SEPTMEBER 2016
ISSUE
03
Volume 10

THE ASSET JOURNAL

ASSET MANAGEMENT COUNCIL

INTEGRATED ASSET MANAGEMENT

Smarter and More Scientific: A Decision Support System, for Integrated

Asset Management

Operational Interfaces – asking the right questions

An Integrated Approach to Operations and Maintenance

ERNST KRAUSS EDITOR IN CHIEF

I recently returned from a work assignment in the USA, where we reviewed the capability of an organisation to deliver Operational Readiness during the Project. The refreshing part was that the Oil and Gas Operator was looking to understand what needed to be done early in a Project to ensure life cycle support for their facility. An interesting point for me to note was that the ISO 55001 requirements were not known to them, but they intuitively (and by experience) put a large number of steps in place that could be directly linked back to the Asset Management Systems Standard. A number of key steps found in the Systems Engineering Standard were clearly visible and implemented, while some other essential parts were thought to be of lesser relevance to being ready to start a complex processing plant.

Integration of Asset Management is obviously a topic that is of increasing importance, as I also found out that many Councils (or Counties) in the USA are looking towards the Asset Management concept to improve what they are doing and make Resident's taxes reach further. Linking in a smart way technical, financial and organisational aspects of an organisation will with increasing awareness be demanded more and more by Stakeholders. Value delivery through Asset Management will create opportunities for integration of all elements constituting a Business. Our feature articles in this volume of 'The Asset' will share some thoughts and ideas about the importance of integration of functions, processes and methodologies.

In the background, the AMBoK team also directs their attention to the practicality of implementing Asset Management into organisational and business life. The newly released Asset Management Maturity Model will certainly assist organisations to see how the elements of an Asset Management System impact on their business, highlighting specific areas for improvement. Other work undertaken focusses on the integration of support systems and how these IT solutions might aid the general management of Assets and assuring performance. Leaves us to anticipate the time when Asset Management as a life cycle concept finds its way into formal education. Perhaps you can share an integration experience with us, either on linkedin, the Asset Management website or in an article. We welcome your contributions, thoughts and feedback on the Journal.

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Publisher: The Asset Management Council
Chief Editor: Ernst Krauss
Publication Design: nonilou
ISSN: 1834-3864

For all enquires please change contact to:
publications@amcouncil.com.au
Asset Management council
PO Box 2004 Oakleigh Vic 3166
Tel 03 9819 2515

From the Chief Executive Officer

CEO,
DR ANNE GIBBS

Global Issues Local Solutions – the Big Questions in Asset Management is the theme for the 2017 International AM Council AMPEAK Conference to be held 2nd to 5th April 2017 at Brisbane Convention and Exhibition Centre.

Organisations are looking for continuous improvement and to deliverconsistent and sustainable outcomes for stakeholder such as improvedreliability, improved maintenance, better use of risk tools, IT systems fit for purpose, predictable returns. Asset Management is a mechanism to helpderive value from our assets. The ISO55000 set of standards is around amanagement system that provides structure for organisations to use to helpderive that value. The AMCouncil is known in the international asset management community as a member of the GFMA for its work in assisting the global AM community in delivering the ISO55000 set of standards. Setting an overall framework in which to undertake asset management provides a basis for an organization to integrate asset management into its business processes. The principal objective of integrated asset management is to achieve the best possible match of assets with an organisation's delivery strategies to achieve the desired outputs and outcomes. This is done through the appropriate development and implementation of the essential organizational asset management principles, themes, frameworks and functions. A certain level of management insight and expertise from diverse organisational disciplines is required to integrate processes of managing physical assets during their useful lives. The Asset Management Certification Scheme comprises competency sets expected of asset managers at career stages grouped into four levels. Asset managers who have attained recognition for each of these competency sets (CAAM, CPAM, CSAM, CFAM) can provide comfort to employees that the organisation has the necessary skill levels to provide integrated asset management solutions for the organization. The asset management certification scheme competency sets are listed on the AMCouncil website.

The AM Council has developed four framework models, each of which appeals to a certain asset management function in an organisation

1. Organisational leaders have a strategic perspective on asset management and would find the Concept Model provides the conceptual framework from which the foundation elements of asset management can be identified, documented and implemented.
2. Management is interested in the tactical perspective of asset management and the Asset Management System Model defines the part of a management system for the management of assets and their relationship between the parts.
3. Operational perspective on asset management is in Implementation of asset management within an organization and here the Asset Management Capability Delivery Model is used. The primary purpose of the Capability Delivery Model is to document a typical set of processes that can be used to Provide guidance for the application of an asset management system; Develop and implement an asset management system capability; and Develop and implement an asset capability(solutions) for an organisation.
4. The asset management council's asset management maturity model is a performance improvement tool allowing an organisation to test its level of asset management maturity, find nay gaps and opportunities for better integration of its asset management systems and processes considering the ISO550001 principles and GFMAM landscape.

One big question in asset management is how to use ISO55001 standards toassist in integrating asset management into the business and obtaining value from asset management. We welcome your participation in the International AMPEAK17 Conference in Brisbane during the first week of April 2017 and look forward to receiving papers addressing the conference topic including the questions around integrated asset management.

From my desk: Chairman's Letter

CHAIRMAN,
GLENN INGRAM

When I think about integrated asset management, I think about a Rubix cube, you need to understand how each side affects the other in order to arrange it in the right order. Asset management integration is important concept that helps organisations cover the whole life cycle of an asset and how this asset will be managed. This method has a number of benefits such as enabling business decisions, engagement with stakeholders, multi criteria analysis and it will help organisations optimise their investment strategy.

With the increase of machine complexity and market competitiveness integrated Asset management became imperative. It has been considered as an effective approach to improving Asset management. The holistic view of the whole business objectives, activities, resources, processes, asset conditions and other constraints of the organisation are met through appropriate implementation of integrated asset management. Poor asset management will result in significant financial waste.

When thinking about the decision making process, I see that Integrated asset management helps provide a decision support mechanism. This mechanism enables users to make decisions based on grass root asset condition data, at the same time taking into account the information in different dimensions such as financial data, human resource, business risk and inventory. This journal edition will show a number of cases where integrated asset management delivered great value for organisations and helped them deliver their organisations strategic objectives.

I'm looking forward to October as we hold the Asset Management Council Leadership team weekend in my home town, Brisbane. On that weekend more than 35 volunteers give up their weekend to participate in a number of discussions that help the asset management council shape its future strategy and to define the initiatives that it will implement to service its members.

A call for papers for AMPEAK17 was recently launched and lencourage all asset management practitioners to make it a priority to meet at AMPEAK17. AMPEAK is the hub that will bring you the cutting edge knowledge and case studies around the world. I take AMPEAK as on opportunity to reflect and learn what is new.

ARTICLE 1 – INTEGRATED ASSET MANAGEMENT

Natasha Bosman-Gertenbach, B.Eng. (Civil), M.Eng. (Transport), Senior Engineer, HDR Angela Hili, B.Eng. (Civil), Project Manager, Transurban Ltd

INTRODUCTION

Historically the approach to funding transport infrastructure maintenance has been more reactive than proactive. In the current market, limited available funds are driving more efficient asset management and optimisation of maintenance investment strategies.

HDR recently worked together with Transurban Queensland (TQ) to study the optimum pavement investment strategy over the life of a section of the Logan Motorway and Gateway Extension Motorway, Queensland.

The project team was faced with two main problems in developing a program of works namely:

- Analysing a large volume and array of data to enable business decisions
- Communicating the analysis and outcome to non-technical stakeholders

This case study outlines the process the team developed that simplified the complexity and scale of the project in order to undertake a multi-criteria analysis to develop a revised program of rectification works.

Tech 1

CASE STUDY

Transurban Queensland (TQ) is the franchisee for the Gateway Extension Motorway and Logan Motorway operating under a Road Franchise Agreement (RFA) with the Queensland Government. When the RFA was developed in 2012, portions of the franchised road network had notionally exceeded their design horizons.

The RFA outlined a requirement to prepare a Pavement Rectification Program (PRP) to rectify non-conformances identified on the Gateway Extension Motorway and Logan Motorway within a pre-determined timeframe. TQ prepared the original program in 2011, and has delivered two large pavement rehabilitation projects on the westbound carriageway of the Logan Motorway in the last three years. Initial investigations undertaken prior to the delivery of the next project indicated that the pavements had not deteriorated to the extent predicted. Based on these findings, and the significant volume of pavement rehabilitation remaining in the PRP, TQ developed the PRP Review Project (PRP Review) to consider the whole of life cost impacts, project delivery program and the long term pavement maintenance costs.

FRAMEWORK FOR DELIVERY

In order to achieve the project objectives, the project needed to balance the organisational and technical context in line with ISO55000.

This balance was spread across three project stages:

Stage 1: Condition assessment

Stage 2: Pavement investment strategy assessment

Stage 3: Multi-criteria analysis

Figure 1 represents the project progress in terms of inputs and outputs.

STAGE 1 CONDITION ASSESSMENT

The condition assessment stage was conducted in a technical context and included the collection and evaluation of data.

Available existing data was collated and a gap analysis undertaken to identify areas requiring further investigation. Further investigations undertaken included:

- Geotechnical testing (test pits, trenches, etc.)
- Detailed visual assessment

The collated investigations formed a large volume of data and data sets that then required evaluation and consideration. The volume of data presented a challenge in viewing and considering the data holistically. To address this, integrated pavement plans were developed. The integrated plan summarised all the data in uniquely named 100m segments in accordance with TQ's asset management system.

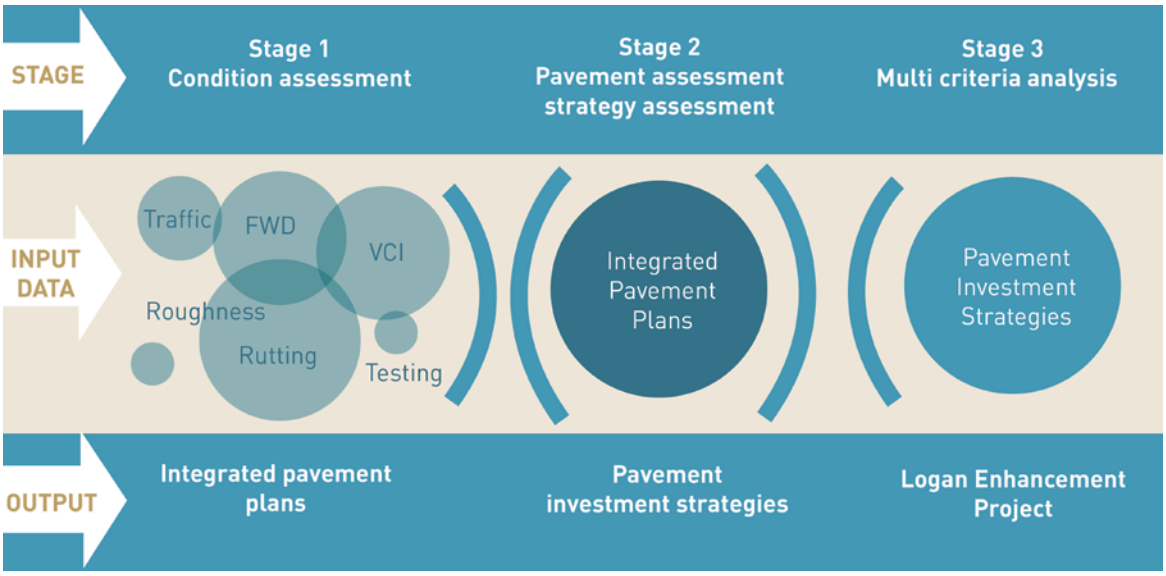

Figure 1 – Framework for delivery

Figure 2 below page displays an example integrated pavement plan

Evaluation of the data in the integrated format enabled easy identification of the cause and mechanism of distress across the project network, both in isolated locations, and homogeneous sections. The integrated pavement plans also supported the development of pavement treatments and strategies outlined in Stage 2.

STAGE 2 PAVEMENT INVESTMENT STRATEGY ASSESSMENT

Three pavement investment strategies were developed that took into account TQ's organisational context and the technical requirements of the various homogenous segments. These strategies consist of multiple treatments that were then applied to different homogenous sections along each motorway. By undertaking an analysis of the strategies in this way, the project team were able to understand the typical treatments that were required and the suggested pavement structures that should be investigated in future detailed design scenarios. The treatment options were common within the strategies and were selected to minimise raising the existing road surface level thus limiting impact to existing road furniture and reducing costs. The treatments developed included:

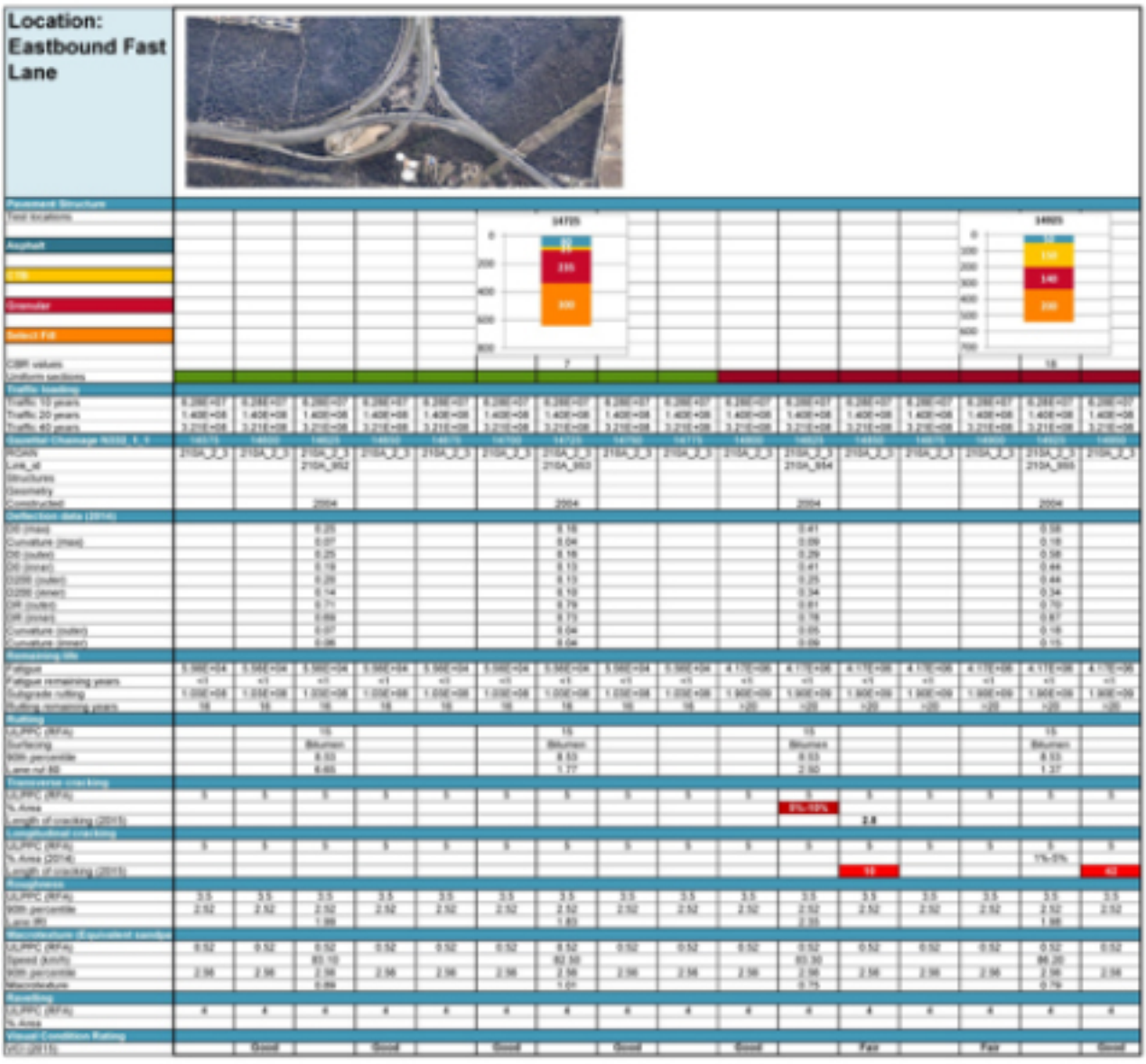

Figure 2 – Example Integrated Pavement Plan

- **Treatment 1 –** Short-term treatment and resurfacing actions - aimed at repairing the isolated poor areas by means of heavy patching, and resurfacing the remainder of the traffic lanes
- **Treatment 2 –** Long term structural treatment – structural remediation that addressed the pavement's structural capacity
- The strategies applied across the PRP Review network were:
- **Strategy –** typically delayed the structural remediation of the pavements for five years. This strategy required a partial rehabilitation at the end of the concession period to ensure the hand-over remaining life requirements were met. This strategy involves treatment 1, 2 and then 3 in succession and was generally suited to pavements with a theoretical structural remaining life greater than five years where only the surfacing requirements need attending
- **Strategy 2 –** typically involved the structural remediation of the pavement at the beginning of the assessment period and required partial rehabilitation at the end of the concession period. This strategy involved treatments 2 and 3 in succession and was generally suited to areas where the bound layers have fatigued, but the overall structure may still resist subgrade deformation and in situ stabilised layers may still be reused
- **Strategy 3 –** typically involves medium-term structural remediation with further strengthening after ten years. This strategy involves treatment 3 then 2 and is generally suited to areas where the carriageway will be widened in the long term

STAGE 3 MULTICRITERIA ANALYSIS

The project objective to optimise the whole of life investment strategy for the pavements needed to be assessed with TQ's operational context. This involved demonstrating that the proposed strategies provided a safe and reliable network to the road users before, during and after implementation of the strategies. In order for the evaluation to yield optimal outcomes, the strategies were evaluated using a multi-criteria analysis. The organisational drivers were categorised into the requirements of the relevant stakeholders and formed the basis of a multi-criteria evaluation matrix.

CONCLUSION

The PRP review identified a wide range of rehabilitation strategies and a large number of homogeneous sections. The revised PRP developed a reliable program with estimates that enabled the development of:

- Informed Capital Expenditure forecast for TQ
- Reliable planned operational pavement maintenance expenditure

KEY OUTCOMES

A key asset management outcome was the development of the integrated pavement plans. These plans acted as the asset manager's road map, informing each phase of the study. The integrated plans acted as the guide to all further stakeholder discussions and options analysis.

- In addition, the integrated pavement plans produced a number of advantages:
- During the condition assessment the integrated pavement plans were used to verify data
- The data could be compared to other data sets to determine whether a non-conformance was functional or structural, and if other mechanisms of distress needed to remediation or rehabilitation
- During the pavement investment strategy assessment, treatment options could be developed that considered the asset as a whole. The proposed treatments and strategies could take into account the proximity to ramps, the condition of adjacent lanes and the condition of adjacent homogenous sections
- During the evaluation stage the integrated pavement plans acted as a visual representation of the data. The plans linked the technical analysis to the physical asset thus facilitating discussions with various stakeholders without the stakeholder having to digest volumes of technical information.
- The integrated pavement plans simplified complex data to an easily understandable and viewable format that could be understood by both technical and non-technical stakeholders

The intention of the integrated pavement plans are not to replace sophisticated proprietary data analytics software, but rather to provide a snap shot of the network which is easily understandable by all levels of the organisation.

ARTICLE 2 – SMARTER AND MORE SCIENTIFIC: A DECISION SUPPORT SYSTEM FOR INTEGRATED ASSET MANAGEMENT

From Yong Sun*, Lin Ma, Liqun Zhang and Sheng Zhang paper AMPEAK 2008

1. INTRODUCTION

Numerous organisations such as the manufacturing industry and transport enterprises heavily rely on their assets to do business, either making products or providing services. Optimal Asset Management (AM) is imperative for these asset intensive organisations as AM costs can occupy a sizeable portion of the total costs of business [1]. AM activities without optimisation could result in significant financial waste. Presently, integrated AM has been considered as an effective approach to improving AM. The integrated AM demands a holistic view of the whole business objectives, activities, resources, processes, asset conditions and other constraints of the organisation in the AM. The need for optimal integrated AM becomes pressing with increasing complexity of machines and competitive market pressure.

AM involves a variety of decisions. To optimise AM, the AM decisions must be optimised first. However, optimisation of AM decisions, especially integrated AM decisions, can be difficult because each of the decisions often involves multiple actors, different objectives and constraints. An effective approach to overcome the difficulty is using computerised systems to assist in decision making [2-3]. Such computerised systems are termed as Decision Support Systems (DSS). Although the DSS has been developed for decades, an all-inclusive definition of DSS is still absent [4]. The definition used in this paper comes from Mallach who defined the DSS as "a computer-based information system whose primary purpose is to provide knowledge workers with information on which to base informed decisions" [5]. According to this definition, a great number of DSS can be found.

However, despite the numerous DDS, none of them can meet industrial needs for making optimal integrated AM decisions satisfactorily. On the one hand, general DSS or DSS designed for other domains such as financial management are difficult to be used for AM decision support, if not impossible, because AM decisions need sound AM domain knowledge. On the other hand, the existing AM decision support software packages often focus on a specific AM aspect – more often which is maintenance optimisation [3]. Further more, these software packages are often developed based on some specific models. Given that AM involves different types of assets, organisations and business scenarios, this type of software packages is insufficient as serving the demand of modern AM. Nevertheless, there are software packages in which different models have been embedded to deal with different aspects in AM such as reliability analysis, life cycle cost analysis, maintenance scheduling and inventory management.

However, these packages often supply a number of tools for each aspect only.

2. INTEGRATED AM DECIOSN FRAMEWORK

As mentioned in Section 1, integrated AM decisions are made based on the recognition that financial measures are the fundamental measures of enterprise success and extend beyond maintenance to include all factors that determine and influence the total lifetime cost of ownership, as well as the value generated by the assets. There are islands of excellent models and systems that need to be further developed in the context of the integrated AM decision support and to be integrated through information technology platforms for different industry applications. The total integrated AM decision framework as shown in Figure 1 was proposed for this purpose.

This framework indicates that in term of data resources, the integrated AM DSS is basically composed of the following two types of integrations (refer to Figure 1):

1) Horizontal integration: when making an asset management decision, the information in different dimensions such as financial data, human resource, business risk and inventory should be considered.
2) Vertical integration: high level strategic asset management decision must be made based on grass root asset condition data.

In terms of system relationship, the following two types of integration need to be considered:

Miro integration, i.e., the system itself is well integrated. All required data manipulation, asset health prediction and asset management decision analysis (not just providing analysis tools!) are conducted in a logic manner in the system.

Macro integration, i.e., the system can be integrated with enterprises' existing IT systems so as to capture data from these systems and to deliver analysis results back to the systems. At most time this integration will be realised through the Internet. In a broader sense, CIEAM experts will be also integrated into the system so that CIEAM can provide web-based service to industries.

3. SYSTEM DESIGN REQUIREMENTS

The framework presented in Figure 1 provides a guideline for the system development. From system design point of view, the following requirements are considered.

3.1 The scope of the system

This system focuses on integrated AM decision support. It provides information and analysis tools to support asset managers to make optimal AM decisions such as asset operational and maintenance decisions, capital renewal decisions and job priority. It will not be a new enterprise system. However, the system also integrates different enterprise information that is necessary for making AM decisions.

3.2 The roles of the system

Basically, the system plays two roles for AM decision support:

(1) **Information display:** The system needs to present all information that is necessary for decision making such as asset specifications, performance and health conditions; AM related cost and resources; as well as AM related standards and rules in a logic and user-friendly manner.

(2) **Decision support:** The system should enable the users to conduct different analysis for prioritising their decision options and optimising decisions. It should also enable the users to simulate different AM scenarios and conduct sensitivity analysis.

3.3 The usability of the system

Usability is defined as "a set of attributes that bear on the effort needed for use, and on the individual assessment of such use, by a stated or implied set of users" [6]. Simply speaking, usability indicates the system must be user-friendly. To achieve this purpose, the following three points are highlighted in the system design:

(1) Information displayed is meaningful and self-explanatory.

(2) Users can find the required functions and analysis tools easily without much training.

(3) Major interfaces can be easily navigated from each other.

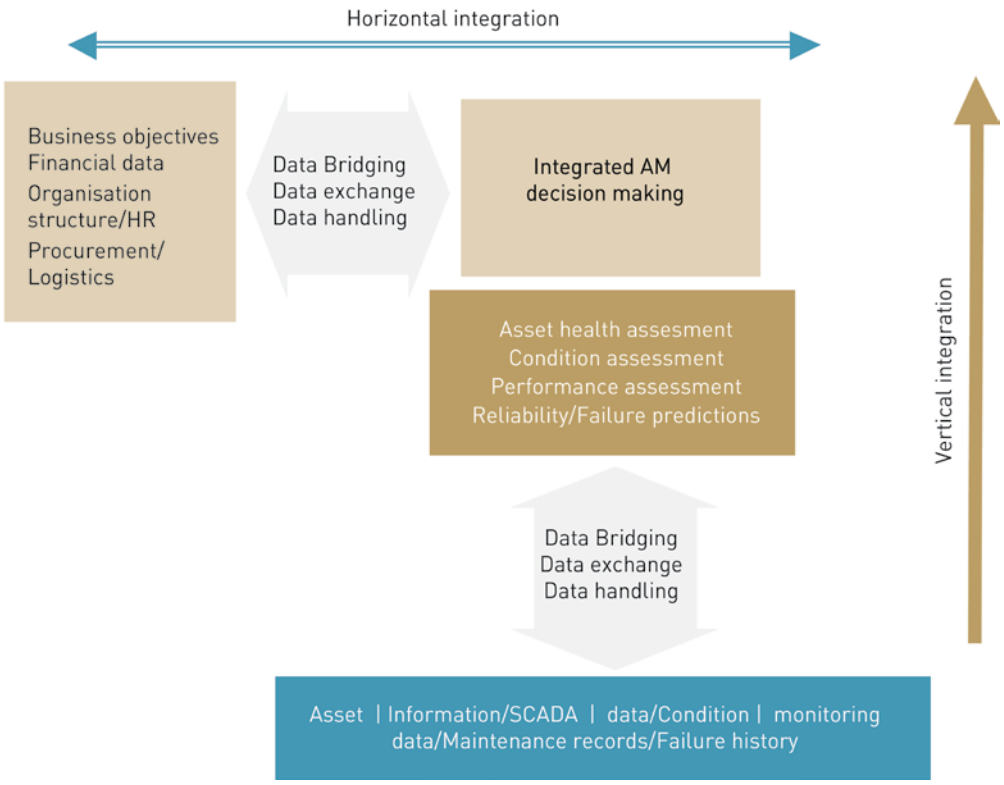

Figure 1 – The Total intergrated AM decision framework

4. SYSTEM DESIGN

4.1 System structure

In correspondence with the integration framework and the system requirements shown above, the system is designed to a five-level structure which consists of enterprise level, site level, system level, equipment level and component level (Figure 2). Different level has different focus based on the particular decision demands associate with the level:

Enterprise level: This level provides overall AM information and analysis in an enterprise, with a focus on the impact of asset performance on the business of the enterprise.

Site level: Most large-scale or medium scale enterprises are usually composed of several sites (plants). This level provides overall AM information and analysis in individual site, with a focus on the impact of asset performance on the business of the site.

System level: This level provides system associated information and analysis with a focus on system health prediction. A system is a collection of equipment and auxiliaries which are arranged based on a specific design to perform desired functions under specified conditions.

Equipment level: This level provides equipment associated information and analysis with a focus on equipment health prediction. A piece of equipment is a single machine or item that is composed of a number of components according to a specific design for a particular purpose with acceptable performance under specified conditions.

Component level: This level provides information, especially health condition information and analysis that is associated with components. .A component is a part of a piece of equipment that is commonly maintained (repaired/replaced) as a whole.

A typical way to use the system is to drill down or go up one level by one level. However, users can navigate from any level to any another level.

4.2 Major graphic user interfaces

The system provides various Graphic Users Interfaces (GUIs). Due to the limitation of the space, this paper introduces some major GUIs only.

(1) Master GUI at enterprise level

Interfaces for the enterprises level starts from two critical indicators that interest most CEO: asset capacity and AM cost (Figure 3).

Given that the applications of term "capacity" seem confusing in the industry, the concept of this term is particularly discussed here.

Different definitions of capacity can be found in literature. For clarification, asset capacity in this paper is defined as the amount of output, space or service provided by assets during a given period. It can be classified into

Maximum capacity. This is the highest capacity that assets possibly provide under their extreme working conditions. Operating at this capacity will significantly shorten asset life.

FIGURE 1

Design capacity. This is the nominal capacity of new assets under designed conditions. Operating at this capacity is usually optimal for assets.

Demand capacity. This is the capacity that is required by the business of enterprises.

Actual capacity. This is the capacity that assets have actually provided.

Capable capacity. This is the capacity that assets are able to provide under their current health conditions and normal operation if there is no outage.

Potential capacity. This is the capacity that assets can provide under their current health conditions and operating conditions.

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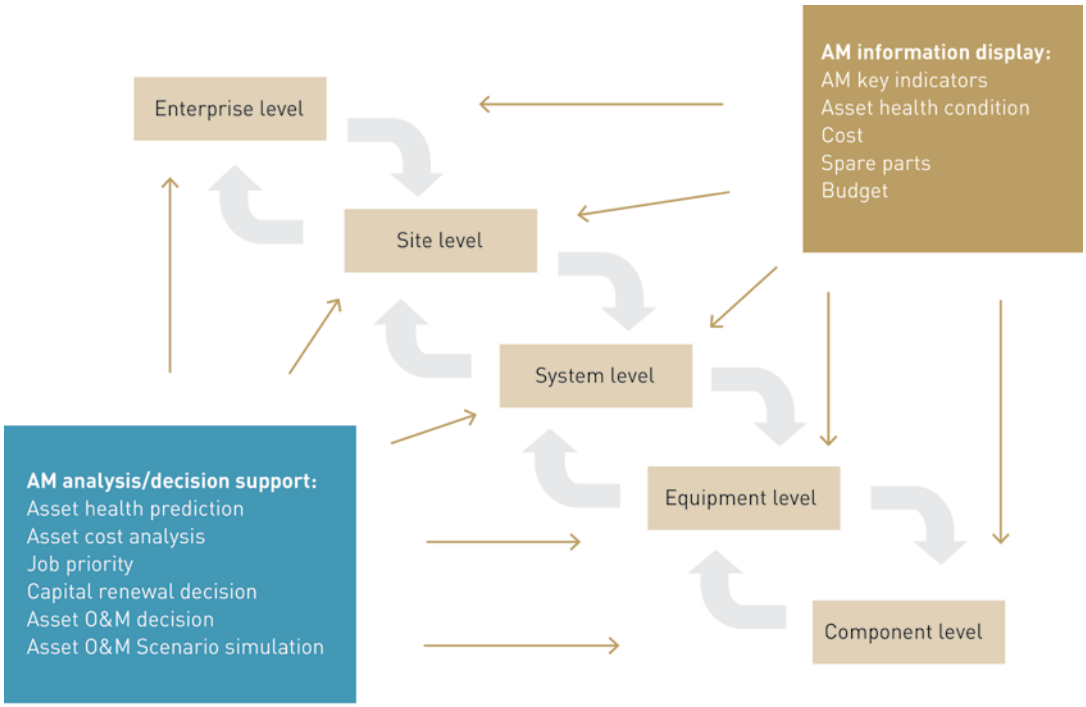

Figure 2 – System Structure

In Equation (1), availability is "the ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided" [7].

If the actual capacity of an enterprise is lower than its demand capacity, the enterprise will suffer from loss. The organisation can drill down to the site level to identify which sites have caused the capacity shortage. From there, the organisation can further drill down to the system level to investigate which systems have the problem.

(2) Master GUI at system level

The master GUI at system level is composed of four parts: system health condition, system maintenance cost, system diagram and the health conditions of its critical equipment.

(3) GUI for vibration analysis

As vibration is a commonly used condition monitoring parameter in mechanical systems, the decision system contains a comprehensive vibration analysis tool.

(4) Master GUI for capital renewal decision support

As indicated in Section 3, decision support is a core role of the system. The system provides a number of integrated decision support modules for users. One of these modules is capital renewal decision support.

5. CONCLUSION

This paper presents a novel decision support system for integrated Asset Management (AM) - IAMDSS. This system enables users to make decisions based on grass root asset condition data, at the same time taking into account the information in different dimensions such as financial data, human resource, business risk and inventory. In addition, it can be integrated with the existing IT systems in enterprises so as to extract data from and return analysis outcomes to these organisations through the Internet. This ability also enables the experts of CIEAM (the Cooperative Research Centre for Integrated Engineering Asset Management) to provide web-based services to industries.

The system offers different integrated decision modules such as renewal decisions and maintenance decisions. In these modules, data requirements, analysis tools and decision procedures have been well defined. Users no longer need to select individual mathematical models. Given that the users at different organisation levels often have different focuses, the system is designed based on a five-level structure from enterprise level down to component level. Correspondently, the user graphic interfaces at each level have been designed to provide particular information that interests the major users of the individual level.

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ARTICLE 3 – OPERATIONAL INTERFACES – ASKING THE RIGHT QUESTIONS

Author: Patricia Fuster | QHSE Management Systems specialist with Thomas & McKinlay Consulting.

OPERATIONAL INTERFACES – ASKING THE RIGHT QUESTIONS

How teams interface can impact your ability to create real and lasting operational performance and business improvements. So what questions do both organisations and individuals need to ask of each other to achieve effective interfacing?

Participating in the Asset Management Council Panel session on "Efficiencies and Productivity Improvements in a Constrained Environment" at the 2016 Australian Oil & Gas Exhibition and Conference got me thinking about the many aspects of an efficient work environment. Those aspects are valid regardless of whether we are talking about a constrained or non-constrained environment.

When I looked at the thoughts and knowledge that came together, I saw the obvious place to start was a larger and more multi-faceted conversation around internal organisational interfaces.

Organisational interfaces might look like common sense. But it is in those areas considered common sense that the cracks often appear. One of the reasons for this is common sense is not that common and shouldn't be the ruling factor for people working together; particularly when conditions change or become constrained.

CAPITAL ASSETS & HUMAN RESOURCES

All organisations have capital assets and human resources. Decision makers take time to choose the equipment, maintenance and reliability/ integrity plans, and spare equipment, based on the design process. The same care should be taken in choosing an appropriate structure, the right people, their competencies, training, etc.

In this process the main questions asked are who does what, where, when and how? Along the way business and operations teams define, redefine and measures are taken on what are the appropriate financial and human resources. While this sounds logical, the process often neglects looking at the human factor and the culture of an organisation navigating through changes.

CREATING A CULTURE OF EFFICIENCY

While I'm not an expert in organisational cultural dynamics, I do know that creating a constructive organisational culture and keeping it alive is key to any success, and no less important than the decisions regarding maintenance of equipment.

Effective interfaces enable a culture of efficiency. Clarity in terms of strategy and communications are critical in creating a culture of efficiency and productivity. Individuals need to maintain a healthy interface with relevant business functions, and interested parties both within and outside the organisation. In this way people not only read instructions, but have the chance to understand the principles and the intended spirit behind activities.

Creating the desired organisational culture, one that communicates well internally and externally and feels ownership, is a function of the leadership. Voicing concerns, likes and dislikes should have a place in the communications as well as an understanding on agreements and final decisions and directives to be followed. Not hearing those voices can be damaging for business – as it is with safety or environmental protection.

Business policies posted on the wall or one liners briefly spoken to all employees and leaving it at that or showing new employees how to find the set of policies, procedures, records, plus online or Intranet is not nearly enough. Similarly, a quick introduction or endless meetings are not the path to successful communications and interaction either. Communications are an ongoing effort and the doors should be open to questions and hands on training. Mentorship programs are an area that appears to be understated of late, but what a treasure smart seasoned mentors can be.

Of course, you need to choose those that understand the fine lines between mentoring and micro-managing!

Assuring competency, providing adequate training, creating dialogue, and teaching conflict management are all part of building the culture of an organisation and also contribute to better interfaces that work together for continuous improvement.

Continuous improvement, as much as emerging constraints, demand flexibility. When the organisation understands efficiency and the need for flexibility re-assigning of tasks with no guilt to make things work at an optimum level is far simpler. Flexibility enhances creativity and the opportunity for multiplying the number of smarter more efficient and effective ways of doing things. The positive constraint of flexibility is nobody can forget that they have a team to interface with too.

FUNCTIONAL INTERFACES MATTER

All individuals and therefore organisations have their ups and downs but we all have to review and revise, learn the lessons and get things back under control as quickly as possible.

Management systems that promote continuous improvement while reducing or mitigating business risks is what leads to improved competitiveness and performance. Management systems make evident the required interfaces.

In a constrained or changing environment changes might start by redefining the capital assets and human resources required and push for the redefinition of interfaces, internally and

externally with clients, industries, stakeholders. Having these concepts in mind in a constrained environment becomes all the more important. Achieving the best and most efficient interface at all times requires both leaders and individual's full understanding of his/her responsibilities and accountabilities.

Ask yourself and the organisation: How up-to-date is the definition of roles and responsibilities? Are functions and people working together, not in conflict or creating repletion?

More incidents happen due to faulty human interactions than faulty equipment!

A simple Google reveals many examples of environmental incidents, oil spills, explosions all over the world as well as in our own backyards.

The word 'automation' has invited many to believe that operations run in automatic at all times. But even the hardware for automation, valves and sensors, require maintenance. More than one spill in common waters like rivers or seas have happened when controls were switched to manual. But look at the evidence and more often than not the Maintenance Group did not properly involve or communicate with all relevant teams! Or part of the organisation was not trained in what to do to continue operating in manual mode!

In this scenario for example: Is Central Maintenance talking to satellite operations? Is Operations allowing proper time for Maintenance? Are people being well informed of temporary changes? Are individuals introduced to their new interfaces?

An individual should question himself/herself regarding roles and responsibilities and the organisation will ask the same questions of internal and external teams.

Here are some questions to get you started on the path to better organisational interfaces and efficiency gains.

*Patricia Fuster is a QHSE Management Systems specialist with Thomas & McKinlay Consulting.

LEADERS NEED TO ASK……

- Is there clear leadership?
- What is the expected performance?
- Is the management system still current?
- Are people working together?
- Is the organisation's knowledge and culture working together?
- Are responsibilities defined and communicated?
- Are accountabilities defined and communicated?
- Is personal contribution appreciated?
- Who is our team?
- How do we interface internally and externally?
- Who are our counterparts?
- How much flexibility exists?

INDIVIDUALS NEED TO ASK….

- Do you know what your obligations are?
- Do you know what you are responsible for?
- Accountability vs Responsibility, how are they aligning?How do you relate to your team?
- Who is your team?
- How do you relate to your external clients?
- Who are your external clients?
- Do you have anything to share with your team other than the regular tasks?
- Is there any new knowledge or chat that could help you in your tasks?
- Is there anything you could guide others with?
- Do you know what is non-negotiable?

ARTICLE 4 – AN INTEGRATED APPROACH TO OPERATIONS AND MAINTENANCE

N Marathe J Scott B Lee paper ICOMS 2009

1. INTRODUCTION PMIP METHOD

The PMIP method is described by the Sydney Water Procedure BMIS0134 and is discussed in the following report.

1.1 Prioritisation of Facilities

Prioritisation is based on the ratio of annual mechanical and electrical maintenance cost to replacement asset value (RAV), which is compared to the Industry benchmark value of 3%. (Mitchell 2002) This figure doesn't include the value of the general plant civil works or plant infrastructure; however it does include the cost of infrastructure associated with the Mechanical/Electrical asset cost.

While the industry benchmark value is 3% of RAV, Sydney Water's target is for facilities to meet 2% of RAV for annual maintenance costs. This value is used as a driver to prioritise facilities inclusion in PMIP.

The first filter uses the above criteria to rank facilities based on potential savings at each plant if the ratio of average annual maintenance cost vs RAV were to be reduced to 2%. The percentage of maintenance cost to RAV is given as a measure of maintenance performance that can be compared across plants.

The potential savings from the reduction in maintenance costs is compared with the cost of carrying out a PMIP to determine if PMIP is cost effective.

The current range of maintenance cost to RAV for the 30 ranked treatment facilities is from 4.55% at the North Richmond Sewage Treatment Plant (STP) to 0.35% at the Bellambi Storm STP with the average RAV of 1.81. However it is important to note that the replacement asset values for treatment facilities was last updated in 2005; and in order to reduce the requirement to re-audit regularly, the values are updated yearly using a price escalation factor. As a consequence of this three new facilities have not been audited and ranked and a further eight may be underestimated due to recent amplification works.

1.2 Selection of Assets

Key parameters used in the selection of assets:

Availability - The percentage of time a piece of equipment or system is available to work / function, either by design or by operation (Facilities Maintenance, SWC) and is represented by the formula

MTBF – Mean Time Between Failures, MTTR – Mean Time To Repair (Torell & Avelar 2004)

Maintenance history is used to calculate the availability, mean time between failures and total maintenance cost for each piece of functional equipment and rank them by worst performance in a top twenty ranking sheet.

The calculation of maintenance performance is based on the labour booked to maintenance tasks, for example breakdown downtime is assumed to be from the job notified time to the labour completion time. Operator knowledge of process performance is used to find equipment that is not achieving the required process outputs.

The second filter uses a combination of maintenance history and operational performance to find the problematic or worst performing equipment at the facility. Typically ten asset types are selected rather than a single asset and any improvement to a poor performing asset can be applied to other equipment of the same type at the facility.

1.3 Data Collection

Detailed historical information is compiled once the equipment list for the PMIP has been selected. This data includes the past breakdowns, corrective and preventive maintenance, the preventive maintenance schedule and the reliability data from the asset selection process.

Microsoft Excel reports are compiled from Maximo: Sydney Waters' maintenance database. Much of the data collection process is automated to reduce the time taken collecting data and increase the amount of time that can be spent in data analysis and field inspections.

The Work Order History Report compiles the maintenance history of a functional group of assets. An example of this may be a pumping unit, the pump is classed as the functional equipment, the motor, starter, instrumentation and controls would be included in the report. The reason for this grouping is because it is assumed that any failure of these pieces of equipment would result in a loss of pumping ability. Useful information includes;

1. Description of work
2. Dates and Times of the failure and maintenance work
3. Maintenance work type for example Breakdown Maintenance (BM), Corrective Maintenance (CM), Preventive Maintenance (PM), Project Services (PS)
4. Feedback given by the maintainer, a free text field.
5. Labour and Material costs for the work.

The work orders are grouped by failure mode as described in Section 1.4 below

The PM Schedule Report compiles the preventive maintenance jobs done on the functional group of assets. It contains the job plan numbers, due dates, estimated hours and frequencies of PMs. It can be used to identify inconsistencies between similar equipment and duplication of work.

The Job Plan Report compiles the tasks planned on the preventive maintenance jobs. It can be used to identify tasks that need to be added to address specific failure modes.

1.4 Reliability Analysis

Reliability analysis is conducted using a decision framework as shown in the PMIP Process Flowchart, see Figure iii below. Each decision is supported by documentation as described in the right column of the flowchart.

The first step of the reliability analysis is to take the data collected and use it to determine the failure modes, (Moubray 1991) defines 'a failure mode is any event which causes a functional failure'. Root Cause Analysis (RCA) is used to determine the cause of each failure mode; the functional failure, failure mode and root cause is represented using a Cause Effect Diagram as shown in Figure ii as shown below.

The failure modes that are the highest priority are those that result in a lengthy, frequent or costly functional failure. The next step is to develop a plan to address the high priority failure modes by modifying the preventive maintenance program, the equipment operation or the equipment itself by overhaul, upgrade or replacement.

2. CASE STUDIES

2.1 Case Study No.1 Rouse Hill STP Inlet Screens

The inlet screens are the first stage of the process at an STP and their purpose is to trap and remove solid materials such as timber, plastic bags and rags from the wastewater flowing into the plant see Figure iv below. They are a continuous belt type and utilise rows of self cleaning filter combs arranged in a staircase configuration. The duty cycle, set in the control system, utilises the water level sensor to initiate the operation of the screens.

A recent assessment of the worst performing assets based on maintenance data highlighted the majority of issues were related to blockages caused by rags or other solids. Whilst the inlet screens were not failing frequently, it was agreed that their effectiveness was the root cause of the downstream equipment failures.

Figure I – Rouse Hill Inlet Screens

Analysis of the side seals of the screens, see Figure v above, indicated that these solid materials were bypassing the units and causing unnecessary breakdowns further downstream to equipment such as mixers, grit pumps and sludge pumps. It was clearly visible that several "teeth" in the belt were damaged due to the ingress of large objects in the stream. In discussions with the plant team it was agreed to remove both screens individually to assess where bypassing could possibly be occurring.

Once the inlet chamber was drained, it became apparent that the material fitted to either side of the machine to maintain the seal and direct flow through the screens was badly worn and was the root cause of the bypassing.

Although there was a bimonthly and annual service, it was found that the work required was not being carried out as per the job plan and the main channel was not being drained to assess the overall condition of the screen.

The frequency of the minor servicing was altered from bimonthly to quarterly and the importance of the annual service, which included the draining of the channel for the inspection of the seals, was highlighted to the plant team as discussed by (Killick 2005)

This investigation highlighted issues such as non-compliance with preventive maintenance requirements and lack of cleaning the channel for inspection of seals. The outcome was a revised PM program, modified job plan, awareness session with Operations and Maintenance (O&M) personnel and ongoing discussion with the Operations team during the monthly maintenance networking meeting.

The repairs to the side seals and replacement of the damaged "teeth" are estimated to have the potential to save in the vicinity of $25,000 per annum on the eight pumps and mixers in the reactors as shown in Figure vi below. It is important to note that choking has not reduced at this stage, as rags have not been flushed from the process, a shutdown and cleanout is scheduled when system demands allow. This shutdown will allow the removal of the rags from the process.

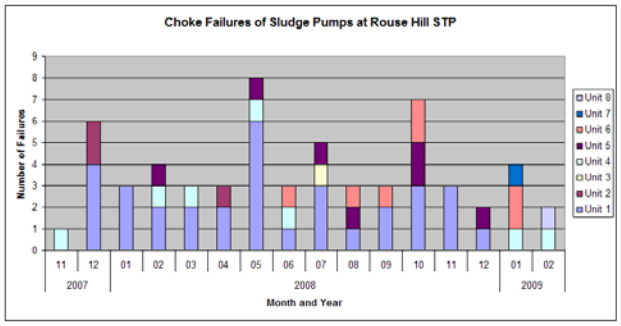


Figure 2 – Graph of BMs Relating to Chokes

2.2 Case Study No.2 Liverpool STP Sludge Drop Off Pumps

The Sludge Drop Off Pumps transfer sludge from two, 2.7ML digesters to a storage tank in another area of the plant, a distance of approximately 600 metres. They are a progressive cavity type pump and are controlled by level sensors and a Variable Speed Drive (VSD) on a duty / standby arrangement, transferring product at a flow rate of 8.5 – 9 l/s.

Figure 3 – Sludge Drop Off Pumps

Although both pumps were flagged on the "top twenty asset list", hidden costs and production frustrations were occurring due to increased after hour's call outs. The majority of failures consisted of No.1 VSD tripping on over current and No.2 tripping on an over torque limit. Some circumstances would see the pump stalling on start-up, resulting in no flow without initiating an alarm. The control logic was checked and it was found the flow transmitter fitted to the system was in fact not in the pump control circuit. This prohibited the standby pump from starting due to the no flow situation with the duty pump.

Close monitoring of the start up operation of both pumps confirmed that the motors were stalling and could not get the pumps started. Either inadequate torque or an excessive load in the pump itself could have caused this situation. The pumps consumed 2.5 kW to run which was considerably lower than the rated 11 kW motor fitted to the unit. This indicated that starting torque was the problem and not the running load. Several parameters were adjusted on the drive and observed over the following week, but periodic failures were still occurring.

Consultation with both O&M teams indicated that once the duty pump had started, it remained running until the digester level had dropped to the set point, a period of up to 3 to 4 hours. An alternative theory suggesting that the sludge was drying out in the pump and increasing the initial load was seriously considered. The control philosophy was modified to have a time based changeover and not the existing "stop/changeover" method. After these assessments were made and several other program modifications implemented, the pump failure rate has reduced to zero at the minimal cost of troubleshooting/root cause investigation.

3. POST PMIP REVIEW

Previous programs run to date are reviewed annually to assess the effectiveness of the projects and preventive maintenance changes. The three years history before the program is used as a benchmark for the years after. The St Marys and Winmalee programs have enough historical data to perform an annual review.

St Marys was the trial program, a range of projects and preventive maintenance program changes were recommended and some of these projects were not implemented for various reasons. Post PMIP results showed an increase in PM costs in line with the number of tasks introduced. The failure rate decreased by 25% in the first year, 17% over the next two years and the total cost of maintenance rose slightly.

Winmalee was the second plant targeted for the PMIP. A 20% increase in PM costs and minor overhaul projects resulted in a total cost reduction in the following twelve months of 35%. Rouse Hill has not seen a complete 12 months post PMIP, however, the early indication are mixed due to some outstanding work. Glenfield & Liverpool have just completed 5 and 6 months post PMIP and would take at least another 12 months to see complete benefits of PMIP.

4. CONCLUSIONS

The PMIP process engages with O&M to deliver systematic improvements to problematic mechanical & electrical operating assets across a large network of treatment plants and network operations. The case studies have shown some operational and maintenance savings and improvements to reliability. This process has also ensured a partnering approach to the relationship between O&M teams and delivered consultative solutions to mitigate failures including prioritising projects for the Opex and Capex program. There are issues of slow implementation of recommendations to selected asset types and preventive maintenance programs that each extend the time taken to realise benefits. A facility based Reliability – Operations – Maintenance (ROM) team approach is recommended to fast track benefits from PMIP.

Myth 8 – All I need to know is th

References

A. International Electrotechnical Vocabulary (IEV)

B. US MIL-HDBK-338B, Electronic Reliability Design Handbook, 1998.

C. Navair 00-25-403 Guidelines for the Naval Aviation Reliability Centered Maintenance Process

D. MIL-STD_2173 Reliability Centered Maintenance Requirements for Naval aircraft, weapons systems and support equipment

INTRODUCTION

There is a view that when determining either the time to undertake preventive maintenance or its resourcing with spares and related logistics, all that is needed is the mean time between failure (MTBF) of a particular asset to do those calculations to manage an item and achieve its organisational intent.

This paper addresses the belief that the technical characteristic of MTBF is the primary value necessary to managing an asset over its whole of life. Additionally, there is an underlying implication that all I need to focus on is that technical MTBF value to "manage" an item to achieve business objectives. The underlying assumption is that other measures such as costs and human performance are not that relevant.

An application of the role of "MTBF" values in determining condition monitoring task frequency shall be assessed for the validity of this statement.

IMPLICATIONS

As with previous Myths "the view that only one figure is required to work out maintenance task periods and resourcing effort" can also result in conservative maintenance programs where there may be adverse operational and financial outcomes from:

- Increased operational risk and costs from failures due to incorrect application of failure data
- Overproduction - Performing preventive maintenance and overhauls at intervals more often than what represents a desired balance between the performance required, the cost of that performance and the associated risk exposure;
- Inventory growth – Overstocking rotable/pools of repairable items and increasing consumable spares to resource expected increases in rate of activity both preventive and corrective periods;
- Increased overheads – each additional task brings with it unproductive staff time such as waiting for tools, parts documentation, transportation, or time spent travelling to the maintenance site;
- Increased defects/failures and risk – flowing from inappropriate intervention with ensuing likelihood of poor quality of corrective maintenance due to unnecessary time pressure and human error/ violation.

TECHNICAL FACTS

MTBF is a measure of the reliability of an item or its "probability of operating to a defined standard for a defined time, in a defined environment". This measure of failure related times (or durations) are defined in the IEV (with associated notes) as:

mean operating time to failure MTTF is the expectation of the operating time to failure.

- *Note 1 to entry: In the case of non-repairable items with an exponential distribution of times to failure (i.e. a constant failure rate) the MTTF is numerically equal to the reciprocal of the failure rate. This is also true for repairable items*

e MTBF in order to manage it well

if after restoration they can be considered to be "as-good-as-new".

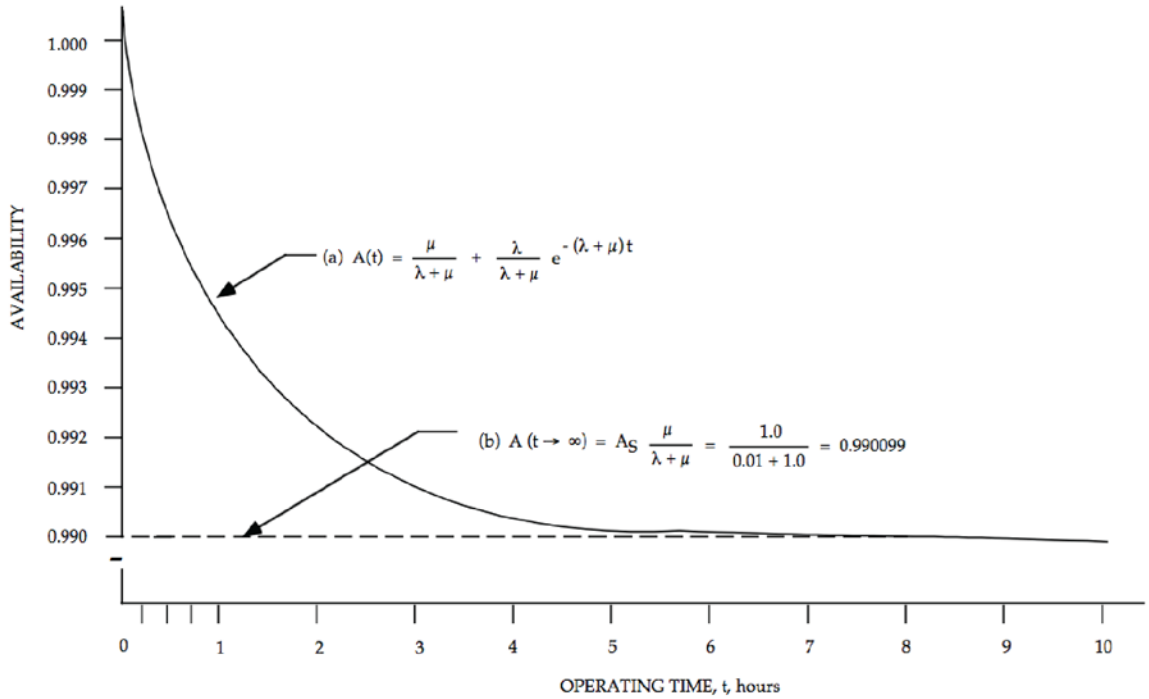
- *Note 2 to entry: See also operating time to failure (192-05-01).*

mean operating time between failures [MTBF or MOTBF] is the expectation of the duration of the operating time between failures.

- Note 1 to entry: Mean operating time between failures should only be applied to repairable items. For non-repairable items, see mean operating time to failure.
- MTBF is closely related to, and a component of, equipment or item "availability" which defines the probability that an item shall be available when required. There are many forms of availability assessment. The difficulty faced by the use of availability as a measure is demonstrated at Figure 1 from MIL-HDBK-338B, which shows the degradation curve of operational availability over time from 100% at new to the long run average after often a considerable period of time in long lived equipment. There are also additional definitional issues such as:
- Is this measuring instantaneous availability eg tell me what was available at 0700 every morning OR
- Is this measuring total available time divided by total time over some defined period.

Despite these challenges, for repairable equipment, operational availability is often of more importance than pure reliability as it provides a measure of the impact of maintainability on the assurance of overall performance.

Thus more than just reliability is needed to assess a system's likely availability and hence usefulness. Low reliability systems that recover very quickly may have greater utility than a highly reliable system that is very difficult to recover. More than just MTBF is important to the management of assets to achieve their desired balance of performance cost and risk. Mean time to repair (MTTR) also becomes of equal significance and may be traded against MTBF to achieve a desired balance of performance, cost and risk, a required outcome of asset management.



(a) INSTANTANEOUS OR POINT AVAILABILITY
(b) STEADY STATE AVAILABILITY OR INHERENT UPTIME RATIO, $\lambda = 0.01$ fr/hr; $\mu = 1.0$ rp/hr.

Myth 8 – All I need to know is the MTB

ROLE OF MTBF IN DECISION

Making MTBF, as a measure of reliability, is used for a number of purposes across the life cycle of a system or physical asset.

In the initial stages of architecting a system concept for delivering a function, the future potential costs of a system concept can be explored through application of failure mode and effects analysis combined with reliability, maintainability and supportability assessments where:

- FMEA determines what failure effect function;
- Reliability assessment (MTBF) determines how often those failure might occur;
- Maintainability assessment (Mean time to repair MTTR) determines what maintenance tasks are necessary, their frequency and duration;
- Supportability determines what resources are necessary to undertake those maintenance tasks and how long they might take to source and apply (Mean time to support MTTS).
- During the ownership stage these initial predictions and allocations can be confirmed and the actual operational capability of the built system can be assessed. While MTBF data is important, decisions will reflect the need to achieve a balance of performance, cost, and risk that requires more than just the simplistic value of how often something is likely to fail in the future. Knowledge of maintainability and supportability performance is equally necessary.

GENERAL APPLICATIONS

- During the design stage of a system, item MTBF will provide us with some knowledge of the individual failures associated with firstly a failure mode in an item, which represents the way in which the item fails. Secondly, these individual failure modes can be aggregated by summation, to the performance of the equipment.
- Finally, the construction of a reliability block diagram can then allow the system performance to be determined by summating the individual equipment impacts depending on their series or parallel relationship. Readers should note that in repairable systems there are two types of failures being:
- functional failures (those where the items specified function, described by a measurable value and its allowed variance, has been exceeded) and
- conditional failures (those where the items assessed condition has reached a measure where the future potential for functional failure of the item is no longer acceptable).

MTBF represents the summation of these two failure outcomes.

Thus MTBF by itself is a poor measure of the cost of failures, as the two scenarios of functional failure and conditional failure will have significantly different costs to the business.

SPECIFIC APPLICATION OF MTBF

In the preventive maintenance domain a number of calculations that relate to equipment maintenance actions use MTBF as a variable. One of those task types, and the most common, is condition monitoring. However, more than MTBF is necessary to identify a task period that represents the desired (best) balance of performance, cost and risk.

Condition monitoring goes under many names and is applied in many ways from real time monitoring to periodic sampling. It is the most common process in maintenance as it:

- Is applied to the vast majority of operating items being those that possess random failure characteristics, and
- provides a protective function to give confidence that the item is of a condition that can be expect to continue service until its conditionally assessed when next due.
  Sampling condition monitoring tasks that require the regular assessment of condition against some form of qualitative or quantitative measure requires six variables as follows to allow their optimal task period to be determined:

BF in order to manage it well continued....

- Frequency of failure of MTBF;
- Expected consistent time from a defined condition to a functional failure;
- Costs of business being, cost of each task, cost of functional failure, and cost of discovered conditional failure;
- Task effectiveness as a derivative of the task, its description and its delivery. (as per MIL STD 2173)
- The algorithm, contained in Reference C, applied to identify the optimum condition monitoring task period is relatively insensitive to MTBF variation. Other variances such as task effectiveness and warning period have significantly greater influence. These impacts on the "Percent Change to Optimal Task Period (Days)" are shown as the ordinate value at Figure 2 below.
- Thus it is more important to manage the human variation than the equipment variation when it comes to determining preventive maintenance program content.

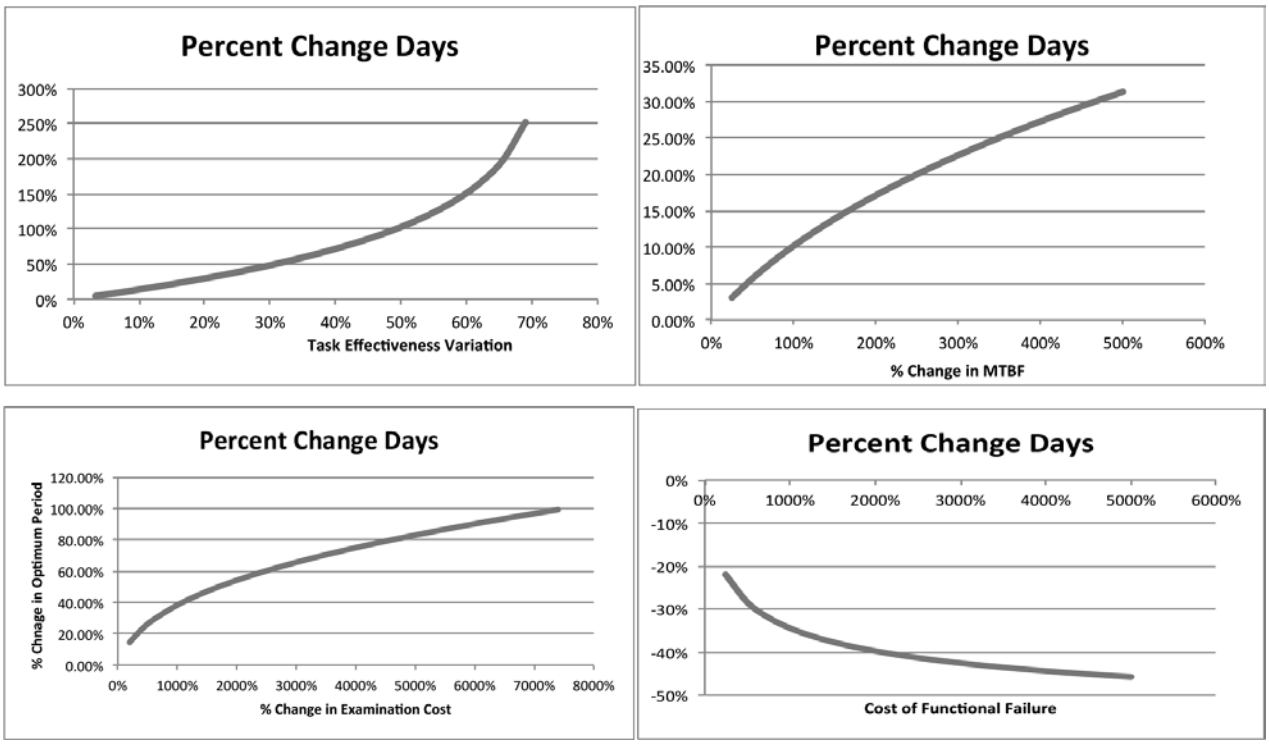


Figure 2 – Impact of a Change to Optimisation Variables

Myth 8 continued....

Secondarily and potentially more importantly "customers don't notice averages"; customers feel the variation, not the average. Consider and MDBF of 10 business days. What does the data say about the current assets capability?

Whilst the failure data may indicate a normal distribution, look at the distribution to find the Mean and Standard Deviation (which helps us know the variation). MDBF might in fact be 17 days but what is the variation? The Standard Deviation helps us approximate that variation. The real answer could be that 68% of all failures could occur in-between ~2.96 days and ~12.16 days i.e. some of the time, we will not make the customer promise of an MDBF of 10 business days. Moreover, the significant gap from the Mean creates a high level of frustration. From a customer impact perspective, MDBF is not that useful and it is common practice in transport industries, for example, to measure customer impact using measures like customer delay minutes.

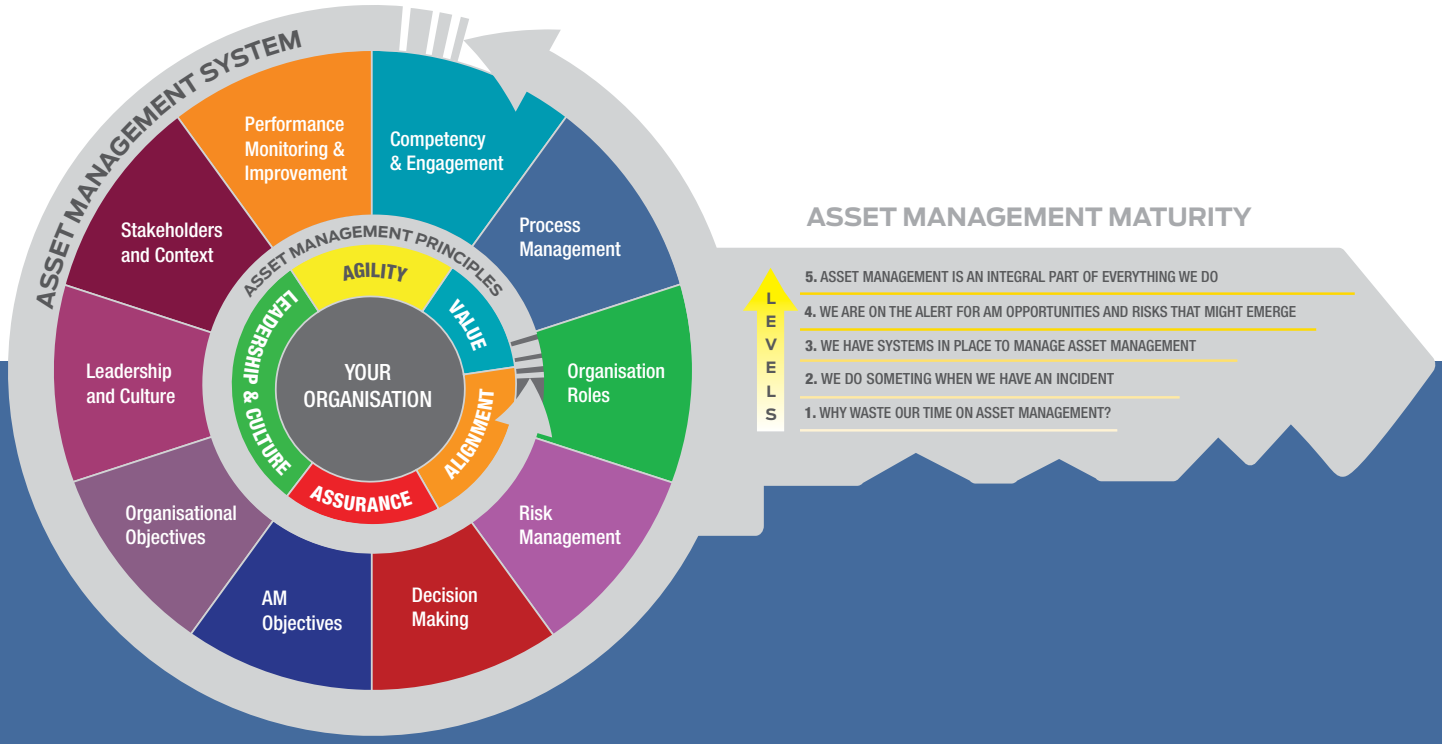
CONCLUSION

MTBF is only one of a number of item and organisational characteristics necessary to manage an asset. While technical knowledge such as MTBF is valuable information as to cost of ownership, the management function requires a variety of other information. This information relate to financial and human performance to be able to manage an asset over it's life and achieve an organisation's desired balance of performance cost and risk.

Hence the belief that "All I need to know is the MTBF to manage it well!" is confirmed as mostly a myth.

Unlocking value in asset management

ASSET MANAGEMENT COUNCIL



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Tutorial 7

Asset Management system and Organisational Systems Model Continue

1. PROCESS MANAGEMENT

Business processes define how work is performed in an organisation. There are a broad range of asset management taxonomies including APQC and CMMI, ISO 15288 'Systems engineering — System life cycle processes' which can apply to the full life cycle of systems/assets, typically covering conception, development, production, utilisation, support and retirement of systems, and to the acquisition and supply of systems.

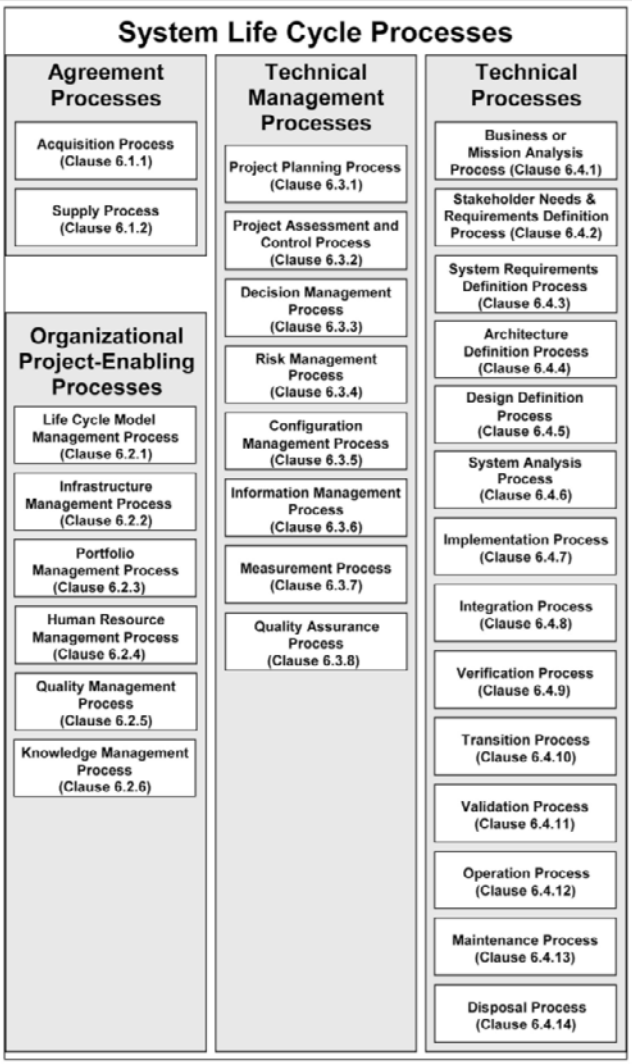
The deliberate intent of the ISO/IEC 15288 Systems Engineering standard is to provide a combined technical and managerial approach to the way in which processes should be managed – that is, identified, developed, produced, used, supported and retired.

The processes and activities performed during the life cycle of a system, according to ISO15288, can be placed into one of four process groups:

- Agreement processes
- Organisational project enabling processes
- Technical management processes
- Technical processes.

The four process groups and the processes included in each group are depicted in Figure 1. Each of the processes within those groups can be described in terms of its purpose and desired outcomes and the activities and tasks, which need to be performed to achieve those outcomes.

System Lifecycle Processes



1.1. PROJECT MANAGEMENT PROCESSES

In relation to the management of assets, project management is a tool that is employed at all levels (both strategic and operational). Such typical projects often known as strategic planning and/or capability planning, involve the development of concepts of operations and functional performance specifications leading to the identification, design and build of key and often complex and costly assets and asset systems.

ed…

At the operational level, projects are typically represented by project/maintenance planning, be it in response to a breakdown or the development of a shutdown outage followed by project assessment and control processes.

Project management therefore has a key role in the management of assets.

1.2. FINANCIAL MANAGEMENT PROCESSES

Within the management of assets, financial management can involve complex analyses to identify, document and compare costs and benefits over long timeframes. The need to include financial management and its associated systems, approaches and standards within the management of assets though, is an obvious connection. As noted above, this integration remains an immediate challenge.

Regardless of that challenge, the role of financial management in relation to the management of assets is to participate in approaches to develop an appropriate balance between the cost to do something (treat the risk), the resultant risk from the expenditure of those resources and the expected asset (and organisational) performance output/outcome.

The IFRS and accompanying IAS suite of standards published by the International Accounting Standards Board (IASB) provides good practice standards relevant to asset management financial decision making and reporting. The standards provide a common set of terms to be used in the financial management of assets and asset systems. A cornerstone of the IFRS/IAS suite is the use of accrual accounting methodologies.The principal objectives of the IFRS Foundation (who publish the IFRSs) are to:

- develop a single set of high quality, understandable, enforceable and globally accepted International Financial Reporting Standards through its standard-setting body, the International Accounting Standards Board;
- promote the use and rigorous application of those standards;
- take account of the financial reporting needs of emerging economies and small and medium-sized entities (SMEs); and
- promote and facilitate adoption of IFRSs, being the standards and interpretations issued by the IASB, through the convergence of national accounting standards and IFRSs.
- The IASB is the independent standard-setting body of the IFRS Foundation. Its members are responsible for the development and publication of IFRSs.

1.3.OTHER MANAGEMENT PROCESSES

These systems engineering life cycle process descriptions and their associated notes are not intended to preclude or discourage the use of additional processes that organisations might find useful. Nor do they provide a complete and implementable set of quality procedures that achieve a complete description of a task set. Further detail is necessary to provide a more accurate representation of how to conduct a defined task. An example of that level of detail is provided in IEC standards and others.

Organisations should use tailoring guides and their detailed technical knowledge of the business and industry to develop and apply a set of detailed standards. In this case the IEC Dependability standards support a number the higher level SE processes which would satisfy some or all of the ISO 55001 requirements.

1.4. APPLICATION OF STANDARDS

Systems engineering is supported by three related standards with differing purposes and levels of detail. This is evident from the following purpose statements:

- ANSI/EIA 632 – To provide an integrated set of fundamental processes to aid a developer in the engineering or re-engineering of a system.
- IEEE 1220 – To provide a standard for managing a system from initial concept through development, operations and disposal.
- ISO/IEC 15288 – To establish a common structure for describing the lifecycle of systems created by humans.
- The role of the systems engineering standards is to:
- provide a benchmark of what must be done and why, when defining an organisation's policies and procedures for systems engineering functions;

Tutorial 7 continued....

- describe how the organisation can establish technical processes, as well as the use of those processes by suppliers and the assessment of both internal and supplier systems engineering capability;
- set a basis for awarding contracts, and
- define industry acceptable sets of practices.

1.5. AGREEMENT PROCESSES

Organisations are producers and users of systems. One organisation (acting as an acquirer) can task another (acting as a supplier) for products or services. This is achieved using agreements. Generally, organisations act simultaneously or successively as both acquirers and suppliers of systems. Agreement Processes can be used with less formality when the acquirer and the supplier are in the same organisation. Similarly, they can be used within the organisation to agree on the respective responsibilities of organisation, project and technical functions.

1.6. ORGANISATIONAL PROJECT – ENABLING PROCESSES

The organisational project-enabling processes are concerned with ensuring that the resources needed to enable the project to meet the needs and expectations of the organisation's interested parties are met. The organisational project-enabling processes are typically concerned at a strategic level with the management and improvement of the organisation's business or undertaking, with the provision and deployment of resources and assets, and with its management of risks in competitive or uncertain situations. The organisational project-enabling processes establish the environment in which projects are conducted. The organisation establishes the processes and life cycle models to be used by projects; establishes, redirects, or cancels projects; provides resources required, including human and financial; and sets and monitors the quality measures for systems and other deliverables that are developed by projects for internal and external customers.

The organisational project-enabling processes create a strong business image for many organisations and imply commercial and profit-making motives. Nevertheless, the organisational project-enabling processes are equally relevant to non-profit organisations, since they are also accountable to stakeholders, are responsible for resources and encounter risk in their undertakings. This International Standard can be applied to non-profit organisations as well as to profit-making organisations.

1.7. TECHNICAL PROCESSES

The technical management processes are concerned with managing the resources and assets allocated by organisational management, and with applying them to fulfil the agreements into which the organisation or organisations enter. They relate to the management of projects, in particular to planning in terms of cost, timescales and achievements, to the checking of actions to ensure that they comply with plans and performance criteria, and to the identification and selection of corrective actions that recover shortfalls in progress and achievement. They are used to establish and perform technical plans for the project; manage information across the technical team; assess technical progress against the plans for the system products or services; control technical tasks through to completion; and to aid in the decision-making process. Please note that technical management is 'the application of technical and administrative resources to plan, organise and control engineering functions' (IEEE STD 1002-1987). Typically several projects will co-exist in any one organisation. Technical management processes can be employed at a corporate level to meet internal needs. The Technical Processes are concerned with technical actions throughout the asset life cycle. They transform the needs of stakeholders first into a product and then, by applying that product, secondly, provide a sustainable service, when and where needed in order to achieve customer satisfaction. Technical processes are applied in order to create and use a system, whether it is in the form of a model or a finished product. They apply at any level in a hierarchy of system structure.

AM COUNCIL NEWS

Chapter news

CANBERRA CHAPTER

Photo: Jim Kennedy

The ACT Chapter held a technical session on Friday the 19th of August titled Standards Gaining the Edge in Asset Management. The session discussed the development of the AM Maturity Model and status of supporting IEC and ISO, presented by Mr Jim Kennedy (sensi). Members covering a broad range of industry sectors attended the session, which was well received and generated constructive discussion on the use and benefits of the model. Key to the discussion was how the AM model varied from those used in the past by industry (CMMI, P3M3, etc), with Mr Kennedy clarifying that the AM Model was much easier to use. The Asset Management Council has developed an asset management maturity assessment tool that will allow organisation to assess their maturity level and help them on their journey to excellence. The outcome of the assessment is a rigorous analysis that identifies performance gaps and strengths across a range of domains including some ISO 55001 sections. The assessment will also help organisation benchmarking their performance nationally and internationally to guide them on their maturity path.

With the piloting of the model about to start in earnest over the next few months, Chapter members expressed a desire for a follow up presentation by Jim on the lessons learned during the pilot and how they have been used to both further shape the model and benefit industry. There was a broad consensus during the discussion that the model should receive the broadest piloting across as many industry sectors as possible. To be part of this launch please register your interest here http://www.amcouncil.com.au/knowledge/asset-management-maturity.html

The Canberra chapter would like to thank mr Kennedy for his time and valuable presentation

NEWCASTLE CHAPTER

The Newcastle chapter of the AM Council hosted more than 60 delegates at a seminar focussed on ISO 55001 Asset Management. Beautiful weather welcomed the

attendees at the Marina Views function centre overlooking Newcastle Harbour on Tuesday 9th August.

The sessions were structured around the "what", "why" and "how" of ISO 55001.

- What the new standard is about – Peter Kohler outlined the background of the standard
- Why organisations should refer to the standard – John Hardwick provided some useful information on the "why" organisations would benefit.
- How it has been implemented in various industry sectors – Four presentations outlined how it is currently being implemented - including accreditation.

There were 2 concurrent streams of two presentations following the introduction of the standard where 3 speakers presented their experiences of how they are implementing the standard in their organisations.

AM COUNCIL NEWS continued....

Dwayne Pretli from Downer, Stuart Horvarth from Hunter Water and Michael Killeen from NSW Trains via video-link; all talked about the process, wins and challenges in their journeys.

The fourth presentation on the How was from Yngve Amundsen of DNV Business Assurance. This particular discussion was centred on the certification process. He spoke of the experience in assisting organisations in the implementation of the standard and the certification process.

Following the formal presentations, the speakers made themselves available on a discussion panel to field questions from delegates. Many questions were posed from those early on their journey as well as those considering implementing the standard.

Feedback has been very positive from a number of sources where delegates found the inclusion of those on-the-ground going through the process very helpful.

We encourage those not yet familiar with the standard and the benefits to find out more on the AM Council website and consider enrolling in the Asset Fundamentals course run by the AM Council.

TASMANIA CHAPTER

The Asset Management Council technical seminar held last Friday 19th August in Campbell Town Tasmania once again proved to be a very successful day. Presentations provided a variety of innovative experiences from industry asset managers to assist in the sharing of knowledge across the group. TasWater presented a process for determining a framework for the determination of asset criticality. TasRail presented the actions taken to get the trains back on track after the devastating floods across Tasmania. TasNetworks provided a case study on load balancing for residential properties suffering outages on Bruny Island and a former Pt Kembla steel works employee provided a case study on alternative preventative maintenance strategies to control the milling operations of the tin mill operations. Nicholas Boyd provided an insight into life working in Angola and the process for deep sea oil rig operations and the complexity of safety in an undersea working environment.

Following the retirement of the incumbent Chairman Andrew Sneesby an election was held for the position of Chapter Chair for Tasmania. The ballot results gave the position to Glen Mackintosh from TasWater. We trust Glen will take this group forward and expand the membership even further throughout Tasmania. We wish him well in this new position as an active member of the Council.

Presenters were:

Paul Davis, TasWater
TasWater's Asset Criticality Framework

Ongoing capital and operational expenditure is required to achieve business objectives across asset intensive businesses. However, in a funding-constrained environment, assigning these funds requires a means of identifying the relative importance of different assets to the achievement of business objectives. Understanding Asset Criticality helps solve this problem. This presentation introduces some preliminary work that we've undertaken to understand criticality across our infrastructure asset base. Criticality definitions and factors to distinguish criticality of different assets are introduced. Preliminary results are presented together with some examples of current and planned future uses of criticality assessment within TasWater.

Jonathan Culberg, TasNetworks

In three phase electrical networks, the power transfer capacity of overhead transmission lines and underground cables can be limited by imbalanced loads. Configuring the supplied loads to be evenly balanced on all three phases will allow network operators to use their transmission assets to their fullest potential.

Jonathan will provide an overview of a recent project undertaken by TasNetworks to balance the load on a supply feeder in order to alleviate a constraint on a submarine cable. To achieve this, a new system was implemented within TasNetworks that greatly reduces the time required to survey the phase connections on feeders.

Jonathan Drew, TasRail

The paper presents an overview of the impact on TasRail and its Customers of the 6th June 2016 flood event, provides details of the infrastructure damage and how TasRail responded to meet our Customer's needs and minimise the impact.

Nick Boyd, Simplot

This presentation provides an insight into what it's like to work in Angola as well as looking at the sorts of offshore subsea equipment, vessels and operations which BP adopts to extract oil and gas in the region.

John Carter, (retired) Pt Kembla Steel Mills

During his time at the steelworks John was involved in a number of major changes and incremental improvements to production planning and scheduling. John will talk briefly about the production process and the requirements for successful planning and scheduling in the tin mill. John will also talk about projects he implemented to make improvements to the processes including production units only running to customer requirement rather than just trying to produce maximum tonnes, thereby improving maintenance availability on any given production unit. This was achieved by convincing production managers the value of time not producing and allowing small maintenance jobs that could be done in 2-3 hours. This then meant on planned maintenance days where previously they always ran over time were now finishing ahead of time.

Andrew Sneesby

An overview of the AMC Maturity Assessment Process

SYDNEY CHAPTER

Sydney's Desalination Plant was the site for a technical tour held by the Sydney Chapter on 18 August. The tour was a fascinating example of how a strategic and potentially vital public asset is managed.

More specifically aspects of special interest included:

- management and maintenance of a large scale and complex asset in long term stand-by/preservation mode,
- advanced technologies (including the reverse osmosis process,)
- innovative design (including capture of unused energy for use in moving the waste high salt concentration water back to the ocean)
- unique environmental care measures,
- provision for future up scaling if needed and,
- that it is in gradual recovery mode from major damage caused by the tornado of mid December 2015.

It was also enlightening to gain a greater appreciation of the inter-relationship between technical asset management decisions and high level commercial and contractual conditions for an asset of this scale and public importance in the context the unexpected and very significant damage caused.

All in attendance were very thankful to SDP and their GM Operations Gavin Ovens for making this informative tour possible.

VALUE DRIVEN ASSET MANAGEMENT SYMPOSIUM

ASSET MANAGEMENT COUNCIL

21 OCTOBER 2016, BRISBANE CONVENTION & EXHIBITION CENTRE

Case studies demonstrating how mangers create greater value for their organisations and insights into how asset management can be applied to:

- Reduce insurance premiums
- Deliver value to employees
- Increase productivity and efficiencies
- Provide a safer working environment
- Reduce environmental impacts
- Understand auditor requirements
- Preparing for the future
- Using data to predict future maintenance requirements
- Setting performance objectives for customer satisfaction

REGISTER: www.amcouncil.com.au/symposium
Download Flyer here: **www.amcouncil.com.au/files/Asset_Management_Council_1609_ValueDrivenAssetManagement_flyer.pdf**

UP COMING **EVENTS**

EVENT	DATE	LOCATION
September 2016		
Annual Reliability Joint Meeting	8/09/2016	Melbourne
How to develop a strategic asset management plan seminar	8/09/2016	Sydney
How to develop an asset management plan seminar	9/09/2016	Sydney
Asset Management and ISO 5500x Management Systems Webinar	9/09/2016	Global
Asset Management Fundamentals	16/09/2016	Sydney
Technical Presentation	5/09/2016	Canberra
Asset Information Strategy & Systems	15/09/2016	Sydney
Technical Presentation	22/09/2016	Perth
Asset Management Fundamentals	22/09/2016	Perth
Technical Presentation	28/09/2016	Brisbane
October 2016		
ARMS Presentation	11/10/2016	Newcastle
Asset Management Fundamentals	12/10/2016	Melbourne
Life Cycle Cost	13/10/2016	Melbourne
How to develop a strategic asset management plan seminar	13/10/2016	Melbourne
How to develop an asset management plan seminar	14/10/2016	Melbourne
Benchmarking	19/10/2016	Sydney
Value Driven Asset Management symposium	21/10/2016	Brisbane
Chapter Asset Management Fundamentals	24/10/2016	Brisbane
Technical Presentation	27/10/2016	Perth
November 2016		
Future Directions For Infrastructure	7/11/2016	Sydney
Decision Making to Asset Renewal	10/11/2016	Melbourne
Field Mobility & Technology Support	17/11/2016	Sydney
Asset Management Fundamentals Course	17/11/2016	Auckland
Asset Management Fundamentals Course	18/11/2016	Melbourne
Asset Management Fundamentals	18/11/2016	Canberra
Technical Presentation	24/11/2016	Perth
Asset Management Fundamentals	24/11/2016	Sydney
AGM and Annual End of Year Dinner	29/11/2016	Newcastle

ASSET MANAGEMENT COUNCIL

2017 AMPEAK

GLOBAL ISSUES:
LOCAL SOLUTIONS

ASSET MANAGEMENT COUNCIL INTERNATIONAL CONFERENCE

SUNDAY 2 APRIL – WEDNESDAY 5 APRIL 17

Brisbane Convention and
Exhibition Centre, Brisbane Australia

CALL For Abstracts

YOUR CHANCE TO CONTRIBUTE TO AMPEAK17 PROGRAM.

THE ASSET MANAGEMENT COUNCIL IS CALLING FOR ABSTRACT SUBMISSIONS FOR THE 2017 AMPEAK INTERNATIONAL CONFERENCE.

The Theme is Global Issues, Local Solutions – **Advancing the Big Questions in Asset Management**

Global megatrends that have evolved are apparent regardless of geographic location and present unique challenges, risks and opportunities. Common issues faced by asset managers across the globe include:

- Asset management systems frameworks, standards and models
- Big data, internet of things
- New emerging technologies
- Meeting customer and stakeholder expectations
- Value and benefits of asset management
- Funding for aging assets
- Education and training
- Industry Sector Applications to Asset Management

AMPEAK17 will consider some of these common global asset management issues and share solutions from academia, from a maintenance practitioners experiences, an asset management journey and from a specific industry sector.

KEY DATES

- Abstract submission closes **Friday 28 October**
- Draft paper **Friday 10 February**
- Final paper submitted **Friday 3 March**

For details and to submit your abstract go to **http://www.ampeak.theconferencemanager.com.au/abstracts.html**

For more information visit **www.ampeak.com.au**

NEW MEMBERS

New AM Council Members

Alexandra Cohen – Brisbane Chapter
Andrew Spence – Sydney Chapter
Anesh Boodhram – Perth Chapter
Anthony Blunden – Newcastle Chapter
Arshdeep Rattan – Perth Chapter
Bill Filmer – Adelaide Chapter
Claire Fazakerley – Melbourne Chapter
Clayton Smith – Brisbane Chapter
Colin Crisafulli – Sydney Chapter
Craig Mair – Brisbane Chapter
Craig Anderson – Melbourne Chapter
Dalibor Balicevic – Melbourne Chapter
Daniel SONG – Sydney Chapter
Dave McMaster
David Speairs – Melbourne Chapter
David Collins – Brisbane Chapter
David Snelgar – Perth Chapter
Dino Moll – Adelaide Chapter
Dominic Wood – Brisbane Chapter
Fuad Nehme – Adelaide Chapter
George clemens – Sydney Chapter
Georgia Roberts – Sydney Chapter
Greg Gibbs – Brisbane Chapter
Ian Boake – Sydney Chapter
Iulius Mincu – Brisbane Chapter
James Herholdt – Brisbane Chapter
James Kornweibel – Perth Chapter
Jim Mccoll – Adelaide Chapter
Jonathan Keith – Perth Chapter
Julie Brady – Sydney Chapter
Kenny Au – Perth Chapter
Linda Hawke – Canberra Chapter
Lutfiye Allahmanli – Brisbane Chapter
Malcolm Hurley – Hobart Chapter
Mark Burgess – Sydney Chapter
Mark Sibly – Overseas Chapter
Mark Grovenor – Sydney Chapter
Mason Henderson – Canberra Chapter
Matthew Spano – Melbourne Chapter
Matthew Pritchard – Melbourne Chapter
Michael Battaini
Natalie Zagninski
Neil Armstrong – Newcastle Chapter
Neil Husbands – Perth Chapter
Oratile More – Brisbane Chapter
Paul van Wyk – Brisbane Chapter
Peter Burchmore – Melbourne Chapter
Peter Crane – Brisbane Chapter
Peter Harvey – Brisbane Chapter
Peter Boettcher – Brisbane Chapter
Peter Hodgins – Newcastle Chapter
Rajkumar Devadoss – Brisbane Chapter
Raymond Simpson – Sydney Chapter
Samuel Bull
Sarah Stephen – Adelaide Chapter
Stephen Tansing – Newcastle Chapter
Stephen Basley – Sydney Chapter
Steven Barnfather
Susan Thomas – Overseas Chapter
Tanya Langdon – Melbourne Chapter
Thanh Bui – Melbourne Chapter
Tom Parkinson – Melbourne Chapter
Travis Partridge – Adelaide Chapter
Troy Kooloos – Melbourne Chapter
Tyler Gibbons – Sydney Chapter

" to invoke thought and debate on the role of asset management in our organisations for both new and existing assets"

ASSET MANAGEMENT COUNCIL

FUTURE DIRECTIONS FOR INFRASTRUCTURE

A One Day Symposium

Monday 7 November 8:30am –5:00pm

The Water Police Court at Justice & Police Museum, crn Philip and Albert St, Circular Quay, Sydney

Cost: $395 members **$495** non-members **$95** students

New South Wales has embarked upon significant investment in new infrastructure assets, that will change daily lives. This symposium provides p erspectives and case studies on effective asset management approaches in a changing operating envi-ronment. The speakers and panellists are local and international leaders in infrastructure development, asset planning, dependability and asset management standards application. They will share stories, approaches and lessons learned that will invoke thought and debate on the role of asset management in as-suring optimal outcomes for the people of NSW.

ATTENDEES WILL GAIN:

- **a clear picture** of what infrastructure in NSW will look like in the near and medium term future
- an understanding of the **value and fit** of asset management within infrastructure organisations, and the **strategic and tactical challenges and opportunities** for asset managers to make a positive contri-bution
- knowledge of **sound principles and tools** through telling of **stories** that can be taken away and applied within similar contexts
- access to **local and international contacts** who face similar challenges with differing yet relevant areas of expertise and experience

More Information and to register visit **http://www.amcouncil.com.au/events**

Who Should Attend

Anyone working in, or who wants to work with,

- infrastructure asset planning, maintenance and renewals
- a certified ISO 55001 as-set management system,
- the improvement of the management of assets for their organisation.

How can we accommodate emerging shifts in external stakeholder requirements?

What frameworks should we be introducing and implementing within our organisations at all levels as asset management professionals?

How might we incorporate international dependability and asset management standards for the planning and management of infrastructure assets?

Membership Application

ASSET MANAGEMENT COUNCIL

ASSET MANAGEMENT COUNCIL LTD
A Technical Society of Engineers Australia

ABN: 15 141 532 747 www.amcouncil.com.au
Phone: +613 9819 2515 Fax: +613 9819 2615 Email: mandy.wan@amcouncil.com.au

Thank you for joining the Asset Management Council. Please complete all sections. Phone or email with any queries.

PERSONAL DETAILS (Please print in BLOCK CAPITALS)

Title (Please circle) Dr Mr Mrs Ms Miss Other (Please specify) Sex (Please circle) F M

Family Name Given Names (in full)

Date of Birth Engineers Australia Membership No

CONTACT DETAILS (Please print in BLOCK CAPITALS)

Preferred Address: ☐ Private Address or ☐ Business Address

Position

Organisation

Postal Address

City State

Country Postcode

Phone Fax

Mobile

E-mail

AREAS OF INTEREST (Please tick)

Technical Topics

- ☐ Reliability
- ☐ Availability
- ☐ Maintainability
- ☐ Performance
- ☐ Spares Planning
- ☐ Maintenance Planning and Scheduling
- ☐ Maintenance Plan development and implementation
- ☐ Maintenance Policy/Strategy development
- ☐ Logistics
- ☐ Shutdown planning and the maintenance interface
- ☐ Asset Management
- ☐ Other:

Issues

- ☐ Skills development
- ☐ Training
- ☐ Other:

Industries

- ☐ Facility Management
- ☐ Consulting
- ☐ Power
- ☐ Transport
- ☐ Defence
- ☐ Oil and Gas
- ☐ Mining and Industry
- ☐ Water and Utilities
- ☐ Infrastructure
- ☐ Other:

Return completed Membership Application with payment to:
Asset Management Council
PO Box 2004, Oakleigh Vic 3166

GROUP AFFILIATION

☐ Young Asset Management Practitioners (18-35 year olds)

CHAPTER AFFILIATION (Please tick one)

☐ Newcastle	☐ Canberra	☐ Sydney	☐ Illawarra	☐ Mackay
☐ Melbourne	☐ Adelaide	☐ Brisbane	☐ Hobart	
☐ Darwin	☐ Overseas	☐ Gippsland	☐ Perth	

MEMBERSHIP FEES Effective Jan 2015 (Please tick one membership type only)

Individual Annual Fee (including GST)

☐ Member $154.00

☐ Student $33.00

Corporate Annual Fee (including GST)

☐ Platinum $9,570.00

☐ Silver $1,804.00

☐ Gold $3,608.00

☐ Bronze $957.00

GST (10%) does not apply to overseas memberships.

CORPORATE MEMBER NOMINEES

Platinum – 30 nominees, Gold – 10 nominees, Silver – 10 nominees, Bronze – 5 nominees

	Name	Email	Date of Birth (Mandatory)	AM Council Chapter
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Contact Asset Management Council to provide more corporate nominee details.

PAYMENT

Method of Payment (please tick one and enclose payment)

☐ Cash

☐ Money Order or Cheque drawn in AUD from an Australian bank) payable to **Asset Management Council Ltd**

☐ International Money Order

☐ Credit Card
(Australian or New Zealand Bankcard only acceptable)

Credit Card Details Please charge my card (tick one card type)

☐ Visa ☐ Bankcard ☐ Mastercard

☐ Diners ☐ American Express

Card no _____

Expiry _____ Amount $ _____

Name on card _____

Signature _____ Date _____

Partners, Corporate Members & Contacts

Partnering Organisations

SAP Australia
www.sap.com

Broadspectrum
www.broadspectrum.com

IFM Investors
www.ifminvestors.com

Platinum

Asset Standards Authority, Transport for New South Wales
Ausgrid
BAE Systems
Broadspectrum
Downer Engineering, Construction & Maintenance
Industry Funds Management ("IFM")
SAP
Ventia Pty Limited

Gold

Airservices Australia
Atos Australia Pty Ltd
Bentley Systems International Limited
BHP Billiton Iron Ore
Bombardier
Capability Partners
Cardno (QLD) Pty Ltd
City of Ballarat
Department of Defence CASG
Essential Energy
GHD Pty Ltd
Hardcat Pty Ltd
Jacobs
K2 Technology Pty Ltd
Lend Lease Services Pty Ltd
Naval Ship Management (Australia)
Power and Water Corporation
Riva Modeling Systems
Stanwell Corporation Limited
Sydney Water Corporation
Teak Yew
Thales Australia Limited Gold
TransGrid
Transurban Ltd
Ventia Utility Services Pty Limited
Vesta Partners
Wave International Pty Ltd
Western Power

Silver

ActewAGL Distribution
AECOM
AGL
AMCL
ASC Pty Ltd
City of Perth
IBM
Kellogg Brown & Root Pty Ltd
Lake Maintenance Pty Ltd
Logsys Power Services
Lycopodium Infrastructure Pty Ltd
Metro Trains Melbourne (MTM)
NSW Department of Trade & Investment
NSW Office of Environment and Heritage, National Parks and Wildlife Service
Programmed Facility Management
Public Transport Authority
QinetiQ Australia
Refining NZ
SKF Australia Pty Ltd
SNC-Lavalin Rail and Transit
Sydney Trains
VicTrack

Bronze

Activa Pty Limited
Advisian Pty Ltd
Ajilon
Akzo Nobel Pty Limited
ALS Industrial
AMCL
ANSTO
ARMS Reliability Engineers
Asset Management Academy Ltd
Asset Management Council
Assetivity Pty Ltd
Aurecon Australia Pty Ltd
Babcock Pty Ltd
Bluefield
Brisbane Motorway Services
Broadcast Australia
Comdain Infrastructure
Country Fire Authority (CFA)
Covaris Pty Ltd
Department of Economic Development, Jobs, Transport and Resources
Electrix Pty Ltd
Energex Limited
Fremantle Ports
GDF Suez Australia Energy
Gladstone Area Water Board
Goulburn Valley Water
Griffith University
Hobsons Bay City Council
Hunter Water Corporation
Indec Consulting
Ingenia Pty Ltd Bronze
Innovative Thinking IT
Institute of Quality Asset Management
LogiCamms
Macutex
Maintenance & Project Engineering
Maintenance Systems Solutions Pty Ltd
Melbourne Water
Meridian Energy
Meridium Pty Ltd
MWH Australia Pty Ltd
Nexus Global Australia
NRG Gladstone Operating Services
Opus International Consultants
Pacific Hydro
PHC Projects
Port Authority of NSW
Port of Newcastle
PricewaterhouseCoopers
QENOS
Ramco Systems Australia Pty Ltd
Redeye Apps
SEQWATER
Shoalhaven Water
State Water Corporation
Tasrail
TasWater
Terotek (NZ) Limited
The Asset Management College
Townsville City Council
United Energy Bronze
Velocity Energy Bronze
Water Corporation
Water Treatment Services
WaterNSW

ASSET MANAGEMENT COUNCIL

THE ASSET JOURNAL

Asset Management Council
PO Box 2004
Oakleigh Vic 3166
Tel 03 9819 2515
www.amcouncil.com.au