ASSET MANAGEMENT COUNCIL

AMBOK Publication

ASSET MANAGEMENT BODY OF KNOWLEDGE

000

Framework for Asset Management

Second Edition

ENGINEERS AUSTRALIA

Technical Society

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AMBoK Publications

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Framework for Asset Management

Preamble

The benefits of asset management are numerous: more predictable and sustainable cash flows; the final outcome of the profit and loss; the value of the assets on the balance sheet; and the ability to both support an expected share price and achieve market share. These benefits are being increasingly recognised by business and government alike, and are supported by a number of factors, including the publication of numerous state and national government reports into the management of critical community and public assets; and the development and publication of an international standard on asset management (the ISO 55000X suite was published in January 2014).

The realisation that asset management contributes directly and indirectly to a number of important factors means that a common asset management language, for better communication within organisations and across industries, is increasingly considered by top management to be more important than ever.

The Asset Management Council is committed to advancing the asset management knowledge and capability of both its members and stakeholders, and as such, it has brought together some of the best technical asset management professionals within Australia to further expand and strengthen the Asset Management Body of Knowledge (AMBoK).

The AMBoK Team are charged with making AMBoK accessible to, and useable by, members and stakeholders of the Asset Management Council. A forward-thinking Technical Team, consisting of numerous volunteers in senior positions in asset-intensive industries across the board, the AMBoK Team supports the Asset Management Council in enabling value from effective asset management. The Asset Management Council has a strong link to “best practice” in the field of physical asset management, no doubt due to our diligent AMBoK Team. Members of the AMBoK Team are actively involved in the development and continual improvement of Asset Management Council content.

This publication provides the asset management community with a concise picture of the principles, concepts and processes of asset management, including emphasis on the key roles of stakeholders, leadership, culture and asset management maturity. It is the interaction of the tangible and intangible aspects of an organisation that can produce asset management maturity and excellence, and therefore the biggest benefit for organisational efforts.

AMBoK Publication 000: Framework for Asset Management, Second Edition presents an intellectual framework and context through which asset management information can be developed and universally understood, whilst providing opportunities for both individuals and organisations to build their asset management capabilities.

About the Asset Management Council

The Asset Management Council is a Technical Society of Engineers Australia, the peak body for all engineering disciplines, and is a founding member of the Global Forum on Maintenance and Asset Management.

From our start in 1994, we have been committed to the promotion and education of asset management and maintenance practices in industrial, commercial, academic and government sectors. Our vision is ‘enabling benefits for all from effective use of assets’. We provide a platform for technical knowledge to be learnt and shared, and opportunities for networking through key activities. As a national not for profit organisation we provide independent information and guidance on asset management across the multitude of industry sectors and professional roles in asset management, both in Australia and globally.

Our objectives are to:

- Strengthen and enhance the asset management and maintenance engineering capabilities of asset management practitioners and organisations
- Promote excellence in the practice of asset management and maintenance engineering
- Promote practitioner participation in, and contribution to activities of the Company
- Facilitate linkages at national and international levels
- Facilitate active participation from other disciplines and professions; and
- Encourage research and increase the body of asset management knowledge.

The Asset Management Council continues to grow as a greater number of organisations understand the importance of employing asset management principles to enhance their organisational capability. Our membership base reaches far and wide, and has representation from a range of asset intensive industry sectors and service providers, including government and private organisations.

In order to undertake this leadership role in asset management in Australia, the Asset Management Council comprises a Board, national office staff, 13 regional Chapters and volunteers from across Australia. This dedicated group of people deliver a range of programmes to Asset Management Council members and the broader asset management community, including the Asset Management Body of Knowledge (AMBoK) publications and models, asset management training and certification, asset management awards, technical journal and articles and a range of conferences and forums.

Our vision: Enabling value from effective asset manage

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1 Introduction

This publication, *AMBoK Publication 000: Framework for Asset Management,* is based on factors that are intrinsic to the Asset Management Body of Knowledge. These factors are the Asset Management Council's definition of asset management, its principles of asset management and the Asset Management Council Models.

This publication outlines these foundational factors below, and then examines in detail the Asset Management Council Models.

1.1 Asset Management Definition

The Asset Management Council defines asset management as:

"The life cycle management of physical assets to achieve the stated outputs of the enterprise"

This definition specifies a focus upon the delivery of a stated capability in which assets play a key role, and in which the business must manage its physical assets commensurate with the business need for that capability. Thus, the definition is concerned with short, medium and long-term considerations. This definition also defines the boundaries of asset management and differentiates it from other key management processes.

Asset management is concerned with all aspects of capability from the conception of the need, through its complete operating life, and then to disposal.

1.2 Principles of Asset Management

Asset management is founded on a set of principles. If any one of these principles is missing from the management of assets, the organisation will likely see a reduction in the value that its assets provide. The principles should directly influence an organisation's asset management systems and plans.

These principles of asset management are:

1. Output Focus
2. Capabilities
3. Level Assurance
4. Learning Organisation.

These are discussed further in Section 7.1.4.

1.3 Asset Management Council Models

The Asset Management Council has developed a number of models that illustrate and describe asset management. They are:

1. **Asset Management Concept Model**: Conceptually presents the basis of successful asset management.
2. **Asset Management System Model**: Illustrates the key components of an asset management system and how they inter-relate.
3. **Organisational System Model**: Depicts the typical components of an organisation's management system and how they integrate.
4. **Capability Delivery Model**: Schematically presents processes, within a number of disciplines, that may be used in part or entirety, to deliver successful asset management.
5. **Maturity Model**: conveys the extent to which leadership, culture, human performance and the asset management system are integrated into the whole organisation, while contributing to its success.

These models will be examined in detail from Section 7 onwards.

1.4 Asset Management Council Governance Framework

Collectively, the definition, the principles and the asset management models serve two purposes: to provide the Asset Management Council with a consistent framework for the development, provision, maintenance

and improvement of delivered services; and to provide the asset management community with a concise picture of the principles, concepts and processes of physical asset management.

The models, principles and definition of asset management, together with the Asset Management Council vision, values and code of ethics provide the governance framework for the business activities of the Asset Management Council.

These activities involve the processing of a range of inputs and demands to develop a range of outputs for the asset management community. Inputs, for example, may include standards, technical writings and stakeholder requirements etc.; while the outputs may include AMBoK activities, training, events, forums, conferences, publications, and building individual and organisational capabilities.

This process is represented by the flow chart below (Figure 1):

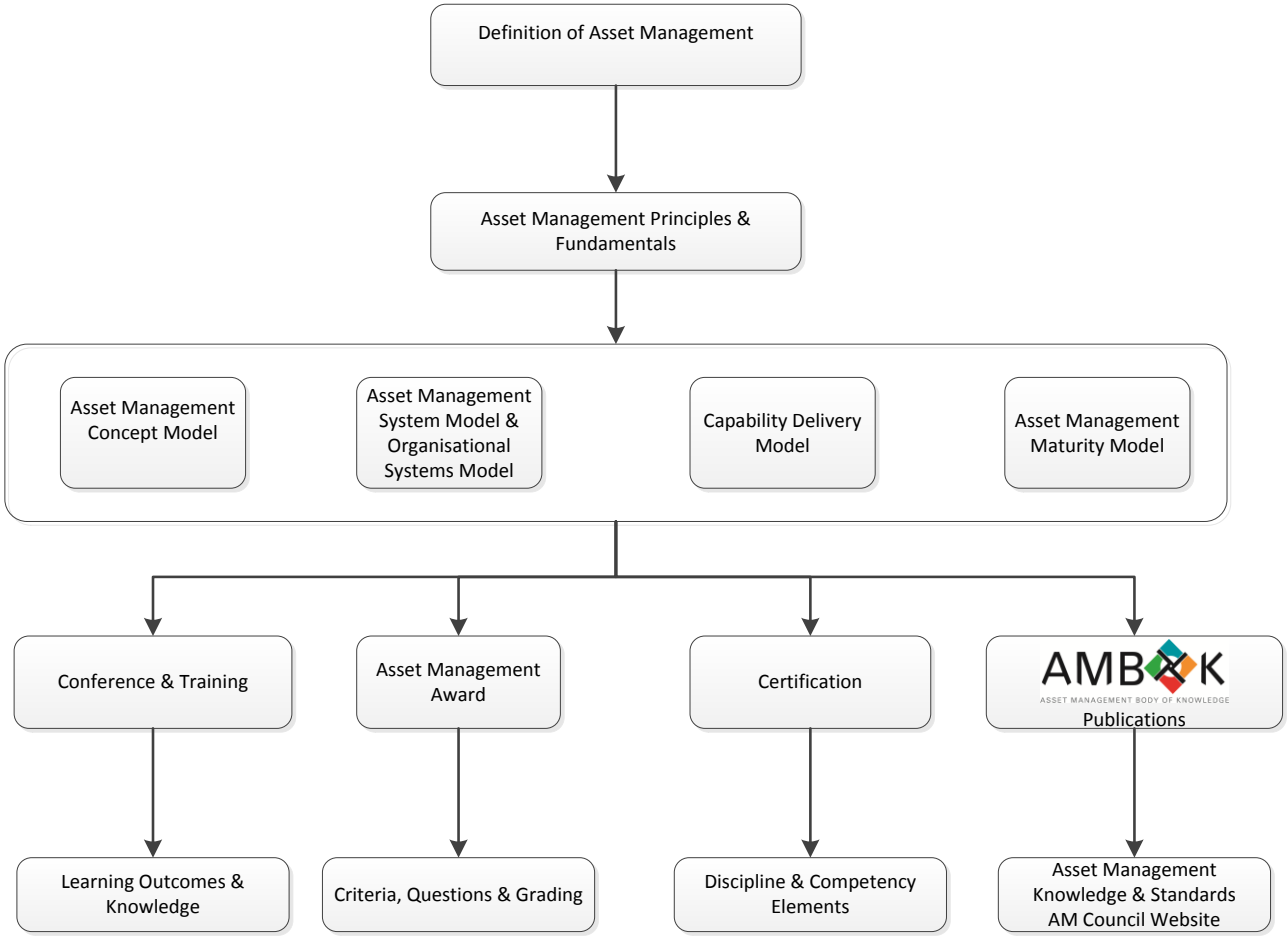


Figure 1: Asset Management Council Governance Framework

2 Stakeholders

Stakeholders frame an organisation and determine the needs and constraints on the business. Stakeholders are therefore key to all asset management processes, plans and decisions. Accordingly, stakeholders play a critical role in all Asset Management Council Models presented in this publication. Stakeholders sit at the uppermost levels of the each model, emphasising their overarching influence.

Given this, it is crucial to be clear about what ‘stakeholder’ actually means. As reinforced in ISO 55000, a stakeholder or ‘interested party’ refers to an individual or organisation that can affect or be affected by (as perceived by the stakeholder) an organisational decision or activity. With respect to asset management, stakeholders within an organisation can be internal or external.

Stakeholders set requirements for leadership to execute the organisational objectives. These requirements typically include, shareholders expectations, regulators expectations, employee expectations, customer expectations, suppliers expectations and the broader public’s expectations. Stakeholders’ needs and expectations should be documented and communicated. These may be captured in a statement of stakeholder needs and should reference any mandatory requirements, as well as the expectations of different stakeholder groups.

Stakeholder requirements may include decision making criteria; safety and environmental issues; profit and financial needs; community expectations; product volume and quality; and legal compliance.

3 Leadership and Culture

Leadership and culture are essential enablers for the successful application of the discipline of asset management. As with stakeholders, both leadership and culture play critical roles in every model presented in this publication, reflecting their indispensable nature to successful asset management. In fact, leadership acts a translator of stakeholder requirements into organisational objectives.

Leadership is, in fact, the driver to change behaviour and culture. Leadership of an organisation is responsible for establishing the antecedents and consequences of behaviour, and thereby has a flow-on effect within the organisation and the organisational culture. Leadership enables teamwork to be translated into planned results, potentially at the level of excellence, and becomes a worthwhile process when it becomes active: when there is no longer a single leader, but all employees are guided by the values and culture of the organisation.

In an ideal workplace, team members work together to create products, high value services and significant results. This requires that the command alternates between team members without the designated leader losing the 'mantle' of leadership. This displacement of the leadership role allows the group to receive varied leadership (guided by organisational values and culture), which results in better performance. Making leadership a process rather than a single position is the essence of high performing teams.

In establishing such leadership, an organisation should clearly define the responsibilities and authorities for both the management of assets and the supporting asset management system. An organisation should also ensure that its employees are both competent and authorised to act on those responsibilities. Regular consultation with employees and service providers on changes/improvements to the asset management system is very important in creating appropriate culture.

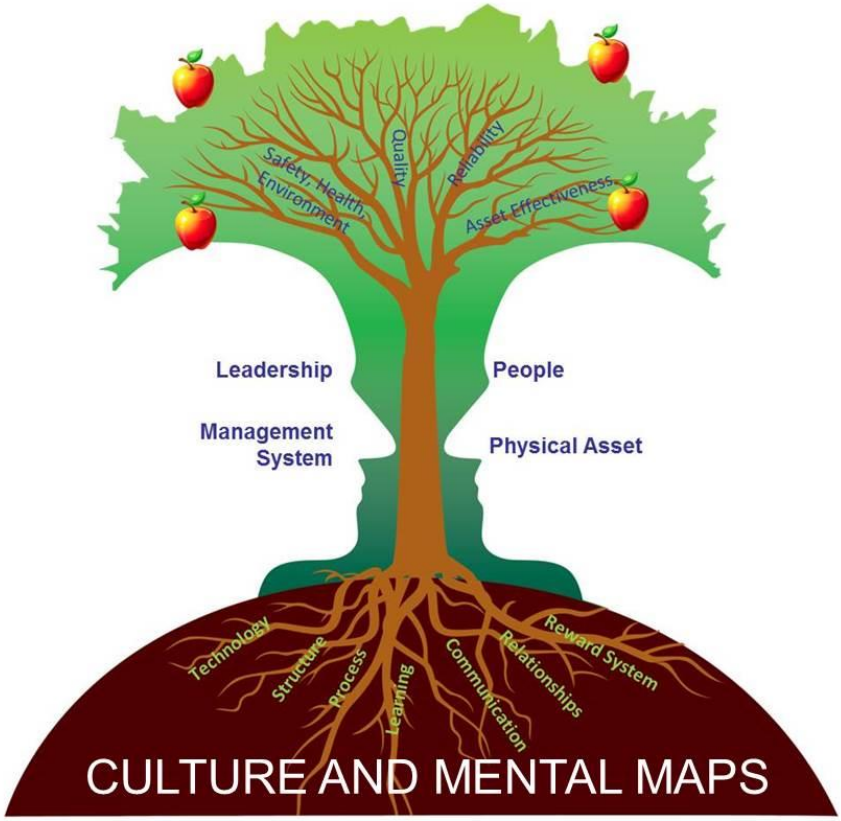


Figure 2: Asset management must have the right environment to flourish; the right leadership, behaviour and culture. This tree metaphor was chosen because it illustrates, at an axiomatic level, that leadership, culture, emotions and behaviours are vital. It is imperative that all these elements function together if the desired outcome is to be achieved (Living Asset Management, 2013)

by the same token, an aligned and integrated approach requires a matched leadership style to successfully achieve the desired outcomes. The leadership style of an organisation should be focused on the organisational intent, and engaged employees should understand the organisational purpose, and consistently achieve the organisation's goals and objectives. Leadership and commitment from all levels of management is an essential prerequisite for successfully establishing, operating and improving asset management within an organisation.

This focus on leadership and culture, in conjunction with the technical, tangible side of asset management, provides the difference between high performing organisations and those that are not. Leadership and culture can facilitate or impede the implementation of the asset management system. It is the interaction of the tangible and intangible aspects of an organisation that can produce asset management maturity and excellence. Traditional tangible changes, such as reliability, quality, safety and asset management manuals, alone are not as effective as a change in culture and leadership.

Achieving desired outcomes, whether they are higher share prices, improved efficiency and performance, or lower costs and reduced risk, are all potential results of the right leadership and culture within organisations. Asset management-focused organisations proactively apply these concepts to become, and distinguish themselves as, high performing organisations. It is for these reasons that leadership and culture feature prominently in all models presented in this publication.

For more information on leadership and culture in asset management, please see Living Asset Management, a publication from the Asset Management Council and ABRAMAN (The Brazilian Society of Maintenance and Asset Management).

4 Key Concepts of Asset Management

There are several key concepts of an asset management organisation. Understanding them aids successful implementation of asset management. The key concepts are summarised here.

4.1 Cost, Risk and Performance

The notion that the outcome of the management of assets is a balance between the cost of providing the asset performance to an agreed level of risk is a key concept of asset management, and contained in ISO 55000. The phrase used in ISO 55000 is “Effective control and governance of assets by organisations is essential to realise value through managing risk and opportunity, in order to achieve the desired balance of cost, risk and performance”.

As such, the Asset Management Council considers that for such a balance to be ‘demonstrable’ the following issues should be considered, namely that:

- risk is usually expressed as the agreed residual risk associated with the delivery of the agreed asset performance, based upon the organisational risk management approach and the stakeholder agreed decision making criteria, imbedded in the risk approach;
- performance is usually expressed as quantitative measures such as Reliability, Availability, Maintainability and Supportability (RAMS) against an agreed time frame and an agreed performance functional specification (expressed in terms that relate to the business need- such as an agreed speed/power curve and specific fuel consumption per unit power etc.), over which the relevant risks have been identified and mitigated; and
- cost is usually expressed in dollar terms, but may include other measures, where appropriate. The cost associated with this balance is usually reflective of the aggregation of the risk mitigation measures (maintenance, spares, access, special tools etc.) and the direct enabling costs (such as fuel etc.). It may also include the opportunity costs associated with any asset down time. Each organisation will need to have its own agreed cost structure.

4.2 Decision Making Criteria

The Asset Management Council recommends the use of rational decision making using quantitative criteria that are demonstrably linked to the objectives of the organisation via a defined and repeatable process.

This is demonstrated in ISO 55001 by the requirement that an organisation (through its stakeholders) develop and apply agreed and approved decision making criteria.

Organisations should therefore consider how such a balance might be able to be demonstrated.

5 Key Terms

The key terms presented below may aid the reader in better understanding this publication.

Key Term	Definition
Acquisition	The process by which an entity obtains/acquires an asset capability for its stated purposes.
Capabilities	The inherent functions of an organisation or physical asset.
Configuration Management	The management of the functional and physical attributes (data) of a system/asset and its part sub-systems and assemblies
Continuous Improvement	A process to assess, identify and improve performance of a management system and/or asset, and often called PDCA.
Culture	A set of learned beliefs, values and behaviours the way of life shared by the members of a society or organisation.
Demand Management	The establishment of sound relationships with stakeholders who may be internal or external to the organisation.
Inputs	Resources and constraints required to deliver outputs.
Leadership	The process of influencing and directing the performance of group members towards the achievement of organisational goals.
Learning organisation	An organisation that actively seeks change in environment or domain knowledge and adapts to improve its products or services.
Level of assurance	Quantifiable level of confidence in the delivery of a capability.
Life cycle	Evolutionary phases of a system/asset, product, service, project or other human-made entity from conception through retirement.
Operations & Maintenance	Combination of processes and tasks necessary to implement the required support, through which the requisite outputs and level of assurance should be delivered.
Outputs	The stated requirement for services or products required by the enterprise.
Physical asset	A combination of interacting elements organised to achieve one or more stated functions.
Systems Engineering	An interdisciplinary, collaborative approach to derive, evolve and verify a life-cycle balanced system solution which satisfies customer expectations and meets public acceptability.

6 Asset Management Council Reserved Terms

The Asset Management Council has a number of what it deems 'reserved terms'. These terms are used throughout this document, as well as in other Asset Management Council publications. When one of these reserved terms appears in Asset Management Council text, it refers only to one particular item or concept, rather than the generic meaning of the word or term. For example, the word Landscape, when used in Asset Management Council text, refers *only* to the Asset Management Landscape, a tool from the Global Forum on Maintenance and Asset Management (GFMAM) to promote a common global approach to asset management. The full list of reserved terms is below.

Reserved Term	**Meaning**
Component	Refers to the Encapsulating and Structural Components of the Asset Management System Model.
Elements	Refers to Structuring Element, Governance Element, Structured Element, and Business Asset Element which are all Elements of the Asset Management Maturity Model. Elements can also refer to Competency Elements within the Capability Delivery Model, and the Asset Management Council Certification Scheme.
Framework	Refers to a governance structure for the objectives, plans and activities of the Asset Management Council. Also refers to AMBoK Publication 000: Framework for Asset Management.
Landscape	Refers to the Asset Management Landscape, an initiative of the GFMAM. The Asset Management Landscape structured representation of asset management knowledge and practices form which such can be compared, contrasted and aligned around a common understanding of the discipline of asset management.
Lenses	Refers to Maturity Lenses which are a key part of the Asset Management Council Maturity Model. Maturity Lenses are specific attributes of asset management. Their analysis provides useful insight into the manner in which asset management is implemented within the asset management function of an organisation.
Qualities	Refers to Maturity Qualities, a key part of the Asset Management Maturity Model. Maturity Qualities are specific attributes of asset management. Their analysis provides useful insight into the manner in which asset management is implemented and supported across the entirety of an organisation.

7 Asset Management Concept Model

7.1 Introduction

7.1.1 Purpose

The purpose of the Asset Management Concept Model is to both present the basis (way of thinking) of asset management, and to document the fundamental basis of asset management.

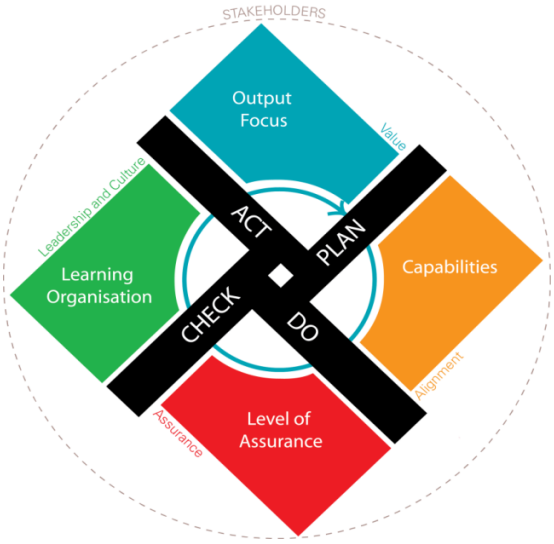


Figure 3: Asset Management Concept Model

7.1.2 Description

The Asset Management Concept Model documents the basis of asset management. The model's intent is to serve as a conceptual framework from which the foundational elements of asset management can be identified, documented and implemented.

The Asset Management Concept Model consists of four key principles, connected by a set of processes within which a Plan Do Check Act approach is implemented. These are encased by a 'Stakeholder Circle'.

7.1.3 Stakeholders

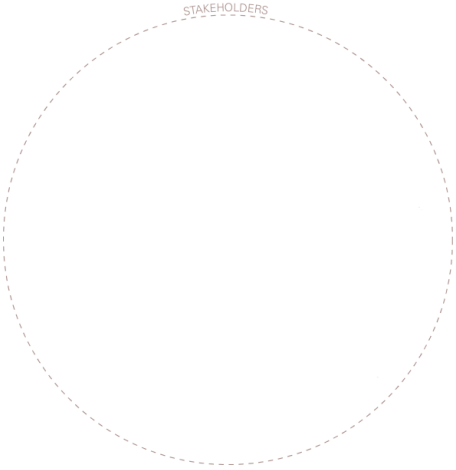


Figure 4: 'Stakeholder Circle'

The first part of the Asset Management Concept Model is the 'Stakeholder Circle'. Here, stakeholders are conceptually represented as encompassing and influencing all asset management activities. For more information on the role of stakeholders in asset management, refer to Section 2.

7.1.4 Principles

The second part of the Asset Management Concept Model are the principles of asset management.

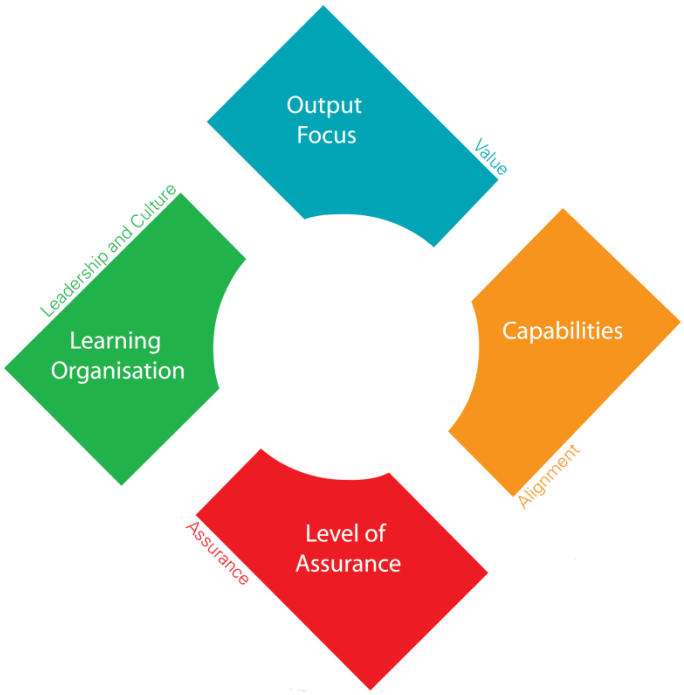


Figure 5: Four Principles of the Asset Management Concept Model

The four principles within the Asset Management Concept Model are:

1. Output Focus
2. Capabilities
3. Level Assurance
4. Learning Organisation.

7.1.4.1 Output Focus

The first key principle of asset management is that an organisation and its assets must have an "output focus". This focus on the delivery of an output must be matched to the organisational objectives as described in agreed policies, strategies and plans. These business objectives will usually be defined in the external agreements that the organisation has committed itself to achieve.

These outputs may be defined in a variety of ways where each can be measured in an agreed manner so that it is clear whether the output or service was actually delivered.

7.1.4.2 Capabilities

The second principle is "capabilities". Capabilities are inherent in organisations and assets alike. To achieve outputs requires capabilities. Asset management is not about the physical asset itself – it is about what the asset can do - the asset's capability.

The achievement of the required output will usually require, not only requisite asset capability, but also other enabling capabilities such as operating instructions and maintenance and spares. These support capabilities are themselves enabled by other enabling capabilities such as finance, human resources, information technology and corporate guidance.

Capability Example: A pen may not always be needed to write - its needed capabilities depend upon what it is required to do. If that use is as a paperweight then the ink inside the pen is of more importance (because of its weight) than the sharpness of the nib and the strength of its structure. Objects can have many capabilities.

When establishing the need for enabling capabilities it is critical to link them to the output intent within the operating context. Thus, a maintenance task from an Original Equipment Manufacturer may be of little value if the context of use of the asset is not known or is significantly different from its original context of use.

7.1.4.3 *Level of Assurance*

The third key principle is "level of assurance" or level of uncertainty. That is, what is the level of confidence that the asset will achieve its intended or designed outputs of safety, service and cost effectiveness? "Certainty" and its reciprocal "uncertainty" are all about risk, which links the context of use to the achieved outcomes.

Risk is the combination of the probability or likelihood of an event and its consequence. The consequence of most aircraft accidents is death. However, people confidently fly in aircrafts, because they are reasonably certain that the aircraft will perform to an expected standard. People are certain because of the way the risk is managed by the use of assessment tools during design and later in the provision of support and enabling capabilities.

Management of risk is a key role of asset management. It provides a level of assurance that the systems and equipment that comprise assets, will deliver the required measurable and testable capabilities. Thus, the concept of "level of assurance" is actually incorporated with the concept of an "output".

Level of Assurance Example: An interurban passenger rail system, with its existing asset configuration and associated operating and maintenance management regimes, may be able to produce the required timetable performance for each train with a probability of 92% at a given cost. Here the 92% relates to the level of assurance or confidence that 92% that randomly selected trains will arrive at their destination on time.

However, operating environments are always in a state of change as are organisational structures. For example, suppose the Board of the organisation appoints a new CEO who is driven to lower costs and cuts fixed budget expenditure by 10%.

The question is then asked, "If I only need 80% on time running what would that cost?" What would we now do differently to manage that asset and what would the real difference in cost be?

For example the difference between a 75% level of confidence and a 99.9% confidence is a ratio of 250 to 1 i.e. if 99.9% represents one failure per month then 75% represents 250 failures per month, clearly the resourcing

Organisations that are good at asset management effectively manage "what if" scenarios involving a trade-off between level of confidence and the consequences, because they are able to connect actions to consequences.

7.1.4.4 *Learning Organisation*

The fourth key principle of asset management is a "learning organisation" where lessons are harvested from measuring and analysing performance and learning is disseminated and actioned. An organisation that actively seeks change in environment or domain knowledge and adapts to improve its products or services is a learning organisation.

It is self-evident that good asset management organisations are learning organisations. They have transparency of process, and transparency of the decision making involved. Their approach can be considered as a view of continuous improvement that focuses on people, their understanding of their role within the organisation; their ability to look at the processes and resources provided, and their ability to challenge those arrangements and not feel threatened. Plan Do Check Act: A Process

Within the principles of the Asset Management Concept Model is the Plan Do Check Act Process. Asset management is a process, or a series of steps or acts, for performing a function or accomplishing a result, meaning that there is a start and a finish. In between, there are feedback loops to continuously sustain alignment of the managed assets and the stakeholders who are served or affected by the asset.

Figure 6: The Plan Do Check Act Process

The process follows the classic Plan Do Check and Act model, originally defined by Walter A Shewhart more than fifty years ago.

Asset Management System Model

8 Asset Management System and Organisational Systems Model

8.1 Introduction

A management system is a set of interrelated or interacting elements of an organisation to establish policies, objectives and processes to achieve organisational objectives. A management system can address a single discipline or several disciplines.

In small organisations there may not be a formally documented system. However, the larger the organisation, the more likely it is that there are written instructions about how these policies and processes. This ensures that nothing is omitted and that all are clear about who needs to do what, when and how.

The Asset Management System Model defines the parts of a management system for the management of assets (that is, the Asset Management System) and the relationship between these parts.

In addition to defining those relationships, the Asset Management System Model depicts the linkage between the stakeholders needs, the organisational leadership and culture and the organisational objectives to the asset management objectives.

The Organisational Systems Model in turn, illustrates the inter-relationship between the various management systems of the organisation. This will be expanded upon in Section 8.5.

8.1.1 Purpose of the Asset Management System Model

The purpose of Asset Management System Model is to illustrate the key elements of an asset management system and how they inter-relate

8.1.1 Purpose of the Organisational Systems Model

The purpose of Organisational Systems Model is to depict the typical components of an organisation's management system and how they inter-relate.

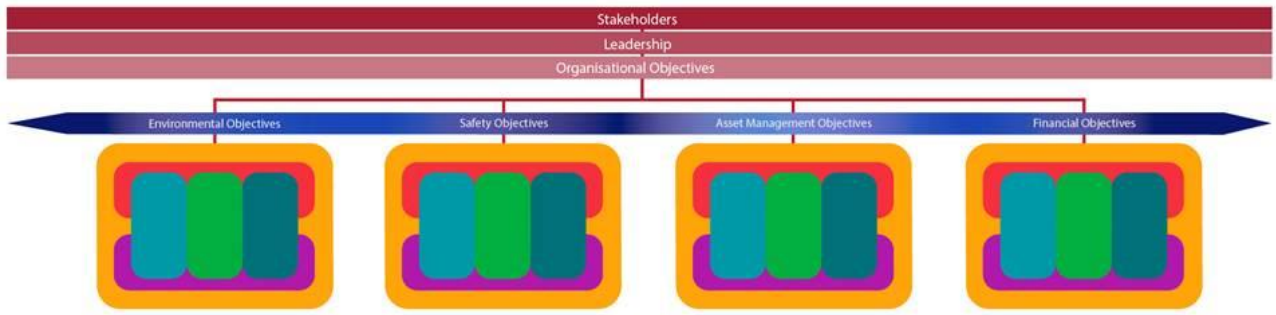


Figure 7: Organisational Systems Model

These models are presented together as one is embedded within the other: the Asset Management System Model is a system within the Organisational Systems Model.

8.2 Components of the Asset Management System Model

8.2.1 Stakeholders

A stakeholder of a system is an individual or a group that is directly affected by the performance of the system and can have an influence in creating its future (Gharajedaghi, J., (2011-08-09). Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture (Kindle Locations 6299-6301). Elsevier Science). In these models, stakeholders are depicted as the top influence for the Asset Management System, and Organisational Systems. For more information on stakeholders, see Section 2.

8.2.2 Leadership

These models illustrate how leadership transforms stakeholder requirements into organisational objectives, then into asset management objectives. For more information, see Section 3.

8.2.3 Organisational Objectives

An organisational objective refers to an overarching purpose or target which sets both context and direction for organisational activities. Organisational objectives are derived from stakeholder needs and are officially established through the strategic level planning activities of the organisation.

Organisational objectives are set within the context of the organisation.

8.2.4 Asset Management Objectives

Asset management objectives are translated from the organisational objectives as part of strategic asset management development.

Asset Management Objectives must be in concert with all other management system/function objectives, as per the Organisational Systems Model. When combined with all other management objectives (e.g. financial, safety, production/operations, etc.), they collectively enable the achievement of the required business objectives.

The scope of the asset management objectives relates to those activities necessary for the management of assets (in the achievement of the organisational objectives). When determining this scope, the organisation should consider: the organisational context, the requirements from stakeholders, and the interaction with other management systems, if used.

The organisation should define the assets and/or asset systems covered by this scope, and the scope should be documented information.

8.2.5 Performance Monitoring and Improvement

Performance monitoring is imbued in everything, in every system and every process. It is concerned with monitoring the delivery of various objectives, including KPIs and KRAs. Performance monitoring and improvement comprises two parts:

- performance monitoring and improvement of the assets themselves against the objectives set; and
- performance monitoring and improvement of the management system.

The relationship between the parts is also important in understanding the performance of the asset management system. Table 1 defines the relationship between the achievement of the asset management objectives and the compliance with the asset management system.

		Asset management objectives achieved	
		Yes	**No**
Management system compliance	**Low**	Problem with the asset management system	Problem with the asset management system
	High	No problem	Problem with the asset management system

Table 1: Mapping of asset management objectives and management system compliance

8.2.5.1 Monitoring asset management objectives

Asset management performance should be evaluated against whether the asset management objectives have been achieved, and if not, why not. Where applicable, any opportunities that arose from having exceeded the asset management objectives should also be examined, as well as any failure to realise them.

Performance evaluation and improvement of the asset management objectives is dependent on two sub-functions. The first is continuous improvement, which increases the efficiency within the existing paradigm or framework.

The second is strategic review. This sub-function identifies that the current plan will not achieve the objectives and develops a new plan which is then embodied in the management system. The types of changes this sub-function may generate include changes to policy, changes to the procedures manual, and changes to the objectives.

Performance monitoring is a strategic, top-level activity. Its operational function sits in the continuous improvement function in the Capability Delivery Model (see Section 9.3.10 for more information).

8.2.5.2 Monitoring compliance with the asset management system

The performance of the asset management system should be evaluated against any objectives set specifically for the system itself (either when it was established, or following previous evaluations). The primary purpose of evaluating the system should be to determine whether it is effective and efficient in supporting the organisation's asset management. The adequacy of the decision-making processes should be examined carefully. Periodic audits should be used to evaluate the performance of the asset management system; these may be complemented by self-assessments.

8.2.5.3 Auditing the management system

Auditing is a useful activity to monitor and understand compliance with the management system. Key elements of the management system shall be audited every two years with a view to completing the equivalent to Table 1 and taking action appropriately.

An audit may comprise:

- review of the results the management system has generated;
- review of the artefacts the management system has generated and comparison of these to what is defined as a requirement in the management system; and
- Interviews with the people involved in the management system.

8.2.5.4 Data and information requirements

Effective asset data management and the transformation of data to information is a key to monitoring and measuring asset performance. The process for analysis of data and its conversion into information shall include the:

a) methodology and techniques for evaluating and validating the information collected and recorded against the established performance indicators;

b) quality control of data used and information reported;

c) responsibilities for compiling, analysing, storing and protecting data; and

d) transforming of data into relevant and reliable information for interpretation of relevant employees.

8.2.6 **Decision Making**

As every organisation is faced with the need to make decisions in a range of areas including asset management, effective decision making is an essential part of any management system. Despite this, there is a high degree of variability in terms of the approach and results. This often leads to frustration with those seeking to have decisions made, as they are constantly requested to bring forward new options, provide inordinate amounts of detail or generate slight variances on the existing options despite the seemingly disproportionate amount of effort required to generate the additional analysis.

Unfortunately, much of this 'additional analysis' is more often about the alternatives and risks whereas decisions, including those in asset management, are about four things:

1. the context of the decision,
2. objectives,
3. alternatives, and
4. potential risks.

In addition to being clear about the decision to be made, asset management decision making needs to explicitly identify the objectives or the criteria against which the options/alternatives will be assessed.

Whilst there are a range of decisions made in asset management - too many to mention here - decisions are usually one of five types:

- The "complex decision" that requires examination of a large amount of information and involves the judgment of many people. For example, repair or replace decisions for major assets.
- The "Yes/No" decision that involves only two alternatives: to take or reject a course of action; or to do something in a different way or to continue as before. For example, the decision on whether or not to proceed with a modification recommended by the original equipment manufacturer (OEM).
- The decision as to whether a single proposed course of action is sound enough to be implemented.

- The decision in which an original alternative must be developed by the decision-maker or asset management. For example, the design and construction of new plant and equipment or building.
- The routine decision for example, hiring, purchasing of equipment or services, developing of personnel policies, and other everyday decisions.

The objectives or decision criteria explicitly define the implicit rules of decision making, whereas decisions themselves are applications of the decision rule to specific situations. Achieving a higher order of individual responsibility or decentralised decision making requires a higher order of collective responsibility or centralised agreement on decision criteria.

In asset management the decision criteria are prescribed by the asset management objectives: each decision needs to provide value as determined by the contribution of the options to the asset management and organisational objectives and the consequences of the decision need to be assessed against these criteria.

Assuming a rational approach, each alternative needs to be considered against the decision criteria and the 'best' option selected. If cost, risk and performance are the three Key Result Areas (KRAs) for an asset management system and each organisation generates its own Key Performance Indicators (KPIs) associated with these KRAs, then the effects of each alternative on these KPIs should be separately assessed and the 'best' one chosen as the preferred option. The extent to which this can be quantitatively conducted will depend on the quality of the data available to support the decision.

Typically, policies establish those criteria by which people make decisions. Whereas the asset management policy will contain some of the 'acceptable' values for the 'typical examples' above, other business management system policies will contain 'acceptable' values for others, for example the Finance policy or AASB 116 may be used to define whether life cycle cost should be used and what values should be included. Ultimately though, the decision may be a trade-off between the 'musts' and 'wants' of the decision criteria, and the preferred option may not be without some downside which needs to be assessed.

Clearly, decision making needs to be integrated with the 'process' and 'organisational roles' elements of the management system.

From an organisational roles perspective, the management system needs to ensure decisions are being made by appropriately authorised and competent people with due consideration to an objective and rational decision making. A critical step in the process is to identify who can make the decision. The person needs to have the necessary authority (actual or delegated) to make the decision. The identification of the decision maker can be tactically important if it is likely that the decision will be subject to any legal challenge as, if this occurs, the decision maker is likely to be an important witness.

8.2.7 Risk Management

Management of risk is a fundamental activity within a management system.

The application of the techniques of risk management are all encompassing both within the asset management system and the supporting process management as well as to the supporting technical and financial decision making processes.

Put another way, risk management within asset management can be described as the tool that enables the desired future to come true. It is from this perspective that the role of the risk management process can be appreciated, both as a tool with which to identify and treat risks at an operational level, and also in a strategic sense as a tool that enables organisations to achieve their goals.

In this way every organisation can understand and 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 risk management process is applied both to tailor the management system requirements to the needs of the organisation and to define the processes, activities and tasks which need to take place. The management of risk as part of asset management occurs at all organisational levels. The risk attitude adopted by the organisation's Board and Executives should be reflective of stakeholder needs, and the level of assurance the stakeholders require that their needs will be met. This risk attitude should then be reflected in the organisation's risk management plan, and then evidenced in the processes and procedures used by the various technical processes used as part of the asset management system. These technical processes may apply to any one or more risk tools, such as FMECA, HAZOP, Reliability modelling etc., as warranted by the asset criticality and even industry sector (refer to ISO/IEC31010 Risk management – Risk assessment techniques for risk assessment concepts, processes and the selection of risk assessment techniques).

Even on a daily basis, the management of risk is incorporated into the safety systems applied before, and during, operational and maintenance activities. What is common across all of these processes is that the assessment of risk, and the organisation's current attitude to risk, will impact the decisions made to eliminate or mitigate risks during the specification, design, construction/acquisition, operation, maintenance and eventual disposal of assets.

An organisation's risk profile will be the aggregation of many individual risks, each with their own individual levels of severity. The organisation's risk management plans should also provide a view as to how these risks are collectively managed and communicated. There are many techniques to do this, but organisational risk registers are a common tool used to record these risks. Each risk register has a set of mitigating actions/controls identified from the risk analysis processes, and each risk is allocated an organisational 'owner', who has accountability that the identified risk remains managed to a level which is acceptable within the organisation's attitude to risk.

All staff should understand the risk management framework and its application within the asset management system processes, particularly as it involves the reporting of risks and the requirement to follow risk treatment plans as applicable.

8.2.8 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.

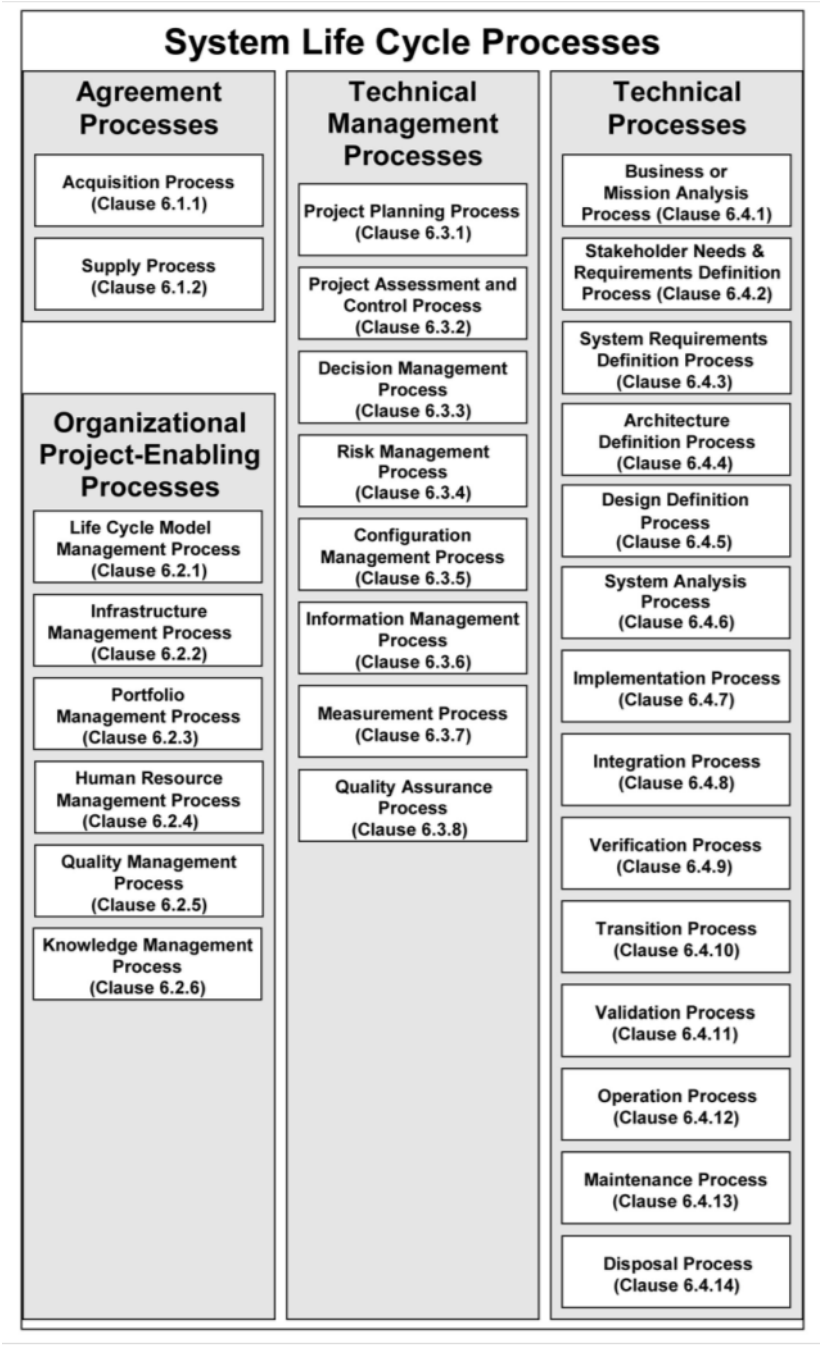


Figure 8: System Lifecycle Processes

8.2.8.1 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.

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.

8.2.8.2 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.

8.2.8.3 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.

8.2.8.4 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;
- 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.

8.2.8.5 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.

8.2.8.6 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.

8.2.8.7 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.

8.2.9 **Organisational Roles**

Roles and responsibilities must support the decisions made within the approved processes used within the asset management system. Responsibility and accountability for the acquisition, operation and maintenance, improvement and disposal of assets should both support the management chain and be delegated through the management chain.

The asset management system exercises no authority or control over how programs and projects are organised or administered. The asset management system should complement, and be consistent with, the responsibility that all managers have for the safe and appropriate operation and maintenance of assets. The asset management system requires that decisions relating to the design, construction and maintenance of assets are based on an assessment of the impact on the technical integrity, and that such assessment is undertaken by personnel who are deemed both competent and authorised to make that assessment.

All staff should have some level of responsibility within the risk management plan of their organisation, particularly to identify and report hazards. The responsibilities of key personnel in the asset management system should be detailed in the risk management plan. The risk management plan must also contain the approved decision making criteria to be used by individuals who make decisions. In this way, consistency in identifying and managing risk is achieved across the whole organisation.

The top management is to ensure that risk is managed and properly coordinated and audited. This responsibility may be delegated to a dedicated individual.

Responsibility for risk passes through the management chain, therefore the individual making a decision must have the appropriate level of authority to make a decision. A decision not only represents a chosen alternative (and why it was chosen), but also represents an instance of the use of a level of authority that an organisation uses to formally control the quantum of risk accepted by the organisation.

As a result, assessment and treatment of risks to technical integrity should be undertaken by staff with the appropriate level of engineering delegation. The authorisation (or delegation) of those staff should be based upon measurable competencies and should be formally recorded by the organisation, including the level of authorisation, based upon the risk exposure to the organisation.

8.2.10 **Competency and Engagement**

8.2.10.1 Competency

The organisation should identify competencies required to implement the processes (make decisions) used within the asset management system and as may be expressed in position description/profile statements. These statements are to include any specific competencies required to manage the organisation's risk associated with the making of decisions.

All personnel within the asset management system should be assessed as being competent to perform their duties before undertaking them. The organisation should ensure that there is a system in place to review the competency of key personnel at regular intervals and take appropriate action where a competency gap is identified.

8.2.10.2 Engagement

Employee engagement is crucial for successful asset management. Providing a transparent, traceable and logical link between decisions, activities and tasks of employees to the organisational objectives allows those employees to be engaged in their work, and able to make timely and accurate decisions to the benefit of the organisation as a whole.

Employee engagement is built on the foundation of earlier concepts like job satisfaction, employee commitment and organisational citizenship behaviour, although employee engagement is broader in scope. It shows the two-way relationship between employer and employee, It is usually a good predictor of organisational performance and is usually assessed through a series of survey questions. Engaged employees are emotionally attached to their organisation and highly involved in their job with a great enthusiasm for the success of their employer. Engaged employees will go the extra mile beyond the employment contractual agreement.

8.3 Asset Management System Model Inter-relationships

There are several key points of the inter-relationship between the parts of the Asset Management System Model.

The role of the stakeholders, leadership and culture and the organisation objectives is to frame and scope the requirements for the asset management system. Stakeholders define the risk appetite of the organisation through the development, publication and approval of the risk plan and related decision making criteria (Go/No Go) to be used by the organisation. Leadership and culture define the style and behaviours that support the management of assets within the organisation. Finally, the organisational objectives are the more tangible translation of the strategic direction and specific targets of the organisation to be achieved, and within the required timeframe.

The role of asset management objectives is essentially a 'linking' one. The understanding that asset management objectives should be developed in concert with and in support of, the other functional objectives of the organisation is crucial. Asset management objectives must clarify how all the elements of the Asset Management System Model (as designed) contribute to those objectives.

Performance monitoring and improvement holds two roles. Specifically, in relation to the asset management objectives, performance monitoring and improvement should be applied to the continual improvement of the achievement of those objectives. Additionally, performance monitoring and improvement should be applied to all aspects of each part of the Asset Management System Model.

The role of the decision making function is to ensure that the application of the stakeholder-approved decision making criteria should be demonstrable within the defined technical and financial processes.

The role of the risk management portion is also two-fold. It ensures that the application of the stakeholder-approved risk management plan should be demonstrable within all elements of the Asset Management System Model; and the application of risk based, data driven technical and financial processes are demonstrable.

The role of process management section is to apply processes that can demonstrate what must be done and why, when defining an organisation's policies and procedures for asset management functions, and describe how the organisation can establish and use technical and financial processes.

The organisational roles section holds several functioning roles. This section ensures the organisational structure is consistent with the objectives and functions of the organisation, as well as ensuring there is clarity in individuals responsibilities, and accountabilities for both the individual and the rest of the organisation. Its role is to further enable people to make decisions who are demonstrably authorised to do so by the organisation, and finally to apply engineering and financial regulatory structures.

The role of competency and engagement is the application of people to make decisions who are demonstrably competent by the organisation; and the management of factors that ensure the work force 'wants' to do a good job, understands the objectives of the organisation and feels that their actions are contributing to those objectives. It is also responsible for the application of engineering and financial competency structures.

8.4 Artefacts of the Asset Management System Model

The artefacts of the Asset Management System Model include:

- Stakeholder Decision Criteria – A document that contains senior management approved information that supports consistent decision making throughout the organisation. Such decision making criteria contains the approved Go/No Go criteria either in quantitative or qualitative form. This information might normally be included in the organisation's risk management plan.
- Asset Management Policy – a document which states the intentions and direction of an organisation, as formally expressed by its top management (ISO 55000). Asset management policy is a decision criterion at a higher level of abstraction. Policy essentially deals with choice dimensions (variables involved), why questions, underlying assumptions, and expected outcomes. Asset management policy decisions are value-loaded choices that are explicit about their implications for the asset management objectives (Gharajedaghi, J., (2011-08-09). Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture (Kindle Locations 6779-6781). Elsevier Science).
- Strategic Asset Management Plan (SAMP) – documented information that specifies how organisational objectives are to be converted into asset management objectives, the approach for developing asset management plans and the role of the asset management system in supporting achievement of the asset management objectives (ISO 55000).
- Asset Management Plan (AMP) – documented information that specifies the activities, resources and timescales required for an individual asset, or a grouping of assets, to achieve the organisation's asset management objectives (ISO 55000).

Other detailed artefacts (plans and required documents) are produced from within the Capability Delivery Model, and are presented in Section 9.4.

8.5 Organisational Systems Model

The Organisational Systems Model illustrates the inter-relationship between the various management systems of the organisation, including the Asset Management System Model.

Like the Asset Management System Model, the Organisational Systems Model identifies the importance of firstly, stakeholders and secondly, leadership, and their roles in creating the organisational objectives. The model illustrates then how organisational objectives influence various functional objectives, including asset management objectives. The Asset Management System Model sits within the Organisational Systems Model.

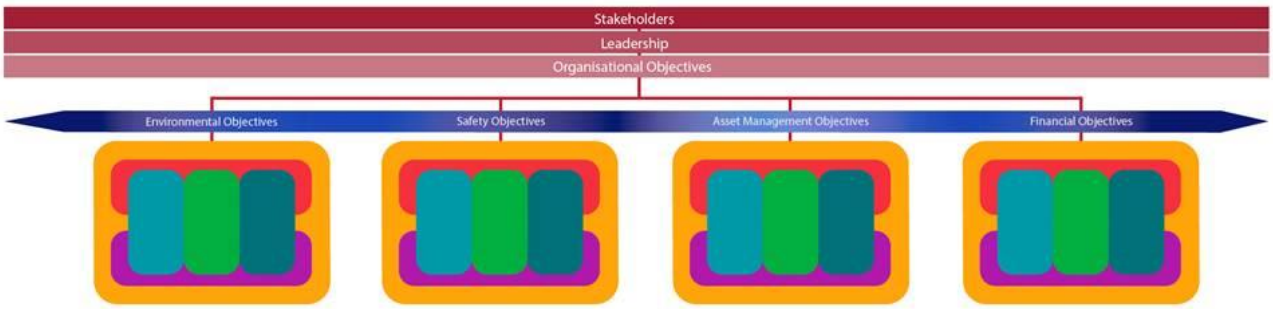
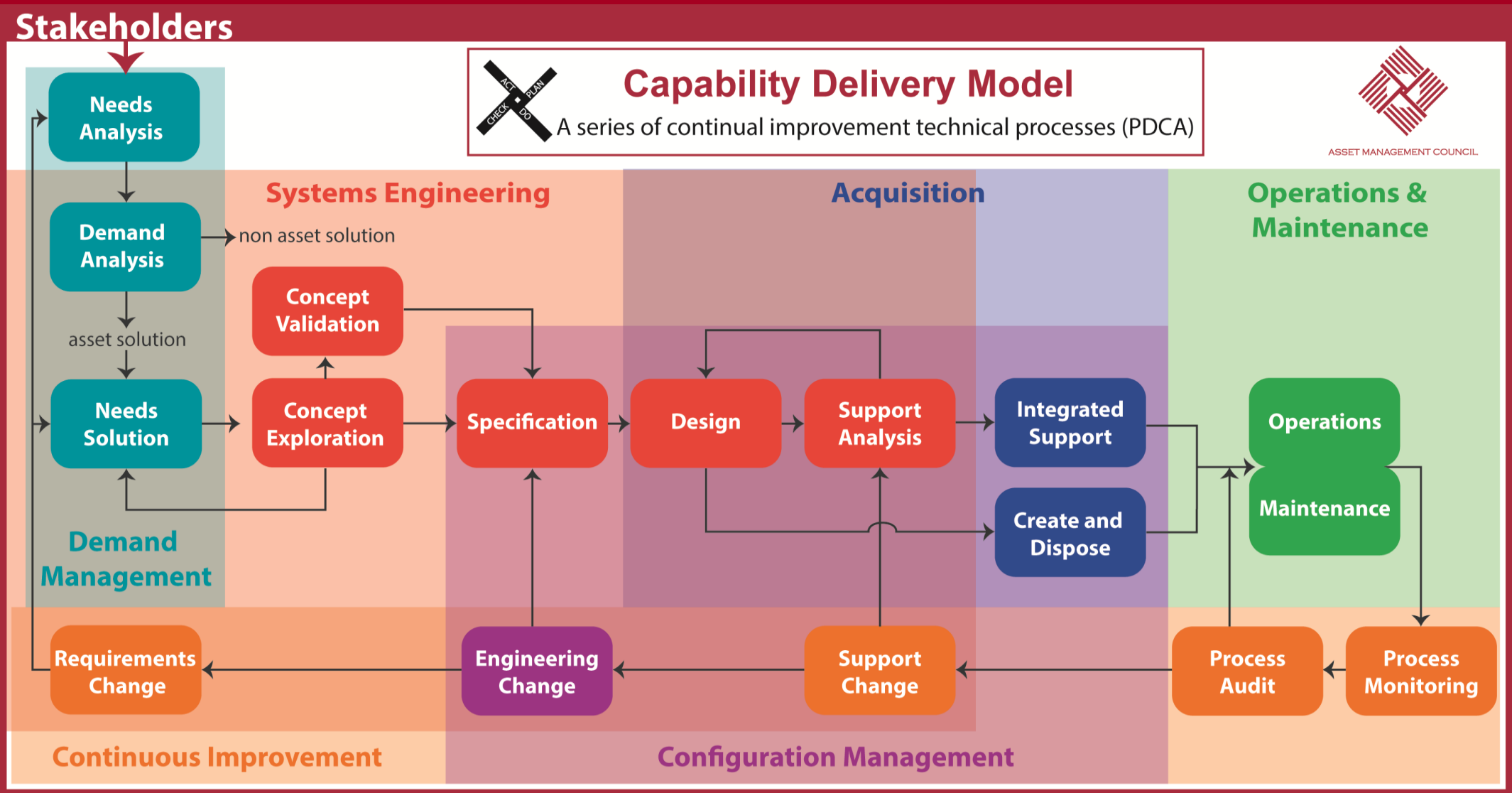


Figure 9: Organisational Systems Model

8.5.1.1 Organisational Systems Model inter-relationships

There are two key points of the inter-relationship between the elements of the Organisational Systems Model. Firstly, the role of the functional objectives, in that each set of functional objectives (e.g. asset management objectives) are individually necessary and are collectively sufficient, to achieve the organisational objectives.

Secondly, the role of strategic plans of each function of the organisation, in that each functional strategic plan (e.g. the SAMP) is individually necessary and collectively sufficient, to achieve the organisational objectives, and further that the organisational strategic plan is the collective of all the functional strategic plans.


Stakeholders
Capability Delivery Model
A series of continual improvement technical processes (PDCA)
ACT
PLAN
CHECK
DO
ASSET MANAGEMENT COUNCIL
Needs Analysis
Demand Analysis
non asset solution
asset solution
Needs Solution
Demand Management
Systems Engineering
Concept Validation
Concept Exploration
Specification
Acquisition
Design
Support Analysis
Integrated Support
Create and Dispose
Operations & Maintenance
Operations
Maintenance
Requirements Change
Engineering Change
Support Change
Process Audit
Process Monitoring
Continuous Improvement
Configuration Management

9 Capability Delivery Model

9.1 Introduction

In order to implement an asset management system, an organisation itself must choose appropriate:

- technical, financial, enterprise and agreement processes;
- organisational roles, structures and competencies;
- technical, financial and operating plans; and
- risk-based decision-making plans.

The Capability Delivery Model schematically presents processes that may be used in part or entirety to deliver the stated outputs of the organisation.

The processes are shown in six main disciplines:

1. Demand Management
2. Systems Engineering
3. Configuration Management
4. Acquisitions
5. Operations and Maintenance
6. Continuous Improvement.

These disciplines are associated with a number of national and international Standards, such as ISO/IEC 15288 Systems Engineering.

Each of these disciplines have a number of enabling competency elements and sub-elements, which in turn may have a number of competency sets and supporting units of competency. The disciplines and enabling competency elements are discussed in further detail in Section 9.3.

9.2 Purpose of the Capability Delivery Model

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.

Other purposes of the Capability Delivery Model include identifying and documenting:

- the typical engineering and financial disciplines involved in those processes;
- the enabling principles used in the management of assets;
- how to create and define organisational functions within an asset management organisation; and
- the relevant ISO and international engineering and financial management standards relevant to the processes associated with the management of assets (see bibliography for Standard names).

9.2.1.1 Industry Specific Information

The IEC TC 56 Dependability committee is currently in the process of developing a Technical Specification that documents the relationship between ISO 55000 and ISO 55001 to the IEC Dependability Standards and the International Financial Reporting Standards. That document is expected to be available in June 2014.

A number of Asset Management Council members are participating in the development of that specification.

That technical specification is intended to provide:

- a brief introduction to both asset management and the requirements for an asset management system;
- the benefits from the use of an established and common set of asset management system processes and procedures, tools and techniques to manage assets; and

- a description of the relationships between the Asset Management System to the tools and techniques, processes and procedures of:
    - existing IEC Dependability standards;
    - relevant International Financial Reporting Standards (such as IAS 16 Property Plant and Equipment and the IFRS Taxonomy Guide); and
    - through the use of the ISO/IEC 15288 Systems Engineering as a technical process management standard.

The specification will enable industry specific guidelines to be developed using a common structure and common technical and financial terminologies.

9.3 Sections of the Capability Delivery Model

9.3.1 Stakeholders

In this model, stakeholders are depicted as the overarching influence for the asset management system, and its disciplines. For more information on the role of stakeholders, refer to Section 2.

9.3.2 Demand Management

Demand management establishes sound relationships with stakeholders who may be internal or external to the organisation.

Figure 10: Wizard of Id, 2011, www.JohnHartStudios.com (by permission of John L. Hart FLP and Creators Syndicate, Inc.)

The demand management process comprises three core parts. Needs analysis which is applied to capture requirements and identify and assess the value of each 'need' in preparation for demand analysis**,** which critically examines value against potential cost of each need and agree a final 'need' definition. Demand analysis assesses each identified need within a wider context of use by all stakeholders and future operational and environmental scenarios. The needs definition is generally stated in the form of a business case that links value to initial expectations of program cost and hence an understanding of the potential return on investment.

Demand management takes a very proactive stance in identifying future changes in need through statistical modelling techniques. Increasingly, the ability to assess the future is enabling a more accurate determination of risk, leading to quantitative rather than qualitative solutions.

The process is recursive meaning that the same activities of analysis and definition take place firstly, at a strategic level creating strategic plans intent on acquiring broad capabilities. A more detailed application of the same processes at a project level, rather than whole of portfolio level, would then define requirements for specific projects and then at lower levels to define requirements for specific items of equipment.

Figure 11: Optimal Asset Configuration

Depending on context, the process may push back against unsustainable stakeholder expectations by matching demand or needs with affordable services and products.

9.3.3 Demand Management Competency Element

9.3.3.1 Needs Analysis

Needs analysis, is the process by which stakeholder demands/requirements are analysed and documented.

Needs analysis is the determination of what "deficiency" or need (public, personal, business etc.) is required to satisfy a desire or actual requirement. This may be a collective agreement between stakeholders that a need has arisen and requires an outcome to improve a situation. The documented needs can transform into a demand.

9.3.3.2 Demand Analysis

Demand analysis is a process where stakeholder demands/requirements are tested and documented, to both establish sound relationships with stakeholders and to push back against an infinite level of expectations and matching demand.

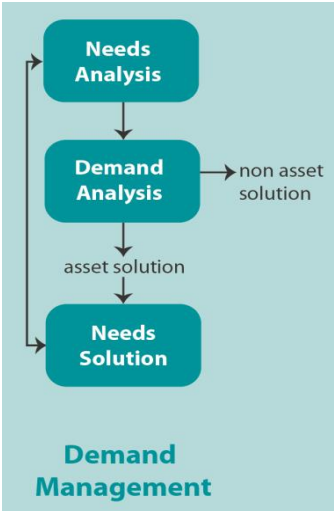


Figure 12: Demand Management in the Capability Delivery Model

Inevitably, the solution to managing demand is not necessarily just one or the other of the two options of asset or non-asset. Rather, it involves a balance of combinations of both asset and non-asset solutions.

9.3.3.3 Needs Solution

Needs solution is a process used to develop and document "user needs" in an output-focused, non-technical manner, where user needs are expressed in descriptive, measurable terms reflecting the user's normal expressions. User needs are usually described in an Operational Concept Document (OCD) or Concept of Operations (CONOPS).

An OCD or CONOPS may:

- document the purpose of the system;
- identify the business needs that the system will satisfy;
- document user expectations;
- describe the basic concepts behind the system;
- describe the system's characteristics and behaviours from a user's point of view; and
- indicate a range of acceptable solutions.

The OCD is a user-oriented document that describes the characteristics from which an asset solution will be developed. The OCD is used to communicate overall quantitative and qualitative system or situation characteristics to the users, designers and other organisational elements.

For example, the users could express in the OCD their need for a "highly reliable" system, and their reasons for that need, without having to produce a measurable reliability requirement at the same time. The OCD provides a mechanism for users and organisations to express thoughts and concerns on possible solution strategies and to record design constraints, the rationale for those constraints, and to indicate the range of acceptable solution strategies.

The OCD also provides analysis that bridges the gap between the users' operational needs and visions and the designer's technical specifications, without becoming bogged down in detailed technical issues. The OCD documents a system's characteristics and the users' operational needs in a manner that can be confirmed by users without requiring any technical knowledge beyond that required to perform normal job functions.

9.3.4 Systems Engineering

Systems engineering is a well-documented and standardised process and can be defined as an interdisciplinary engineering management process to evolve and verify an integrated, life cycle balanced set of system solutions that satisfy customer needs.

A simpler definition would be “the translation of a set of stakeholder requirements into a balanced and verified solution”.

The verification process is carried out to ensure that the outputs of the design stage (or stages) meet the design stage input requirements. The solution is verified by checking that system specification requirements, which are measurable and hence testable, are achieved layer by layer, from performance requirements into sub systems, equipment and parts.

Design validation is the process of ensuring that the final product conforms to defined user (customer) needs and/or requirements. The Systems Engineering “V” Process is shown in Figure 13.

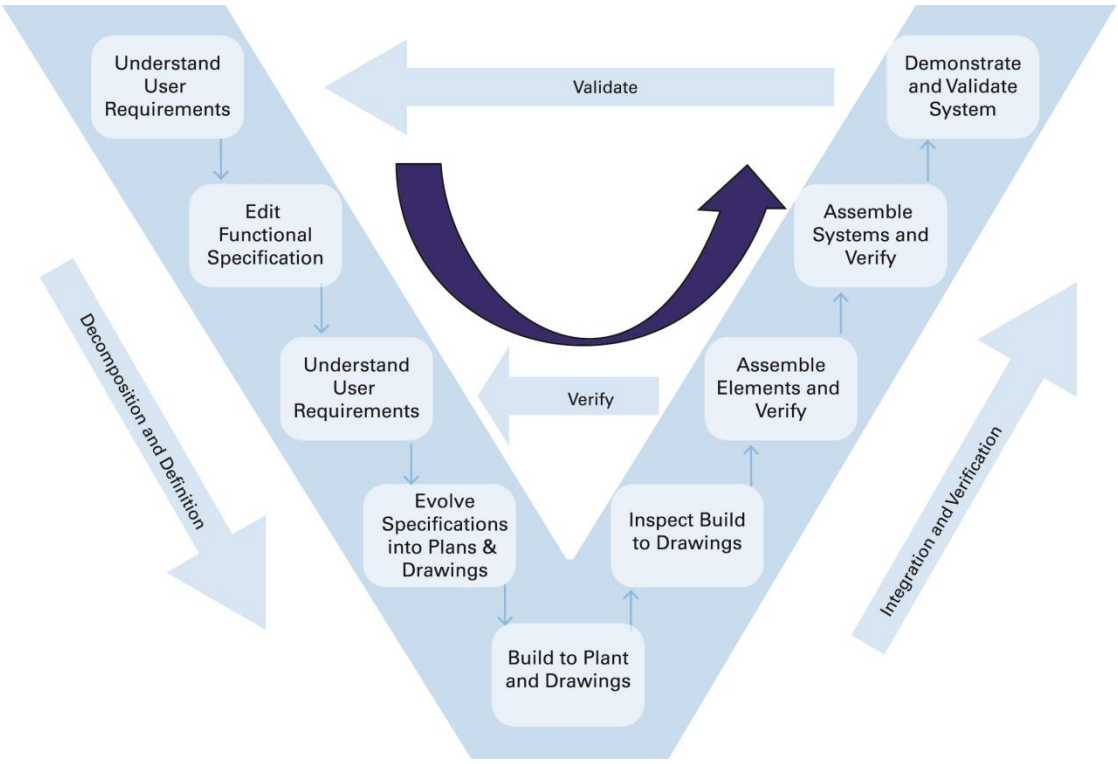


Figure 13: Systems Engineering ‘V’ Process

The solution achieves balance by using lowest life cycle cost as a balance between what is paid today (design and manufacture, sometimes called capital expenditure or CAPEX) against what is paid tomorrow (maintenance and operation, sometimes called operating expenditure or OPEX).

Systems engineering is at the very core of the Capability Delivery Model. It is a connective tissue linking stakeholder needs at the front end of the model to the all the asset related expenditure required to assure agreed service capabilities. It can be argued that all the finances of an asset dependent organisation go either directly into the conduct of asset acquisition/dispose, operations and maintenance or to the enabling functions that support those tasks.

9.3.5 Systems Engineering Competency Elements

9.3.5.1 Concept Exploration and Validation

“Concept” is the first stage in the asset management life cycle. This stage can apply to a variety of asset scopes from whole networks and large petrochemical facilities to incremental improvements involving new equipment and systems. This stage commences with the identification of a need that could be met by the provision, replacement or upgrading of an asset.

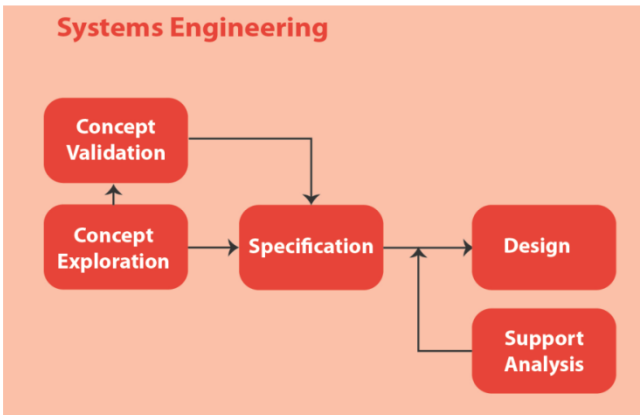


Figure 14: Systems Engineering in the Capability Delivery Model

Concept exploration represents the initial exploration, fact-finding, and planning period, when economic, technical, strategic, and market bases are assessed

through stakeholder and market survey, feasibility analysis and trade-off studies. Alternative solutions to meet an identified need are also developed.

Concept validation involves development of experimental or prototype models and removal of any high-risk aspects that may be evident in the conceptual solution. Support systems needed across the life cycle are also identified and included in the evaluation of alternatives to achieve a balanced life cycle solution.

Typical outputs of the concept exploration and validation stage are stakeholder requirements, concepts of operation, assessment of feasibility, preliminary system requirements, outline design solutions in the form of drawings, models, prototypes, etc., and concept plans for enabling systems, including whole life cost and human resource requirements estimates and preliminary project schedules. Stakeholder feedback to the concept is obtained.

Implementation of this stage requires appropriate methods, techniques, tools and competent human resources to undertake market/economic analysis and forecasting, feasibility analysis, trade-off analysis, technical analysis, whole life cost estimation, modelling, simulation, and prototyping. At the completion of this stage, decisions such as whether to continue with the development of a solution in the following specification stage or to cancel further work are made.

9.3.5.2 Specification

Engineering specifications provide the design basis for equipment to be designed or purchased and become part of the configuration documentation for an approved design. They range in complexity from a comprehensive document that describes the functional and performance requirements, to a simple “one page” statement of requirements.

Specification commences with a detailed understanding of the functional requirements and outline of a feasible solution that can be achieved with manageable risk. Planning for this stage begins in the preceding stage to ensure the organisation has the necessary capabilities available to undertake acquisition (if needed) by whatever method is chosen. The capabilities include methods, techniques, tools and competent human resources. Developing this information set is a complex task and has profound implications for the remainder of the asset life cycle.

The outputs of this stage must be sufficient to enable the managed acquisition of assets (as part of the CAPEX) and their necessary support such as operational and maintenance capabilities (as part of the OPEX). Additionally, the hardware, software and operator interfaces must be specified, and the functional requirements for integrated support defined.

To reduce error, most organisations use defined specification formats and content. Specifications also provide the necessary hooks into company-specific standards and policies, enabling the company to specify not only what is to be achieved, but also provide its view of what is the range of acceptable design solutions and practices.

9.3.5.3 Design

Design is both the process and the end product. The design competency element translates requirements into solutions which are represented by structured data such as a drawing or plan or process description. Design in this case can be defined as:

- Design (verb) - “the process of defining, synthesising, selecting, and describing solutions to requirements in terms of products and processes”; and
- Design (noun) - “the product of the process of designing that describes the solution (conceptual, preliminary or detailed) of the system, system elements or system end items”.

Effective design management is essential to maintain the safety and integrity of assets and to comply with state and industry statutory obligations. It enables the business to obtain and maintain quality accreditation such as AS/NZS ISO 9001[1] and to deliver a quality design service in support of the business outputs.

The key design tools in determining likely risks of failure in terms of operational and maintenance impact is Failure Modes Effects and Criticality Analysis (FMECA). The FMECA process is best conducted during design, when improvement options are relatively cheap to implement while only paper/electronic media is involved.

1 ISO 9000:2004 Quality Systems

Inevitably, design work involves the application of established design principles, rules and standards to meet the requirements of a specification for new or altered infrastructure. These are known as design standards.

Selecting and applying design standards is integral to the design activity and essential to achieving appropriate levels of safety and integrity. Inappropriate use of standards that considerably exceed needs can substantially increase the cost of construction and maintenance. The application of design standards leads to the creation of two supporting standards as shown in Figure 15.

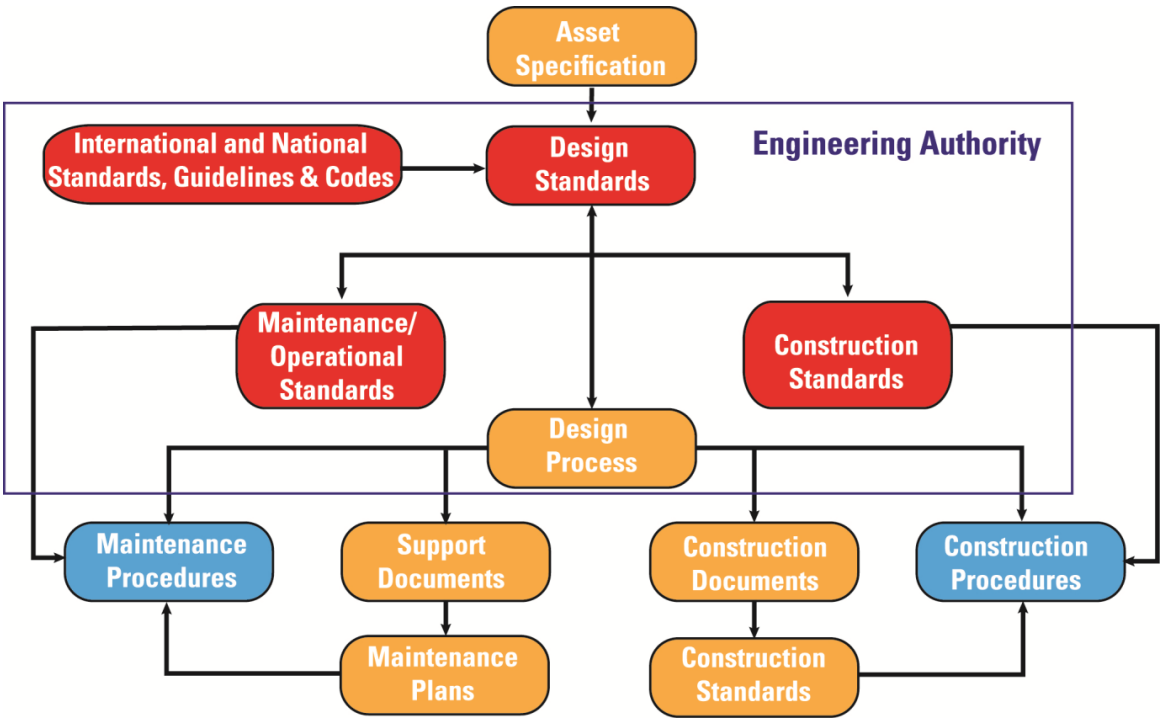


Figure 15: Application of Design Standards

As shown in Figure 15, an asset specification leads to a design solution achieved by a design process applying design standards. This solution comprises support documents such as maintenance plans and associated enabling capabilities such as personnel, training, spares, etc. Plans are developed both for construction and maintenance actions which refer to procedures for each task in the plan. These procedures refer to standards where necessary, to define the limits.

9.3.5.4 *Support Analysis*

Asset support requirements are the wherewithal that enable a design solution to achieve its output capability today, tomorrow and for the duration of the intended life of the design.

Support analysis involves analysing support needs, over the life of the asset, to optimise where to invest money. The greatest challenge in the support analysis process is, if there is only certain funding available, how is it spread amongst these support elements, which all affect each other and also impact on dead and live time? this is the greatest challenge in asset management for engineers, statisticians and data collectors.

The advantage of having determined support analysis during the development of the design solution is that when the asset is acquired, there is enough time to buy the support for it. Required support should be in place on the first day of the commissioning function and in fact its verification should be part of that commissioning activity. It matters little that the asset is brand new: it can, and will, fail if the right spare is not available or the staff are not trained appropriately. Without required support, the design intent of the asset will not be achieved and the business case will be compromised.

9.3.6 **Configuration Management Competency Elements**

Configuration management is the management of the functional and physical attributes of a system, an asset and its part sub-systems and assemblies. It also includes the derived information representing the integrated support needs.

Configuration management is a poorly understood and applied discipline in most organisations, including many regarded as good managers of assets. Certainly all have some fundamental knowledge of establishing asset registers and processes for change control and of drawing numbering and version control. However, these disconnected capabilities do not achieve the core intent of good configuration management practices.

They do not formally manage the changing functional and physical configurations of their asset systems along with the derived information necessary to sustain the asset capability both short and long term.

Configuration management is the 'guardian' to the acquisition process. This role recognises that if the functional requirements for a system change, it is likely that the design and subsequently the support requirements will also change. Configuration management change control provides a formal test check that identifies the implications and answers the questions:

- Do I still want to make this change?
- Is it a worthwhile thing to do?

Figure 16: Garfield Cartoon, 22 Jan 2011, www.garfield.com

9.3.7 Configuration Management Competency Elements

9.3.7.1 Engineering Change

The aim of engineering change is to validate that the process monitoring, process audit and support change processes indicate a high level of compliance with the requirements of the asset management plans. Then, if necessary, validation that the assets and system collectively deliver the specified performance and as a result, identify and justify changes needed to the technical design of the affected assets and systems.

Figure 17: Configuration Management in the Capability Delivery Model

Engineering change requires a structured process around the identification of why change is required, the impact of change on current business, and the outcome of the change. The level of approval of the Engineering change will depend upon the complexity of the change. For instance a simple like-for-like asset replacement will require a lower level approval than a complex system change associated with a major upgrade or investment.

It is good practice to identify levels of change based on the risk associated with the change, the complexity of the change and the effort to implement it. Governance of change must address all elements of systems engineering to ensure the correct support functions are updated and assure the required level of support.

9.3.8 Acquisition Competency Elements

9.3.8.1 Integrated Support

Integrated support comprises all the support needed for the asset to deliver the requisite output, namely:

- Maintenance;
- Spares;
- Data and information technology;
- Finance;
- Packaging, handling and support; and
- Training.

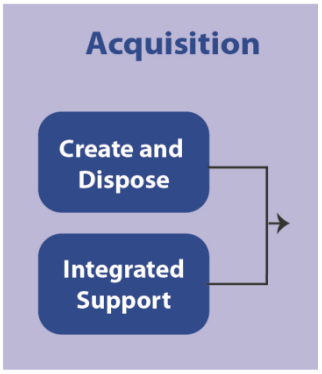


Figure 18: Acquisition in the Capability Delivery Model

Integrated support has inherent characteristics that affect two major performance aspects of the ownership of equipment. Firstly, how long it is 'alive' for – often measured as mean time between failures which defines the *reliability* of the asset; and secondly, how long it is 'dead' for – often measured as mean down time or the *maintainability* of the asset.

These two design-inherent performance characteristics of reliability and maintainability will determine the availability of the equipment. Regrettably, each and all of the integrated support elements affect both reliability and maintainability.

For example, the spares that are procured will affect how often a system dies and when it does die, how long it takes to 'bring it back to life' again. If multiple spares have not been bought or are stored far from the item, then mean down time will be longer. If the spares are of poor quality, or stored incorrectly they may not last as long and the mean time between equipment failures will be shorter. This same influence on both reliability and maintainability is a characteristic of each one of those support elements – all affect reliability or maintainability in some way.

This integrated approach is intended to assure that necessary support is available on the first day of service so that on the second day of owning the asset, if there is a failure, the spares, employees, facilities and tools are available to fix it. The necessary support is available to achieve the inherent design capabilities of that equipment. Both operations and maintenance functions require similar support elements. For example, the operations function will need simulators, will need manuals and training and will certainly need people, etc.

9.3.8.2 Create and Dispose

The create and dispose process incorporates measures to ensure that the:

- delivered asset meets the operational and business needs of the organisation and can be maintained in a safe and effective condition throughout its life, as specified in specification and request for tender documentation produced in the previous stage;
- final design or delivered product is verified and validated against the specified requirements using systems engineering and quality assurance processes and procedures;
- disposal process is completed, for major asset disposals in line with the disposal plan; and
- project objectives are achieved with minimum risk.

These tasks may be conducted by different organisations depending on the acquisition method selected. Either way, the end user must manage its risks by assuring that the processes followed represent good practice no matter who is contracted to deliver them.

This stage has important implications for safety and environmental management and for ongoing support costs. Disposal must be considered during acquisition and the implications of selected materials and design solutions on life cycle cost clearly identified. Short life systems subject to regular obsolescence should have a disposal plan costed into the acquisition program.

Disposal does not simply represent a decision to stop using the asset. Only when full owner accountability has ceased and the asset is removed from Technical Maintenance Plans and the equipment register can the equipment be regarded as fully disposed of. This will also include the disposal of all supporting capability that is dedicated to the disposed asset. Retention of some risk and FMECA data could be required under the State legislation.

Example: To establish the required maintenance tasks, an understanding of the functional requirements of the asset together with the expected modes of failure is essential.

Good practice is to use FMECA as the starting point to understand failures and assign the appropriate maintenance tasks preventing the consequences of failure.

Without the knowledge of the functional failure, its effect and criticality to the business, planning of maintenance cannot be effective and can lead to misunderstood reasons for maintenance and ultimately to inefficient management of the maintenance plans.

Deactivating or disposing of infrastructure assets often involves maintaining it in a safe condition (nearly always because not all hazards relate to the item being used) before it can finally be removed, but after it is no longer in active use. Disposal may include managing a particular site or equipment, such as a decommissioned bridge with significantly changed operational functions. These could include local

community use, environmental management requirements, or operating in line with Government heritage requirements.

Asset disposal should be considered when the asset is in the earliest stages of planning. The costs of disposal can be recognised early and provided for in future budgets. Additionally, a superseded asset and its support provisions are removed from service and from the inventory at the appropriate time to manage risk and reduce cost of maintaining unproductive inventory.

9.3.9 Operations & Maintenance Competency Elements

Operations and maintenance is by far the most enduring stage of the asset life cycle. It begins as soon as an asset is accepted and entered into service and ends with the decision to dispose of the asset. This stage generally consumes the largest portion of the cost of asset ownership. In the case of an asset such as rolling stock, the costs of this stage may exceed initial procurement costs many times when taking the operation of the asset into account.

The focus in the operations and maintenance stage is on the use of assets to provide a defined service, and on their maintenance and support to ensure a continuing capability to meet those requirements in respect of service provision, safety and reliability. Preservation of equipment at a standard that meets statutory responsibilities under the various acts and regulations of Government is a primary goal, requiring continuous and meticulous attention to support planning and management of maintenance and engineering tasks.

Figure 19: Operations & Maintenance in the Capability Delivery Model

9.3.9.1 *Maintenance*

The objective of maintenance is to ensure the realisation of the required safety and reliability levels of the asset, at a minimum total cost, commensurate with the company business plan. Information, which is necessary for design improvements, is obtained during the maintenance process.

Based on the maintenance objectives there are two basic types of maintenance - preventive maintenance and corrective maintenance. Both are an inherent outcome of a design function (as against design synthesis) which includes the support analysis necessary to determine the support required to achieve a certain capability with a known and measurable level of assurance.

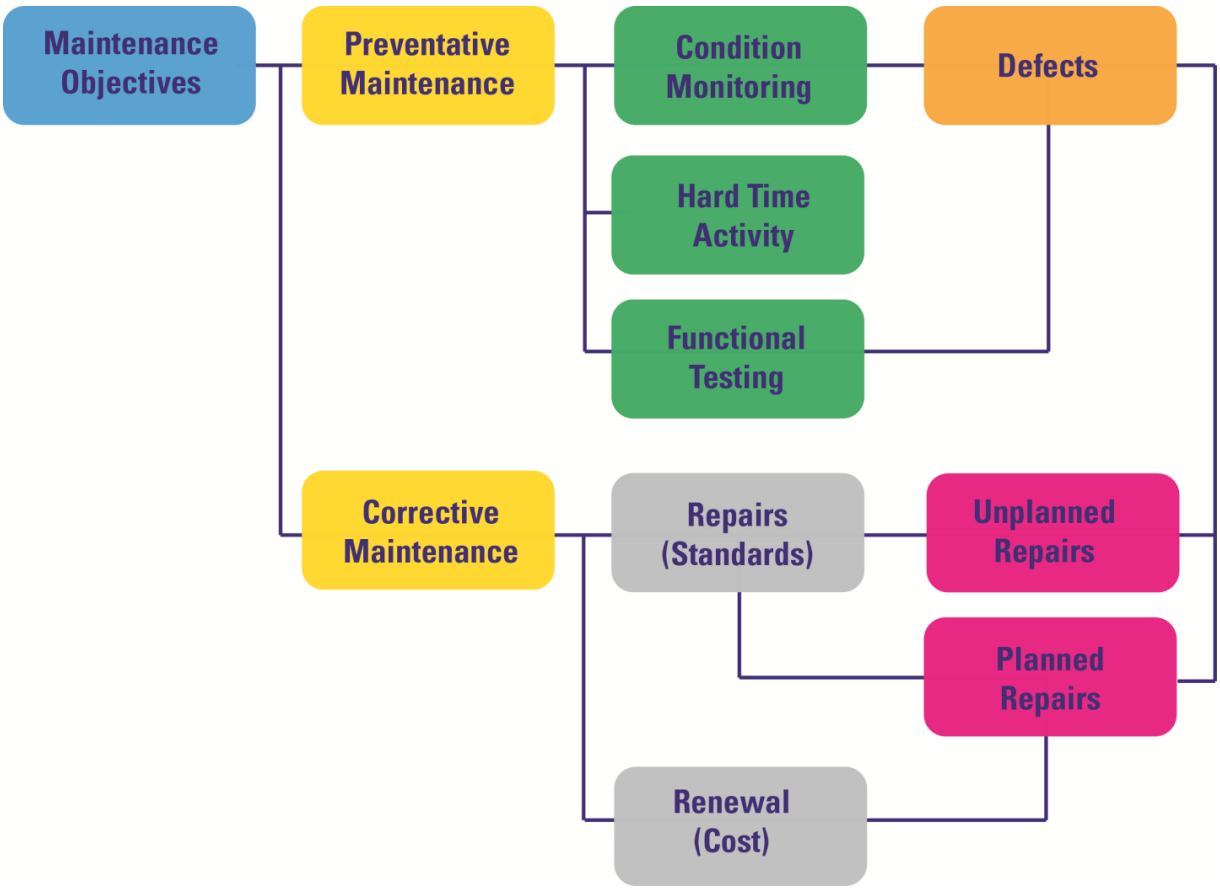


Figure 20: Types of Maintenance

The types of maintenance identified in the Figure 20 have been categorised on the basis of their engineering intent to prevent the functional failure of equipment or to correct a failure (conditional or functional) by restoring equipment to a serviceable state. They are described in further detail below.

9.3.9.2 *Preventive Maintenance*

Preventive maintenance manages operational risk in that it is safety-and-reliability-focused and not cost-focused. Preventive tasks include all scheduled (planned) maintenance actions intended to retain a system or product in a specified condition. These tasks comprise three basic task types:

- ***Condition monitoring*** - Applicable to individual equipment that is examined to see if the equipment will continue to work until the next examination; includes tasks such as vibration measurement, consumable fluid measurements, amount of wear or misalignment of parts, size of cracks or depths of surface corrosion etc.
- ***Hard time activity*** - Applicable to a population of equipment that is serviced in some way, removed and repaired/overhauled or else removed and thrown away as uneconomically repairable. This includes tasks such as cleaning filters, replacing electrolytic capacitors or lubricants, overhauling complex equipment where loads are consistent and can be related to time.
- ***Functional testing*** - Applicable to equipment with hidden failures and intended as a confidence check that it is still working, examples are smoke detector tests and circuit breaker full function tests.

9.3.9.3 *Corrective Maintenance*

Corrective maintenance tasks return failed equipment to a specified standard. There are two types of failures generally determined by a breach of a maintenance standard that defines functional and conditional limits:

- ***Functional failures*** are those where the functional specification has been exceeded, such as leak rate limits or input voltage or signal strength degradation below operable levels, resulting in loss of specified capability. These failures are generally fixed (or temporarily repaired) immediately. For example, replacement of failed circuit cards, switch open circuits,

ruptured pressure vessels or failed pressure piping, cavitating pumps or short circuits in transformer or electrical rotor windings, corroded electrical joints and wiring etc.

- ***Conditional failures*** are representative of an unacceptable future probability of failure and generally managed as "defects" and registered for monitoring and future repair. Repair criteria (time limits) should be based on criticality and anticipated rate of deterioration.

Corrective maintenance tasks comprise two types of activities, Repairs and Renewals.

Repairs of conditional failures (defects) or functional failures conducted on limited sized parts (e.g. piping leaks, repair of a broken rail, or repair of a failed electronic monitoring system). These repairs are conducted in a manner that significantly affects their cost: unplanned (on the spot or in an emergency) or planned.

Renewals address the decreasing cost effectiveness of an existing 'examine and repair' routine maintenance strategy caused by loss of general condition of the asset. They involve the cost effective return to "as new" through a production based process such as overhaul or major replacement that may be the same or modern equivalent technology. These actions are inherently driven by cost benefit analysis based around risk.

In understanding what requires improvement and where is the greatest risk impacting the business – or asset capability – a continuous survey of the performance of assets and their components is desirable.

Establishment of a "Reliability Risk Register" will provide a first pass list of issues to address and may develop into engineering change or even capital project work. An audit may use these registers and the associated work to confirm the activities agreed.

Assurance of process and outcomes will often be in the form of KPI's that may target such elements as safety incidents, asset performance, status of asset integrity, activities prioritised and completed, maintenance and operations. KPI's should be lead as well as lag indicators. This can be effectively used as stakeholder communication providing the level of assurance required by them that the assets are managed / improved in the required manner.

9.3.9.4 *Operations*

The Capability Delivery Model deliberately depicts maintenance and operations as a pair. Alone, neither maintenance or operations deliver the requisite asset outputs and levels of service and both need each other.

Like maintenance, operations requires the development and execution of approved tasks. Like maintenance, only approved persons are able to execute assigned operations tasks.

9.3.10 **Continuous Improvement**

Continuous improvement is a process to assess, identify and improve the asset management process through assurance that defined processes are properly and effectively followed. This is the more operational facet of the performance monitoring and improvement (Section 8.2.5) function of the Asset Management System Model.

At this point in the model the stakeholders have been identified, their needs polled; those business needs translated into a specification and a design solution has been established. A support solution has also been established and is being used fully in operations and maintenance.

Is the process perfect? Probably not.

Many assumptions about the support environment, or the expected reliability and maintainability performance of the selected equipment were made during the design process. Some were accurate, being drawn from existing equipment use, others less so. Additionally, the environment might have changed between the establishment of the initial requirement and the delivery of the assets.

It is actual asset usage that gives us information to verify the entire integrated support package that informs the operations and maintenance staff.

The combined maintenance and operations function is the beginning of the feedback loop. Measure and assess what is occurring in the delivery of those operations and maintenance arrangements, and then feed it

back through a series of loops in the model that are critical in sequence and structure. This is continuous improvement.

The loop can now be closed again, moving back through the originating requirements at the front end of the model, and the sequence and structure can be repeated again with new input. Have the stakeholders changed? What are the key asset-related risks that must be managed? Is an asset solution required? Are the needs definitions correct? Does that definition match the stakeholders' expectations and how they want capability delivered? Is there delivery of sustainable triple bottom line outcomes for economic, social and financial performance?

Revisit demand analysis; or bring in new laws to stop people using as much water, or decreased pressure to keep the water pipes lasting longer. Push back on demands for better services or press for lesser services.

Revisit solutions and look at existing non-asset and asset solutions, given changes in technology over time. Revisit the stakeholders. Who are they, really? What do they really think and do, and what do they really want? Establishing strong relationships with stakeholders and developing sound negotiating approaches to communicating openly and honestly is crucial to continuous improvement.

The process has now gone 'full circle'. Starting with stakeholders, managing their demand and establishing relationships through this concept of demand management, using well-known practices and standards for systems engineering, integrated support, the integration of operations and maintenance management in an optimal process.

9.3.11 Continuous Improvement Competency Elements

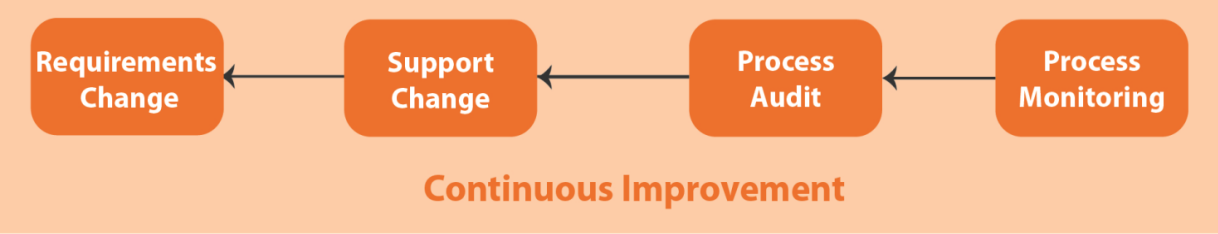


Figure 21: Continuous Improvement in the Capability Delivery Model

9.3.11.1 *Process Monitoring*

Process monitoring is to identify and/or measure that the implementation tasks are being performed as and when required by the asset management plans.

The detail of all the doing tasks and their frequency is defined by the various Operations & Maintenance Plans – are these plans being complied with? The resources for these plans are defined in the integrated support process (i.e. spares, personnel, training etc.) and are the drivers of the maintenance and operations management functions – are they available to the quality and quantity determined during design?

9.3.11.2 *Process Audit*

Process audit checks that the actual action of employees in the operations and maintenance work space is what was agreed to.

9.3.11.3 *Support Change*

The aim of support change is to identify and measure that the performed tasks are delivering their individual objectives as documented in the asset management plans and whether changes to those support tasks are required.

9.3.11.4 *Requirements Change*

Requirements change closes the feedback loop, taking approved engineering changes back to the demand management process to consider whether an asset or non-asset solution is required. A requirement is a capability to which an outcome (product or service) should conform.

9.4 Artefacts from the Capability Delivery Model

The following artefacts are developed from the Capability Delivery Model, namely:

- Systems Engineering Management Plan (SEMP) - A document that describes the plans and procedures for the management of an integrated engineering program that meets the organisation's business needs. The SEMP describes both 'what and how' technical effort will be identified,

implemented, coordinated and integrated to the meet the organisation's cost, risk, timeliness and performance aspects of its business objectives.

- Configuration Management Plan (CMP) - A document used to describe how configuration management of business capability (assets and the requisite ILS support) will be conducted within an organisation. This includes documenting how configuration management is managed, specific roles and responsibilities, how configuration item changes are made and communicating relevant aspects of configuration management to stakeholders.
- Operations Management Plan (Ops Plan) - A document used to describe the plan for managing and directing the delivery of asset/asset system functions (including both asset performance and ILS support requirements) in support of business needs.
- Integrated Logistics Support Plan (ILS Plan) - A document used to describe the necessary logistic support activities, responsibility for those activities and the completion schedule, in support of business needs. In particular, the ILS Plan is used to describe the integrated and iterative processes for developing materiel (being the ILS elements), and a support strategy that delivers the requisite support, as and when needed. Although originally developed for military purposes, it is also widely used in commercial product support or customer service organisations.
- Capital Expenditure (CAPEX) - A document that describes the plan for the expenditure of capital funds used by an organisation to acquire or upgrade capabilities or both (being physical assets such as property, industrial buildings or equipment and its requisite ILS support) in support of business needs. This type of outlay is made by companies to increase the organisational capability (increase the scope of their operations) or to reduce their OPEX costs (increase the efficiency of their operations).
- Operating Expenditure (OPEX) - A document that describes the plan for the expenditure of annual recurring funds that a business needs as a result of performing its normal business operations (that is, using the designed capability (assets and ILS support) to deliver the required business outcomes.
- Safety Management Plan (SMP) - A document that describes the safety management plan for the implementation of the safety management system, including policies and procedures and roles and responsibilities, to provide assurance that all activities carried out within an organisation, will achieve the approved safety objectives.
- Environmental Management Plan (Environmental MP) - A document that describes the environmental management plan (EMP) for the implementation of an environmental management system, including policies and procedures and roles and responsibilities, to provide assurance that all activities carried out within an organisation, will achieve the approved environmental objectives.
- Heritage Management Plan (Heritage MP) - A document that describes the Heritage Management Plan for the implementation of heritage management, including policies and procedures and roles and responsibilities, to provide assurance that all activities carried out within an organisation, will achieve the approved heritage objectives.

10 Asset Management Maturity Model

10.1 Introduction

Asset management maturity is defined by the Asset Management Council as “the ability of an organisation to foresee and respond to its environment through the management of its assets, while continuing to meet the needs of its stakeholders’.

Asset management maturity requires that an organisation deliver outcomes such as customer service, profit, safety and assurance, with the assigned resources and within the requisite delivery period. Asset management maturity is dynamic and should be able to respond to both the changing business environment and changing stakeholder needs in a manner that aligns with the other functions of the organisation (for more information on this, please see Sections 2 and 3, and especially Figure 2).

Asset management maturity can be considered as the extent to which asset management is aligned and integrated into an organisation.

Asset management maturity is described by:

- A set of Organisational Elements – Structuring, Governance, Structured and the Business Assets;
- A set of Maturity Lenses to focus on and analyse asset management across all four Organisational Elements. These Maturity Lenses are used to analyse important aspects of asset management; and
- A set of Qualities that provide a description of the essential nature of asset management maturity across the whole organisation.

10.2 Organisational Elements

There are four Organisational Elements. Each Element aligns with a Fundamental from ISO 55000, as they underpin implementation of asset management and the supporting asset management system. The four Organisational Elements are:

Structuring Element – This Element impacts on everything performed within asset management, but is generally the least understood Element. The Structuring Element is focused on delivering the Leadership and Culture fundamental and is responsible for shaping the Structured Element, the Governance Element, and the way the business assets are regarded. The Structuring Element includes behaviour, emotions, human interactions and interfaces that produce cultural norms and power relations. For decision making processes to be embodied in the organisation, all parts of the Structuring Element must be coherent and aligned, as they underpin the organisation’s values and all other Organisational Elements.

Governance Element – This Element delivers the Assurance Fundamental and is responsible for providing a level of assurance to the stakeholders that the asset management system and asset management within the organisation remain fit-for-purpose and safe to use. The implementation of the asset management system is a good base for an audit program to provide assurance of the Structured Element.

Structured Element – This Element delivers the Alignment Fundamental. It encompasses developing and implementing processes, plans, activities and tasks as part of the asset management system. The Structured Element allows an organisation to develop an integrated approach to the delivery of organisational objectives through the use of the Business Asset Element.

Business Asset Element – This Element delivers the Value Fundamental and encompasses delivery of the organisation’s objectives in relation to the use of assets including physical assets.

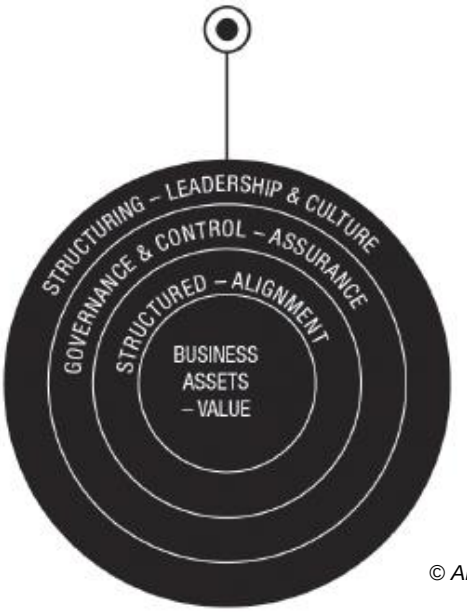


Figure 22: Asset Management Maturity Organisational Elements and Fundamentals

10.3 Maturity Lenses

Asset Management can be viewed through a number of Maturity Lenses – each one provides information about features that span all four of the Organisational Elements and how the Organisational Elements are aligned and being conducted.

These Maturity Lenses may include:

- application of the principles of continuous improvement;
- use of, and access to, information to support asset management related decision making;
- the degree to which asset management focusses on the organisation's objectives;
- the degree to which asset management focusses upon a demonstrable balance of cost, risk and performance outcomes;
- use of competent, capable, authorised and motivated people within asset management.

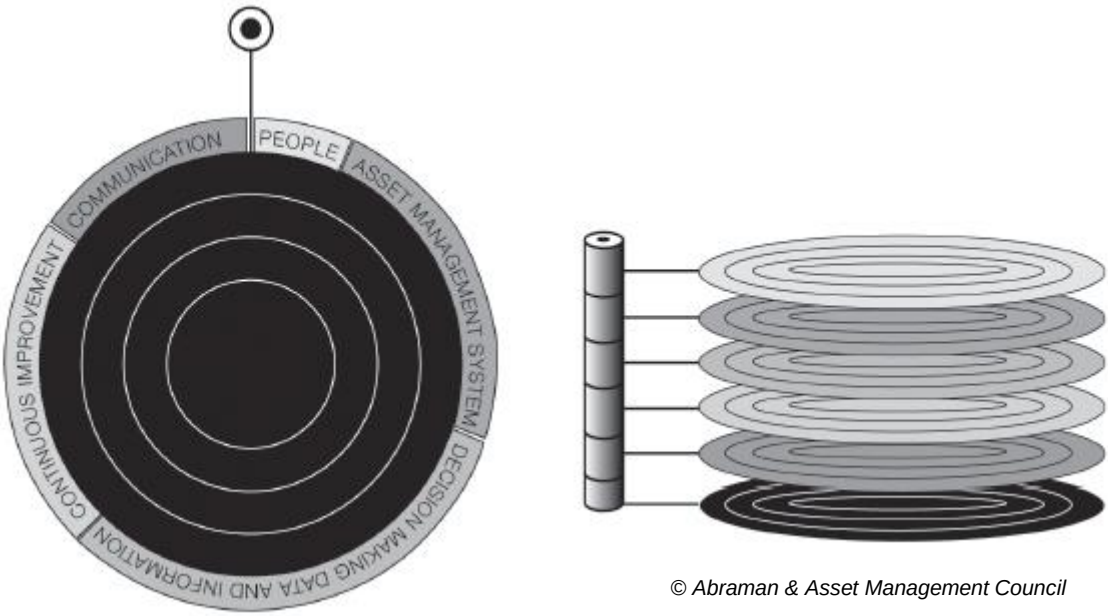


Figure 23: Example of Asset Management Maturity Lenses; each lens provides information across all four Organisational Elements

10.4 Maturity Qualities

While the Organisational Elements describe the parts of asset management maturity from the perspective of asset management, asset management maturity also contains qualities that are universal across the organisation. Such qualities include:

- use of a “common language”;
- evidence of a “shared purpose” and alignment;
- an “integrated approach” to the management of assets adopted by all business functions; and
- evidence of a strong asset management commitment by the organisation’s people.

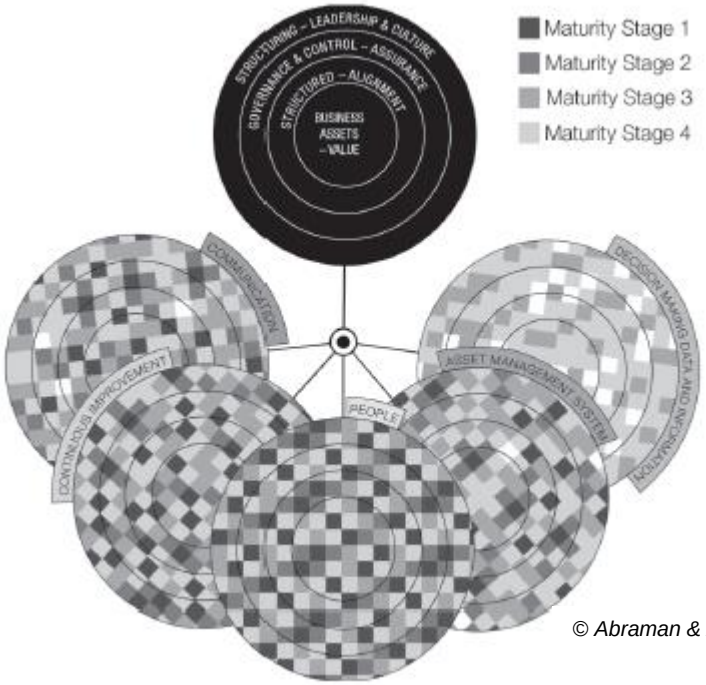


Figure 24: Asset Management Maturity depicting the interrelation of Organisational Elements and Maturity Lenses assessed by Maturity Qualities

10.5 Building Asset Management Maturity

The Asset Management Maturity Model shown above depicts the Organisational Elements of asset management, the Lenses through which to view those Elements and finally, a set of Qualities that need to be present, to measure and develop asset management maturity. The concept of asset management maturity is complex. This is why a number of Lenses to focus on the organisation from different perspectives have been developed. Further, there are a number of universal Qualities to identify asset management maturity.

Asset management maturity is not about benchmarking, but is a tool to assess many factors such as culture, leadership, integration, organisational climate, principles and values and behaviours. It is from this assessment that root causes can be understood and strategies applied to improve performance.

Asset management maturity is dynamic. It is not steady-state. At some point even mature organisations may need to ‘restart’ from an immature stage again, after having achieved a high stage of asset management maturity. It depends on external environments, stakeholder needs and the organisation’s commitment to continuous improvement.

11 Your Feedback

As the Asset Management Council is committed to continual improvement, this document will be formally reviewed - as per the Asset Management Council Review Process - every two years. The next formal review will take place in 2016.

As such, your feedback, ideas and comments are welcome and will be collected and considered for the next formal review.

Please send your feedback to mo.barghash@amcouncil.com.au.

12 Bibliography

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AS/NZS 13000:2009 Risk Management, Principles and Guidelines

BSI PAS 55-1:2008 and PAS 55-2:2008 Asset Management Specifications

EIA 649:1998 – National Consensus Standard for Configuration Management

IEC 60300-3-9:1995 Risk analysis of technological systems

IEC 812:1985 Procedure for a Failure Modes and Effects Analysis

IEEE P1220, Standard for Application and Management of the Systems Engineering Process

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ISO 10007:2003 Quality management systems – Guidelines for configuration management

ISO 14001 Environmental Management

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ISO/IEC 15288:2008 Systems and software engineering – System Life cycle processes

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US Military Standard 882C Program Safety Management

Forthcoming Framework Documents

Asset Management Data/Information

Asset Management Plans Content

Asset Management Systems

Assurance for Management Systems

Competencies and Qualifications

Configuration Management/Systems Engineering in Asset Management

Culture and Leadership

Glossary and Taxonomy Resources

Integrated Support

Performance Indicators and KPIs for Asset Management

Principles

Process Capability

Risk Reliability and Safety

13 Abbreviations

Abbreviation /Acronym	Description
ALARP	'As Low As Reasonably Practical' – Risk Management model
ANSI	American National Standards Institute
AS	Australian Standard
AS/NZS	Australian/New Zealand Standard
BSI PAS	British Standards Institute / Publicly Available Specification
CAD	Computer Aided Design
CCB	Configuration Control Board
CI	Configuration Item
CM	Configuration Management
CMMS	Computerised Maintenance Management System
CM Web	Configuration Management web tool
CMP	Configuration Management Plan
CPI	Consumer Price Index
DoD	Department of Defence
DPWS	Department of Public Works and Services
ECP/R	Engineering Change Proposal/Request
ED-ISG	Engineering Design – Integrated Support Group
EIA	Electronic Industries Association
ETA	Event Tree Analysis
FET	Fault Event Tree
FMEA	Failure Modes and Effects Analysis
FMECA	Failure Modes and Effect Criticality Analysis

FTA	Fault Tree Analysis
Hazop	Hazard and Operability analysis
ICOMS	International Conference of Maintenance Societies
IEC	International Electro-technical Commission
IEEE	Institute of Electronic and Electrical Engineers
ISO	International Standards Organisation
LCC	Life Cycle Costing
LOCE	Loss of Control of Energy
LORA	Level Of Repair Analysis
MDT	Mean Dead Time / Mean Down Time
MPM	Major Periodic Maintenance
MTBF	Mean Time Between Failures
NAVAIR	US Naval Air Force Engineering Authority
NOHS	National Occupational Health and Safety
OEM	Original Equipment Manufacturer
OH&S	Occupational Health and Safety
PAS	Publicly Available Specification
PDCA	Plan Do Check Act
PHA	Preliminary Hazard Analysis
PPE	Personal Protective Equipment
PPP	Private Public Partnership
QRA	Quantified Risk Assessment
RAMS	Reliability, Availability, Maintainability and Supportability
RBD	Reliability Block Diagram

RFT	Request For Tender
RCM	Reliability Centred Maintenance
RM	Routine Maintenance
SE	Systems Engineering
SWOT	Strengths, Weaknesses, Opportunities and Threats
TAM Manual	Total Asset Management Manual
TMP	Technical Maintenance Plan
TP	Task Period
US MIL-HDBK	United States Military Handbook
US MIL-STD	United States Military Standard

14 Mapping to Asset Management Landscape

Asset Management is developing as a professional discipline. Professional and peak bodies with objectives to implement professional standards for people working in Asset Management exist in many countries. Rather than working towards development goals in isolation, a number of collaborative initiatives are underway.

In March 2009, the Global Forum on Maintenance and Asset Management (GFMAM) steering committee asked the Institute of Asset Management of UK (IAM) and the Asset Management Council (AM Council) of Australia to develop a common understanding of asset management.

In May 2010, after a year of discussions, an Asset Management Landscape was presented (see The Asset Journal, Issue 1 Volume 4, 2010). It provides an overview and perspective of asset management and its various features. The landscape is aimed to facilitate communication, understanding and good practice internationally.

In 2014, the Second Edition of the Asset Management Landscape was published. Below the Capability Delivery Model and the Asset Management System Model are mapped to the Asset Management Landscape, Second Edition.

The GFMAM welcomes comment and debate on the concepts in the Landscape.

Capability Delivery Model

Stakeholders

- Stakeholder engagement
- Needs Analysis Strategic planning
- Capital investment decision making
- Risk assessment and management
- Sustainable development
- Asset costing and valuation

Demand Analysis

- Demand analysis
- Capital investment decision making
- Risk assessment and management

Needs Solutions

- Strategic planning
- Capital investment decision making
- Risk assessment and management
- Sustainable development
- Asset costing and valuation

Concept Validation

- Strategic planning

Concept Exploration

- Strategic planning
- Capital investment decision making
- Risk assessment and management

Specification

- Strategic planning
- Systems engineering

Design

- Asset management planning
- Operations and maintenance decision making
- Life cycle value realisation
- Resourcing strategy
- Shut downs and outage strategy
- Technical standards and legislation
- Asset creation and acquisition
- Asset decommissioning and disposal
- Systems engineering
- Configuration management
- Reliability engineering
- Asset operations
- Fault and incident response
- Asset information strategy
- Asset information standards
- Asset information systems
- Data and information management
- Risk assessment and management
- Contingency planning and resilience analysis

Support Analysis

- Asset management planning
- Operations and maintenance decision making
- Life cycle value realisation
- Resourcing strategy
- Shut downs and outage strategy
- Technical standards and legislation
- Systems engineering
- Configuration management
- Asset operations
- Resource management
- Asset information systems
- Procurement and supply chain management

Integrated Support

- Asset management planning
- Operations and maintenance decision making
- Resourcing strategy
- Technical standards and legislation
- Systems engineering
- Configuration management
- Asset information standards
- Asset information systems
- Data and information management
- Procurement and supply chain management

Create and Dispose

- Asset management planning
- Capital investment decision making
- Technical standards and legislation
- Asset creation and acquisition
- Asset decommissioning and disposal

- Systems engineering
- Configuration management

Operations

- Life cycle value realisation
- Shutdowns and outage management
- Resourcing strategy
- Maintenance delivery
- Asset operations
- Resource management
- Fault and incident response
- Data and information management
- Procurement and supply chain management

Maintenance

- Operations and maintenance decision making
- Life cycle value realisation
- Resourcing strategy
- Maintenance delivery
- Asset operations
- Resource management
- Shutdowns and outage management
- Fault and incident response
- Asset information systems
- Data and information management
- Procurement and supply chain management

Process Monitoring

- Systems engineering
- Configuration management
- Maintenance delivery
- Asset operations
- Asset information systems
- Data and information management
- Risk assessment and management

Process Audit

- Systems engineering
- Configuration management
- Maintenance delivery
- Asset operations
- Asset information standards
- Data and information management
- Risk assessment and management

Support Change

- Systems engineering
- Configuration management
- Maintenance delivery
- Asset operations
- Risk assessment and management
- Asset performance and health monitoring

- Management of change

Engineering Change

- Technical standards and legislation
- Asset decommissioning and disposal
- Configuration management
- Reliability engineering
- Risk assessment and management
- Asset performance and health monitoring
- Management of change

Requirements Change

- Technical standards and legislation
- Configuration management
- Reliability engineering
- Asset information standards
- Risk assessment and management
- Asset performance and health monitoring
- Management of change

Asset Management System Model

Stakeholders

- Stakeholder engagement

Leadership

- Asset Management Policy
- Asset management leadership
- Organisational culture

Organisational Objectives

- Strategic planning
- Capital investment decision making
- Life cycle value realisation

Asset management objectives

- Asset Management strategy and objectives
- Capital investment decision making
- Life cycle value realisation
- Resourcing strategy
- Technical standards and legislation
- Asset information strategy
- Asset information standards
- Risk assessment and management

Performance monitoring and improvement

- Asset management system monitoring
- Management review, audit and assurance
- Asset management planning
- Operations and maintenance decision making
- Life cycle value realisation
- Systems engineering
- Configuration management

- Reliability engineering
- Maintenance delivery
- Asset operations
- Asset information systems
- Risk assessment and management
- Contingency planning and resilience analysis
- Management of change
- Asset performance and health monitoring

Decision making

- Capital investment decision making
- Operations and maintenance decision making
- Resourcing strategy
- Shut downs and outage strategy
- Technical standards and legislation
- Systems engineering
- Resource management
- Risk assessment and management

Risk management

- Risk assessment and management

Process Management

- Capability Delivery Model
- Systems engineering
- Configuration management
- Data and information management
- Procurement and supply chain management
- Risk assessment and management

Roles and responsibilities

- Asset management leadership
- Fault and incident response
- Organisational structure

Competency and engagement

- Asset management leadership
- Organisational culture
- Organisational structure
- Competence management
- Risk assessment and management

AMBOK Publication

ASSET MANAGEMENT BODY OF KNOWLEDGE

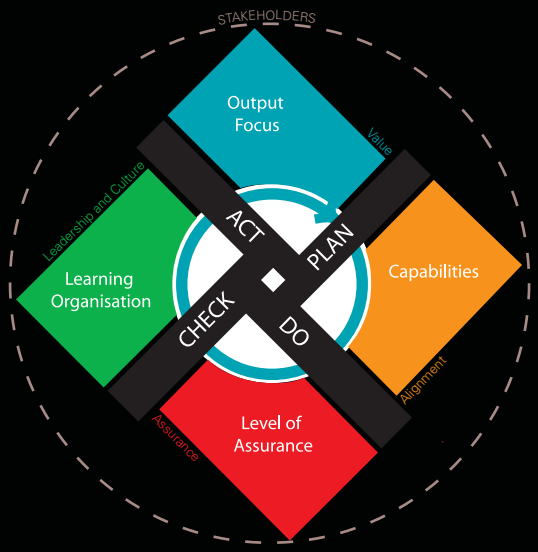
Partnering Organisations

ifm investors

SAP®

TRANSFIELD SERVICES

Asset Management Concept Model



Asset Management System Model

Organisational Systems Model