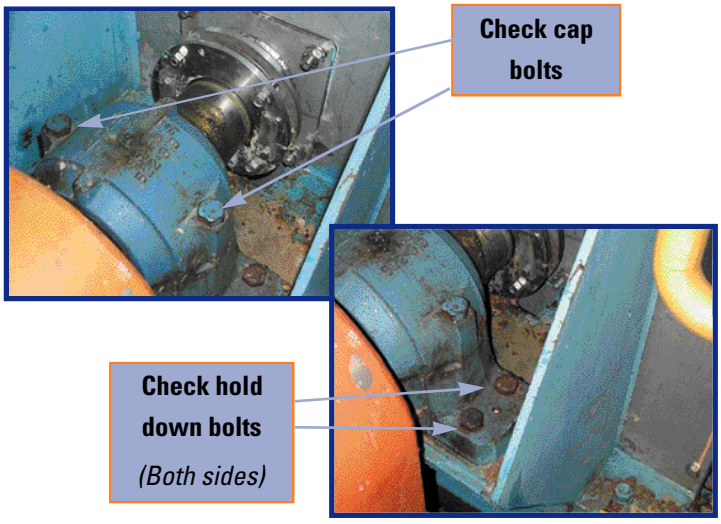
Planned Maintenance Corner

Each issue of the MJ will have a sample Condition Monitoring routine. This issue's sample is provided from IDCON's 3 volume series of books on "Condition Monitoring Standards". This excellence series contains a useful range of Condition Monitoring / Planned Maintenance routines and is available from:

IDCON:
info@idcon.com www.idcon.com

or for the Asia Pacific region:
mail@maintenancejournal.com www.maintenancejournal.com

Condition Monitoring Standard - Screw Conveyor

KEY	WHAT	WHY
Hanger Bearings	Some screw conveyors will have a hanger bearing in the middle. These provide support for screw conveyors that are comprised of two joined screws. Check that lubricating water for hanger bearing is working. 	Without lubricating water, the hanger bearing will quickly wear, allowing the screw to rub on the bottom of the conveyor trough.
Bearings	Check bearings for noise and vibration (feel, listen). Use the infrared gun to check the bearing temperature. Inspect bearing hold down bolts and cap bolts (if applicable) for looseness and corrosion. Check condition of bearing seals, See CMS for bearings for more detail. 	Noise and vibration can be caused by loose mounting bolts or worn/damaged bearings.

KEY	WHAT	WHY
Packing	Check packing to see if product is leaking out. Since most screw conveyors use dry packing there won't be any gland water to check. **Be careful of rotating shaft at packing!** 	
Screw	Check the screw for bent cracked or otherwise damaged flights. Listen for the screw rubbing on the trough. 	Flights that are rubbing on the trough might be due to bearing failure or a bent screw. A bearing failure would cause the screw to rub continuously, whereas a bent screw would cause intermittent rubbing.
Through	Through can be inspected with an ultrasonic device to check thickness of through. Mark the through at a number of points, take reading of the thickness of the through with an ultrasonic thickness tester.	Ultrasonic thickness test enables monitoring of through thickness. It can be especially useful for critical applications where leakage creates a lot of problems

Always Remember - Safety First!

maintenancenews

ArjoWiggins Saves Time with Online Monitoring System

There's no escaping production downtime. But there are two types of downtime: planned and unplanned. The first means an outage need last only a few hours, while the second can amount to a catastrophe. Shutting down operations to perform regularly scheduled factory equipment maintenance is a necessary evil. When equipment fails without notice, however, it can be a company's worst nightmare.

Colin Angus understands that downtime is unavoidable. But he also knows it's controllable. His job as a condition monitoring engineer at ArjoWiggins SAS (Issey-les-Moulineaux, France), a manufacturer of high-quality paper products, is to reduce downtime and maintenance costs. Until a few years ago, he had relied solely on a Microsoft Windows-based application called Entek Emonitor® Odyssey™ from Rockwell Automation to log and analyze vibration data collected from 2,500 points within ArjoWiggins' Stoneywood mill in Aberdeen, Scotland. But the application required considerable manual activity and it did not present information in real time.

Angus knew he needed better information. He initiated discussions with Rockwell Automation to develop a better approach to satisfying ArjoWiggins'maintenance requirements. The result was the development of an automated monitoring system called Enwatch™ Online Surveillance System that enabled the ArjoWiggins plant to reduce lost production time by more than 60 hours.

The Enwatch system was developed in about one year, after consultations with engineers from the Entek unit of Rockwell Automation Global Manufacturing Solutions. The system was deployed in ArjoWiggins in October of 2000 and its impact was felt almost immediately. Within the first 18 months of operation, the plant reduced lost production time by 66 hours. Although the data on the financial benefit of this time savings is considered proprietary by ArjoWiggins, Angus does report that the Enwatch system's ability to collect timely, accurate information, without stretching the resources of the engineering and maintenance departments, has made a significant difference at the company. The 270-point surveillance system, currently installed on two paper machines, has reduced the number of hours required for planned machine shutdowns. 'And there is more scope to change out and inspect suspect equipment before failure, saving us from unexpected downtime,'Angus reports.

Angus says assistance from Rockwell Automation Global Manufacturing Solutions was crucial in identifying trouble spots in the plant. Early in the process, an Entek-affiliated Global Manufacturing Solutions engineer surveyed the machines and associated equipment. Once it was decided to integrate Enwatch with the existing manual data collection system, Rockwell Automation, working with a sub-contractor, installed the new system.

It's important to have continuous contact with a vendor when it comes to sophisticated software. Enwatch uses permanently installed vibration transducers and acquisition units to automatically collect data based on a set schedule. The information is downloaded via a LAN to the Odyssey software, which presents a complete picture of the plant on PCs using Entek PlantLink applications from Rockwell Automation. PlantLink brings an easy-to-read visual display of the vibration data collected from the paper production machines. All points have individual alarm levels.

'We have had some notable successes with the online surveillance system,' notes Angus. 'For example, Enwatch detected damage to an underwire roll bearing due to water ingress. The rolls were removed at a planned shutdown before the possibility of wire failure, which would have involved a 12-hour shutdown if it happened during a production run.'

But the relationship didn't end with the installation of the system. Rockwell Automation dedicated an engineer to set up alarms, determine level and speed parameters, and provide training. 'It was a great help as we weren't just sold a system and left on our own to get on with it,' remarks Angus. That same engineer is still Angus' point of contact at Rockwell Automation. 'We have three good years of specialist continuity.'m RESULTS & BENEFITS: Cut lost production time by 66 hours in the first 18 months of operation Reduced planned machine down-time, thereby reducing maintenance costs Provided automatic data collection every six hours without additional manpower Provided real-time remote monitoring and vibration analysis of critical production equipment Offered complete picture of plant operations through use of PlantLink applications

New PRUFTECHNIK Alignment Tool - LEVALIGN

Yet another addition to the PRUFTECHNIK laser alignment product range - LEVALIGN! The LEVALIGN hardware and software package quickly and easily measures surface flatness with precision and convenience. This system represents an upgrade to the highly successful and respected Rotalign PRO to improve machine running time and productivity.

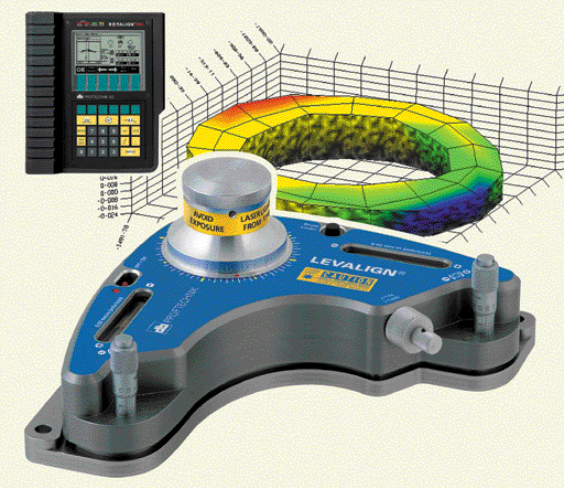
Simply mark a surface grid on the work piece to be measured. Position the sensor at each grid point; with one key press a measurement is taken and stored in the ROTALIGN PRO computer for each location point. The difference in surface profile at each point is calculated and displayed with clear notation of surface flatness or straightness.

LEVALIGN is designed for applications such as machine foundations, bed plates, circular and rectangular flanges and crane slewing rings.

Benefits:

- Precision measurement with resolution better than 0.02mm/m

- Laser range of 20m (40m diameter when working on circular surfaces)
- Capable of measuring horizontal & vertical surfaces
- System uses same receiver and computer as the standard Rotalign PRO



- Inbuilt templates assist user to quickly setup jobs - start collecting results within a matter of minutes
- Professional reporting - including custom tolerances and ëtraffic light' depiction of tolerance conformity

For further details please contact Aquip Systems

Phone: +61 8 9472 0122

Email: sales@pruftechnik.com.au

Web: www.aquip.com.au

Pinnacle Software Meets Multiplex Asset Management's Needs

Facilities management in Australia is a complex and competitive environment with success being determined by systems that deliver flexibility, a customer focus, cost effectiveness and ease of use.

In the past 12 months one of the country's biggest Facilities managers, Multiplex Asset Management - a member of the Multiplex Group - has been growing its Facilities management operations which includes more than 70 properties in the commercial, retail, residential, government and special use sectors.

For institutions with a large property portfolio requiring a group wide asset management system, considerable research needs to be undertaken to identify the most appropriate and cost effective solutions. With Multiplex Asset Management's approach of placing a diverse range of managers on site and spread nationally, an Asset Management system was required to maintain the company's stringent high standards and deliver seamless, effective asset management operations.

With so many sites to co-ordinate, there was a clear need for a system to be implemented that was available to all users, on demand.

Key areas that required specific attention include:

- Maintenance and storage of central databases
- Accessibility to database
- Ease of administration
- Providing complete security of information
- Responsive licencing as not all users would be full time on the system
- Reducing or eradicating the requirements for IT administration
- Information quality and integrity of the highest standard

The solution has been the use of asset management software from Pinnacle.

Pinnacle Enterprise Asset & Maintenance Management Software operates on Multiplex Asset Management's Wide Area Network, using Citrix Metaframe to handle the communications and the network load management. The standardisation of procedures reduces training costs at the same time as it increases accuracy and efficiency of the processes.

Working closely with Pinnacle's implementation experts, the team from Multiplex Asset Management has been highly successful in setting up and administering their asset management requirements. One of the key benefits of this type of asset management software has been that users from all relevant property sites are able to share core knowledge and experience that is maintained in a central system.

At the same time each site has its own special needs and in many cases, Key Performance Indicators set specifically by the particular property owner. For Multiplex Asset Management, these are addressed in the one, standard and customised Pinnacle Enterprise solution.

For Multiplex Asset Management's Maintenance Planning Manager, Raj Parikh, the asset management project has been highly successful, and flexible enough to enable future expansion if required. According to Mr Parikh 'this type of asset management system provides a customer orientated approach that is responsive and flexible. Specifically the system provides Multiplex with standardised methods that are easily adhered to and our costs for setting up a new site are easily controlled as we can switch staff between sites and they are immediately productive'

If you would like further information on the Pinnacle Enterprise software suite please e-mail info@pinnaclesoftware.com.au

or phone 61 (2) 6220 9900 or 44 (161) 955 4414.

Royal Australian Navy selects Aker Kvaerner as preferred tenderer for Integrated Materiel Support

Aker Kvaerner Australia has been selected as the preferred tenderer for the Fully Integrated Contracted Materiel Support for four of the Amphibious and Afloat Support ships of the Royal Australian Navy. Going forward, the Department of Defence intends to negotiate with Aker Kvaerner Australia (includes former Kvaerner Facilities Management) with the aim to agree on a final contract by June.

The Defence Minister has announced the contract is for in-service generation and integrated logistic support services. The scope of work includes planning, and integrated logistics support for the maintenance of the four vessels, together with engineering and integrity management services. The contract is for an initial period of seven years.

The manager of Aker Kvaerner Australia's division for Maintenance, Modifications and Operations, Paul MacFarlane said, 'It is pleasing for us that the Navy has valued highly our track record within the oil and gas industry and our recognition for excellence by the Maintenance Society of Australia. They are clearly looking forward to tapping into the benefits of our new and unique approach to the provision of these services. Our expertise is derived from being part of a global organisation which has access to best practices across a variety of industries and applications.'

Tom Quinn, Managing Director for Aker Kvaerner Australia said 'This represents a new opportunity for Aker Kvaerner Australia to support Australia's defence industry. We have achieved this by combining the Aker Kvaerner group's extensive experience with supplying both maintenance services to the oil and gas industry and support services to armed forces. We are particularly proud of our ability to develop long-term relationships. These are in all cases based upon our ability to deliver high-quality, value-for-money services. We look forward to working closely with the Navy over the coming years, to earn our place as a valuable partner in the provision of their critical service to our country.'

www.akerkvaerner.com

Sydney Water monitors machine health with online condition monitoring technology

Reduced risk of failure and a transformation in maintenance planning are resulting from a new Rockwell Automation condition-based monitoring solution at the Malabar Sewage Treatment Plant.

Sydney Water is the largest water utility in Australia. It supplies water and treats sewage for the four million residents of Sydney, the Illawarra and the Blue Mountains. One of the facilities that Sydney Water Corporation (SWC) operates is the Malabar Sewage Treatment Plant (STP). Located on the coast in Sydney's southern suburbs, the plant is responsible for processing nearly half of the city's sewage.

According to Craig Taylor, asset management specialist at Sydney Water, normal operations at Malabar STP involve sending the primary treated effluent to a deep-water ocean outfall, roughly four kilometres from the shore. Reliable operation of five raw sewage pumps (RSPs) and three centrifuges are critical to the business.

Since protection of the environment is a driving priority, Sydney Water is continuously seeking effective means of minimising the risk of process failure. In 2001 Sydney Water contracted Rockwell Automation to implement an advanced condition-based monitoring solution at Malabar STP. The plant now benefits from real-time feedback of the status of its key machinery systems. Not only does this go a long way to minimising the risk of pollution, but it is also improving the effectiveness of maintenance planning and reliable machine operation.

Peak predictions

Previously, condition monitoring of the facility's rotating plant was carried out manually on a periodic basis. Once a month, Sydney Water staff would connect accelerometers to the rotating machinery--namely, the pumps and centrifuges--as they were running, and would record vibration data using portable vibration analysers/data collectors. This information was then downloaded onto the Enshare plant asset management system, which is used to track, trend and analyse the health of mechanical and electrical assets.

The monitoring was undertaken monthly. Should problems be identified, the information was used to manually raise requests for maintenance--from greasing a bearing to replacing a pump--using Sydney Water's computerised maintenance management system (CMMS), Maximo.

Taylor remarks that when heavy rains occur in the Sydney area, the flows into the plant can be almost three times normal capacity, or 1200 ML/day. Where normally two pumps would have sufficed to handle the load, under these extreme circumstances, four of the five pumps are required. It is at this point that Sydney Water becomes very dependent on the quality of its asset health data--failure of an RSP is to be avoided at all costs.

Monitoring against risk

To provide greater warning of any potential machinery failure, Sydney Water embarked on a project to implement an on-line condition surveillance system at Malabar STP. In 2001, Sydney Water Maintenance Engineer, Nandu Marathe, and industrial automation group Rockwell Automation, carried out an initial conceptual trial for 45 days.

The trial involved the installation of fixed accelerometers, along with direct connections to the corporation's Enshare plant asset management system and Maximo. The purpose was to gauge whether Sydney Water could not only take steps to mitigate against the risk of pump failure at Malabar, but also test the concept of on-line condition monitoring as a maintenance tool.

Adem Adil, Rockwell Automation's Solutions Consultant, explains that Rockwell Automation has a long history of providing tailor-made asset management

Sydney Water maintenance engineer Nandu Marathe, Rockwell Automation's solutions consultant Adem Adil, and Sydney Water asset management specialist Craig Taylor.

systems, and provided the turn-key condition-based monitoring solution, including system design, project management and commissioning.

The core elements of the solution were from Rockwell Automation's Entek product family, including Enwatch surveillance monitors and the Enshare-Maximo Gateway. According to Adil, the reason for using the Entek-based software solution was to keep implementation costs to a minimum. 'The key differentiator with the Enwatch was the ability to gather vibration data and store this into the same Enshare software that Sydney Water know, and have been using, for years,' he says.

Commenced in April 2003, the project was carried out over four months and in two stages: software installation and configuration, and electrical hardware installation at the site. Accelerometers were connected to all five RSPs and all three centrifuges at Malabar. Enwatch surveillance monitors were then provided to automate data collection. Links between the central Malabar control room network server and the running equipment was achieved through the use of Ethernet hubs and fibre-optic cable for the pumps, and a wireless link to the more distant centrifuges.

'When we put together the proposal, we looked at the costs of running 250 metres of fibre optic over to the centrifuges,' says Adil, who was responsible for developing the project scope for Sydney Water. 'The wireless system proved to be more cost-effective and a simpler option--it amounted to a substantial cost-saving.'

To pass the monitoring information from the Malabar control room to Sydney Water's Enshare asset management database server (located 40 minutes drive away in the city), Rockwell Automation installed software on the ëunload PC' transfer station in Malabar's operations support office. Responsible for storing the collected vibration data, the unload PC was configured to send vibration data, via the corporate WAN, to the live Enshare database every ten minutes.

'Instead of taking data once a month under the previous regime, we now have the data coming into the Enshare system on a 10 minute rotation. If there's an alarm, then we'll store that data, otherwise we'll keep one reading every six hours,' says Adil.

Gateway to maintenance

Bringing the information to the plant operators, Rockwell Automation implemented a user-friendly interface, known as the Entek ëPlantLink'. Essentially the interface provides a graphical representation of the health of all machinery being monitored online. Where equipment is running properly, a green visual indicator is used; by contrast, the first and second alarm levels are represented by orange and red respectively.

'We can actually set it up as a screen saver in the production offices,' says Taylor enthusiastically. 'If they see green dots, they know everything is fine. If they see a different colour, then they know something is up and they can investigate further.'

The final step, Adil explains, was to create a direct link between the Enshare system and Sydney Water's Maximo maintenance management system, by installing an Enshare-Maximo Gateway. While the gateway is offered as a standard software product, Rockwell Automation provided a significant amount of site engineering to ensure that the solution was suitably customised to meet Sydney Water's needs.

Adil reveals the advantage offered by the gateway: 'It's a true bi-directional linkage between Enshare and Maximo. The linkage allows the people who are analysing the health of the machine to streamline any requests with the Maximo system. It also allows the guys who are analysing the machine to look at the asset's maintenance history. For example, if a pump item was replaced with a spare unit, it is possible to determine quickly whether there is a problem with the spare now in service.'

Immediate benefits

A certificate of practical completion of the project was granted to Rockwell Automation on August 2003. The most obvious advantage is the greater visibility of the health of the rotating machines--both RSPs and centrifuges--and now, regular analysis is performed on-line. 'It's providing the more selective data we were expecting,' says Taylor, referring especially to the readings now taken automatically during the peak periods each evening.

Taylor also suggests that the greatly reduced time loop is very significant. 'By having the online monitoring 24 hours a day, 365 days a year, we are able to detect changes that may be a trigger for a potential failure.' In this way, Sydney Water has far greater confidence that its Malabar plant will operate as required, without major failure or subsequent downtime for monitored equipment.

The new online system also has important implications for the way maintenance is conducted. 'The Maximo-Entek gateway is the final link in the chain. It lets us create a reactive work order in our Maximo based on the online monitoring,' comments Taylor. 'Basically, we are able to do more of our reactive maintenance on a planned basis.'

Such maintenance issues are far from trivial. Over a twelve month period, Taylor estimates that the greater effectiveness in maintenance planning may translate into a 10 to 15 per cent overall saving in maintenance costs for these units.

Taylor points out that the Malabar trial also has wider ramifications for Sydney Water. In the long term, it will prove the viability of the online condition-based monitoring concept. By reducing the risk to the environment and public health through cleaner waterways, the beneficiaries will be the vast majority of the corporation's owners: the four million residents of Australia's emerald city'.

Technical enquiries

Ross Vaughan,Rockwell Automation Australia Ltd

E-mail: rvaughan@ra.rockwell.com

phone: +61 3 9896 0300

IFS Applications scores highest in Aviation & Defense MRO Survey

In a recent report from industry analyst firm AMR Research, 'Maintenance, Repair, and Overhaul Software for A&D - A Difficult Transition to a Service-Based Model'*, IFS Applications received the highest overall score in terms of full suite MRO functionality. The report covers the needs of manufacturers, service

providers and operators, e.g. airlines or national defense organizations.

According to the AMR Research report, 'IFS scores the highest overall because of strong showings in every category. IFS has a long list of references across the industry and the world. Its component architecture is accommodating to the assembly of the needed functions and integration with other enterprise systems.'

'IFS scoring higher than players such as SAP, Oracle, Intentia and Mincom, is the result of a focused R&D investment in MRO functionality,' Michael Hallen, IFS president and CEO commented. 'As new product opportunities for companies in the Aviation industry shrink, capturing service revenues becomes much more important. This leads to a change in business models. The original manufacturer becomes more involved in the whole life cycle of their products.'

The change to service oriented business models fuels strong demand for MRO software. According to the report, 'AMR Research expects the market to grow at a double-digit rate¢23% Compound Annual Growth Rate (CAGR)¢during the next three years. Much of this growth will be fueled by the changing service-oriented business models'.

With Aviation and Defense being one of IFS' targeted market segments, IFS Applications includes advanced standard functionality that meets the demanding requirements of defense manufacturers and national defense organizations. IFS' fully integrated project tracking and product data management (PDM) capabilities, when combined with other IFS Applications components, make it easier for defense suppliers to operate within government regulatory requirements while managing the design, manufacture, and ongoing spare parts logistics and maintenance support of complex products throughout the product's lifecycle.

IFS customers within aviation and defense include the French, Norwegian, British, Greek, and South African defense as well as suppliers such as General Dynamics, Lockheed Martin, BAE SYSTEMS, Saab Bofors Dynamics, Saab Aerospace, GE Aircraft Engines, Hawker Pacific, the Eurofighter consortium, United Defense and Bristow Helicopters.

* Source: Maintenance, Repair, and Overhaul Software for A&D--A Difficult Transition to a Service-Based Model

AMR Research report, Bob Parker, Marc McCluskey, Kevin Scott

IFS' Web: www.ifsworld.com

MRO Software Enhances Performance Management Capabilities in MAXIMO 5

Delivers Dynamic Personalized Metrics for Real-Time Decision Support

MRO Software, Inc., provider of strategic asset management solutions, announced today the availability of new Key Performance Indicator (KPI) and dashboard performance management capabilities for MAXIMOÆ5, its strategic asset management solution.

MRO Software's MAXIMO 5 enables advanced performance management and includes improved decision support with MAXIMO Dashboard and MAXIMO KPI Manager. This new functionality gives users immediate access to personalized and highly relevant metrics to measure asset performance at a glance.

MAXIMO Dashboard allows users at any level of the organization to select the layout and content in their Dashboard to display information most relevant to their responsibilities. With a view of the business via a dashboard, users can monitor key business metrics, set and monitor operational goals and take a strategic, enterprise-wide approach to asset management. MAXIMO Dashboard provides real-time, actionable information, allowing users to respond quickly to potential problems or opportunities. Dashboard contents are specified by the user, displayed in a variety of formats including dynamic graphs, gauges and lists and require no technical skills to configure.

MAXIMO KPI Manager includes a range of pre-defined KPIs such as Mean Time to Fail, Actual-to-Plan Variance, and Preventive Maintenance (PM) Work Orders Overdue. Custom KPIs are created quickly and easily to allow users at all levels to align their daily metrics with organizational goals. Users create the KPIs to monitor and view in graphical form from the MAXIMO Dashboard. KPI Manager gives users the flexibility to monitor the metrics they need, without having to rely solely on pre-defined, or ëcanned' KPIs. Unlike other solutions, MAXIMO's KPI Manager eliminates users' dependency on IT resources to modify or create new KPIs.

'No other strategic asset management solution provides the range of reporting and display options that are now part of MAXIMO 5, ' said Rich Caplow, director, product marketing, MRO Software. 'The flexibility our customers gain from this variety of KPI's allows them to have the critical metrics available to run their business and make decisions based on real-time information."

This added functionality is available at no additional cost to all MAXIMO 5.2 customers.

http://www.mro.com.

RasGas Selects Meridium to Enable Asset Performance Management Work Processes

Meridium Inc., asset performance management (APM) solutions, today announced a license and services agreement with RasGas Co. Ltd. in Doha, Qatar, for implementation of Meridium's APM software and services.

'We believe Meridium will provide sustainable high availability in our operations, lowering our production risk and operating costs,' said John Fraeijhoven, RasGas Head of Reliability & Integrity Engineering. 'By using Meridium to optimize our asset strategies, we can lower our capital expenditures and leverage our investment in our existing systems like SAP.'

RasGas will utilize Meridium's APM system to enable its unique business processes and provide a foundation for their integrated approach to equipment reliability and overall asset management. The Meridium system will support the industry best practices and methodologies utilized at RasGas, including reliability centered maintenance (RCM), root cause analysis

(RCA), and risk based inspection (RBI).

RasGas was established in 1993 to produce liquefied natural gas and other related hydrocarbon products from the North Field, the world's largest offshore non-associated natural gas field. The mission of RasGas is to become a world-leading LNG company, as measured by profitability, operational performance, commitment and concern for people and the environment.

Elderslie Technologies Enters Distribution Agreement With Singapore Computer Systems

Elderslie Technology Group (ETG) recently announced that it has reached agreement with Singapore Computer Systems Limited (SCS), one of the premier system integration and software solution providers in Singapore, SE Asia and China. The parties have agreed to participate as teaming partners in future IT projects in Asia, including Singapore, Malaysia, Hong Kong and China.

Under the agreement SCS will distribute the ETG world-class software products in Asia. These include GenaWare's GIS, mapping and location based service suite and Pinnacle Software's asset management solution Pinnacle Enterprise. In addition, SCS will use the location and asset intelligence features to develop specialised software to meet a wide range of demands for enterprise and consumer applications.

Elderslie Technology Group, is a wholly owned subsidiary of Elderslie Finance Corporation, an Australian operating lease, finance and investment company with assets of over A$185 million. The Group provides a range of software solutions for GIS, location based services, asset management, telematics, vehicle tracking and telecommunication cost analysis and allocation. Comprising GenaWare, Pinnacle, Vircom and TOMR, Elderslie Technology has offices in Australia, the UK, USA and New Zealand to support its worldwide customer base of over 700 clients and 14,000 licenses.

Singapore Computer Systems Limited, whose parent is Singapore Technologies, a wholly owned subsidiary of Temasek Holdings Limited (the Singapore Government's investment company) is listed on the Singapore Stock Exchange. In 2001, it had sales of over S$540 million. The Group has more than 2200 staff in offices in Singapore, Hong Kong, China, Malaysia, the UK, India, USA, Australia, New Zealand and across SE Asia. As a premier supplier of e-business, systems integration, outsourcing, enterprise and networking solutions, SCS has unparalleled experience and reputation for delivering IT solutions.

For more information, please contact Simon Thompson, Elderslie Technology Group on +61 (2) 9224 0870

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Gold Coast	- 5 - 7 May 2004
Melbourne	- 26 - 28 May 2004
Gladstone	- 9 - 11 August 2004
Sydney	- 23 - 25 August 2004
Email:	mail@maintenancejournal.com
Web Page:	www.maintenancejournal.com

- **Asset Condition Assessment Workshop**

Sydney	- 4th and 5th of May 2004
Melbourne	- 11th and 12th May 2004
Brisbane	- 18th and 19th May 2004
Adelaide	- 25th and 26th May 2004
Auckland	- 16th and 17th June 2004
Email:	npaul@mcp-cg.com
Web Page:	www.assetconditionassessment.com

- **Word Class Shutdowns And Turnarounds Conference**

20th and 21st of May 2004, Bangkok, Thailand
Web Page: www.marcusevans.com

- **Shutdowns And Turnarounds Conference**

21st and 22nd of June 2004, Melbourne, Australia
Email: registration@iqpc.com.au
Web Page: www.iqpc.com.au

- **MSC Reliability Week 2004**

Machinery Health Management Conference
26th - 28th May 2004, Melbourne, Australia
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- **Whole of Life Costing Within Asset Management: Acting Noe To Strengthen Your Assetsí Life Cycles**

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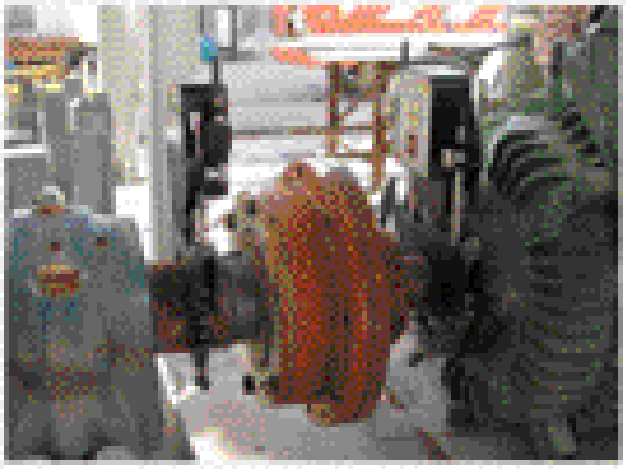

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Course One
Planned Maintenance And Maintenance People
The What, When and Who of Maintenance

1

1. Maintenance Activities

- The different activities performed in maintenance emergency, corrective, preventive, predictive, condition based, proactive, and designing for maintenance.
- The pre-planning process in maintenance
- Shutdown Maintenance - the dangers

2. Consequences of Good or Bad Maintenance

- The direct and indirect costs of Maintenance.
- What do you cost and what are you worth.
- Effect of too little or too much planned maintenance.
- Duties of proving due care of your assets.
- Are "competent" people planning and doing the maintenance work.

Discussion 1: Have your organisations the correct mix of maintenance activities. Do you identify real maintenance costs and respond to those costs

3. Inspections & Condition Based Maintenance

- What inspection and preventive/predictive techniques are now available in maintenance.
- How often should you perform inspections and condition based maintenance activities.
- Increasing the effectiveness of inspection and condition based maintenance activities.

Discussion 2: What techniques for inspections & Condition Monitoring are used in your plant. Are they successful. If not why not.

4. Maintenance Planning and Control

- The different processes and techniques involved with maintenance planning and control.
- The functions performed by a computerised maintenance management system.

5. The People and Structures In Maintenance

- People - The most important assets in maintenance.
- The different organisational structures used for maintenance activities.
- Restructured maintenance; flexibility and team based structures.
- What motivates people to work with the company rather than against it.
- Are teams achievable in your organization? How far can you go.
- Utilising non maintenance resources.
- TPM - Total Productive Maintenance.
- Administrative responsibilities for teams.
- Recruitment and Reward methods.
- Maintenance Outsourcing/Contracting.
- A range of Case Studies on people issues in Maintenance.

Discussions 3: Are your organisations using the right people and structures in maintenance? Successes and failures in people issues.

Who should attend?

Planners, Team Leaders, Team Members, Supervisors, Tradesmen, Operations Personnel, Technicians, Engineers, Systems Managers, and others interested in maintenance of plant and assets.

Each course costs AUS $660.00 per delegate per day (Inclusive of GST)

Course Two
Maintenance Planning
Advances in Maintenance Planning, Maintenance Control and Feedback

2

1. Maintenance Planning in Different Structures

- From chasing breakdowns to total productive and proactive maintenance.
- How does the Maintenance organisational structure affect the roles of planner and supervisor.
- Maintenance Planning in team structures, or for outsourced maintenance.
- Who should be the Planner. Recruitment and Responsibilities/duties of the Planner. Who should not be the Planner. Full time or part time planners.
- Planner to Maintenance Personnel ratio.
- Value of effective planning and planners.

2. Maintenance Planning: Examples Of The Best

- Examples of how the best plan and schedule their Maintenance Activities. Moving from Reactive Planning to Pro-active Maintenance Planning.
- Improving Communication in the Planning process.

Discussion 1: How is maintenance work Planned and Scheduled in your organisations. Planning strengths and weaknesses

3. Developing Maintenance Plans

- Developing maintenance plans. Introducing the various methods currently used.
- Sources of information and expertise. Who should be involved. Using a generic approach. Resources needs.

Discussion 2: The Plan Development Methods in your organizations. Who does it & is it successful

4. Computerised Maintenance Management Systems

- CMMS currently available and a demonstration of some of the improved features of modern CMMS.
- The maintenance planning and control process and how computer systems help improve that process.
- Automating the issue of work and reporting to history. Improving communication and quality of data.
- The move towards Asset Management Systems and beyond the traditional CMMS.
- Linkage to other management systems, control systems, GIS, GPS, Internet, etc.
- Benefits & Problems associated with the use/implementation of a CMMS.
- What makes for successful Maintenance Planning and a successful CMMS. What motivates people to work with the system rather than against it.
- What factors need to be in place if we are to have a functioning system. What factors are required for the BEST functioning systems.

Discussion 3: How well have your organisations selected, implemented and used your Planning Systems and CMMS.

5. Maintenance Stores

- Who owns the store? Stores objectives.
- Introduction to stock control methods for standard, expensive or consumable stock items.
- Improving service levels from your store.
- Maintenance of parts in the stores.

Who should attend?

Planners, Team Leaders, Team Members, Supervisors, Tradesmen, Operations Personnel, Technicians, Engineers, Systems Managers, Stores Personnel, and others interested in maintenance of plant and assets.

Each course costs AUS $660.00 per delegate per day (inclusive of GST)

Course Three

Maintenance Management

Success & Excellence in Maintenance and Asset Management

3

1. Business Success Via Better Maintenance

- The key role that maintenance plays in achieving business success. Maintenance as a profit creator.
- Justifying maintenance resources.
- Proving your worth.
- Maintenance Impact on Safety and Legal Costs.
- Maintenance contributing to long-term competitive advantage.

2. Achieving Maintenance Excellence

- Maintenance excellence - the common features of the best maintenance organizations in the world.
- Excellence in People, Parts and Practices.

2.1 People excellence:

- Leadership, recruitment, training, flexibility, motivation, teams, TPM, performance, rewards, core skills and outsourcing

2.2 Parts excellence:

- Stores management, stores objectives, alliances, internet spares, parts optimisation, improved parts specifications, automated stores, stores personnel.

Discussion 1: How well are you moving towards excellence in people and parts.

2.3 Practices excellence:

- Better corrective Preventive, Predictive, and Proactive maintenance.
- Strategies for reducing down time / repair time.
- Case study on Failure & Replacement analysis.
- Moving through Preventive / Predictive to Proactive Maintenance.
- Improving profits via Proactive Maintenance.

Discussion 2: Discussions on Excellence in Maintenance Practices and introducing the Maintenance Excellence Survey.

3. Maintenance Strategies For The Future

- Setting Strategies: From Policy Statements, Audits, Benchmarking, Gap Analysis and Objectives through to Maintenance Performance Measures and KPI's.
- Examples of Maintenance Objectives and Performance Measures.

Discussion 3: What strategy development, setting of objectives & performance measures are used in your organisation.

4. Analytical Methods In Maintenance

- Maintenance Plan Development and Optimisation Software.
- Examples of how to collect, use, and understand maintenance data.
- Fine tuning PM activities.

5. Asset Life Issues

- Introduction to Plant Design considerations that improve reliability, availability and maintainability.
- Introduction to life cycle costing of assets and terotechnology.
- Plant replacement strategies; software tools.
- Better maintenance specifications of machines and assemblies.

Who should attend?

Maintenance Team Members, Technicians, Planners, Engineers, Supervisors and Managers; plus Production Supervisors/Managers & Accounts/Financial Managers, and others interested in maintenance of plant and assets.

Each course costs AUS $660.00 per delegate per day (inclusive of GST)

The seminar is presented by Len Bradshaw

Len Bradshaw is a specialist in maintenance management and maintenance planning control and an international consultant in this field. Len has conducted over 270 courses for in excess of 8,000 maintenance personnel, both in Australia and overseas. He is managing editor of the Maintenance Journal. He has a Masters Degree in Terotechnology (Maintenance Management) and has held several positions as Maintenance Engineer in the UK and other overseas nations. He is the author of four texts on maintenance management. Len has conducted maintenance management courses for all levels of maintenance staff from trades personnel to executive management.

Seminar Fees

AUS $660 per person per day (Inclusive of GST)

The course fees given above also include Seminar notes as well as lunch and refreshments. Course fee does not include accommodation, which if required is the delegates own responsibility.

Confirmation

A confirmation letter will be sent to each person on receipt of their registration form.

Times

The seminars start at 8:00am and end at 3:30pm, each day. Registration and coffee is from 7:45am each day.

For Further Information

Phone EIT (03) 5975-0083 or Fax Australia (03) 5975-5735,
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www.maintenancejournal.com

VENUES

- **Perth: 29 - 31 March 2004**
  Course One: 29 Mar 2004
  Course Two: 30 Mar 2004
  Course Three: 31 Mar 2004
  Grand Chancellor Perth
  707 Wellington Street, Perth
- **Gold Coast: 5 - 7 May 2004**
  Course One: 5 May 2004
  Course Two: 6 May 2004
  Course Three: 7 May 2004
  Gold Coast International Hotel,
  Staghorn Ave, Surfers Paradise
- **Melbourne: 26 - 28 May 2004**
  Course One: 26 May 2004
  Course Two: 27 May 2004
  Course Three: 28 May 2004
  Rydges Carlton Hotel
  701 Swanston St, Melbourne
- **Gladstone: 9 - 11 August 2004**
  Course One: 9 August 2004
  Course Two: 10 August 2004
  Course Three: 11 August 2004
  Country Plaza Hotel,
  100 Goondoon Street, Gladstone
- **Sydney: 23 - 25 August 2004**
  Course One: 23 August 2004
  Course Two: 24 August 2004
  Course Three: 25 August 2004
  Swiss-Grand Hotel, Bondi Beach
  Beach Road, Bondi Beach NSW

REGISTRATION FORM

Course

✓ Please Tick Course

■ **Course One:** Aus$660 (Inclusive of GST) ☐
Planned Maintenance and Maintenance People

■ **Course Two:** Aus$660 (Inclusive of GST) ☐
Maintenance Planning

■ **Course Three:** Aus$660 (Inclusive of GST) ☐
Maintenance and Asset Management

Venue

✓ Please Tick Venue

☐ Perth
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☐ Melbourne
☐ Gladstone
☐ Sydney

Name of delegate _____ Position _____

Company _____

Address _____

_____ Email _____

Telephone _____ Fax _____

Name of approving officer _____

Position _____

Method of payment

Fee payable $_____

★ ***Cheque*** enclosed made payable to Engineering Information Transfer Pty Ltd

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Cancellations: Should you (after having registered) be unable to attend, a substitute delegate is always welcome. Alternatively, a full refund will be made for cancellations received in writing 14 days before the seminar starts. Cancellations 7 to 14 days prior to the seminar dates will be refunded 40% of the registration fee, in addition to a set of seminar notes. There will be no refund for cancellations within 7 days of the seminar dates. This registration form may be photocopied.

How Do I Register?

1. Fax the completed registration and provide credit card payment details.
   Fax: 03 59 755735
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   VIC 3931, Australia
3. Email Indicate courses/ dates/ venue required and provide details of method of payment to
   mail@maintenancejournal.com

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EIT Multimedia - PV04

MEX

MEX is Australia's leading Computerised Maintenance Management Software. Delivering improved effectiveness and control for you maintenance operation. Combined with dedicated hand-held applications MEX will provide you with a powerful tool for maintenance efficiency.

Whatever your Maintenance sector MEX will address your needs. From manufacturing plants and building facilities to local government, transport and maintenance contractors.

Increased Producivity and Profits

Basic functions of MEX include the Equipment Register; Work Orders; Maintenance Policies; History; Reports; Invoicing and Readings.

These functions ensure that you reduce equipment breakdowns, cut paperwork and save time. You will be able to track the value of your plant and equipment and the Reporting module will help you analyse and improve performance, all combining for a more efficient and effective maintenance operation.

The modular configuration of MEX enables companies to implement additional functionality as required. These modules provide an extra level of system integration including job requests and inventory management.

With MEX you control your maintenance with knowledge. Whether you require detailed information on every aspect of your operation or simply an overview of department efficiency or work scheduled and completed, MEX delivers.

Your Maintenance - Our Expertise

MORE INFORMATION

Talk to people who TRULY understand...

If you would like further information on MEX, HandiMEX and HandiWork please fill in the form below and either fax or mail it back to us.

MEX
MAINTENANCE EXPERTS

320-326 Ipswich Road Annerley QLD Australia 4103
PO Box 6118 Buranda QLD Australia 4102
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Fax: +61 7 3392 4888
www.mex.com.au
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Please send me more information on:

❑ MEX ❑ HandiMEX ❑ HandiWork

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Position: .....

Company: .....

Address: .....

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Your Maintenance - Our Expertise

EFFICIENCY

Maintenance Experts is making maintenance management even easier. Presenting MEX portable maintenance solutions. We have combined excellence in computerised maintenance management with flexible technology to launch maintenance operations to a new level of efficiency.

Maintenance dedicated applications transferring information between MEX and Hand-Held Devices, providing you with total maintenance management in the palm of your hand.

Put maintenance EFFICIENCY on your agenda and take the opportunity to...

- Eliminate paperwork
- Electronically issue workloads
- Capture accurate information
- Remove the need for data entry

Solutions that save you time, money and are seriously simple and easy to use.

SYSTEM requirements - Hardware

Hand-held devices running:

- Palm OS 2 plus; Pocket PC 2002 plus
- Minimum of 8 Mb of ram.

Barcode scanning equipment:

- SPT 1550 and 1700 bar code enabled devices
- "Grabber" barcode scanning device

PC Requirements:

- Pentium based
- 64 Meg Ram
- 50 Mb available hard disk space

SYSTEM requirements - Software

Mex V10 (Access or SQL)

HANDIWORK

HandiWork is efficiency!

When you issue workloads electronically you will know who; what; why; where and when. Download Work Orders to your hand-held device and have the information you need ready to action.

- Filter your Work Order download by department; site; trade code; tradeperson etc
- Include equipment details and tasks
- Capture cost; record comments; issue parts, close and add history all on location
- Automatic upload of information to MEX for a seamless Work Order process.

Moving MEX to your Maintenance

The efficiency of electronic Work Orders offers you great advantages.

- Eliminate paperwork and simplify data entry
- Capture accurate costs; hours worked and parts used
- Track job progress with proficiency
- Ensure quality information for accurate reporting

HANDIMEX

With HandiMEX, the time savings you make on the shop floor carry through immediately to your office. You enter the data into the handheld device, one touch and the data is uploaded to your MEX system, and it is all there, ready to use. HandiMEX includes four task dedicated modules.

Store Issues / Returns

- Issue parts directly to your Work Orders electronically
- Carry out stock returns
- Instant stock level adjustments

Stocktake

- Perform a stocktake of an entire store or selected areas
- Utilise barcodes for accurate inventory identification
- Produce stock adjustment reports

Ad Hoc Work Orders

- Create new Work Orders on location
- Allocate the trade required to do the task
- Capture task details, trades and hours worked

Readings

- Remotely gather equipment readings
- Automatic upload of readings to Work Orders
- Carry last readings and done dates to ensure data accuracy
- Readings can be used to trigger scheduled maintenance

Maintenance Management in the palm of your hand

As the pressure for increasing productivity and business results continues across all industries, the precision and effectiveness of shutdowns and turnarounds has become critical to ensuring consistency in output levels and bottom-line profitability.

Performing an effective shutdown is an example of applying many of the principles of good project management. In order to maximise process efficiency and minimise downtime organisations must be able to predict, develop and run well planned, scheduled and unscheduled, shutdowns and turnarounds.

IQPC is proud to present its third annual ***Shutdowns and Turnarounds*** conference featuring **14 case study presentations** from leading maintenance and shutdown professionals who have tackled the challenges, processes and strategies with a view to continuous improvement for shutdown planning.

Our speakers will share their secrets with you and will address the "how to's" and "watch out's" of shutdowns and turnarounds. In particular, you will hear how:

- **WORSLEY ALUMINA** is monitoring adherence to schedule, safety and resource planning
- **WMC RESOURCES** is employing performance measures to ensure continuous improvements in shutdown planning
- **DELTA ELECTRICITY** is disciplining its organisation to meet deadlines for work requests in order to achieve effective shutdowns and turnarounds
- **MURRAY GOULBURN COOPERATIVE** is eliminating the potential surprises that may hamper an effective shutdown through condition monitoring

By attending this case study driven event you will be able to return to your organisation with the essential information you require to drive continuous improvement strategies in shutdown planning and to make a direct, positive and dramatic impact on your plant's overall profitability.

ACT NOW! DON'T MISS THIS OPPORTUNITY TO NETWORK, BENCHMARK AND TACKLE YOUR SHUTDOWN PLANNING CHALLENGES HEAD ON.

PHONE (02) 9223 2600 AND REGISTER YOURSELF AND YOUR TEAM OF KEY MAINTENANCE PERSONNEL - TODAY!

Who You Will Meet And Who Should Attend

This conference has been researched with and developed for

Directors, General Managers, Officers, Superintendents, Managers, Supervisors and Coordinators of:

▶ Shutdowns ▶ Turnarounds ▶ Maintenance / Maintenance Planning ▶ Technical ▶ Engineering / Engineering Planning ▶ Maintenance Services ▶ Outages ▶ Electrical Reliability ▶ Assets ▶ Project Engineering ▶ Electrical Shutdowns ▶ Mechanical Maintenance ▶ Planning ▶ Projects

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Capture all of the information presented at our conference on compact disc! Your purchase includes a permanent reference of 8-9 CD's and the complete conference workbook. Each presentation is on CD, enabling you to choose a topic and listen to it anytime - any place! Pay only $768.90 (including GST) if you are attending or invest just $878.90 (including GST) if not attending the conference - a cost-effective way to stay on the cutting-edge!

For details and to order, please see the back of the brochure or call Fiona Robinson on (02) 9229 1004, fax (02) 9223 2622 or email fionar@iqpc.com.au

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IQPC sponsors enjoy extensive benefits including:

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SHUTDOWNS AND TURNAROUNDS

21 & 22 June 2004 ▶ Eden on the Park, Melbourne

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To speed registration, please provide the priority code located on the mailing label or in the box below.

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WORKSHOPS ❑ A or ❑ B and/or ❑ C or ❑ D

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Name:

Position:

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Telephone: ( ) **Fax:** ( )

Approving Manager:

Name:

Position:

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Payment prior to the conference is mandatory for attendance

❑ Cheque enclosed for $_____ *(Please make cheques payable to: IQPC)*

Please charge ❑ American Express ❑ Bankcard ❑ Visa ❑ MasterCard ❑ Diners Club

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Note: *Payment includes lunches, refreshments, a detailed conference documentation CD or workbook and all meeting materials. If payment has not been received two weeks before the conference, a credit card hold will be taken. This card will only be processed if we have not received payment two weeks after the conference date.*

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Discounted accommodation and airfares are available through our official travel provider Flight Centre Direct. **If you book your travel through Team Sagitta you will go into the monthly draw to win your flight for FREE!**

Accommodation is available at Eden on the Park, Melbourne. Please state that you are booking for an IQPC conference to be eligible for the discounted rate.

Up to 50% off the full economy airfare or guaranteed best fare of the day is available through Flight Centre Direct - Team Sagitta, phone (02) 8204 7515, fax (02) 8204 7559 or email Rebecca_Ames.nsw@flightcentre.com, quoting the event code F06739. Prices are subject to availability and group airfare conditions may change without notice.

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IQPC recognises the value of learning in teams. Take advantage of one of these special rates:

- $ Groups of 3 or more booking on the conference at the same time from the same company receive a $500 discount from the total registration fee
- $ Register a team of 4 to the conference at the same time from the same company and receive a free pass for a 5th delegate
- $ Ask about multi-conference discounts. Ring (02) 9223 2700 for more details

Please note: Only one discount applies

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1. Gain preferential access to the senior executives in your target market and demonstrate your newest products
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4. Demonstrate your expertise and product excellence

For specific details of sponsorship and exhibition packages, please call Andrew Wood on (02) 9229 1024, fax (02) 9223 3863 or email andreww@iqpc.com.au

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Any information provided by you in registering for this conference is being collected by IQPC and will be held in the strictest confidence. It will be added to our database and will be used primarily to provide you with further information about IQPC events and services. From time to time IQPC may share information from our database with other professional organisations (including our event sponsors) to promote similar products and services. Please tick the box below if you do NOT want us to pass on your details. To amend your current details, advise of duplicates or to opt out of further mailings, please contact our Database Integrity Maintenance Department, Level 6, 25 Bligh Street, SYDNEY NSW 2000. Alternatively, email database@iqpc.com.au, call 02 9229 1028 or fax 02 9223 2622.

❑ I do not wish to have my details made available to other organisations

IQPC CANCELLATION AND POSTPONEMENT POLICY

IQPC does not provide refunds for cancellations. For cancellations received in writing more than seven (7) days prior to the conference you will receive a 100% credit to be used at another IQPC event for up to one year from the date of issuance and a 10% service fee will apply. For cancellations received less than seven (7) days prior to the event no credits will be issued. In the event that IQPC cancels an event, delegate payments at the date of cancellation will be credited to a future IQPC event and will be valid for up to one year from the date of issuance. Where IQPC postpones an event, delegate payments at the postponement date will be credited towards the rescheduled date. If the delegate is unable to attend the rescheduled event, the delegate will receive a 100% credit representing payments made towards a future IQPC event and will be valid for up to one year from the date of issuance. No refunds will be available for cancellations or postponements. IQPC is not responsible for any loss or damage as a result of a substitution, alteration, cancellation or postponement of an event. Nor will any liability attach to IQPC if this event is altered, rescheduled, postponed or cancelled due to a fortuitous event, unforeseen occurrence or any other event that renders performance of this conference inadvisable, illegal, impracticable or impossible. For the purposes of this clause, a fortuitous event shall include, but shall not be limited to: an Act of God; governmental restrictions and/or regulations; war or apparent act of war; terrorism or apparent act of terrorism; disaster; civil disorder, disturbance, and/or riots; curtailment, suspension, and/or restriction on transportation facilities/means of transportation; or any other emergency. Please note that speakers and topics were confirmed at the time of publishing, however, circumstances beyond the control of the organisers may necessitate substitutions, alterations or cancellations of the speakers and/or topics. As such, IQPC reserves the right to alter or modify the advertised speakers and/or topics if necessary. Any substitutions or alterations will be updated on our web page as soon as possible.

Driving Continuous Improvements in

SHUTDOWNS and TURNAROUNDS

Minimising Down Time Through Efficient Resource Planning

Featuring 14 case studies and interactive contributions from:

- WORSLEY ALUMINA
- ALCOA AUSTRALIA
- WMC RESOURCES
- GOODMAN FIELDER
- LOY YANG POWER VICTORIA
- SIRF ROUNDTABLES
- WOODSIDE ENERGY
- QENOS
- BLUESCOPE STEEL
- SMORGON STEEL
- DELTA ELECTRICITY
- EDISON MISSION ENERGY
- MURRAY GOULBURN COOPERATIVE
- MPI MINES - STAWELL GOLD MINES
- CS ENERGY

Save up to $3699 when you register 3 delegates for the price of 2 by 16 April 2004

***Two-Day Conference:* 21 & 22 June 2004**
Eden on the Park, Melbourne

Gain practical strategies and indepth insights from leading organisations and learn how to:

- Develop an efficient shutdown and turnaround plan
- Come in on time and on budget through planning and scheduling
- Monitor resource planning and allocation to eliminate surprises
- Factor safety and OH&S measures to minimise risk

PLUS

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Register Now!

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8.30 REGISTRATION AND COFFEE

9.00 OPENING REMARKS FROM THE CHAIR

Bill Holmes, Director
Industrial Maintenance Roundtable
SIRF ROUNDTABLES

PLANNING AND SCHEDULING FOR SHUTDOWNS AND TURNAROUNDS

9.10 DELIVERING HIGH PLANT RELIABILITY AT THE LOWEST POSSIBLE COST

EXPERT COMMENTARY

High plant reliability at the lowest sustainable cost is the target for many organisations. Bill will discuss how organisations develop environments that deliver safe, timely and on budget shutdowns.

- Key elements to successful plant maintenance
- Common practices of organisations with best practice maintenance strategies
- Understanding the key areas that require process improvement

Bill Holmes, Director
Industrial Maintenance Roundtable
SIRF ROUNDTABLES

9.50 KEYS TO A SUCCESSFUL SHUTDOWN AND TURNAROUND: LOY YANG POWER STATION UNIT 1 MAJOR OUTAGE

CASE STUDY

The Unit 1 major outage involved completion of >200,000 Mhrs of work in 42 days and included the replacement and / or repair of major turbine, generator and boiler plant. ***This lifted the Unit's output from 500MW to >570MW and positioned it for a further six years service at >97% availability.*** After three years of planning and preparation, ***the $70M project came in on time and budget with zero lost time injuries (LTIs), setting a new benchmark in power station outage project management.*** Drawing on his experiences, Colin will detail:

- Planning
- Safety during the outage
- Forward ordering and material management
- Layout and distribution of contracts that drive performance
- Change management

Colin Young, Engineering Manager Power
LOY YANG POWER VICTORIA

10.30 MORNING TEA

10.50 CRITICAL SUCCESS FACTORS FOR A SHUTDOWN: PHASE I TO III - FROM PRE TO POST PLANNING AND SCHEDULING

CASE STUDY

- Shutdowns at the Qenos Olefins Plant
- Shutdowns versus turnarounds
- Shutdown drivers
- ***Phase I*** - pre shutdown
- Collecting work scope - the "expected work", the "other" work and the "cut off date"
- Planning and scheduling
- Integrating process and maintenance work into the schedule
- ***Phase II*** - executing the plan and keeping track of progress
- ***Phase III*** - closure and the wash up meeting

Joao Santos, Maintenance Engineer
QENOS

COMMUNICATION AS A KEY TO EFFECTIVE SHUTDOWN PLANNING

11.30 STRUCTURING CRITICAL COMMUNICATION AND COORDINATION PROTOCOLS

CASE STUDY

Hear how Woodside Energy is ensuring that all parties involved during a shutdown are aware of the shutdown plan, scope of project, scheduled tasks and deadlines by effectively communicating its plan across the organisation.

- Coordinating roles between projects
- Hand overs and communication protocols
- Using good project management protocols as a guide to planning a shutdown

David Birney, Head of Shutdown Planning
WOODSIDE ENERGY

12.10 LUNCH

1.20 ALIGNING SERVICE PROVIDERS AND BUSINESS GOALS TO MEET COMMON SHUTDOWN OBJECTIVES

CASE STUDY

When it comes to an effective shutdown, finding the right balance between quality and time is critical. There is little point in a shutdown being completed on time if the quality of work done does not provide long-term solutions. Hear how Edison Mission identifies and communicates its shutdown objectives to its contactors, maintenance and operations divisions. In this session, Wayne will discuss:

- Setting KPIs to meet business goals
- Tracking KPIs during shutdowns
- Finding the right balance between quality and on time shutdowns
- Structuring and managing the relationship with your alliance contract

Wayne Buckley, Maintenance Coordinator
EDISON MISSION ENERGY

2.00 DEFINING THE OVERALL PLAN FOR SHUTDOWNS AND ESTABLISHING PROJECT SEQUENCES

CASE STUDY

- The overall plan for outage (objectives and goals)
- Setting milestones and scheduling with production and outage timelines
- Allocation of trades and supervision
- Spare parts, tools and equipment isolations (tag and test)
- Commencement of work and monitoring the performance against the plan
- Commissioning and wrap up
- Shutdown critique

Kristian Boyd, Maintenance Supervisor
ALCOA AUSTRALIA

2.40 AFTERNOON TEA

3.00 MOVING FROM A PREVENTATIVE TO A PREDICTIVE MAINTENANCE MODEL

CASE STUDY

- Looking to history and condition monitoring to predict maintenance scheduling
- Improving overall plant efficiency and reducing down time through predictive maintenance
- Utilising routine inspections to identify jobs during shutdown planning

Rob Ellis, Maintenance Manager
GOODMAN FIELDER

3.40 CLOSING REMARKS FROM THE CHAIR

3.50 CLOSE OF DAY ONE

4.00 NETWORKING DRINKS

9.00 OPENING REMARKS FROM THE CHAIR
Shane Brassington
Maintenance Superintendent Steelmaking
SMORGON STEEL

ADDRESSING WORKPLACE SAFETY ISSUES DURING A SHUTDOWN

9.10 BEST PRACTICES FOR MANAGING HEALTH AND SAFETY DURING A SHUTDOWN
CASE STUDY
At Western Port Work, Bluescope has been able to realise direct benefits to the staff and company with improved work practices and increased awareness of safety issues.
- Current developments in safety best practices for shutdowns
- Assessing the real impact of unsafe work practices
- How to measure and monitor direct efforts of improved safety practices

Ross O'Malley, Maintenance Manager
BLUESCOPE STEEL

9.50 MONITORING ADHERENCE TO SCHEDULE, SAFETY AND RESOURCE PLANNING
CASE STUDY
Daily and weekly snapshots of a working plan in progress can provide instant access to the overall efficiency and effectiveness of your shutdown. Hear how Worsley Alumina uses these snapshots more efficiently to provide accurate assessments of adherence to schedule, safety track records and resource planning models.
- Improving compliance of job sheets through daily or weekly snapshots
- Monitoring your work order completion rate
- Assessing the effectiveness of your clearance to work permit system

John Piestrzeniewicz, Shutdown Coordinator
WORSLEY ALUMINA

STRATEGIES FOR BEST PRACTICE SHUTDOWNS AND TURNAROUNDS

10.30 MORNING TEA

10.50 DISCIPLINING YOUR ORGANISATION TO MEET DEADLINES FOR WORK REQUESTS
CASE STUDY
Early preparation in defining the scope and list of work to do during a shutdown can save you significant time and money. This session will explore methods of disciplining your organisation to recognise deadlines and cut off dates for work requests.
- Translating requests for work into a functional schedule for your shutdown
- Getting shutdown plans into action
- Resourcing to keep work on time

Kelvin Roscarel, Project Services Manager
DELTA ELECTRICITY
(subject to availability)

11.30 PLANNING AND SCHEDULING AS AN INTEGRAL PART OF EFFECTIVE SHUTDOWNS AND TURNAROUNDS
CASE STUDY
- Work identification and planning
- Shutdown work scheduling, budgeting and cost control
- Resource planning and allocation
- Learning from past outcomes and previous outages
- Part replacement logistics and resolving scheduling conflicts

Philips David, Senior Plant Manager
CS ENERGY

12.10 LUNCH

1.20 DRIVING CONTINUOUS IMPROVEMENTS IN SHUTDOWN PLANNING
PANEL DISCUSSION
This informal, interactive panel discussion will enable you to learn from the practical approaches and experiences of our expert panellists. You will explore with them how to deploy strategies for continuous improvements and discuss possible solutions to your chief concerns.
Panellists include:
Bill Holmes, Director
Industrial Maintenance Roundtable
SIRF ROUNDTABLES
Shane Brassington
Maintenance Superintendent Steelmaking
SMORGON STEEL
John Piestrzeniewicz, Shutdown Coordinator
WORSLEY ALUMINA

2.00 ADDRESSING SHUTDOWN PLANNING: TRANSITIONING FROM A FIXED TO MOBILE PLANT
CASE STUDY
MPI Mines - Stawell Gold Mines site has addressed new issues concerning its shutdown planning process over the last year. In response, it has moved from a fixed plant to a mobile plant. Hear the key challenges that were faced during this transition and how they were overcome.
- Identifying the differences when planning a shutdown for a mobile plant as opposed to a fixed plant
- Planning and resource allocation
- Planning and scheduling as a key factor to ensuring safety

Dave Quenault, Maintenance Manager
MPI MINES - STAWELL GOLD MINES

2.40 AFTERNOON TEA

3.00 EMPLOYING PERFORMANCE MEASURES TO ENSURE CONTINUOUS IMPROVEMENTS IN SHUTDOWN PLANNING
CASE STUDY
Hugh will discuss how WMC Resources successfully employed performance measures to identify targets for its organisational reliability or continuous improvement program at the Olympic Dam Mine.
- Establishing a continuous improvement program
- Developing performance measures to drive and sustain improvement
- Positive outcomes of the program to-date

Hugh Beveridge, Maintenance Manager
WMC RESOURCES

3.40 ELIMINATING POTENTIAL OBSTACLES THROUGH CONDITION MONITORING AND PLANNING
CASE STUDY
Knowing the condition of your plant at all times is critical when planning a shutdown. Collecting and analysing the right data provides information to plan a predictive maintenance model that in turn can be used as a scheduling guideline for the shutdown plan. Hear how Murray Goulburn Cooperative is using data collected from its condition monitoring system for nine plants to plan more effective shutdowns and turnarounds.
Mark Gurney, Group Maintenance Manager
MURRAY GOULBURN COOPERATIVE

4.20 CLOSING REMARKS FROM THE CHAIR

4.30 CLOSE OF CONFERENCE

Separately Bookable Post-Conference Workshops

Wednesday, 23 June 2004 ◆ Eden on the Park, Melbourne

To ensure you get maximum benefit from attendance at this event, register a team to cover all workshops. Special platinum workshop upgrades are available for additional delegates - see back page for details.

MORNING

WORKSHOP A: 9.00AM - 12.30PM

HOW TO PLAN AN EFFECTIVE SHUTDOWN: A STEP-BY-STEP APPROACH TO PLANNING AND SCHEDULING

A well planned and executed shutdown requires a comprehensive approach to ensure all shutdown targets are met. A step-by-step approach is essential to maintain reliability and availibility of your plant. ***The emphasis in this hands-on workshop will be on a simple, pragmatic and practical approach to planning and scheduling. You will be introduced to the most up-to-date best practice approaches to planning and scheduling an efficient shutdown. In particular, you will learn how to:***

- Identify work scope
- Plan and schedule - maintenance history and data analysis
- Come in on budget through effective planning and scheduling
- Conduct pre and post shutdown analysis
- Schedule critical activity planning
- Incorporate condition monitoring as a preventative tool
- Factor safety and OH&S measures to minimise risk

ABOUT YOUR WORKSHOP LEADERS:

Ian Blair, Senior Consultant and Director of **Advanced Business Management Group (ABMG),** has been working as a consultant implementing manufacturing and telecommunications systems for the past 20 years. His consulting work has been in strategic planning using activity-based costing and performance management as tools for monitoring and rewarding performance. **Peter Robinson,** Managing Director, **Daedalus Compass** (**London and Melbourne**), is an engineer economist of international repute. He is the Founding Chairman and was Public Officer of the Maintenance Engineering Society of Australia. His vast experience includes a range of disciplines and hands-on practice in infrastructure maintenance, support systems and sourcing contracts.

MORNING

WORKSHOP B: 9.00AM - 12.30PM

HOW TO AVOID REACTIVE MAINTENANCE BY CONDUCTING ROOT CAUSE ANALYSIS

Learn how to use this essential and comprehensive root cause analysis tool to provide your organisation with an effective, systematic and consistent process for individuals and teams to use. Also, cover how to then take it further to enable your organisation to record and report outcomes and where appropriate, to communicate outcomes with customers, suppliers, alliance partners and regulatory authorities.

In particular, you will learn how to:

- Gather and evaluate the data necessary for analysis
- Introduce practical, visual tools to find pattern trends and linkages
- Build cause trees that effectively display the range of potential causes and based on evidence, select the root cause and therefore the change to be implemented

Participants will be provided with a structured approach for analysis and explore creative and constructive solutions. Hands-on exercises will be used throughout the workshop to develop the necessary skills at various stages.

ABOUT YOUR WORKSHOP LEADER:

Bill Holmes, Director, **SIRF Roundtables**, is a mechanical engineer specialising in the maintenance of industrial plants. He has facilitated the Industrial Maintenance Roundtable since 1994. The Roundtable brings together seventy of Australia's largest manufacturing and mining organisations to compare practices in delivering highly reliable plants at the lowest cost. In this role he has participated in more than 130 formal benchmarking studies on five continents and coaches the evaluation team for the Australian Maintenance Excellence Awards.

LUNCH

AFTERNOON

WORKSHOP C: 1.30PM - 5.00PM

HOW TO USE RISK-BASED ASSESSMENT FOR SHUTDOWN SCOPE PREPARATION

As owners of plants, risk management of assets is something you do as part of your day-to-day business, regardless of whether you are the CEO, the plant engineer or a maintenance technician. A risk-based assessment (RBA) approach to management of assets systemises this thinking and doing action into a formal, logical and auditable process. ***Through this workshop you will learn how risk-based management is as much about managing people and processes as it is about managing assets. In particular, you will expore:***

- Introduction to RBA methodology
- Aligning shutdown scope of work and business risk
- Utilising RBA as a prioritising and planning tool
- Lighting damage mechanisms and avoiding serious business impact failures

ABOUT YOUR WORKSHOP LEADER:

David Keen, Managing Director, **Plant Reliability Solutions,** is a metallurgist with extensive experience in materials performance, risk-based assessment and process plant reliability management. David's experience includes completing risk based assessments on more than twenty process plants and power utility facilities in Australia, New Zealand and Indonesia, implementing reliability improvement programs on process plants and numerous plant failure investigations.

AFTERNOON

WORKSHOP D: 1.30PM - 5.00PM

HOW TO IMPROVE RELIABILITY THROUGH FAST MAINTENANCE AND FAILURE ANALYSIS TOOLS

The activity of defining and reviewing a maintenance program is one that is generally poorly done. Not surprisingly, if done properly, this process alone can be the most effective means of generating company profits through greater output from the same assets. ***Through this workshop you will learn how this revolutionary PMoptimisation methodology is improving the effectiveness of maintenance programs and strategies. In particular, you will walk away knowing how to:***

- Understand the nine steps of PMoptimisation (PMO)
- Decide where to use RCM and where to use PMO
- Cope with poor failure history

In addition, you will work through a case study so you can learn how the process works in a typical environment.

- Bring along your own problems for evaluation
- Round off the day with a discussion on implementation issues relative to your own organisation

ABOUT YOUR WORKSHOP LEADER:

Steve Turner, Director, **OMCS International,** is a professional engineer and with his colleagues has developed a reliability assurance program known as PMO2000. ***Since its beginning nearly seven years ago, this program has been adopted in over seventy sites across the globe*** and has positioned itself as a practical approach that produces lasting results quickly and effectively. Steve and his licensees have trained over 3,000 people in three languages across the globe.

Call (02) 9223 2600 To Register Or (02) 9229 1024 To Exhibit

REGISTRATION FORM

RELIABILITY AND MAINTENANCE MANAGEMENT

3 & 4 June 2004 - Carlton Crest Hotel, Sydney
7 & 8 June 2004 - Eden on The Park, Melbourne
10 & 11 June 2004 - Sheraton Hotel, Perth

Register Now

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By Mail : Applied Technology (Aus) Pty Ltd
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DELEGATES

10% discount is applicable if you register 3 or more delegates from the same company.

Please tick ✔ the relevant box to indicate your preferred dates & choice of venue.

☐ **SYDNEY** 3 & 4 June 2004 Carlton Crest Hotel
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TIME SCHEDULE

Seminar starts at 9.00am and ends at 5.00pm daily. Please arrive at 8.30am on day one to allow time to register and receive seminar materials. Lunch at 12:30pm to 2.00pm.

VALUABLE DOCUMENTATION

Seminar materials specially prepared by the presenter will be supplied to all delegates. These materials will serve as a continuing reference source for you and your colleagues during and after the event.

CPD RECOGNITION

This training programme is designed to meet the Continuing Professional Development (CPD) needs of participants. A Certificate of Attendance indicating the number of CPD hours achieved will be awarded at the end of the programme. This serve as evidence of your personal and professional commitment to your career.

CANCELLATION POLICY

All cancellation of registration must be made in writing. If you are unable to attend ...
a) a substitute delegate is welcomed at no additional charge.
b) your registration can be credited to a future event.
c) you will receive a full refund less 10% administrative charge if cancellation is received in writing more than 14 days before the event.
d) you will receive an 80% refund of the registration fee if cancellation is received in writing within 7 - 14 days before the event.
e) no cancellations will be accepted within 7 days of the event start date. Full seminar documentation will, however be sent to the delegate.

REGISTRATION FEES

		GST	Total
Individual Fee	AUD$1390.00	AUD$139.00	AUD$1529.00

Group Discount: Send three or more delegates from the same organization and SAVE 10% off the registration fees for each delegate.

Payment Terms: Payment is required before the event. Once received your place is automatically reserved. Registration fee includes lunch, refreshments and full training documentation as specified. Delegates may be refused admission if payment is not received prior to the event. The fee does not include hotel accomodations.

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Please tick ✔ the relevant box to indicate your method of payment:

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A Two-Day Seminar

RELIABILITY and MAINTENANCE MANAGEMENT

With a Value-Oriented Focus on Such Techniques As:

- *Reliability Centered Maintenance*
- *Total Productive Maintenance*
- *Failure Mode and Effects Analysis*
- *Reliability, Maintainability and Availability Analysis*
- *Inspection and Condition Monitoring Policy*
- *Spare Parts Inventory Policy*

presented by

Dr. Nick Hastings

International Consultant and formerly Professor of Maintenance Engineering Queensland University of Technology

SYDNEY
3 & 4 June 2004
Carlton Crest Hotel

MELBOURNE
7 & 8 June 2004
Eden on The Park

PERTH
10 & 11 June 2004
Sheraton Hotel

APPLIED TECHNOLOGY GROUP OF COMPANIES
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RELIABILITY and MAINTENANCE MANAGEMENT

ABOUT THE SEMINAR

Many techniques have been proposed in recent years as providing "breakthrough" approaches to the management of maintenance. These techniques include:

- *Reliability Centered Maintenance*
- *Failure Mode and Effects Analysis*
- *Total Productive Maintenance*
- *Maintenance Outsourcing*
- *Reliability Analysis*
- *Availability and Maintainability Analysis*
- *Inspection Interval Setting*
- *Condition Monitoring*
- *Redundancy and Repair Pools*
- *Spare Parts Inventory Policy*
- *Maintenance Budgeting*

The aim of the seminar is to provide the modern maintenance practitioner with a state-of-the-art overview of a range of techniques, with the focus on identifying those aspects, which will assist us in achieving enterprise profitability through optimum maintenance strategies.

Rather than present any single technique as the "perfect solution", the seminar will illustrate the characteristics, advantages and possible pitfalls of the various techniques from the point of view of business profitability and sustainable equipment management.

This approach will assist practitioners to deal confidently with the many challenges posed by sophisticated modern equipment, high user expectations and the necessity to contain costs.

PROGRAMME OUTLINE

Outline Program - Day 1

Session 1

Introductions and Seminar Outline

- Aims and Basic Essentials for Effective Maintenance
- Equipment Functions and Their Criticality in Terms of Business and Technical Processes
- Formulating Maintenance Strategy
- Outsourcing Advantages and Disadvantages
- Computerized Maintenance Management Systems (CMMS) - Role and Effective use

Session 2

Outline of Reliability Centered Maintenance (RCM)

- Strengths and Weaknesses of the RCM Approach
- Failure Mode and Effects Analysis (FMEA)
- Root Cause of Failure, Anticiparory Failure Analysis
- Effects of Failure, including Safety, Environmental and Hidden Effects
- Severity, Occurrence, Detection and Risk Rating

Session 3

Corrective Actions

- Links between FMEA and RCM
- Maintenance Task Analysis including Statutory Tasks, Inspection, Lubrication, Adjustment and Condition Monitoring Tasks
- Conditions where Action on Failure is an Acceptable Solution

Session 4

Creation and Updating of Standard Work Orders from RCM or Other Data

- Job and Work Load Planning
- Case Study

Outline Program - Day 2

Session 1

Total Productive Maintenance (TPM)

- Role and Importance of Operators and First Line Maintenance
- Continuous Improvement

Session 2

Introduction to Reliability, Availability and Maintainability

- Reliability and Availability Analysis for Repairable Items
- Series, Parallel and Standby Systems
- Reliability of Protective Systems
- Setting Inspection Intervals

Session 3

Reliability Analysis for Non-Repairable Items

- Preventive Replacement Policy Analysis
- Condition Monitoring
- Evaluating condition monitoring options and frequencies

Session 4

Spare Parts Inventory Management Policy Setting

- Repair Pools, Advantages, How to Decide How Big the Pool Should Be
- Slow Moving and High Cosr Spares Policy
- World Wide Web Based Spares Access Systems
- Re-supply Policies Including Air Freight
- Maintenance Budgeting

SEMINAR LEADER

DR NICK HASTINGS is an International Consultant specialising in Engineering Asset Management Systems and an Adjunct Professor of Engineering at Queensland University of Technology. He has a degree in engineering from the University of Cambridge and a Ph.D. in Operations Research from the University of Birmingham.

Nick has extensive experience in management positions in engineering and logistics organisations in Australia, U.K., Hong Kong and Malaysia.

He has also been involved over many years in consultancy activities in engineering asset management in a wide range of industries, including manufacturing, electricity utilities and mining. At Queensland University of Technology, Brisbane, he held the position of Director of the Centre for Asset Management prior to his recent retirement. His recent professional activities include:

- Conducting courses in a range of industrial management topics
- Consultancy in engineering asset management systems in many industries including electricity generation and transmission, vehicle fleet management, glass manufacture, lens manufacture and automotive component manufacture.
- Author of four books in management science fields and numerous research papers on industrial management topics.
- Present or past member of the Australian Production and Inventory Control Society, the UK and Australian Societies of Operations Research, the Institutions of Engineers (U.K. and Australia), the Maintenance Engineering Society of Australia and the Australian Computer Society.