The Institute of Asset Management

Asset Management – an anatomy

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www.theIAM.org

Asset Management – an anatomy

Anatomy = the study of the structure or internal workings of something
for the purpose of examining and analysing its parts

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This document was first issued in draft for consultation at the IAM's Annual Conference at Warwick in June 2011 and has since been aligned with other IAM Projects, the GFMAM Landscape and the work being done on the forthcoming ISO55000/1/2 Standards. However, this process is unfinished and we welcome responses to this document with the intention of improving our understanding – and, to that extent, this is circulated for continued consultation.

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Amendment Number	Date	Comments
1.1	Feb 2012	Finalising for print and correcting typographical errors

The Institute of Asset Management

Contents

Foreword

The discipline of Asset Management is emerging as a 'mainstream' expectation for competent organisations. It draws from both business and financial management and also from technical, engineering, operations and maintenance management. It is particularly challenging, therefore, to gain a good understanding across the whole breadth of the knowledge base but this is, of course, part of its appeal.

More relevant to many readers is the potential for significant benefits and value to be gained by any organisation or business that chooses to apply Asset Management properly.

Asset Management is neither owned nor controlled by the Institute of Asset Management (IAM). However, we do spend a lot of expert time and effort seeking to develop thinking and to produce knowledge, tools and services for anyone interested in this young and emerging discipline.

Most people come to Asset Management having already demonstrated competence in a profession, such as engineering or finance, and probably having additional specialist expertise in a narrower field such as maintenance or auditing. The IAM welcomes people from any discipline and this helps achieve a cross-sector perspective.

The IAM exists to advance for the public benefit the science and practice of Asset Management. Our priorities are to promote and enable the generation and application of knowledge, training and good practice, and to help individuals become demonstrably competent. **We welcome participation from anyone anywhere who wishes to debate and to improve our knowledge and thinking, including this 'Anatomy' document.**

We are committed to remaining independent of commercial and trade associations. We are a not-for-profit Learned Society owned and controlled by our Voting Members (those competent professionals who choose to participate in our work).

As part of our strategy to collect, develop, collate and make available knowledge, services, products and events relating to Asset Management, we have planned to release a series of documents (like this one). Eventually there will be a full series of Subject Specific Guidelines covering all 39 Subjects and a smaller series of Sector Specific Guidelines (where these are desired by a particular Sector). These are not designed as text books or course material but as reference documents for professionals working in this field.

This document will be updated and improved from time to time – and we invite you to register with us so that we can tell you when a new version or companion document is available.

If you want to find out more about Asset Management or IAM activities and projects you may like to read the IAM Framework[1] or visit us at **www.theIAM.org** or discuss relevant topics on LinkedIn, where there is an official IAM Group **www.linkedin.com/groups?about=&gid=965657**.

For further reading and information, please visit **www.theIAM.org/Knowledge**

[1] Due for publication in March 2012.

Asset Management – an anatomy

Anatomy = the study of the structure or internal workings of something for the purpose of examining and analysing its parts

1. Introduction

This book offers readers an appreciation of Asset Management: what it is, what it can help you achieve; the scope of the discipline (including what is not included!) and a description of the fundamental concepts and philosophy.

There will soon, no doubt, be many excellent text books, training courses and qualifications and these will be essential for people intending to learn, and become expert in, Asset Management. But this is not a text book, training course or a list of techniques and tools. Our aim is to provide a high-level view of the discipline and a source of reference for anyone seeking to understand it.

If you are intrigued by these ideas, or simply want to achieve the benefits available to your organisation or business you may wish to learn more. You may also wish to start implementing the thinking in your organisation. Beware! This is not an overnight transformation or instant success. It is more an approach; a way of thinking; a transformation of organisational alignment and a threat to many existing departmental silos. The potential benefits are significant but the implementation requires commitment over a sustained period.

The IAM is aware that Asset Management is a young discipline for many industry sectors and, as we develop the knowledge base, no doubt the descriptions in this document will need to be updated from time to time. If you have downloaded this document from the IAM website, we shall tell you when a new version is available.

We would appreciate your feedback, including any suggestions on how to improve the usefulness or readability of this document. Please complete the Feedback Form at www.theIAM.org/AMA

The benefits of good Asset Management

The IAM promotes the benefits of Asset Management to the Boardrooms of asset intensive businesses as we believe it is more relevant than ever to help companies and governments come to terms with the economic realities we are facing.

How many organisations can answer the following questions?

- Do you understand the risk profile associated with your asset portfolio and how this will change over time?
- Do you understand the business consequences of reducing your capital investment or maintenance budgets by 10% over the next five years?
- Can you justify your planned asset expenditures to external stakeholders?
- Can you easily identify which investment projects to defer when there are funding or cash flow constraints?
- Do you have the appropriate asset data and information to support your Asset Management decision-making?
- Do you know if your people have the right competences and capabilities to manage your assets?
- Do you know which Asset Management activities to out-source?

As organisations are coming under increasing pressure to deliver more for less, it is imperative that these types of questions can be answered.

Organisations that have developed their capabilities in Asset Management to a relatively high level of maturity can answer these questions with a high degree of confidence. This helps enormously when dealing with shareholders, regulators, customers, investors or politicians who do not have the time

or the skills to understand the long-term implications of the decisions they make. Where these decisions impact on assets, asset performance, risk or net value realization, it is the Asset Management community's responsibility to articulate these implications and the adoption of a holistic Asset Management approach is essential to enable this.

The prize for getting it right is certainly very big and touches almost all parts of an organisation. The available case studies and increasing hard evidence demonstrate: a mix of higher performance levels; lower costs; greater consistency; increased confidence and credibility; happier customers, staff and regulators and more sustainable outcomes. Organisations from a wide range of industries are quoting 20, 40% or even 50% gains in business performance, while simultaneously controlling costs, risks and long term capability.

Perhaps even more importantly, organisations that have been evolving their Asset Management approach over several years report a significant re-engagement of the workforce, a breaking down of inter-departmental barriers and a collective, well-motivated commitment to delivering better value-for-money. Asset Management evidently stimulates some healthy bottom-up creativity and innovation as well as providing the necessary top-down alignment of priorities and resource targeting. We intend to accumulate case studies and reported results in the IAM Knowledge Centre and we welcome any additions you care to offer. (**www.theIAM.org/wiki**)

The Anatomy of Asset Management

No self-respecting doctor is ignorant of basic anatomy. They expect to have a working knowledge of the whole body as well as developing deeper knowledge and expertise in a chosen specialty. However it is also true that no single person can realistically seek or claim to be an expert in every medical speciality.

In the same way we would expect everybody in Asset Management to have a working knowledge of the 39 Subjects described here, but the degree to which they might need deep or specialist knowledge will depend on the job or task they perform.

Again, like medicine, each Subject can to some extent be approached and learned independently. But, also like medicine, Asset Management is a holistic discipline and is only achieved by consideration of the complete scope as described by these 39 subjects.

Management System Standards

If you are familiar with BSI PAS55:2008, you will be aware that this specification itemises 28 requirements for organisations seeking to demonstrate good Asset Management practices. This sometimes leads to confusion because 39 Subjects are described here!

It is important to understand that the 39 Subjects describe the body of Asset Management knowledge as a whole, whereas PAS55 is a requirements checklist for an organisation's management system – to direct, control and continually refine Asset Management. This will become even more formal and explicit with the planned publication in 2014 of ISO55000/1/2.

Please note, therefore, that learning about the management system standard alone does not constitute knowledge and competence across Asset Management as a whole!

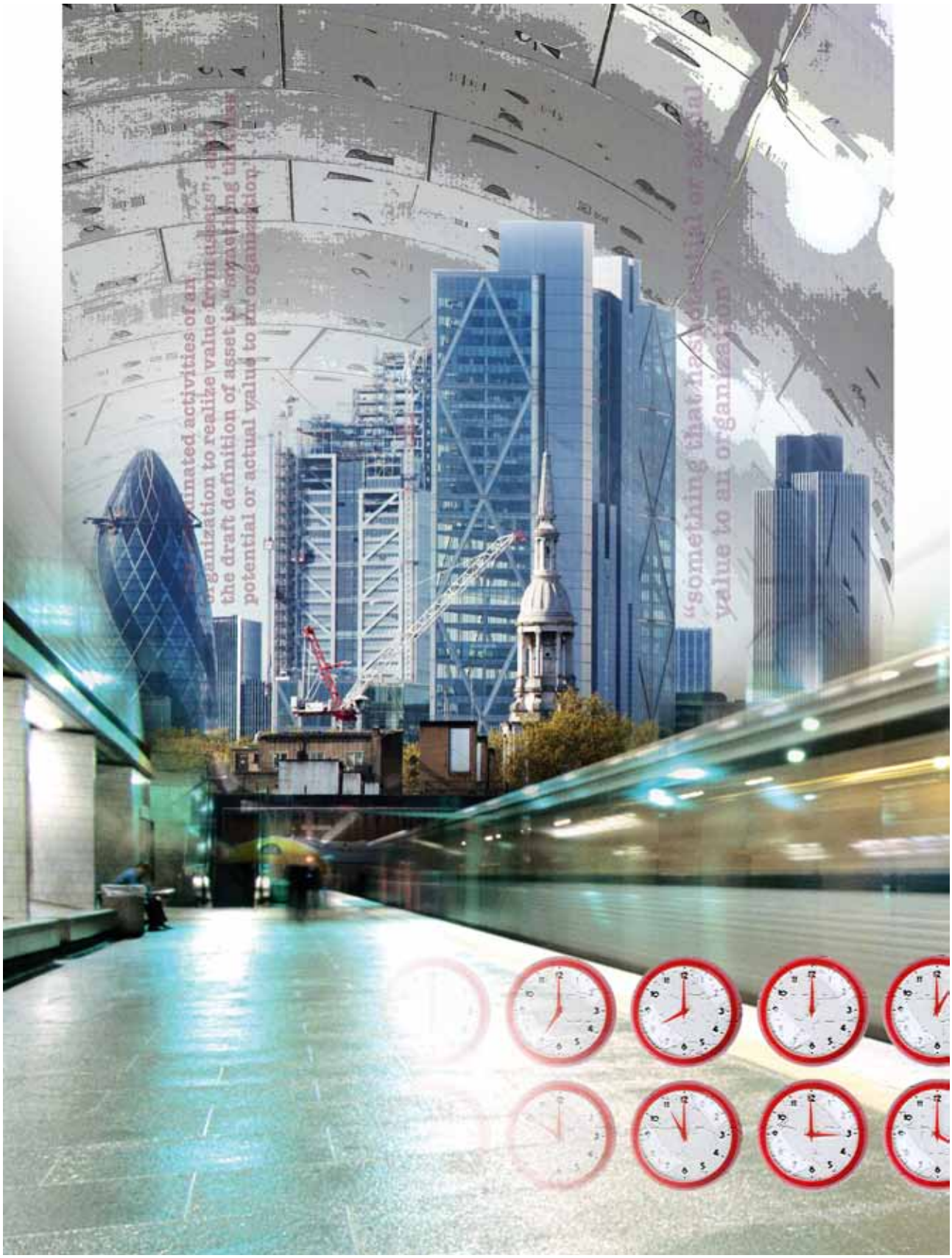
For anyone wanting to master the discipline, knowledge of PAS55 and, in due course, ISO55000 is important but not the whole picture – you really need to learn the whole discipline as represented by the 39 Subjects, albeit to different levels and degrees depending upon your area of responsibility or operational environment.

Sections of this Booklet

This document is set out in several Sections and we recommend that you read Sections 2, 3 and 4 sequentially. However the individual descriptions of the 39 subjects in Section 5 can be used as a reference as you wish.

You will notice that the Subjects are organised in six Subject Groups, which correspond to our conceptual model. The model, the Subject Groups and the individual Subjects are, of course, an evolving picture – a 'work in progress' resulting from considerable international discussion and consensus about the best framework in which to organise Asset Management knowledge and debate.

Although these Subjects can be described individually, they should be not considered as discrete, independent Subjects. Their inter-relationship and the contribution they make as a whole to an organisation's Asset Management capabilities are an extremely important aspect of Asset Management. The jigsaw puzzle only makes sense (and generates maximum value) when all the pieces are joined up to reveal the bigger picture.



2. What does 'Asset Management' mean?

("A rose by any other name…" William Shakespeare, Romeo and Juliet)

As the discipline matures, more and more people have understood that Asset Management is not so much about 'doing things to assets' but about *using* assets to deliver value and achieve the organisation's explicit purposes. So, if Asset Management does not mean managing the assets, what does it mean?

Great efforts have been made to find a better title – without success! However, once understood, the term 'Asset Management' is exactly right for what we seek to do. We provide the techniques for converting the fundamental aims of the organisation into the practical implications for choosing, acquiring (or creating), utilizing and looking after (maintaining) appropriate assets to deliver those aims. And we do so while seeking the best total value approach (the optimal combination of costs, risks, performance and sustainability).

Asset Management gives any interested organisation the knowledge and tools to use chosen assets to achieve its purpose. Moreover these techniques and processes allow such an organisation to demonstrate that it is managing its assets optimally – often of great interest to many stakeholders, whether owners, customers, regulators, neighbours or the general public.

A web search for "Asset Management" reveals not only a predominance of financial services but also a confusing range of flavours and variants. There are many qualifying adjectives attached to the front of the term Asset Management – we find:

- Enterprise Asset Management
- Infrastructure Asset Management
- Physical Asset Management
- Strategic Asset Management
- Property Asset Management
- Facilities Asset Management, and many others.

What are the differences? What do we find in common? In short, what are the underlying 'Asset Management' bits, irrespective the assets we are trying to manage? In most cases, the qualifying adjectives don't help at all – they try to make a special case for something that is inherently consistent, whatever the type or nature of the 'assets'. If you scratch beneath the surface, there are a set of clear, generic requirements for applying the label "Asset Management" appropriately:

In our opinion good Asset Management:

- should be 'enterprise' wide (avoidance of silos)
- applies to asset owners, managers and those with delegated management responsibilities (e.g. outsourced asset responsibilities)
- has to balance costs, risks and performance on different timescales
- applies to tangible/physical and intangible assets;
- applies to public and private and not-for-profit organisations
- will be strategic (aligned with the organisational strategy).

Fortunately the ISO project has enabled the international expert community to converge on the simplest term: "Asset Management", plain and unadorned!

At the time of writing, the draft ISO definition of Asset Management is: **"the coordinated activities of an**

organization to realize value from assets"; and the draft definition of asset is **"something that has potential or actual value to an organization"**.[2]

These may seem very general definitions. This is intentional, as the thinking is common to the use of assets in whatever form they take. It is up to the organisation to choose **how** to manage those assets to derive best value, and 'value' will take different forms to different organisations (including, for example, the 'minimisation of risk or liabilities'). These concepts are explored further in the next section. However, it is not the purpose of this document to repeat all the details, or get any further involved in the emerging Management System Standards, especially as they are in draft form at this stage.

[2] Obviously, these definitions are not IAM copyright. The ISO work is still in progress through Project Committee PC251 and, if you wish to contribute to this work or comment on these draft definitions, you should do so through your National Standards organisation. However, if you are unable to do so, the IAM will take account of any contributions you send us and incorporate them into our submissions process to the PC251 project.

3. Concepts and Principles

Where modern concepts of Asset Management have come from

Asset Management is not new. People have been managing assets for thousands of years. What has changed, however, is the cumulative recognition that good Asset Management involves optimising (within any absolute constraints) the mix of cost, risks and performance over the whole asset life.

These insights have three primary origins:

1. The **financial services** sector has been using the term for over 100 years to describe the juggling act of 'optimizing' risk, yield (performance), short- and long-term security from a mixed portfolio of cash, stocks & shares and other investments. And, despite the spectacular recent failures in the banking sector, the underlying aspirations remain sound (provided that the risks and long-term dimensions are properly handled!).

2. The **North Sea Oil & Gas** industry adopted the term Asset Management in the era following the Piper Alpha disaster and the oil price crash of the late 1980's. Radical change was needed and it was discovered that the creation of small, dynamic, multi-disciplined teams managing each oil platform (the 'asset') with a full life cycle

view, unleashes great creativity and massive improvements in performance, safety and productivity.

3. Meanwhile, in Australia and New Zealand, the **public sector** faced a 'perfect storm' of falling levels of service, escalating costs and poor planning. The public outcry forced a corresponding radical re-think, and the establishment of much better strategic planning, prioritization and value-for-money thinking.

The lessons learnt from these widely different environments have been remarkably similar, with significant convergence of conclusions. Now the message is spreading – over the last 20 years it has been penetrating the electrical and water utilities, road and rail transport systems, mining, process and manufacturing industries at an accelerating rate. All are realising that great opportunities lie in a more joined-up approach to asset lifecycle value optimization.

Distinguishing characteristics of good Asset Management

In a discipline as broad as Asset Management, it can be difficult to pin down the vital individual elements that make the total picture work effectively. As in the medical analogy, an assembly of limbs, organs, muscles and nerves does not adequately describe the whole person and their capabilities, health, longevity etc. Nevertheless there are some observable attributes of good Asset Management (in contrast to "merely managing assets"), captured in the PAS55 British Standards Institute specification and being revised/extended in the current ISO work.

- **Multi-disciplinary**: Asset Management crosses *departmental and discipline boundaries* and is focused on net value-for-money.
- **Systematic**: rigorously applied in a structured *management system.*
- **Systems-oriented**: looking at assets in their *systems context*, again for net, total value.
- **Risk-based**: incorporating risk appropriately into all *decision-making.*
- **Optimal**: seeking the *best compromise between conflicting objectives*, such as costs versus performance versus risks, and short-term versus long-term impacts.
- **Sustainable**: plans must deliver optimal asset *life cycle value*, including ongoing system performance, environmental and other long term consequences.
- **Integrated**: at the heart of good Asset Management lies the need to be *joined-up*. The total jigsaw puzzle needs to work as a whole – and more than just the 'sum of the parts'.

To recognize and understand these features, it is also essential to clarify some underlying concepts:

- how Asset Management realizes 'value' from assets
- what is a 'life cycle'
- what we mean by 'optimal' and
- what is a 'management system'.

Underpinning concepts

Assets and Value

Assets are things that have actual or potential value, and Asset Management achieves the realization of that value. However, what constitutes 'value' will obviously depend on your viewpoint. An investor seeks good profit or capital growth, a customer wants high standards of performance at low cost, a regulator looks for assurance, efficiency and long-term sustainability. Value can be realized in the buy-&-sell (capital value) sense, or in the asset utilization (performance value) sense. It can even be seen as a negative – if, for example, the 'asset' is a liability (a risk, responsibility or debt), in which case the value realisation objectives would be to control or minimise this liability.

Value (and value-for-money) must reflect the mix of stakeholders and their expectations, and the best way of satisfying these potentially competing expectations with available funding and any absolute (e.g. legal) constraints. The key concept is that it always involves trade-offs between, or combinations of, the different interests e.g. Net Present Value of short-term plus long-term consequences rather than just today's or tomorrow's performance figures. Common trade-offs, and the need to optimise the combination, exist between short term and long term goals, between costs, risks and performance outcomes, between capital investment and subsequent operating costs, between asset utilization and asset care (maintenance).

Value will also often involve a mix of tangible and intangible benefits or risks – in which case some quantification or scaling methods will be needed for the intangible elements (such as reputation, customer satisfaction, employee morale or environmental responsibility).

Assets themselves have different levels of granularity – some organisations identify individual equipment items as discrete assets, towards which investment, maintenance, spares or other activities are directed. However such units generally yield functional performance and value only in a systems context – the network, production line, infrastructure facility or other larger entity.

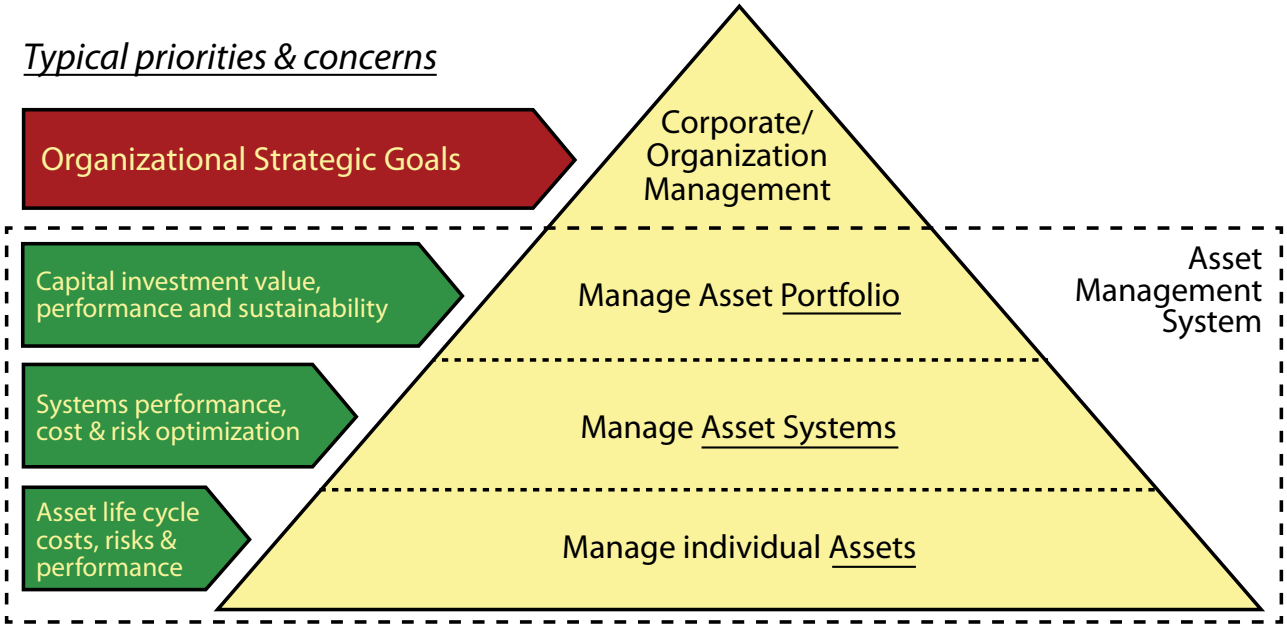


Figure 1. Hierarchy of assets within an integrated management system

So, to maximise value (various aspects of performance in relation to expenditure, risks etc) it is essential that we understand both the inputs, costs and risks at discrete intervention and asset unit levels (at various stages in their individual asset life cycles), and the higher, systems integration levels of benefits or performance realization, again considering different timescales and horizons. This is why other organisations define their 'assets' at higher levels (such as whole networks, infrastructure systems or productive units) – it enables a full value-for-money picture of the life cycle activities (inputs) and total performance benefits. However such systems-level Asset Management may have reduced precision and agility in determining what is really worth doing, where, when and why.

Asset Life Cycles

The concept of asset life cycles is easy to understand at the lowest levels of asset 'granularity', such as physical equipment components. However assets can only contribute value in a systems context – and more complex systems can have finite or infinite 'life', depending on how we choose to manage them. 'Patch and continue' maintenance strategies, asset replacements, modifications, obsolescence, changing functional demands, re-cycling and other options need to be considered, and the asset may even have a series of 'owners' during its 'life', with different objectives, value criteria and planning horizons. Asset life cycle planning, life cycle costs and value realization periods must be understood if short-termism and 'false economies' are to be avoided.

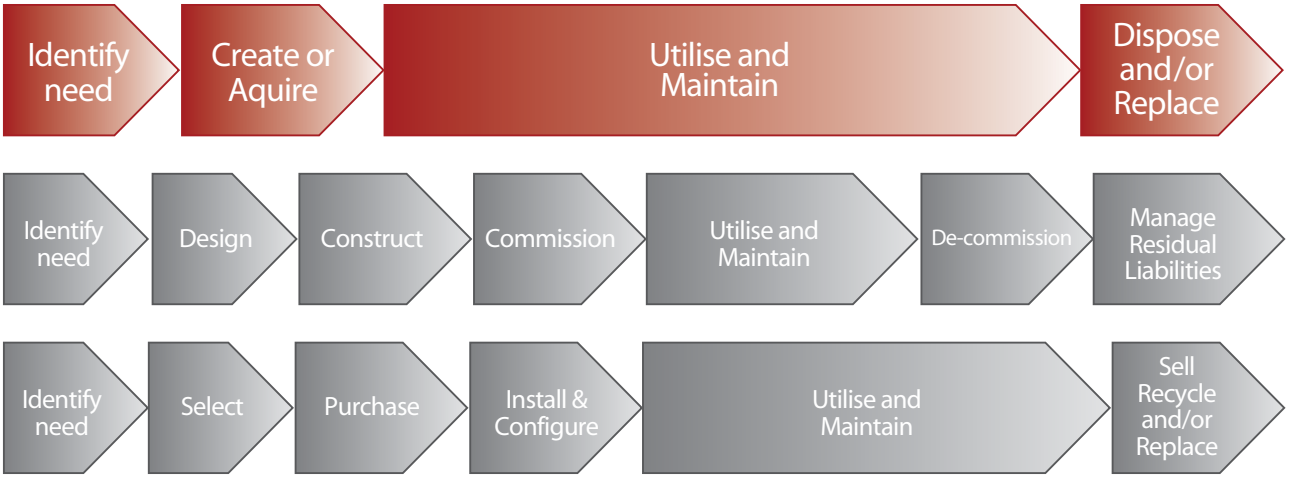


Figure 2. Core asset life cycle stages and examples of variations

Optimized decision-making

Optimal, risk-based decision-making is also a vital element underpinning successful Asset Management. This involves finding the right compromise between competing interests, such as asset utilization/performance versus asset care (maintenance), capital investment cost versus operating expenditures, or short-term benefits versus long-term sustainability.

The goal in each case is to determine the optimal *combination*, yielding the best net value, including any risk exposures, indirect or intangible impacts and long-term effects. This involves understanding a range of quantification techniques, including how to put a price on risk and intangibles, and the real-life complexities of asset deterioration, reliability engineering and financial calculation methods.

It is also important to be proportionate – Asset Management decisions vary greatly in complexity and criticality, so it is inappropriate to apply the same level of sophistication to all decisions. Simple, non-critical decisions can and should be made with (educated) common sense, whereas higher impact decisions, with multiple influences, options, timings or inter-dependencies require greater systematic, multi-disciplined and auditable optimisation methods.

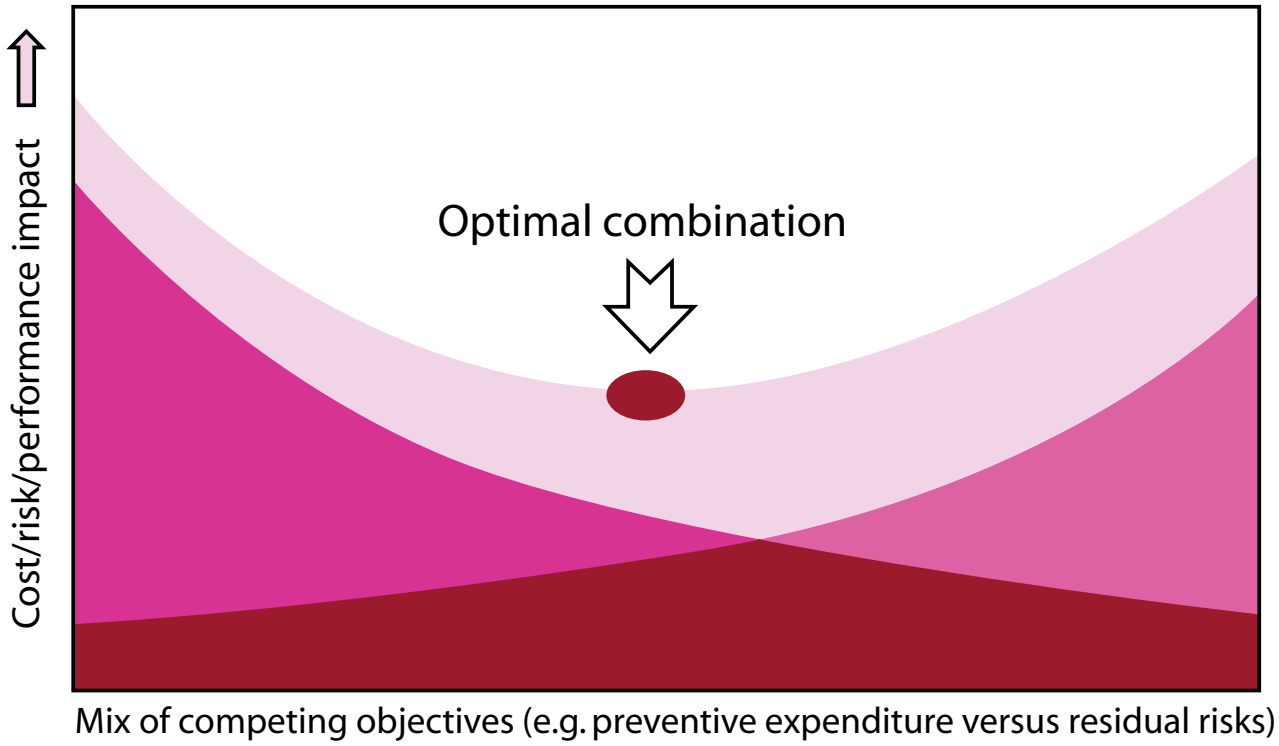


Figure 3. Best value achieved by optimising total cost/risk/performance impact.

An Asset Management System

Coordinating the many facets of Asset Management requires a system of direction and control – a 'management system'. PAS55 provides a checklist of requirements for such a system, and covers the establishment of clear policy and strategic direction, specific Asset Management plans, operational controls and continual improvement activities. It also identifies a range of 'enablers' that have been found, by the many organisations participating in the PAS55 development, to be essential to the coordination, efficiency and sustainability of a joined-up Asset Management model.

Note, however, that the term "Enterprise Asset Management" (EAM) system is sometimes used to describe one of these enablers – the software systems used to hold asset information and to facilitate work planning and control, materials management, procurement etc. Care must be taken not to confuse this with the overarching management system for Asset Management.

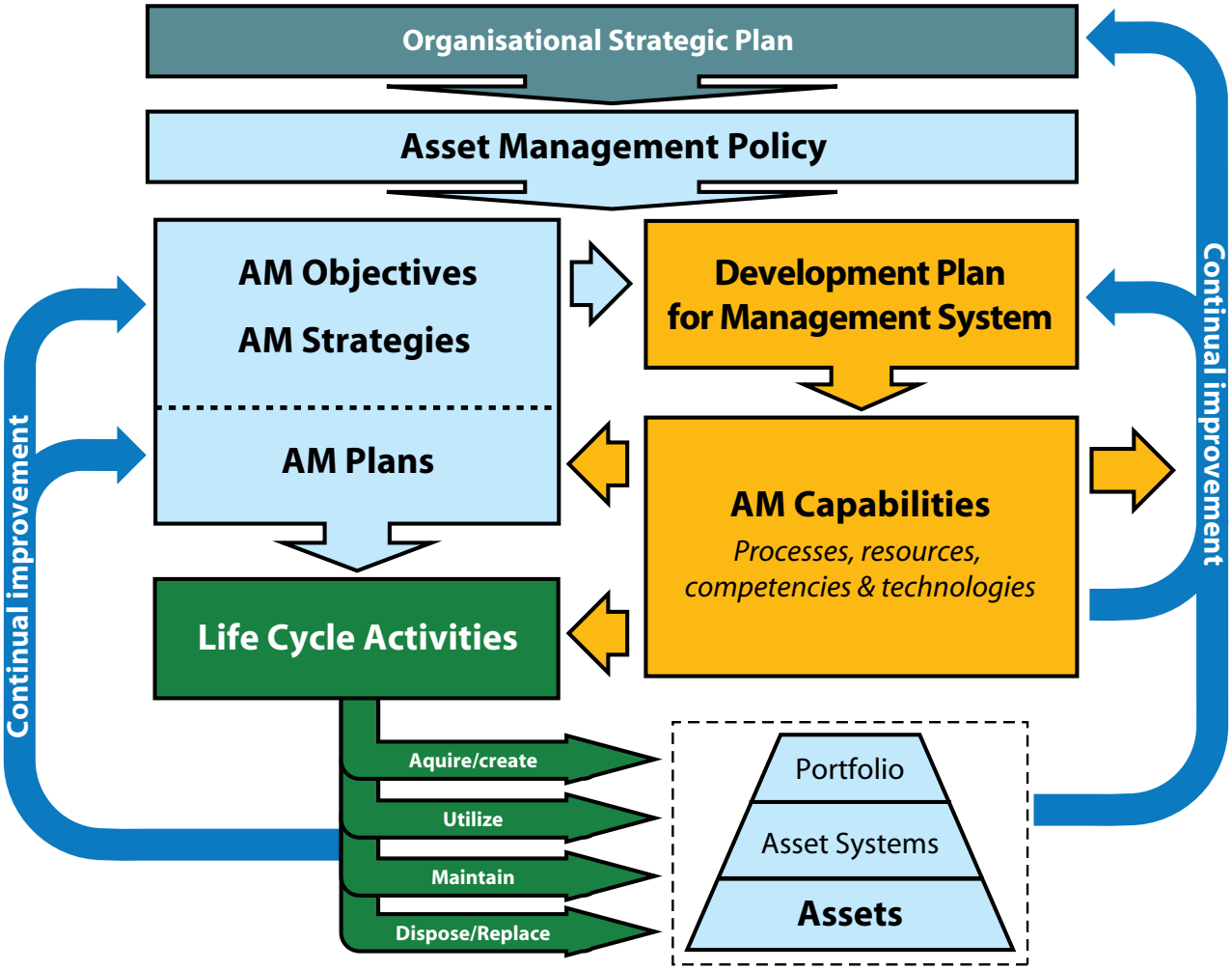


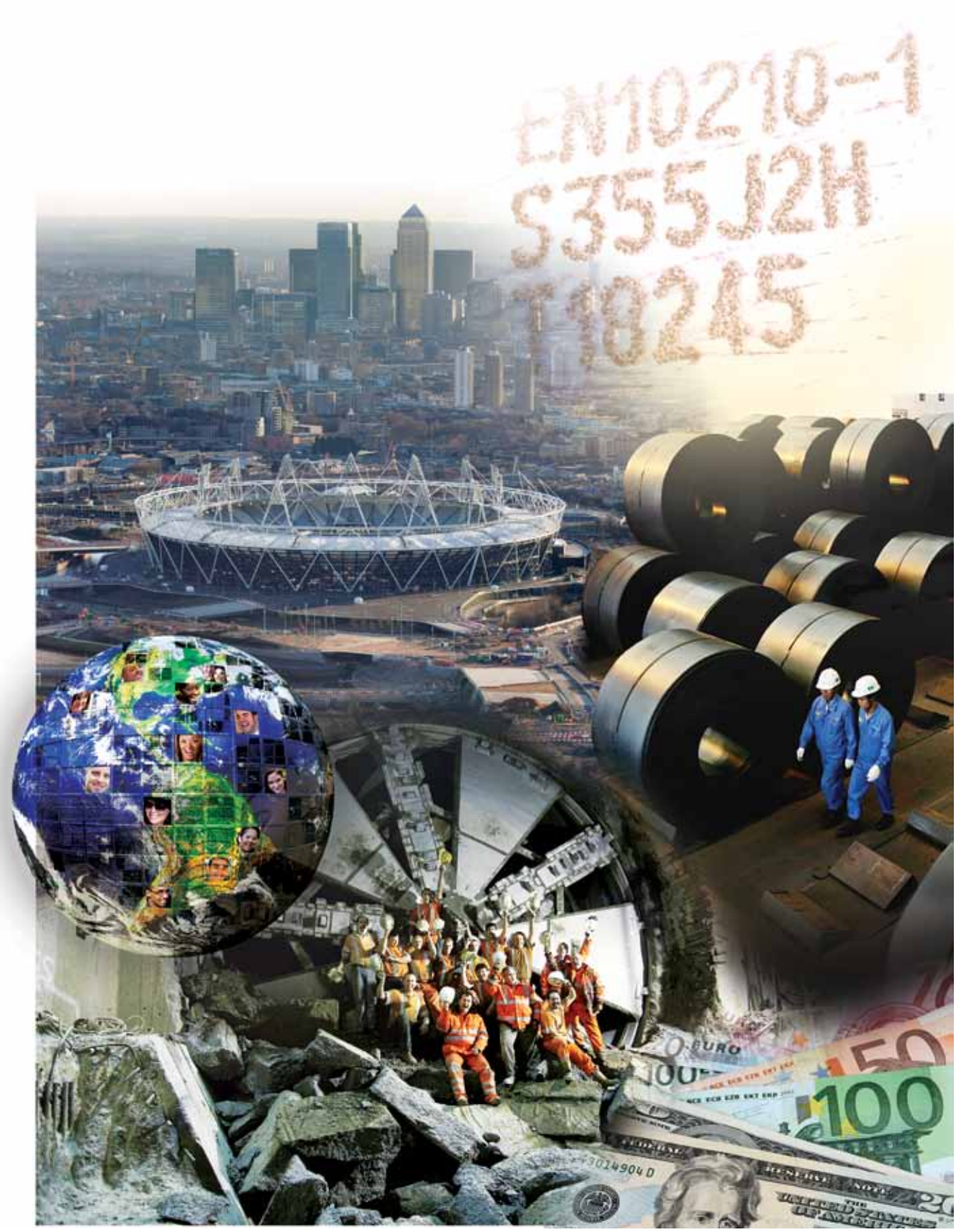
Figure 4. Example of key elements within an Asset Management System

"Line of sight" within the management system

The backbone to a good management system for assets is the clear connectivity between the organization strategic plan (commonly called the business plan) and the on-the-ground daily activities of individual departments (planning, engineering, procurement, operations, maintenance, performance management etc).

We call this the 'line of sight' because people on the front line need to have direct visibility of the reasons for their activities – why the task is needed, not just how to do it. Such alignment brings obvious advantages of prioritization and coordination of purpose, but it also helps to stimulate creativity and innovation: staff who understand what is important (and why) can often identify new and better ways of achieving these goals.

Line of sight goes both ways, of course. It also ensures that senior management decisions and corporate strategies are rooted in fact-based realities – the asset capabilities, performance, opportunities and constraints. Feedback and continual improvement are therefore key elements of an Asset Management system – and apply at many levels (see Figure 4 left).



4. The Scope of Asset Management

People 'do' Asset Management

The understanding of the principles of Asset Management has developed significantly over the last decade and a number of approaches, standards and models have been developed across the world. It is becoming increasingly necessary to align these various approaches and to develop a global view, in particular for companies that operate Asset Management systems in many countries.

Asset Management differs, for example, from Quality Management (e.g. ISO9001), Lean, 6-SIGMA, Total Productive Maintenance and so on, although it can incorporate such methodologies. Asset Management is best seen as an *integration framework* that enables organisations to achieve their explicit aims in a structured way. They may choose to use any combination of tools and techniques to achieve these aims, provided that they are appropriately applied and deliver 'added value'.

It is vital to remember that people 'do' Asset Management and therefore people, and their knowledge, competence, motivation and teamwork, make the biggest difference to good or poor Asset Management. The tools and technologies may be helpful, but the engagement of the workforce, the clarity of leadership, and the collaboration between different departments and functions are the real differentiators of a leading Asset Management organisation.

Similarly, Asset Management is not about just managing the assets for their own sakes. Asset Management is about deriving value from the assets in a structured and predictable way. Even if the role of the organisation is limited to the 'governance' responsibility for assets, there are plenty of opportunities to optimise what is spent, and when, in relation to the risks, obligations and liabilities incurred.

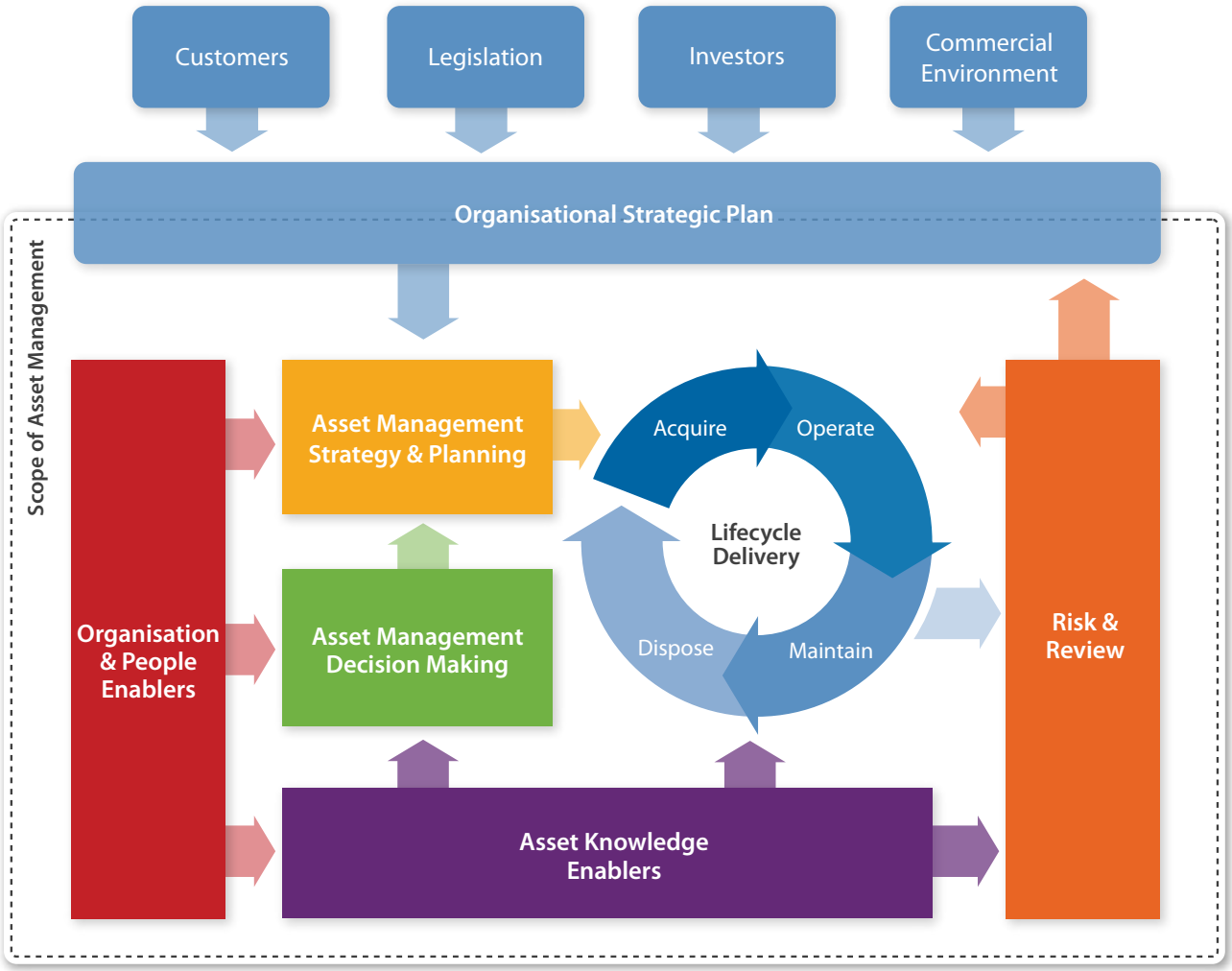
The IAM Conceptual Model

The IAM takes the view that there is no perfect model. Instead we welcome a variety of useful models either because they are preferred by some individuals or because they explain a theory or practice in different ways for different purposes.

The following section presents the current conceptual model used by the Institute to which all the Subjects and Subjects Groups are aligned.

The Conceptual Model is designed to describe the overall scope of Asset Management and the high-level groups of activity that are included within this discipline. The Model highlights the fact that Asset Management is about the integration of these groups of activity and not just the activities in isolation. It also emphasises the critical issue that Asset Management is there to serve the goals of the organisation. The 'line of sight' from an organisation's goals to its Asset Management activities or 'alignment' that is promoted in PAS55 is a concept that we continue to emphasise.

The Asset Management Subject Groups are shown in the IAM conceptual model for Asset Management below.



The 39 Subjects and 6 Subject Groups

Over the last year, the IAM has been working with international partners within the Global Forum for Maintenance and Asset Management (GFMAM) to achieve global consensus on a common definition of the 39 Subjects that form the core of the Asset Management Landscape.[3] These 39 Subjects are also being used to develop a common approach to the definition of Asset Management qualifications through an International Accord.

The Asset Management Landscape has been built around these 39 subjects and now provides a stable platform on which the IAM and other GFMAM members can base and align their knowledge creation work. These subjects are described in detail in Section 5.

The Asset Management Subjects are linked to 6 Subject Groups that link to the conceptual model.

It is important to understand that these 39 subjects are intended to describe the complete scope of Asset Management. Therefore any person who intends to become demonstrably competent or expert in this field will need to know enough of the complete breadth of all the subjects in addition to any deep and detailed expert knowledge in any one of them.

These subject Groups are split into the following 39 Subjects.

Asset Management Strategy and Planning	• Asset Management Policy • Asset Management Strategy • Demand Analysis • Strategic Planning • Asset Management Plans
Asset Management Decision-Making	• Capital Investment Decision-Making • Operations & Maintenance Decision-Making • Life Cycle Cost and Value Optimisation • Resourcing Strategy and Optimisation • Shutdowns & Outage Strategy and Optimisation • Aging Assets Strategy
Lifecycle Delivery Activities	• Technical Standards & Legislation • Asset Creation & Acquisition • Systems Engineering • Configuration Management • Maintenance Delivery • Reliability Engineering and Root Cause Analysis • Asset Operations • Resource Management • Shutdown/Outage Management • Incident Response • Asset Rationalisation & Disposal
Asset Knowledge Enablers	• Asset Information Strategy • Asset Knowledge Standards • Asset Information Systems • Asset Data & Knowledge
Organisation and People Enablers	• Contract & Supplier Management • Asset Management Leadership • Organisational Structure & Culture • Competence & Behaviour
Risk & Review	• Criticality, Risk Assessment & Management • Contingency Planning & Resilience Analysis • Sustainable Development • Weather & Climate Change • Assets & Systems Performance & Health Monitoring • Assets & Systems Change Management • Management Review, Audit and Assurance • Accounting Practices • Stakeholder Relations

[3] This agreement was reached by GFMAM in mid-2011 (see www.gfmam.org)

The Global Forum on Maintenance and Asset Management (GFMAM) has been established with the aim of sharing collaboratively advancements, knowledge and standards in Maintenance and Asset Management.

The members of GFMAM (at the time of issue of this document) are:

- Asset Management Council (AMCouncil), Australia;
- Associação das Empresas Brasileiras de Manutenção ABRAMAN), Brazil;
- European Federation of National Maintenance Societies (EFNMS), Europe;
- Gulf Society of Maintenance Professionals (GSMP), Arabian Gulf Region;
- Iberoamerican Federation on Maintenance (FIM), South America;
- Institute of Asset Management (IAM), UK
- Plant Engineering and Maintenance Association of Canada (PEMAC), Canada
- The Society for Maintenance and Reliability Professionals (SMRP), USA.
- The Southern African Asset Management Association (SAAMA), South Africa

The enduring objectives of the GFMAM are:

1. To bring together, promote and strengthen the maintenance and Asset Management community worldwide
2. To support the establishment and development of associations or institutions whose aims are maintenance and Asset Management focused
3. To facilitate the exchange and alignment of maintenance and Asset Management knowledge and practices
4. To raise the credibility of member organizations by raising the profile of the Global Forum

The Global Forum on Maintenance and Asset Management has recently issued 'The Asset Management Landscape', which provides an overview and perspective of Asset Management and its various features (this document can be downloaded from www.gfmam.org).

Each GFMAM Member incorporates this Landscape as part of their Asset Management Framework. An Asset Management Framework shows how and where a Member's 'Knowledge and Practices' fit within the Asset Management Landscape.

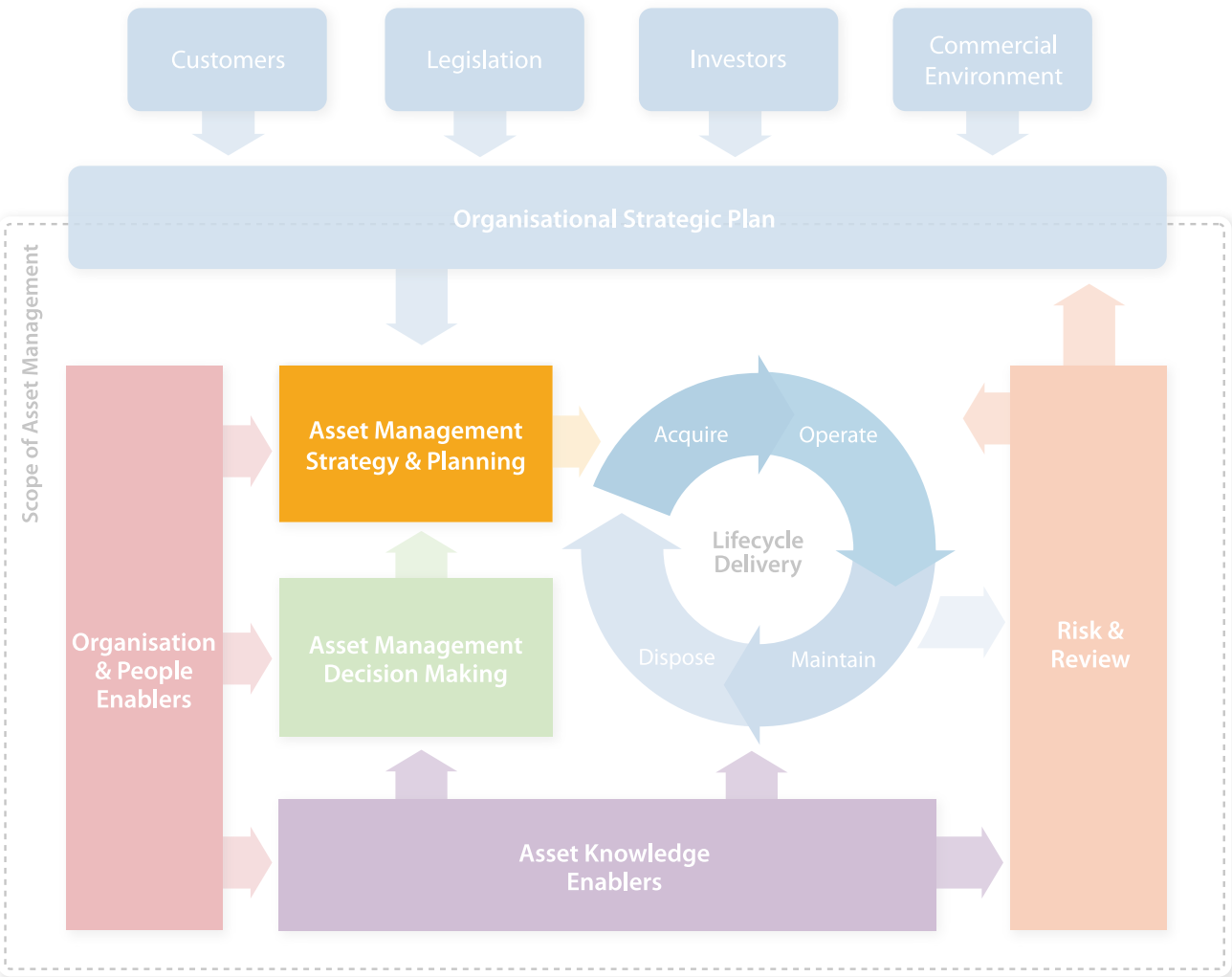
The IAM Framework has been produced primarily for this purpose but is also helpful in understanding whether or not membership of the IAM might be useful for you or your company.

5. Subjects Groups and Descriptions

Each Subject Group and each of the 39 Subjects are described in more detail in the following sections. These descriptions were developed by IAM members and reviewed and edited by IAM Faculty to ensure consistency across the 39 subjects. The IAM is gradually publishing individual Subject Specific Guidelines as downloadable documents.

Although these Subjects are described individually, they should not be considered as discrete Subjects. The inter-relationship between the Subjects and the contribution they make as a whole to an organisation's Asset Management capabilities are an extremely important aspect of the Asset Management Landscape

5.1 Asset Management Strategy & Planning



The Asset Management Strategy & Planning group contains the core Asset Management activities required to develop, implement and improve Asset Management within an organisation, taking into account business and organisational objectives and the effects of changing demand over time on the asset portfolio. The output of this group is typically an **Asset Management Plan** which clearly explains what the organisation plans to do with its assets with respect to acquisition, maintenance, operation and disposal and what level of service will be delivered as a result of these activities.

Asset Management Strategy & Planning needs to consider the required outputs from the assets, both now and in the future, and the options for delivering these outputs for the lowest whole life costs. In many organisations, this requires consideration of an **Asset Management Plan** over long timeframes, for example 50 years, to ensure the long-term implications of Asset Management Decision-Making are understood. It is therefore important that the Asset Management Strategy & Planning activities are undertaken in parallel with the **Asset Management Decision-Making** activities.

Asset Management Strategy & Planning also needs to take account of the uncertainties associated with long-term planning. These uncertainties could include:

- What are the future levels of demand?
- Will required levels of service change?
- Will assets deteriorate at the assumed rate?
- How will risks change over time?
- What new technology will become available?
- What are the future changes in legislation and regulation?
- What will the economic business environment be like in the future?

It is important that the implications of these uncertainties are understood in terms of likely impact on cost, risk and level of service. This may necessitate the development of **Asset Management Plans** for a number of different scenarios to reflect different assumptions around these uncertainties.

The Asset Management Strategy & Planning Group covers the following Asset Management Subjects:

- **Asset Management Policy**
- **Asset Management Strategy**
- **Demand Analysis**
- **Strategic Planning**
- **Asset Management Plans**

Each of these is now described in more detail.

5.1.1 Asset Management Policy

An Asset Management Policy is the cornerstone of an organisation's approach to Asset Management. As such it provides both the confidence that the organisation is translating its overall organisational strategic plan into an effective **Asset Management Plan**, and provides the start of an organisation's 'line of sight', the golden thread of rationale which ultimately justifies every Asset Management activity the organisation undertakes.

'Line of sight' is an essential concept for effective Asset Management. The project manager or technician at the 'sharp end' of an organisation should be able to trace the rationale for what he or she is doing upwards through a clear set of plans, objectives and strategic statements to something in the organisational strategic plan (i.e. the organisation's topmost vision). This requires a clear framework within which **Asset Management Decision-Making** is made and presented. The purpose of the Asset Management Policy is to set this framework out.

PAS55 sets out a list of 11 requirements for an Asset Management Policy which fall into five broad categories (in no particular order):

- Consistency – is the Asset Management Policy consistent with the organisational strategic plan,

other organisational policies, and in particular the organisation's overall approach to the management of risk?

- Appropriateness – is the **Asset Management Policy** appropriate for the nature and scale of the organisation?
- Compliance – is there a commitment in the Asset Management Policy for the organisation to comply with all relevant mandatory regulations and laws, whether voluntarily or not?
- Principles and framework – is there a clearly laid out set of principles and a framework within which the Asset Management System (and its line of sight) can be created?
- Continual improvement – is the Asset Management Policy supported by top management, effectively communicated and reviewed regularly, with a commitment to continual improvement of the Asset Management System it defines?

Many organisations have difficulty getting the right balance for their particular circumstances. Some prefer a single page Asset Management Policy which can be pinned on all their notice boards for all to see. They then understandably struggle to fit all the requirements outlined above into a single page. In reality, an Asset Management Policy does not need to be a single page, but should not realistically stretch to more than a few well crafted pages. The main object should be clarity of thought and presentation, setting out as coherently as possible how Asset Management will contribute to the achievement of the organisational strategic plan.

Therefore the structure, length and content of the Asset Management Policy will vary from organisation to organisation, from a single document to a structured group of documents, possibly with a single page 'Asset Policy Statement' for the notice boards. What is important is to make clear to anyone reading it exactly how the organisation's Asset Management System works, and to provide a clear link to the first level of the organisation's line of sight.

5.1.2 Asset Management Strategy

An Asset Management Strategy can be considered as the second stage of decomposition of the organisation's 'line of sight' which was initiated by its **Asset Management Policy**. As described under **Asset Management Policy**, the line of sight is essential to effective Asset Management, ensuring the justification for all Asset Management activities at the 'sharp end' are clearly justified at all levels in the organisation.

The Asset Management Strategy should define what the organisation intends to achieve from its Asset Management activities and by when. This should include both:

- The current and future demand on, and condition and performance requirements of, the organisation's assets and how the organisation intends to deliver these future requirements.
- The current and future Asset Management capabilities of the organisation, i.e. its processes, information, systems, people, tools, resources etc. and how the organisation intends to develop its future capabilities to a level of maturity necessary to deliver its organisational goals.

A key requirement for an effective Asset Management Strategy is the inclusion of Asset Management objectives that are Specific, Measurable, Achievable, Realistic and Time-bound (SMART).

The Asset Management Strategy does not have to be a single document, in fact it often helps if it is not, but a coherent Asset Management Strategy must be in place for an organisation to be an effective Asset Manager.

PAS55 sets out a list of 12 requirements for an Asset Management Strategy which fall into seven broad categories (in no particular order):

- Consistency – is the Asset Management Strategy

consistent with the **Asset Management Policy** (and hence the organisational strategic plan) and other organisational policies and strategies?

- Risk-based Approach – is the Asset Management Strategy risk-based in its approach, i.e. does it prioritise activities according to the criticality of the asset or Asset Management activity under consideration?
- Lifecycle Approach – does the Asset Management Strategy explicitly consider the lifecycle of the assets and the interdependencies between each of the lifecycle stages?
- Framework – does the Asset Management Strategy set out a clear framework for the development of Asset Management objectives and plans which includes the appropriate level of optimisation, prioritisation, and management of information?
- Stakeholders – does the Asset Management Strategy include an assessment of how stakeholders will be engaged and communicated with?
- Functional, performance and condition requirements – does the Asset Management Strategy identify present and future functional, performance and condition requirements for the assets and how the organisation plans to meet these?
- Continual improvement – is the Asset Management Strategy supported by top management, effectively communicated, and reviewed regularly to ensure it is still fit for purpose in meeting the Asset Management Policy and organisational strategic plan?

The biggest challenge facing any asset intensive organisation is creating an Asset Management Strategy that clearly maintains the line of sight initiated by the **Asset Management Policy**. Many organisations find the development and introduction of an Asset Management Framework helps with this. Within the Asset Management Framework the structure and content of the Asset Management Strategy is clearly defined, with the relationships between documents set out in the form of a top-level diagram and the development of lower level document templates to support the consistent generation of each document within the framework.

5.1.3 Demand Analysis

With the development of an **Asset Management Strategy** there is an important element that needs to be considered and that is the demand for the product or service being produced and how this demand translates into the required outputs that the organisation's assets will need to deliver. In some cases the organisations may have a good understanding of the future demand and this has been taken into consideration into the organization strategic plan but for others this may be more difficult. It is therefore important to undertake demand analysis before being able to fully develop the Asset Management objectives and to develop the organisation's **Asset Management Plan**.

Demand Analysis involves analysis of historical demand, and the drivers of this demand, to forecast future demand for the product or service being offered and the requirements this demand will place on the asset portfolio. In Demand Analysis there are several elements that need to be considered:

- Historical demand
- Change in demand over time
- Price changes over time
- Changes in required levels of service
- Impact on the future performance, condition and capability of an organisation's assets.

Other factors that have to be incorporated are price elasticity, marketing elasticity, income elasticity, and cross elasticity. The elasticity identifies what the demand or price will do as a result of the factor itself. For example if a product or service is price in-elastic it means that a large change in quantity of sales does not change the price of the product or service. Consideration also needs to be given to the impact of regulatory price controls for organisations working in a regulated sector.

Naturally, there is a higher level of uncertainty the longer the forecast is. This uncertainty needs to be reflected in the **Strategic Planning** processes within an organisation and in the resulting **Asset Management Plan**. The **Strategic Planning** processes also need to consider the capacity and capability of the assets to deliver the forecast demand and how this may limit an organisation's ability to service an increased demand for a product or service.

One of the main reasons to perform demand analysis is to be able to forecast the return on assets or return on investments utilizing a normal Net Present Value (NPV) method based on the incremental costs and revenues for each of the strategic asset investments identified. Building and optimizing a NPV model and incorporating the demand analysis allows the asset manager to run different scenarios and to optimize the **Asset Management Strategy** and **Asset Management Plan**.

The asset managers of today and the future need to be involved in developing the scenarios for the assets and based on the outcome of those scenarios the Asset Management objectives defined within the **Asset Management Strategy** will become more relevant. This is discussed further in **Strategic Planning** below.

5.1.4 Strategic Planning

Developing an integrated strategic planning framework and associated processes will ensure organisations adopt a consistent approach to developing work volumes and costs across different asset groups to a level of rigour appropriate to the criticality of the different asset types. This will help to ensure funding requirements across the different asset groups are consistent and adequately reflect their potential to impact on risk and outputs.

A strategic planning framework should be used to describe how asset information and renewal and maintenance policies are used to develop an organisation's strategic **Asset Management Plan**. A strategic framework should provide guidance on the most appropriate method to develop work volumes, cost schedules and output measures for different types of asset including the use of appropriate decision support tools.

The strategic planning framework and associated planning processes should describe how **Demand Analysis** and required outputs are considered and modelled in the development of the organisation's proposed maintenance, renewal and enhancement work volumes. The strategic planning processes should enable organisations to develop work volumes and costs for different scenarios to reflect potential changes in demand, output requirements or funding constraints.

The development of different scenarios will enable organisations to more clearly articulate the impact of funding constraints in terms of impact on performance, risk and cost.

The strategic planning processes should describe how confidence levels in asset information and unit costs will be determined and how this will the impact on the confidence levels in the resulting work volumes and costs in the **Asset Management Plan**. The use of confidence levels will help internal and external stakeholders to understand the relative maturity of

the work volumes and costs within the plan compared to the criticality of the different asset groups.

The strategic planning processes should reflect the criticality of different asset types in the approach to determining work volumes and costs to ensure the level of rigour in the development of the **Asset Management Plan** is proportional to the criticality of the different asset types.

The Strategic Planning processes should describe how an organisation intends to ensure that the **Asset Management Plan** is aligned with the day to day delivery plans used by the organisation and how any variations between these different plans are handled.

5.1.5 Asset Management Plans

Essentially the Asset Management Plan will set out how physical infrastructure assets will be managed, over a specific period of time, to achieve Asset Management objectives. Typically, the **Asset Management Strategy** will define an organisation's Asset Management objectives and define what level of service and what outcomes they want to achieve. This could be to maintain current customer service and/or to improve customer service or environmental service in specific areas.

An organisation's **Strategic Planning** processes will produce an Asset Management Plan that defines the activities that an organisation intends to undertake in order to deliver these objectives and level of service. These activities could include capital investment to build new assets, capital investment to renew life-expired assets, an operational maintenance regime, disposal of assets, rationalisation of assets or education campaigns.

For example an Asset Management objective to reduce sewer flooding of properties could be achieved by a combination of a number of activities, not limited to, but including:

- providing protection at domestic properties e.g. by installing flood gates
- capital investment to replace sewers, overflows and pumping stations
- maintenance activities to remove tree roots
- a customer education campaign to reduce disposal of unsuitable items in the sewer that can lead to blockages and flooding such as fats, oils, greases and nappies.

The decision about the optimum blend of activities necessary to achieve a specific objective would be analysed using the approaches described in the Subject Group **Asset Management Decision-Making**. Responsibilities should set out who leads each activity and which part of the organisation or its suppliers will carry out each activity. It may also specify how decisions are made and who is responsible for **Asset Management Decision-Making**.

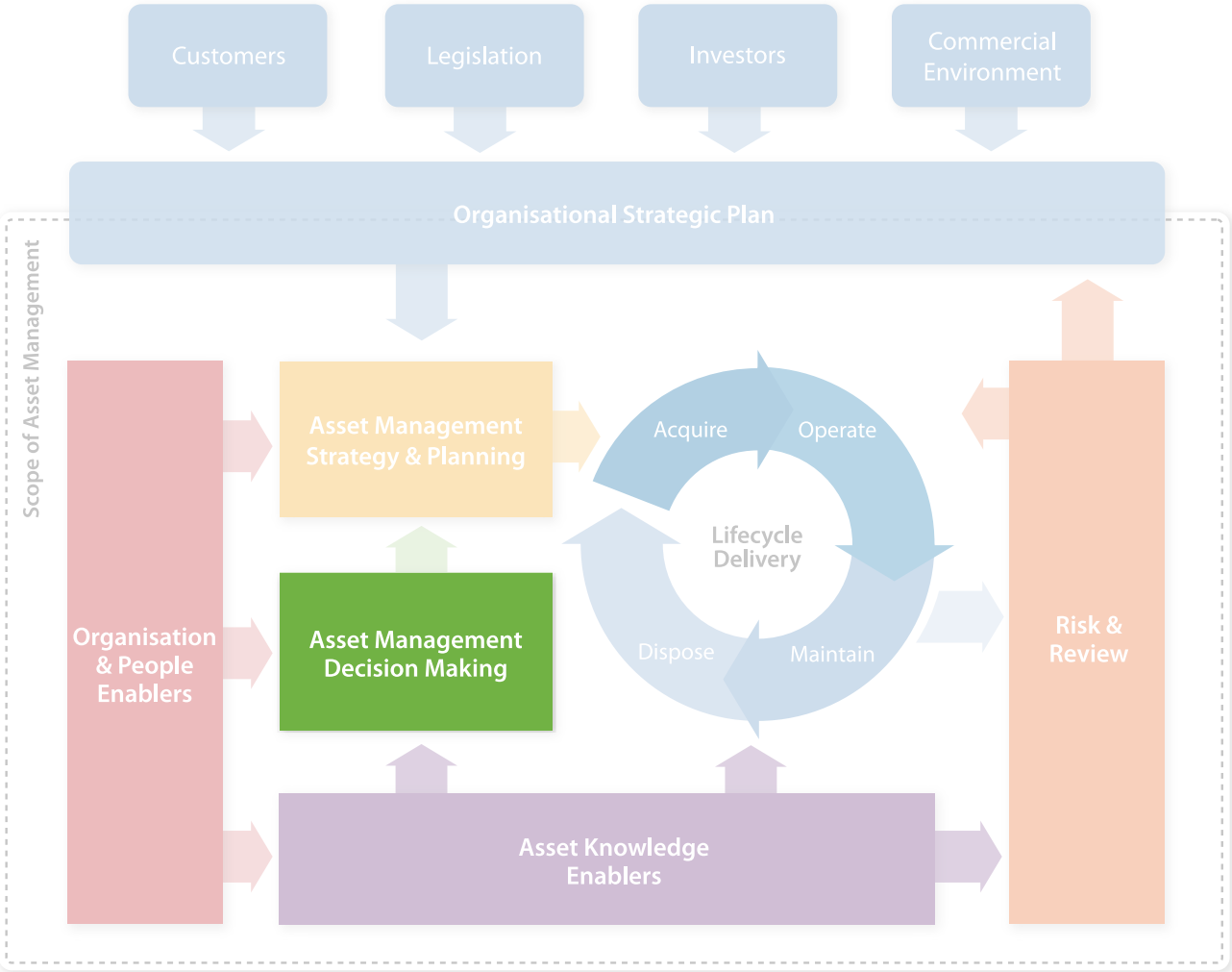
The resources needed to deliver each activity should be identified and this may include human, financial, physical, natural and knowledge resources. The plans may also specify how the plan will be funded, for example from central government, shareholders, borrowing or changes to charges.

Within the Asset Management Plan each activity should have timescales to describe when it will be delivered and when the benefits will be achieved.

The Asset Management Plan may also describe how the plan has been justified and how activities & resources have been optimised to deliver the lowest whole life cost or value. The justification describes the costs and benefits associated with delivering the Asset Management objective.

In addition an Asset Management Plan may also include information on current assets and their performance, on stakeholder engagement and how the plan will be approved, monitored, reviewed and updated.

5.2 Asset Management Decision-Making



The key to making good Asset Management decisions is acquiring appropriate knowledge and applying this within a robust decision-making framework. An **Asset Management Strategy** should be in place which is derived from and consistent with the **Asset Management Policy**.

Having a consistent **Asset Management Policy** and **Asset Management Strategy** provides a stable framework to allow joined up Asset Management Decision-Making. The **Asset Management Policy** provides the overarching principles which are in place to enable the **Asset Management Strategy**, objectives and plans to be produced and implemented. The **Asset Management Strategy** would typically contain the criteria to be used to optimise Asset Management Decision-Making.

Asset Knowledge is also a crucial element in Asset Management Decision-Making. **Asset Knowledge** required about the assets can be grouped into the following areas:

- **Strengths and Weaknesses**: Understanding the

criticality of your assets and the condition of the assets.

- **Opportunities**: the action that can be taken to improve the condition of the assets, new technology or skills that can be brought into the organisation to improve Asset Management capability.
- **Threats**: the risks to performance and to understand the mitigating actions that can be put into place to manage these risks.

Asset Management Decision-Making is crucial at all stages of the asset lifecycle and should be made in a co-ordinated fashion to optimise whole life value given any underlying constraints, statutory legislation or regulatory obligations.

Asset Management Decision-Making is typically undertaken in parallel with **Strategic Planning** and is key to developing an optimised **Asset Management Plan**. Asset Management Decision-Making is sometimes undertaken for specific one-off decisions, for example to optimise a major investment scheme and the output would be included in the **Asset Management Plan**.

However, for more generic decisions, for example the optimum renewal policy for assets in widespread use, Asset Management Decision-Making can be undertaken once and embodied in asset specific policies. These policies would then be combined with **Asset Knowledge** to develop work volumes and costs for the portfolio of assets within the **Asset Management Plan**. The outputs from the application of these policies need to be continually reviewed to ensure they are in line with the assumptions made during the Asset Management Decision-Making processes.

The Asset Management Decision-Making Group is made up of the following Subjects:

- **Capital Investment Decision-Making**
- **Operations and Maintenance Decision-Making**
- **Lifecycle Cost and Value Optimisation**
- **Resourcing Strategy and Optimisation**
- **Shutdowns & Outage Strategy and Optimisation**
- **Ageing Assets Strategy**

Each of these is now described in more detail.

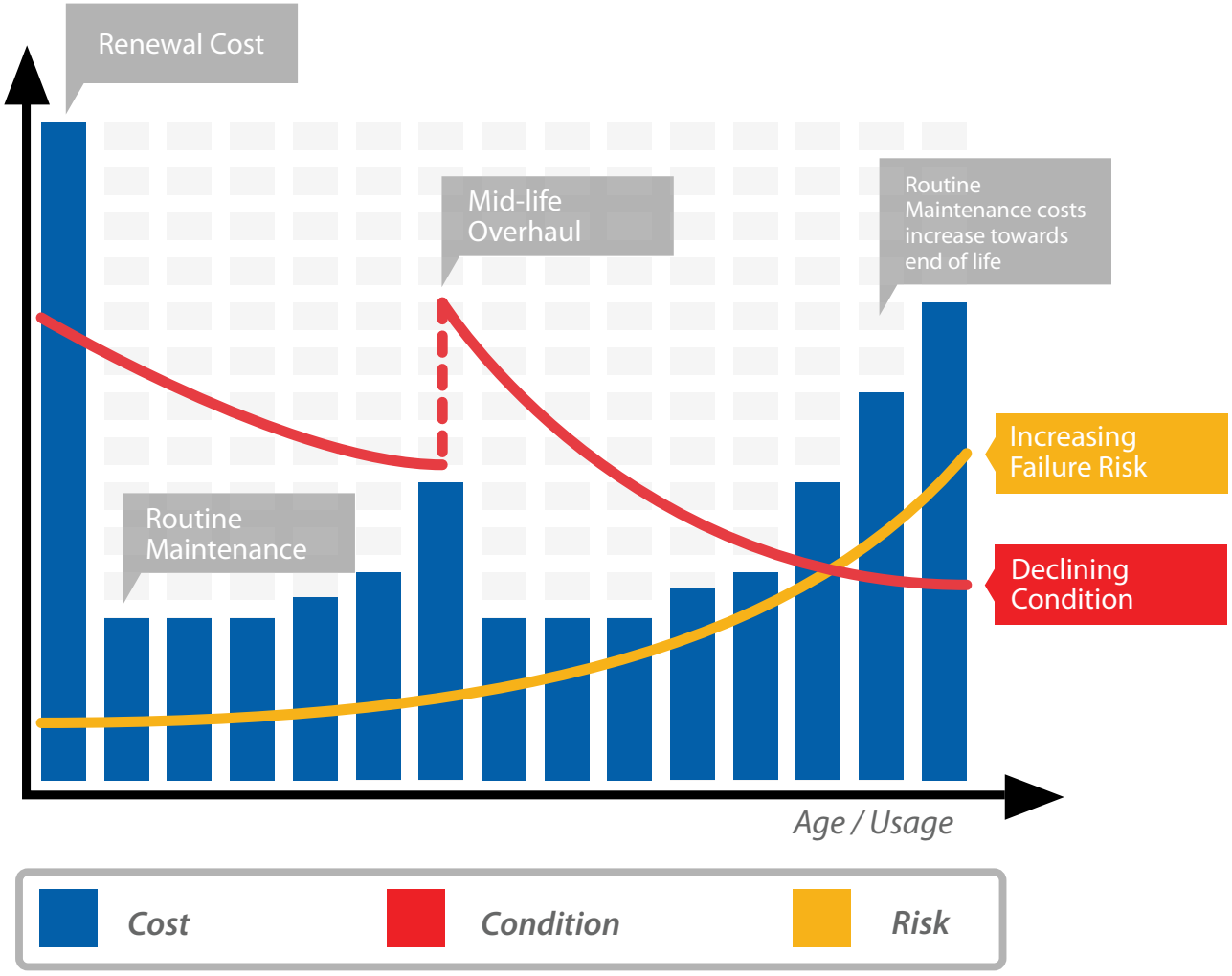
5.2.1 Capital Investment Decision-Making

Historically, the timing and costs for new capital programmes tended to be based on relatively simple assumptions or an analysis of historical expenditure.

Increasingly, stakeholders are demanding greater justification for capital expenditure submissions which traditional approaches are unable to deliver. A lack of asset data and knowledge, uncertainty associated with asset deterioration and uncertainty about future maintenance costs makes this justification difficult.

Capital Investment Decision-Making is concerned with understanding asset degradation and trading-off capital costs, maintenance costs, risks and their probabilities in order to optimise a capital investment decision, both in terms of timing and in terms of the choice of asset. In order to undertake this decision-making effectively, the costs and risks associated with an asset, and how these costs and risks change over time or with usage, need to be understood. The diagram below shows how costs and risks might change with time for any given asset or asset system.

Capital Investment Decision-Making involves both understanding these lifecycle costs and risks and also determining the best point at which to overhaul or renew the asset. Lifecycle cost analysis is typically used to determine the intervention(s) that represent the lowest lifecycle costs.



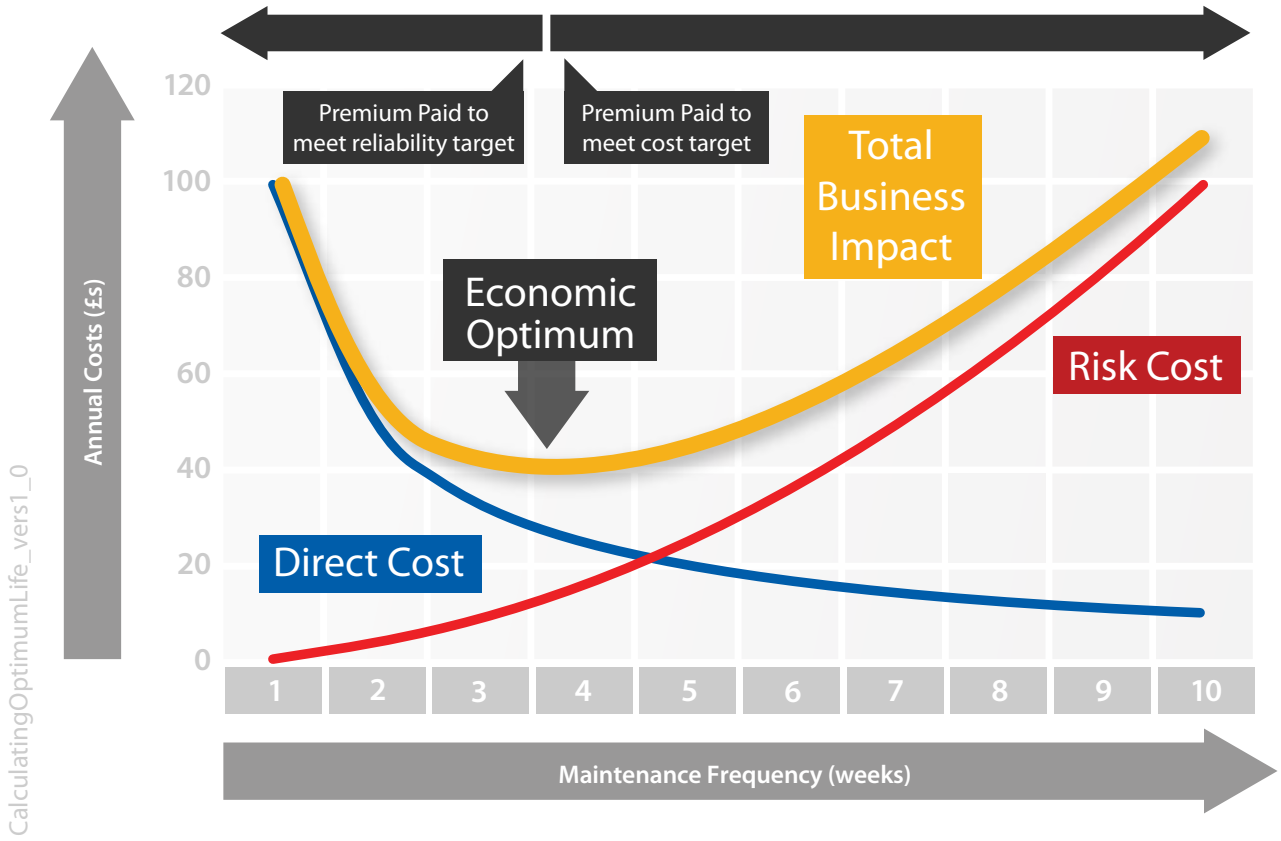
In reality, there may be external constraints that impact on an organisation's ability to intervene at the optimum time (for example **Technical Standards & Legislation** or funding constraints) but lifecycle cost analysis will help an organisation to understand the whole-life implications of any sub-optimal intervention in terms of increased future costs and risks.

It may be necessary to introduce statistical analysis to help with Capital Investment Decision-Making for very long-life assets where degradation information is poor or very complex asset systems where there are interdependencies between different assets or components. Bayesian statistics is often used in these circumstances. This has advantages over a classical statistical approach in that a population view, known as a *Prior Model*, can be updated by samples, meaning a representative sample is not required. Bayesian statistics also makes use of variable quality data, and can learn from actual degradation and costs over time.

5.2.2 Operations & Maintenance Decision-Making

Historically, manufacturers and equipment suppliers have tended to provide a list of maintenance and inspection tasks and associated recommended intervals for an asset, which are then adopted by the user without much consideration of the operating environment in which the asset is being used. There is increasing pressure to try to reduce operational expenditure on assets; and maintenance regimes therefore need to be justified (as with **Capital Investment Decision-Making**) to demonstrate the value of the maintenance to the organisation.

To support better justified Operations & Maintenance Decision-Making, maintenance techniques such as 'Reliability-Centred Maintenance' (RCM) have been adopted, which incorporate Failure Mode and Effects Analysis (FMEA), to ensure that maintenance tasks and intervals are more appropriate for the different



types of failure modes that can occur and the different consequences that result from those failures.

However, some applications of RCM have run into difficulties in justifying that the outputs of the work provide the optimal balance between the cost of undertaking maintenance and the risks (both commercial and safety) of failure. With a standard RCM process, it is difficult to know that the level of reliability being achieved is cost-effective. It may be more appropriate for a business to accept a lower level of reliability where the cost of achieving higher reliability is disproportionate.

Risk-Based Maintenance (RBM) techniques can be used to enhance the RCM process to ensure that maintenance intervals are optimised for a cost-effective level of reliability and risk. The key to a risk-based approach is understanding and quantifying the trade-off between the cost of undertaking maintenance and the increasing risks associated with a deteriorating asset. This trade-off, and the determination of the optimum maintenance interval in terms of the lowest Total Business Impact, is shown in the diagram (left).

These techniques can be used to develop robust maintenance regimes in the form of maintenance standards or specifications that can be fully justified from both a cost and risk perspective to internal and external stakeholders. The execution of these maintenance activities is described in the Subject **Maintenance Delivery**.

5.2.3 Lifecycle Cost & Value Optimisation

For an organisation to develop an optimised **Asset Management Plan**, there are many considerations and drivers that must be taken into account. One area of increasing interest to internal and external stakeholders is the extent to which an organisation can demonstrate that its **Asset Management Plan** is sustainable. As well as the environmental, safety and social aspects of being sustainable, there is always one element that each and every company needs to achieve, the bottom-line profit. If a company is not able to make a profit, it can be argued that the company itself is not economically sustainable.

Lifecycle Cost & Value Optimisation processes will help asset intensive companies to make the right decisions and to maximize the return on asset value by combining the outcomes from the **Capital Investment Decision-Making** and **Operations & Maintenance Decision-Making** processes. Lifecycle Cost & Value Optimisation requires the calculation of costs, risks and revenues over the life of the assets or asset systems and can be split into the four areas of the asset lifecycle itself: plan, acquire, operate & maintain and dispose.

Individual **Capital Investment Decisions** may not sufficiently address the trade-off between maintenance and capital investment and, likewise, individual **Operations & Maintenance Decisions** may not consider the opportunities to reduce maintenance costs through better design. Considering the lifecycle cost ratios over the phases plan, acquire, operate & maintain, and dispose which might typically be 1%-30%-60%-15% then most of the costs are incurred in the operate & maintain phase but many of these operating and maintenance costs are 'locked-in' by the time the design is complete. It is therefore important for organisations to include representatives from all phases of the lifecycle at the design stage of any significant investments. Modelling of lifecycle costs should be undertaken to understand the impact of different designs on the lifecycle costs. It should also be noted that costs of disposal are generally increasing as a percentage of lifecycle costs due to environmental considerations and disposal costs should therefore also be considered in any lifecycle cost modelling.

Asset lifecycle costing and value optimization is an important but often undervalued part of the **Asset Management Strategy** and should be used to optimise the whole-life value of the organisation's **Asset Management Plan**. As well as reducing the lifecycle cost it will also demand asset owners to think

about sustainability issues such as CO_2 emissions, energy consumption, health and safety considerations (see **Sustainable Development**) and in the end being able to remove the asset at lowest environmental impact.

5.2.4 Resourcing Strategy & Optimisation

As described earlier, **Asset Management Plans** are derived from a long-term **Asset Management Strategy** which in turn ensures that the organisational strategic objectives are achieved in a way that reflects priorities, optimizes cost, risk and performance, and is sustainable. **Asset Management Plans** need to include all activities related to managing asset performance and risk, which means both capital and revenue expenditure.

To achieve the delivery of these plans it is necessary for plans to include an appropriate Resourcing Strategy which reflect the changes in requirements for the foreseeable plan horizon. The Resourcing Strategy for delivering the **Asset Management Plan** needs to include consideration of resources, and develop an optimal solution which may include a mix of internal and external (contracted) services. Identifying the appropriate mix can be complex, is influenced by external factors and may be constrained by working practices and political or union considerations. Organisations need to identify whether resource requirements are core capabilities, capabilities that it wishes to develop or retain 'in-house', or if they are capabilities which are more appropriately bought in. The decision will be influenced by market availability of suitable suppliers over a period matching the plan. The level of 'in-source' versus 'outsource' is a strategic decision, and good organizations set out clearly their strategy.

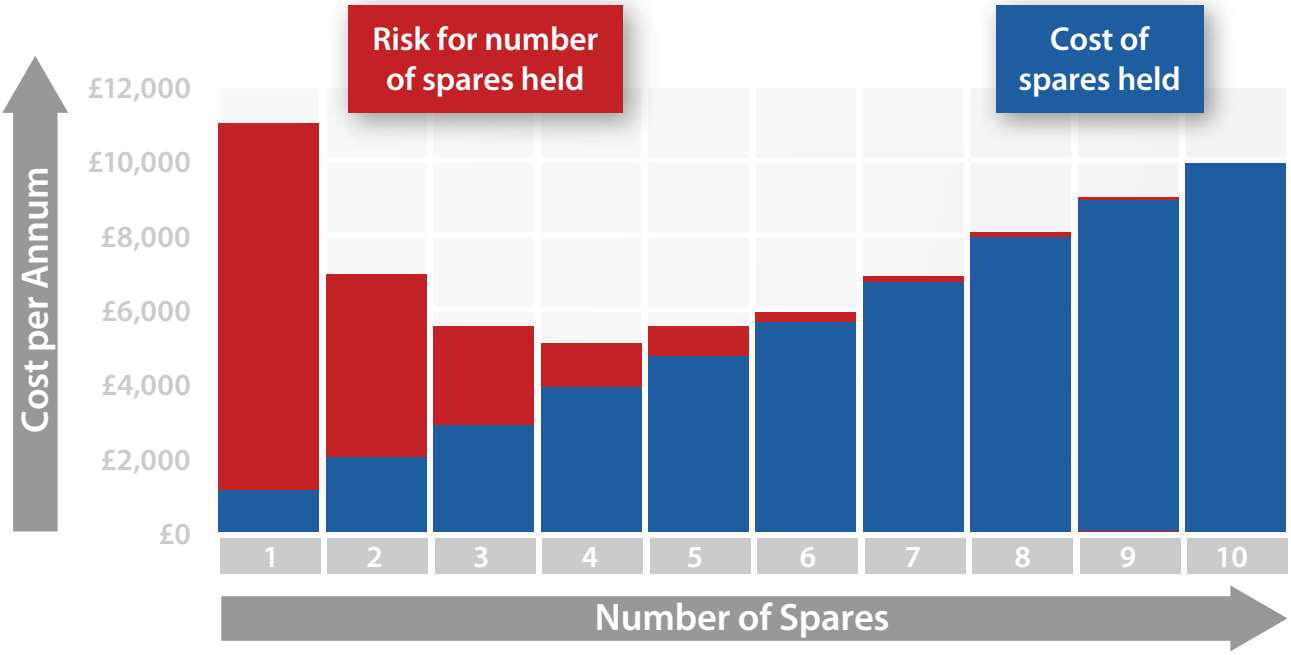
Organisations that mainly outsource can be described as 'thin asset managers' and for these, it is of strategic importance to retain sufficient in-house capability to be able to specify, manage and monitor outsourced services. The Resourcing Strategy and 'in-house' capabilities will also inform the procurement strategy. This enables the procurement of services through turnkey contracts, partnerships, framework agreements and other vehicles which enable long-term commitments compatible with the resource requirements in the **Asset Management Plan**. The Resourcing Strategy requires consideration of the complete supply chain to ensure that capabilities will be available to meet the plan (see **Contractor & Supply Management**).

The Resourcing Strategy needs to ensure that the skill sets are matched to the changing requirements of the business, including technology changes and workforce demographics. This will include developing competences, succession management, recruitment and training. It is important that the planning process informs the HR strategy to ensure that the future workforce is matched to the needs of the plan. Good organisations develop their employees using mechanisms such as performance management and personal development plans.

The Resourcing Strategy should also consider the spares strategy, particularly for spares of critical items, as an important contributor to achieving availability targets. Historically this has not been well managed, with spares often being either not procured or being overstocked. There are tools and techniques for optimising spares that consider the cost of holding spares versus the risk of spare unavailability as shown in the diagram opposite.

It is also important to recognise obsolescence and shelf life. Opportunities often arise for using modular and standardised spares which can be used to replace a variety of assets.

The Resourcing Strategy should define how specialist tools are to be managed, ensuring that they are available and matched to work requirements and where appropriate calibrated, inspected and maintained. It is possible to make economies



and improve performance by rationalising specialist tools and putting them into a managed system with clear accountabilities.

Materials management is normally achieved as an integral part of the production process or project management and the Resourcing Strategy should define how an organisation intends to approach this. Efficient and effective delivery of the **Asset Management Plan** requires that material scheduling is matched to the activities and properly under control, particularly where lead times are long or uncertain. In some cases additional stock may be retained (or delivered early) in order to mitigate risk of the consequences of stock shortages.

Matching and optimising the resources to the **Asset Management Plan** is a part of the wider process of prioritisation and optimisation. The **Asset Management Plan** requires alignment and optimisation based on a number of criteria, including resources, and will often need to consider the opportunities of aligning work and 'bundling' it into packages for execution to maximise availability of asset systems (see **Shutdown & Outage Strategy & Optimisation**).

5.2.5 Shutdowns & Outage Strategy & Optimisation

For many industries, planned plant or system shutdowns and outages are an essential aspect of Asset Management as they are required to facilitate maintenance, inspection and project work which cannot be executed when assets are operating. Whilst such shutdowns are often essential to ensure asset safety and/or regulatory compliance, from an operational perspective they are undesirable. Organisations would prefer to be able to use their assets continuously to maintain production or deliver higher service levels.

Shutdowns and outages have inherent risks associated with interrupting stable processes and systems. In particular, the start-up phase following any major shutdown or outage is a very risky period and 'infant mortality' or re-commissioning problems are a major concern. Shutdowns and outages are expensive to execute and often require large amounts of skilled labour resource, which is often scarce and in great demand. An organisation would typically develop a Shutdowns & Outage Strategy which optimises the trade-off between asset operations and the need to perform work on the assets and would consider these various risks and calls on resource.

Historically, shutdown intervals have been established with no real strategic thought process. Indeed, in many cases, the initial reason for the current shutdown interval is either not known or has become redundant. Furthermore, it is common that, because a shutdown occurs at a specific interval, a cycle of re-enforcement develops whereby maintenance and engineering staff use the assumed opportunity to plan or defer work into the shutdown, thereby establishing a shutdown interval 'self-fulfilling prophecy'.

Shutdown & Outage Optimisation involves the utilisation of robust, auditable processes by a multi-disciplinary team, which first assesses whether a task must be done in the shutdown. Those that are shutdown dependent must then be subjected to cost, risk and benefit analysis to define their individual optimal interval, i.e. where the Total Business Impact is a minimum (see **Operations and Maintenance Decision-Making** for a description of Total Business Impact). These tasks should then be assembled into a work list or schedule so that the optimal schedule of work can be determined. This may involve moving tasks from their individual optimal periodicity as the resultant combined cost, risk and benefit values will represent the lowest Total Business Impact for the work package. Often this work is done using decision support tools and techniques.

Whilst Shutdown & Outage Optimisation is a logical process driven activity supported where appropriate by technology, it must be noted that there is a significant cultural change element to moving from a traditional shutdown interval strategy to one that is optimised. Individuals may be reluctant to change from the current method through concern of altered risk levels as well as more personal motives such as empire protection (see **Organisational Structure & Culture**).

5.2.6 Ageing Assets Strategy

Ageing assets represent a particular challenge for asset managers. While the eventual failure of an asset may be inescapable, the economic end-of-life situation can be overlooked – especially when lifetimes are measured in years or decades.

The end of an asset's economic life is characterised by increasing operating costs and falling reliability, culminating the functional failure of the asset. At the same time, legislative changes or changing requirements may mean the continued operation of an asset is uneconomic, even though it continues to function acceptably. An Ageing Assets Strategy should not only recognise where the economic end-of-life situation has occurred, but also to forecast this eventuality well in advance.

Another important consideration is how the end-of-life situation will be managed. One common approach is simply to react to any unforeseen functional failures, sometime referred to as fix-on-fail. This can be effective where there are low-criticality assets with low consequences of failure. Even for higher-value assets, fix-on-fail can be a valid approach where there is underlying asset redundancy and the failure rate is low. For example, this has historically been the approach taken by many utility companies over a number of decades, even with their relatively costly or critical assets.

An alternative approach is to replace assets prior to functional failure. While such planned replacement can involve considerable capital expenditure, the costs associated with unplanned functional failure may be many times higher. The section on **Capital Investment Decision-Making** earlier explored some of the techniques to determine the optimum time for planned replacement. In the highly regulated environment in which many asset owners operate, these costs are driven higher still by stringent requirements in terms of service performance, safety legislation and environmental concerns. It is therefore important to determine these costs to enable planning of cost-effective asset replacement.

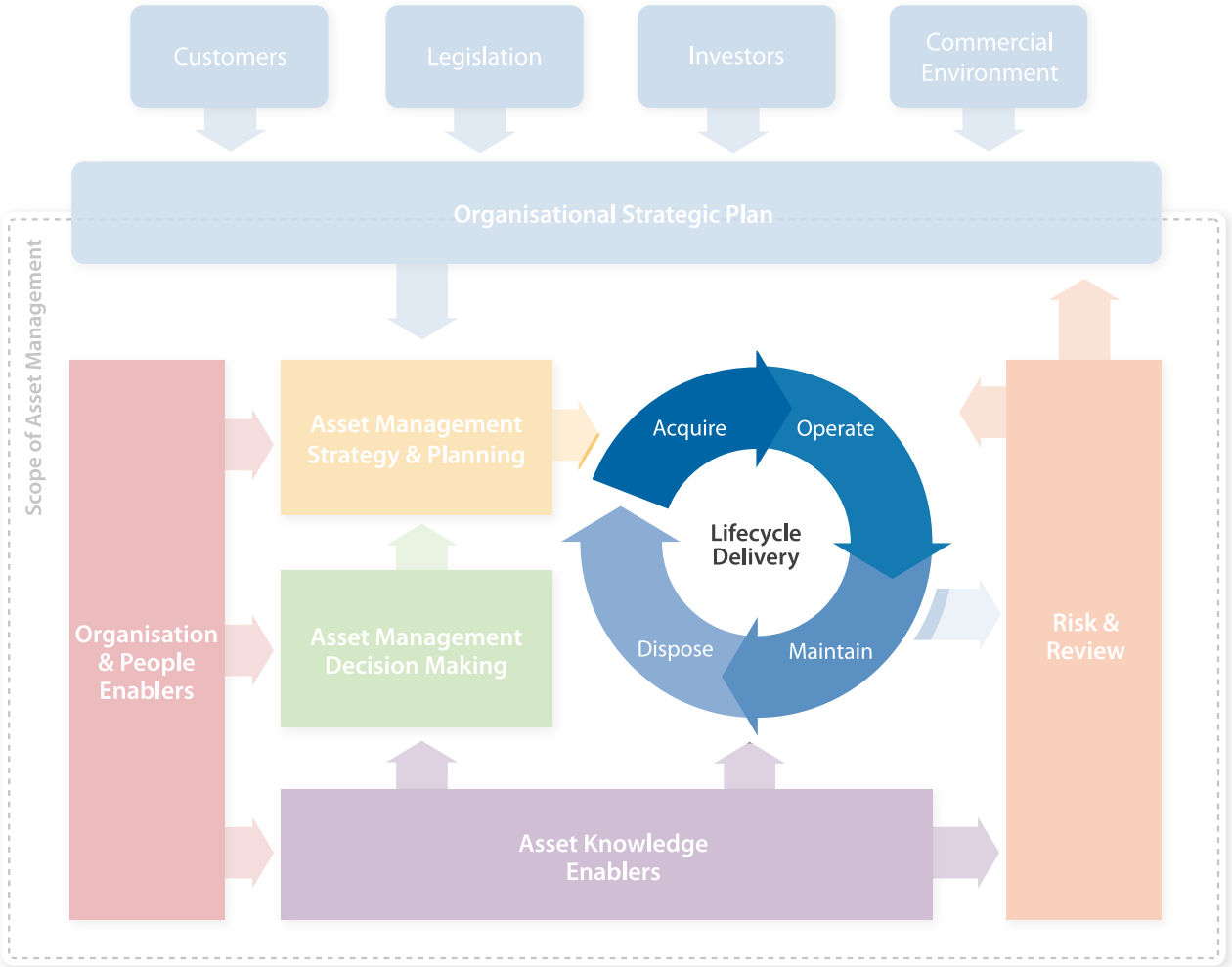
When faced with large numbers of critical assets

moving towards the end of life, the planned approach often becomes more attractive. For example, electricity companies have in recent years moved towards this model by attempting to forecast asset performance and plan renewal. This approach has helped to prevent a large increase in failures and ensured that customer service standards have been maintained. In this environment, the key question changes from '*What is the condition of the asset?*' to '*When will the condition of the asset become unacceptable?*' Such forecasting techniques are a key component in the development of an effective Ageing Assets Strategy.

Sitting between the above approaches, there may be a range of specialised solutions all designed to slow the onset of end-of-life. These solutions will range from simple changes to maintenance regimes to extensive asset refurbishment programmes. The determination of the most efficient strategy requires analysis of the available life extension options, the future needs for the asset, the costs of asset disposal and an assessment of the costs and benefits of alternative interventions.

The aim of an effective Ageing Assets Strategy should be to enable the identification and prediction of the end of economic life and the efficient management of assets as they approach this phase. The implementation of such a strategy should provide asset managers with the tools they need to determine the most cost-effective strategy for the ageing assets under their stewardship.

5.3 Lifecycle Delivery Activities



The Subject Group on **Asset Management Decision-Making** has explored the approaches for undertaking many of the trade-off decisions Asset Managers are typically faced with. However, it is in the Asset Management Lifecycle Delivery Activities where the majority of the expenditure is incurred. There are significant opportunities to identify efficiencies through the adoption of good practice Asset Management in these Lifecycle Delivery Activities, as well as significant risks of increased costs if these activities are not well managed.

The Lifecycle Delivery Activities should not be considered in isolation as individual activities. Even though the decisions about what assets to acquire may have already been taken, a lifecycle approach to Lifecycle Delivery Activities should still be adopted. For example, it is important to ensure the **Maintenance Delivery** phase of the lifecycle is represented at the **Asset Creation & Acquisition** and **Systems Engineering** phases of the asset lifecycle to ensure maintainability issues are considered at the design stage. The **Asset Disposal** phase should also be considered at the **Asset Creation & Acquisition**

and **Systems Engineering** phases of the lifecycle as there may be opportunities to influence the disposal costs through changes in the design or materials used.

It is also important that lessons learned from the **Maintenance Delivery** phase of the lifecycle are fed back to the **Asset Creation & Acquisition** and **Systems Engineering** activities to continuously improve the design of assets and asset systems.

The Lifecycle Delivery Activities Group contains the following Asset Management Subjects:

- **Technical Standards and Legislation**
- **Asset Creation and Acquisition**
- **Systems Engineering**
- **Configuration Management**
- **Maintenance Delivery**
- **Reliability Engineering & Root Cause Analysis**
- **Asset Operations**
- **Resource Management**
- **Shutdown/Outage Management**
- **Incident Response**
- **Asset Rationalisation and Disposal**

Each of these is described in more detail below.

5.3.1 Technical Standards and Legislation

Most organisations have to comply with a range of technical standards and legislation that may be defined externally to the organisation but also may have been developed internally. The **Strategic Planning** processes and **Asset Management Decision-Making** clearly need to take account of these technical standards and legislation in developing an organisation's **Asset Management Plan**. It is a requirement of PAS55 that an organisation establishes and maintains a process for indentifying and assessing relevant standards and legislation.

In many sectors, technical standards and legislation are moving towards a risk-based approach defining required outputs rather than defining inputs. These types of technical standards and legislation facilitate an Asset Management approach to decision-making as they allow organisations to determine an approach that is appropriate for that organisation. However, many technical standards and legislation may have been developed many years ago, before some of the **Asset Management Decision-Making** capabilities were developed and often define specific interventions and periodicities.

It is important to understand that, where technical standards or legislation cause an Asset Management activity to be undertaken that is sub-optimal, the cost of this sub-optimal intervention should be quantified. An example of this might be legislation that requires an inspection to be undertaken every 3 months, but an analysis of costs and risks (see **Operations & Maintenance Decision-Making**), reveals that the optimum time to undertake the inspection is every 12 months.

If this 'cost of compliance' is significant, it may be worth challenging the relevant technical standard or legislation to try to change this. Where these are internal standards, this may be relatively straightforward to do, and may result in significant benefits to the organisation. Where these standards are defined externally to the organisation or where interventions are defined in legislation, it may still be worth trying to challenge these if the potential benefits to the organisation are significant.

5.3.2 Asset Creation and Acquisition

Once an organisation has decided that capital investment is required to achieve the strategic plan (see **Capital Investment Decision-Making**), choices must be made as to how the plan will be delivered. The four most common delivery strategies chosen by organisations, either singly or in any combination are:

- acquisition of existing assets from another organisation
- building new assets either on "green field sites"

or add-ons to existing facilities
- replacement of existing assets at the end of their service or economic life
- refurbishment of existing assets to extend their service life.

In more complex organisations, the choice of delivery strategy may be supported by tools that compare the high level cost and benefit of each option. Once the delivery strategy has been chosen, the expenditure is likely to be managed through one or more projects, each with its own set of deliverables, time, cost and quality project success criteria that align with the strategic plan.

Individual projects are likely to be managed through a lifecycle that is divided into different phases, separated by governance decision gateways where financial sanction for the next phase is approved. Typically, capital governance processes are based on an interpretation of the Association of Project Management (APM) structure:

- Concept phase – the project manager establishes the project team that includes the asset manager in the role of project sponsor. The project deliverables/benefits and success criteria (typically constraints such as funding, health and safety and customer targets) are confirmed by the project team.
- Definition phase – the project team explore one or more options and select the one that will best meet the project deliverables within the constraints of the project success criteria. Investment appraisal models are generally used to support the decision making process where there is more than one option. Typically the Net Present Value whole-life cost and cost/benefit ratio are calculated.
- Implementation phase – the project team procure the solution to deliver the approved project benefits to detailed time, cost and quality targets.
- Handover and closeout phase – the completed project is handed over to the end user, who is likely to be the operator/maintainer. The sponsor determines whether the expected benefits have been realised and the project team reviews how the project was delivered and identifies lessons to be learned.

IT tools are often used to build, and then monitor delivery against, the project schedule and plan,

then capture, costs including manpower, plant and materials. Where multiple projects are managed within a programme, the tool can be used to optimise the delivery plans to maximise the opportunity to deliver as efficiently as possible. For example, creating a flat expenditure profile is preferable to one that has peaks and troughs in demand for resources.

5.3.3 Systems Engineering

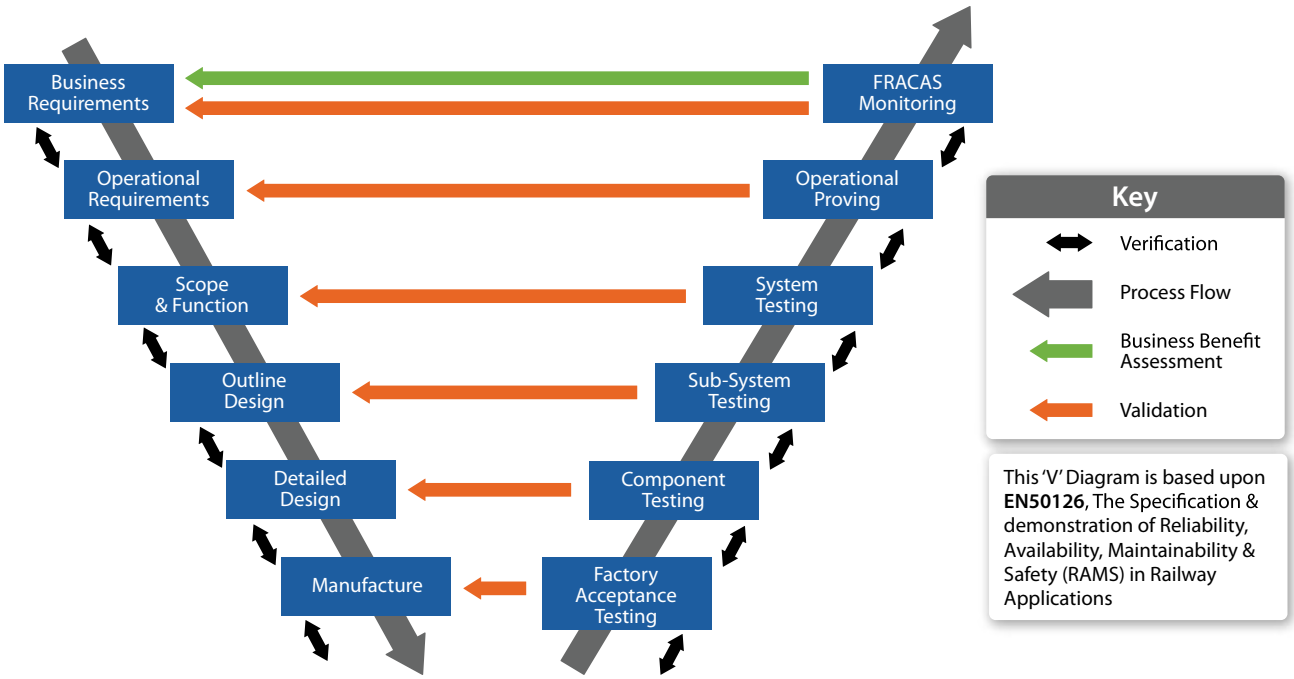
Asset Management cannot be successfully conducted based on individual assets, but must take into consideration the whole asset system that considers the interrelationship and dependencies between the key assets. Systems Engineering in an Asset Management context is the practice of ensuring effective planning, optimal design, performance, performance operation and maintenance at an asset system level.

This tends to be practised in industries with complex and possibly dynamic assets, where relationships between assets can be several times removed from physical or functional points at which they have an influence. Systems Engineering will be applied at the design of the system, or sub-components, for complex asset systems, and this complexity will normally prevail when maintaining the system.

Systems Engineering includes the consideration and apportioning of Reliability, Availability, Maintainability and Safety (RAMS) requirements and the consideration of interfaces with existing assets or systems. Systems Engineering also includes the development of functional and technical specifications, safety approval of equipment, installation processes and acceptance processes including the comparison of the assets that are delivered with original RAMS requirements.

A typical Systems Engineering approach is shown in the V-diagram below. This shows how the requirements are apportioned through the design process on the left-hand part of the V and components are integrated and validated into an overall system on the right-hand part of the V to meet these requirements.

A good practice approach to Systems Engineering can be found in ISO 15288, *Systems and Software Engineering, System Life Cycle Processes*.



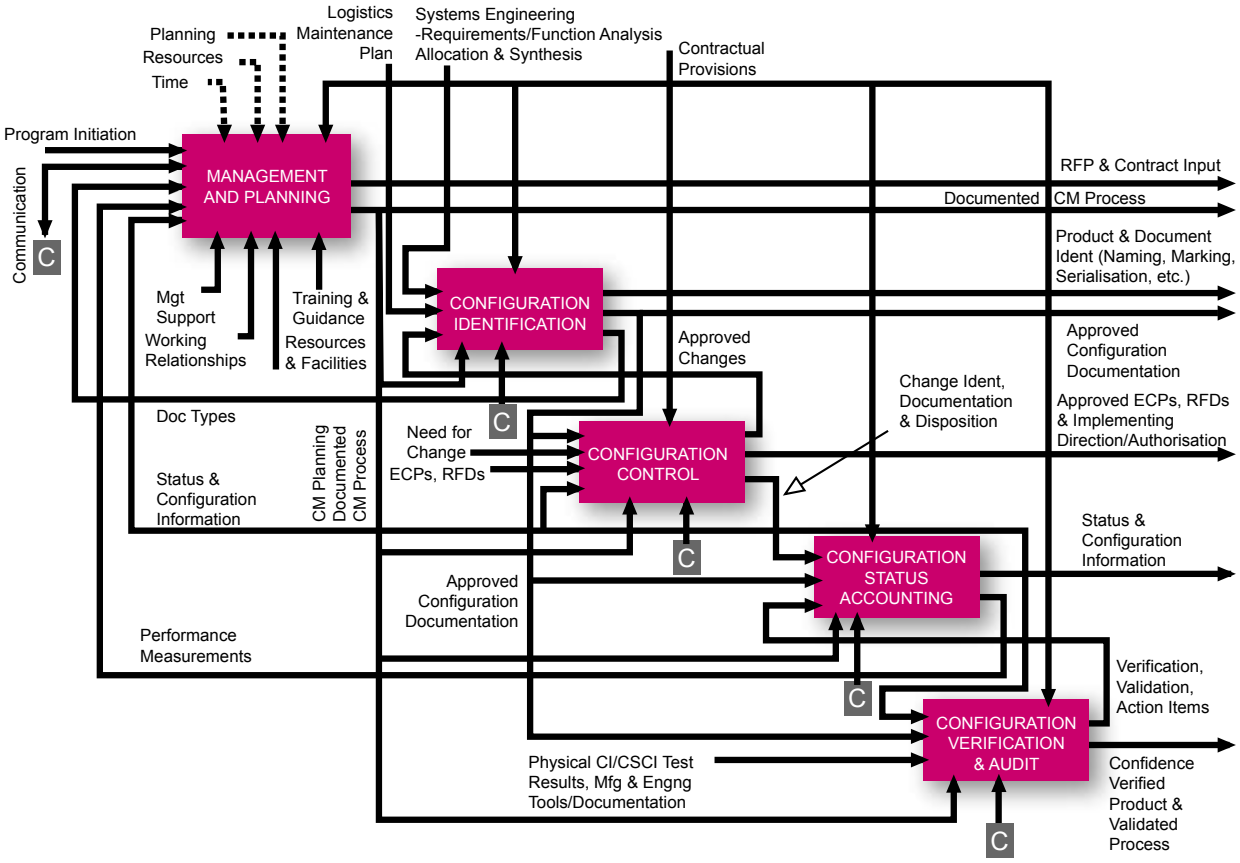
5.3.4 Configuration Management

Configuration Management identifies the functional and physical attributes of components, software and related documentation at various points in time, including identifying links between items within a system. It provides a process for systematic control of changes to the identified attributes of items for the purpose of maintaining integrity and traceability throughout the lifecycle.

A good top-level overview of configuration management is provided in the diagram below, sourced from the military standard MIL-HDBK-61A, *Configuration Management Guidance*.

This diagram provides an overview of the principles of configuration management which can be described as follows:

- Configuration Management and Planning – this element is the overall establishment of the documented controls and mechanisms for undertaking Configuration Management, which includes the elements of 'Configuration Identification', 'Configuration Change Control', 'Configuration Status Accounting' and 'Configuration Verification & Audits', as defined below. Configuration Management Planning includes the requirement to produce appropriate Configuration Management Plans.
- Configuration Identification – configuration identification is the process of identifying a configuration item (a hardware and/or software/data product) and its defining attributes. The attributes of a configuration item are recorded in configuration documentation and baselined, with a formal configuration change control process applied to manage changes to the configuration item's



defining attributes and associated baselines.

- Configuration Control – configuration control is a set of processes and approval stages required to manage any changes to a configuration item's defining attributes and to re-baseline them as necessary.
- Configuration Status Accounting – configuration status accounting is the process of recording and reporting on a configuration item and its defining attributes, as well as any associated configuration baselines, at any given moment in time.
- Configuration Verification & Audits – configuration audits can include functional and physical configuration audits. A functional configuration audit would ensure that any defined functional and performance attributes of a configuration item have been implemented/achieved, while a physical configuration audit ensures that a configuration item is installed in accordance with the requirements of its approved supporting documentation.

5.3.5 Maintenance Delivery

The overall objective of maintenance is to ensure that the assets remain safe and operational to meet their service duty and performance requirements. The process of determining the appropriate maintenance and inspection regimes to achieve this objective is described in **Operations and Maintenance Decision-Making** previously.

Maintenance Delivery is therefore about how the people and processes that need to be coordinated to deliver these regimes do so in the most effective and efficient way.

The operation and maintenance phase of the lifecycle can last a significant time and account for a significant proportion of an organisation's budget. It is therefore important that planning and delivery of maintenance is optimised to ensure that the service and performance requirements are achieved at minimum whole life cost. This should ideally start from the design of the assets, accommodating maintainability and supporting integration of assets into operation. However, the operating context, objectives and constraints generally change over the course of asset life (and of course asset condition may deteriorate) so maintenance management includes the need to keep the arrangements under review.

Maintenance takes many forms and needs to be determined and documented appropriate to the assets in line with the **Asset Management Strategy** and **Asset Management Plans**, for example:

- Inspection, Testing & Monitoring – non-intrusive checks to confirm safety and integrity of assets and to provide information for determining maintenance and renewal needs, perhaps using a work bank to collate and prioritise required activities. This may include the use of remote monitoring systems.
- Preventative Maintenance – planned maintenance undertaken to prevent (reduce the risk of) faults, failures or excessive deterioration from occurring. The criteria for initiating preventative maintenance may be time-based, condition based or usage based but should always take account of risk.
- Corrective Maintenance – planned activities performed to repair defect, damage or condition that is un-intended, is outside specified limits and where work is necessary to bring the asset up to standard and keep it operational.

Maintenance Delivery is informed by **Asset Data and Knowledge** and includes the need to retain records of inspections and measurements in order to understand the way the assets are performing and to plan accordingly. Maintenance interventions need to be scheduled (or perhaps rescheduled if missed) and logistical support arranged, for example access, plant, tools, spares, consumables. The activity is often coordinated using a Maintenance Management System tool.

There are generally legal and commercial responsibilities involved in maintenance management, which might include:

- Meeting legislative, environmental or safety requirements and standards.
- Ensuring asset inventories, configuration and interfaces are maintained.
- Managing the supply chain.
- Ensuring the competence of resources.
- Providing technical and quality assurance.
- Considering manufacturer warranties and provision of specialist support services.

5.3.6 Reliability Engineering & Root Cause Analysis

Reliability is defined as the ability of an item to perform a required function under given conditions for a given time interval in ISO 60050 (191), *Quality Vocabulary, Availability, Reliability and Maintainability Terms*.

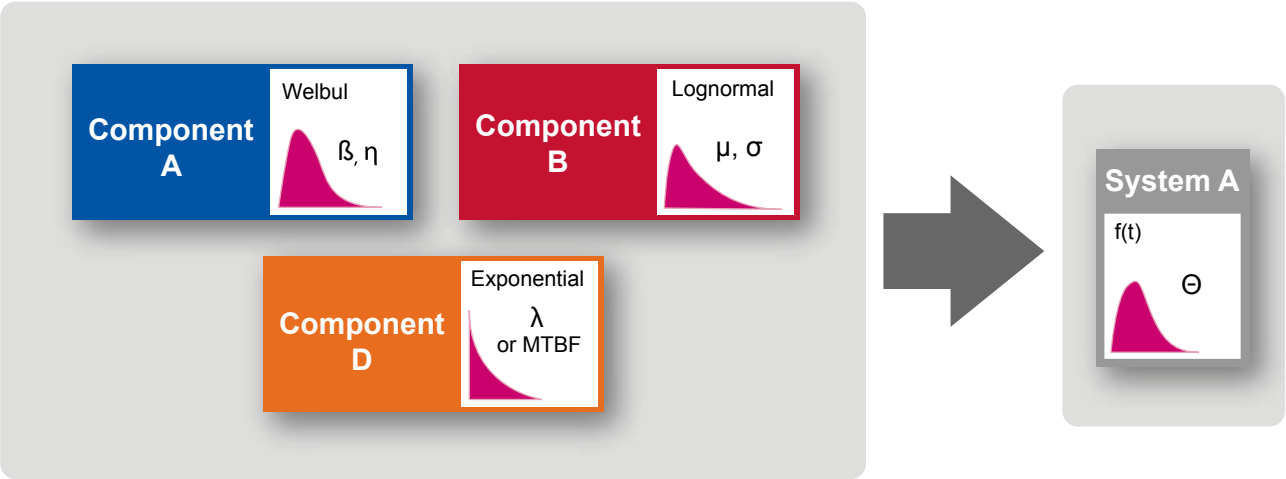
Reliability Engineering consists of the systematic application of engineering principles and techniques throughout a product lifecycle to ensure that a system or device has the ability to perform a required function under given conditions for a given time interval. Reliability Engineering is an ongoing process starting at the conceptual phase of a product design (including defining system requirements) and continuing throughout all phases of a product lifecycle. The goal always needs to be to identify potential reliability problems as early as possible in the product lifecycle and ensure that the reliability requirements will be met. Changes to a design are orders of magnitude less expensive in the early part of a design phase rather than once the product is manufactured and in service.

Reliability Engineering is concerned with four key elements:

- Reliability deals with potential events – this means that failure is regarded as a probabilistic phenomenon: and the likelihood of failure may be random or may vary over time according to a distribution (probability density function). Reliability Engineering is concerned with delivering a specified probability of **not** failing, at a specified statistical confidence level.
- Reliability is predicted on required function – generally, this is taken to mean operation without failure. However, even if no individual part of the system fails, but the system as a whole does not do what was intended, then it is still assigned to the system reliability. The system requirements specification is the criterion against which reliability is measured.
- Reliability applies to a specified period: usually time – Reliability Engineering seeks to ensure that components and materials will meet the requirements during the specified period. Note that units other than time may be used, for example km or number of cycles.
- Reliability Engineering – activities are restricted to operation under stated conditions. This constraint is necessary because it is impossible to design a system for unlimited conditions.

The activities for production of a particular system include the following:

- Participate in the planning stages to ensure that resources for a good Reliability Engineering program are being allocated.
- Prepare a reliability program plan by listing the required reliability tasks, when it should be performed, who will use the results, and the resources (time, people, money) that the task will use.
- Calculate the allowable system failures for each system component.
- Conduct a Failure Modes, Effects and Criticality Analysis (FMECA) – see **Operations & Maintenance Decision-Making**.
- Evaluate the reliability potential of alternative designs.
- Ensure that all components in a design will actually behave as the designer anticipates and that they will have suitably long lives.
- Provide information to designers on how to improve the life of a system and its ease of maintenance.
- Provide information to maintainers by defining the maintenance requirements.
- Formulate and run tests on components, subsystems, and the system itself.



- Investigate user complaints and field failures. Set up processes to ensure that information about field failures is timely, accurate, well organised, and targeted at those who can do something with it.

To assess the reliability of a system, it is necessary to construct a model that represents the times-to-failure of the entire system based on the probability density function of the components, subassemblies and/or assemblies from which it is composed, as illustrated in the diagram above.

Once a system or a group of assets are operational, it will be necessary to record the **Root Causes** of any failures that occur which would typically involve the deployment of a Failure Recording and Corrective Action System (FRACAS). It is important that any such system enables the **Root Causes** of failure to be captured and that this information is captured in a way that is consistent with the FMECA that was undertaken. This enables feedback to the **Operations and Maintenance Decision-Making** on actual failure rates for different failure modes which may influence the choice of maintenance or inspection intervention.

5.3.7 Asset Operations

Asset Operations is an important contributor to achieving an organisation's objectives and service delivery requirements and it is therefore important that Asset Managers provide guidelines to Operators about how to operate the assets within the appropriate design, maintenance and operational parameters. This may include the development of an Asset Operations strategy and plan which would outline the approach, activities and resources involved in managing and implementing operations.

An Asset Operations strategy would define the organisation's approach to ensuring that the assets or assets systems meet their functional requirements, are operated to deliver the required service level, meet all statutory and technical requirements for health, safety, security and reliability and achieve and sustain defined levels of physical, functional and financial performance.

An Asset Operations plan would describe the activities necessary to deliver the Asset Operations strategy and would include consideration of how the operations activities could impact on:

- Effective risk management
- Extended asset life
- Reduced operating and maintenance costs
- Compliance with statutory obligations
- Provision of a healthy and safe work environment
- Improved performance of asset systems
- Investment predictability through a lifecycle approach
- Asset performance aligned with users' expectations of productivity and service delivery

- Improved user satisfaction
- Enhanced community perceptions.

Key risks associated with an inadequate Asset Operations strategy and plan could include:

- Asset loss or systems failure, including consequential financial loss
- Reduced asset life
- Breach of statutory obligations
- An unhealthy or unsafe environment and consequential liabilities
- Inefficient systems performance
- Unpredictability of performance and expenditure demands
- Loss of esteem with stakeholders.

One of the common contributory factors in these risks is operational error and for many years the trend has been to reduce risk through:

- Greater automation of system control
- Better equipment and assets
- In-built protection in equipment
- Inherent fail safe designs
- Better maintenance.

However, operator errors in many organisations have continued to rise. Techniques such as Total Productive Maintenance (TPM) and Ergonomic Studies at the time of design are now being used to try to design out the potential for operational error at the design stage of the Asset Management lifecycle. The appropriate use of these techniques should be defined in the Asset Operations Strategy.

5.3.8 Resource Management

The **Resources Strategy & Optimisation** activities described in Section 5.2.4 cover the approach to optimising the use of resources at the time the **Asset Management Plan** is put together. Resource

Management examines how well an organisation plans and allocates resources to Asset Management activities to enable the work defined in the **Asset Management Plan** to be carried out efficiently and safely. It covers analysis of current resources (people, plant, tools and materials) against future work demands, evaluation of work priorities and risks, use of project management tools and techniques to ensure efficient use of resources and spares and inventory management.

5.3.9 Shutdown & Outage Management

Optimising shutdown intervals is a developing area of interest within the Asset Management community (see **Shutdown & Outage Strategy & Optimisation**) and it is true that this can bring significant benefit in terms of extending intervals between shutdowns. However this does not completely remove the requirement for shutdowns or outages. It is therefore essential that the shutdown or outage is managed in the most efficient and effective way possible to minimise direct costs and lost opportunity by minimising its duration.

Shutdowns & Outage Management is essentially about managing project-type events during which a large number of engineering tasks are executed. These tasks vary in complexity from simple inspections to integrated asset/asset system overhauls. To facilitate this, a large influx of human resource, normally contractors, is required. Shutdowns and outages also have significant logistical issues associated with ensuring that material, parts and specialist tools/equipment are available at the time of the shutdown. In addition each task within the shutdown window needs to be carefully planned to ensure that there are no conflicting requirements for resource, material, tools, equipment or access and we need ensure that the correct sequence of actions is executed. All of this must be done whilst having a minimum impact on health, safety and the environment and within budget and the allotted shutdown duration.

Shutdowns & Outage Management does not begin when the shutdown commences but is a continuous cyclic process with varying levels of activity during the cycle. Key to sustainable Shutdowns & Outage Management is the recognition that dedicated shutdown management structures are required. Shutdown intervals can range in duration, and are typically many years apart, leading to the experience base within the organisation being eroded through organisational change, promotion and retirement.

Shutdowns & Outage Management is a fundamental business activity and the associated management processes need to form part of the organisation's business management processes. These processes and performance management measures must be linked to the organisation's strategic goals in line with the requirements of PAS55. These management processes will identify the key elements of the shutdown management cycle, for example scope exploration, scope freeze, detailed planning, execution, post shutdown, pre preparation, which leads to the next shutdown or outage. The activities within these typical phases and the timeframes at which they are required will be dependent upon the complexity of the shutdown or outage.

Shutdowns and outages are essential cyclic events. The management of them is a continuous fundamental business activity. Their management requires robust processes and tight control to realise the opportunities presented and avoid their huge inherent risks. The processes used by an organisation to manage shutdowns or outages enable work to be carried out efficiently and safely in accordance with the Shutdown & Outage Strategy.

5.3.10 Incident Response

Incident Response covers the ability of an organisation to predict and respond to asset failures and non-asset incidents in a systematic and appropriate manner. This includes incident detection and identification,

identification of appropriate response resources, information management and communications, competence of response teams, use of standard responses, temporary and permanent repair procedures, site access and handback, reporting, updating of asset information systems and response evaluation.

Incident Response should be aligned to maintaining or recovering service outputs following unplanned events, and mitigating the consequential effects. As service output can often be a defining measure for asset performance, the approach to Incident Response should be considered in the **Asset Management Strategy** and the Incident Response activities should be included in the **Asset Management Plan**. The approach to Incident Response should consider the criticality of the different assets and the potential for incidents to impact on service or outputs.

The degree to which asset managers and operational teams can prepare for unplanned incidents varies according to the assets and the corresponding service. For example, no amount of planning can significantly reduce the time taken to shut-off very large diameter water mains, irrespective of the resources on hand. However, in such circumstances the provision of alternative supplies to affected customers and measures to clean up the affected area will be enhanced by effective planning for the incident.

5.3.11 Asset Rationalisation and Disposal

Any rolling programme of asset renewals and refurbishments needs to deliver improvements to the assets, address existing serviceability issues and deliver enhanced serviceability outputs against the targets set by the Business. The investment may well be budget constrained or based on investment that provides best value when measured against the required performance targets.

As part of any **Asset Management Strategy** there should be continuous reviews with regard to the effectiveness or viability of the assets in question.

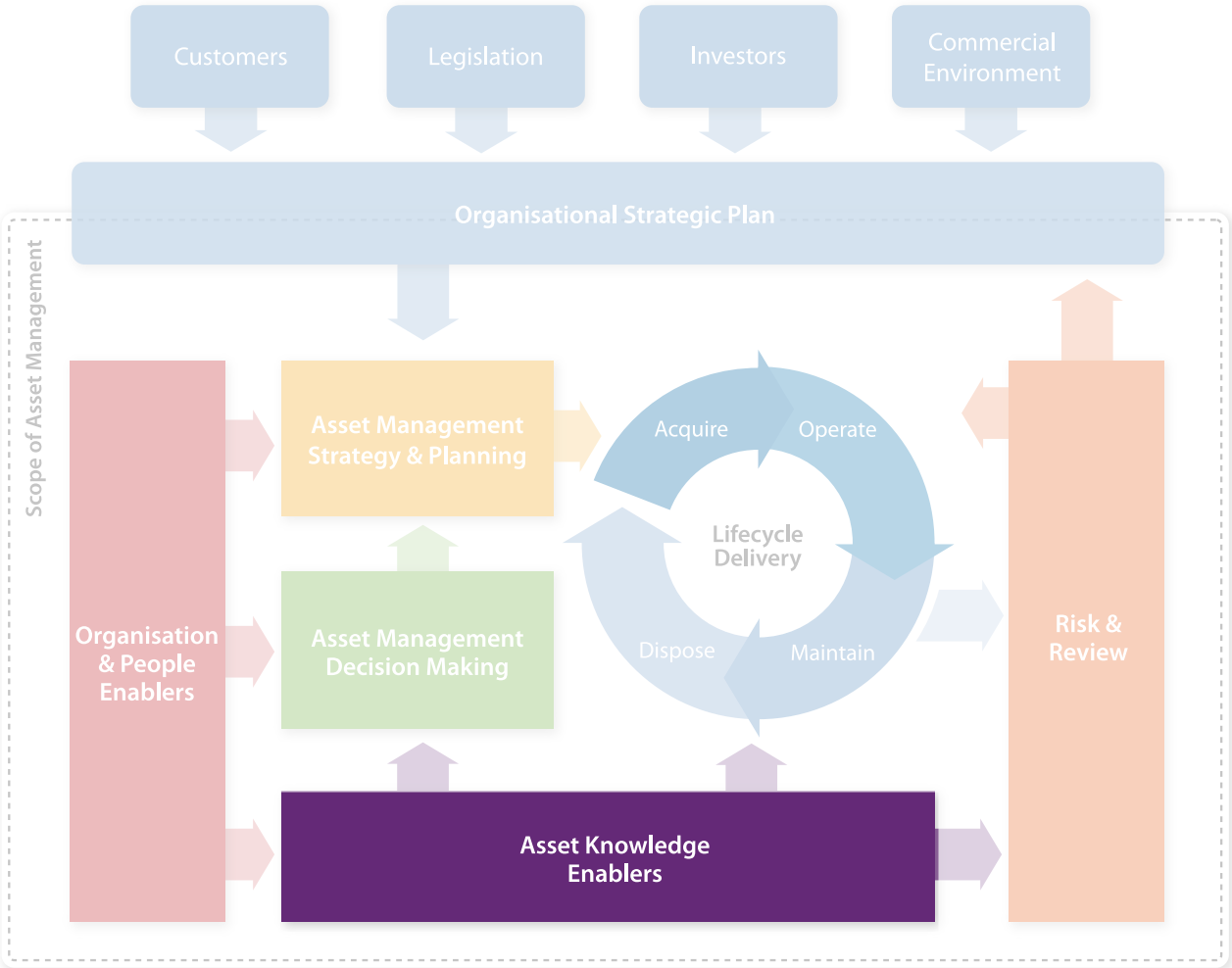
Drivers for asset rationalisation and disposal decisions could include one or more of the following:

- Changes to standards rendering the assets unsuitable for the latest requirements.
- Changes to the required level of service.
- Changes to the required capabilities the asset or asset systems are expected to achieve.
- Changes to Health and Safety legislation rendering the assets unsuitable for operation or viable for decommissioning / disposal.
- Changes to financial constraints e.g. decision made to move production to another site.
- Assets become beyond their useful life, for example uneconomical repair.
- Ageing assets expected to become obsolete or unsupportable.
- Implications based upon the outputs of the Environmental Impact Assessments, risk assessments.

Rationalisation of assets where there is an over capacity, often where required capacity or service levels have changed over the years, is an area of Asset Management that many organisations overlook. There can be significant benefits from reducing the number of assets employed, even where these assets have significant remaining lives. Such decisions should be subject to an evaluation of costs, risks and benefits (as described in **Capital Investment Decision-Making**) against the operational needs of the business.

As previously mentioned, it is often the case that, over the life of an asset, the most significant cost is that of operation and maintenance and not the design and construction. However, asset decommissioning and disposal costs can also be significant and are frequently a differentiator when considering options for capital investment. Understanding these costs and feeding them into the **Capital Investment Decision-Making** processes is therefore extremely important.

5.4 Asset Knowledge Enablers



Asset intensive organisations rely on asset data, information and asset knowledge as key enablers in undertaking both strategic Asset Management activities and operational activities.

- **Data** – Numbers, words, symbols, pictures, etc. without context or meaning, i.e. data in a raw format, e.g. 25 metres.
- **Information** – A collection of data expressed with a supporting context e.g. The span of the bridge is 25 metres.
- **Knowledge** – A combination of experience, values, information in context, and insight that form a basis for decision making.

Asset information is a collective term which can include the following general information types:

- Records of the existence of a physical asset, collectively known as an asset inventory.
- Attributes about these assets e.g. make, model, serial number, age, capacity.
- Location, spatial information and connectivity information – especially in Geographical Information Systems (GIS).
- Subjective information about the asset, such as asset performance, condition and serviceability assessments.
- Planned short, medium and long term asset

intervention activities and the history of past activities.
- Documents, CAD drawings and photographs of the asset.

An overall **Asset Information Strategy** defines the activities an organisation will undertake to ensure that its asset information meets current and future requirements.

Asset Knowledge Standards are utilised to define explicitly the data and information that is required, the format it is required in, who should provide it and when it shall be provided.

Asset Information Systems, or applications, are utilised to automate Asset Management processes and to provide consistent decision support analysis. Asset information is typically an input to such processes, may be modified or created by the process and will be an output of the process.

The quality of **Asset Data & Knowledge** should be assessed, understood and managed in order to ensure that it provides effective support to business decision making and processes. Typically, asset intensive organisations do not have all the asset information they would ideally require, and the information they have may not be to the required quality. Therefore, organisations will need to assess and prioritise data gathering and data cleansing activities to focus on areas that will be beneficial.

The Asset Knowledge Enablers Group contains the following Asset Management Subjects:

- **Asset Information Strategy**
- **Asset Knowledge Standards**
- **Asset Information Systems**
- **Asset Data and Knowledge**

Each of these is described in more detail below.

5.4.1 Asset Information Strategy

Asset information is a combination of data about physical assets used to inform decisions about how they are managed. Good asset information enables better decisions to be made, such as determining the optimal asset maintenance or renewal frequency for an asset. The decision may be based on information regarding the asset's location, condition, probability and consequence of failure, work option specifications and costs, constraints such as resource availability, and other business priorities, such as compliance with regulatory requirements.

An Asset Information Strategy should define how an organisation intends to collate, maintain, utilise and dispose of asset information to support both strategic planning and lifecycle delivery activities. The Asset Information Strategy should take into account the lifecycle costs of the provision of asset information and the value the information adds to the organisation in terms of improved decision-making and support the day-to-day delivery of Asset Management activities. The Asset Information Strategy should be demonstrably aligned with an organisation's **Asset Management Strategy** and objectives.

An Asset Information Strategy should include considerations of:

- Key decisions and the information required to support these.
- Relationship with the end-to-end business process for Asset Management.
- The proposed approach to defining information requirements taking into account the costs providing asset information & the value of the information.
- Information flows, system interfaces & logical data model.
- Data management and governance arrangements;
- The costs, benefits and timescales for delivery of improvements to asset information.
- Main system functionality required from Asset Information Systems.

- Core Asset Information Systems required.
- A description of how different asset information systems (both existing and proposed) will integrate.
- A strategy for migrating from existing systems to new systems.

The Asset Information Strategy should contain objectives relating to the proposed improvements in asset information that are Specific, Measureable, Achievable, Realistic and Time bound (SMART).

Internal and external stakeholder consultation should be undertaken to ensure that the Asset Information Strategy captures their information and access requirements. The **Asset Information Strategy** should be signed-off by the appropriate stakeholders within the business.

5.4.2 Asset Knowledge Standards

Asset intensive organisations rely on asset data, information and asset knowledge as key enablers in undertaking both strategic Asset Management activities and operational activities. Asset Knowledge Standards are required to ensure that asset information is collected, categorised and provided to agreed levels and to agreed timescales. Standards for the measurement process also determine the link between the data and its meaning (for example height is height above ground, condition is tested by standard method).

The Asset Knowledge Standards required will typically include:

- Classification of assets to an agreed hierarchy in order to allow an overall asset inventory to be created and managed.
- Definition of the required attributes that should be gathered and managed for each asset type.
- Common approaches to the assessment and recording of the condition of an asset in order to support strategic Asset Management planning.
- Common methods for categorising asset defects and failures for use in planning remedial actions to improve service and reliability.
- Defined approaches to the assessment and recording of the performance or serviceability of an asset to support long and short term planning activities.
- Agreed methods for assessing and recording the utilisation of an asset to help determine overall asset lives and intervals between intervention activities.

Asset Knowledge Standards should also define the level of quality and accuracy that is appropriate for the different types of information, taking into account the criticality of the different assets and the criticality of the decisions that are made using the Asset Information.

5.4.3 Asset Information Systems

Asset Information Systems are the applications and systems that collect, store, process and analyse the asset information that an organisation requires to manage its assets over their lifecycle. These systems ideally store, or are integrated with, a register of all of the company assets. This allows integrated planning and operational activities to be effectively undertaken.

Asset systems can range from complex integrated Enterprise Asset Management (EAM) suites to mixed environments of "Best of Breed" software, bespoke applications and spreadsheet based analytics. The optimum mix of applications will depend on the size and complexity of the organisation and the nature of the regulatory environment it operates in.

Typical Asset Information Systems include:

- An asset register to detail the assets of interest to an organisation.
- A Geographical Information System (GIS) to record the location and spatial details of assets.
- Work management systems to plan and record work activities related to an asset.
- Logistics systems are required to manage the storage, issuing and use of spares.

- Possession management systems are used to plan access to assets for work activities.
- Demand management systems will forecast how demand on assets will change over time.
- Decision Support Tools such as investment modelling systems are used in strategic planning activities.
- Process, telemetry and SCADA systems provide a record of how well assets have performed and are meeting their service requirements.
- Condition monitoring systems monitor key condition indicators of assets, such as temperature and vibration, to help predict possible future failures.

Across the Asset Management lifecycle, different functions of an organisation will have an interest in the asset and will require asset information presented and manipulated in differing formats, therefore it is just as important to have a robust reporting system as part of the asset information systems.

5.4.4 Asset Data & Knowledge

Asset intensive organisations rely on Asset Data & Knowledge as key enablers in undertaking both strategic Asset Management activities and operational activities.

Asset Data quality is a generic term to cover a number of specific data quality measures, these include:

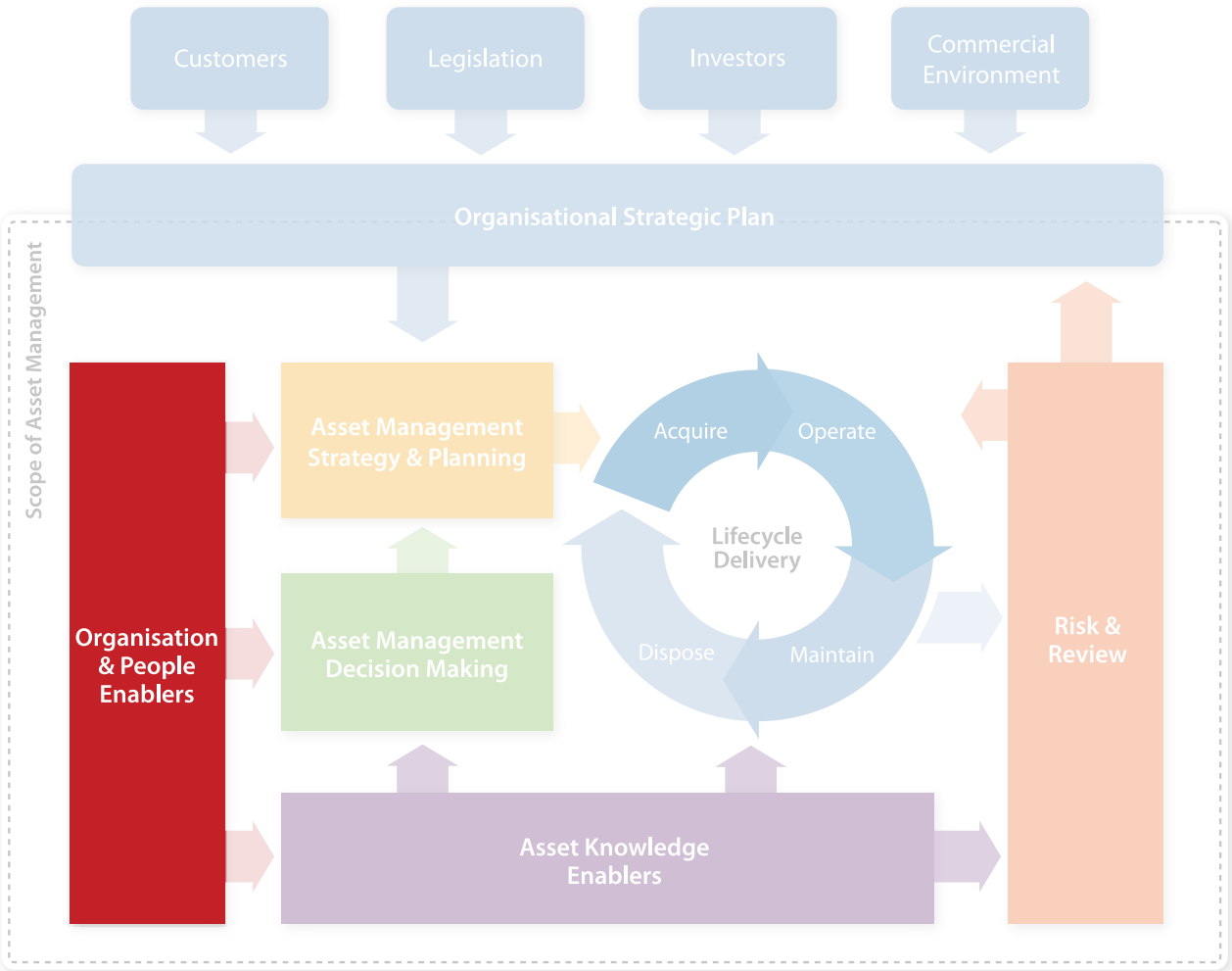
- Accuracy – the data is a true reflection of the physical entity it represents.
- Clarity – data interpretation is unambiguous
- Completeness – a complete set of data is available for each data record.
- Consistency – data is consistent in its definition, rules, format & value.
- Correctness – all data held is verified as valid and up-to-date.
- Integrity – the structure of data and relationships is maintained consistently.
- Uniqueness – all keys should be unique with no duplication of data.

Organisations should assess the quality of their data, and then develop a data population plan to ensure that missing, or sub-standard data can be acquired within acceptable timescales. Processes for the provision of asset information resulting from asset interventions (e.g. asset replacements) should be specified. Business decisions must incorporate suitable controls based upon actual data quality.

Asset Knowledge is a more subjective topic. Knowledge is derived from the combination of experience, values, information in context, and insight. The quality of this understanding will affect the reliability and quality of decision making. For example, forecasts of future behaviour require good knowledge not just good data.

The ISO 8000 series of standards, currently under development, will provide guidance on Data Quality and the importance of linking Asset Data to the organisational goals of the business.

5.5 Organisation and People Enablers



Asset Management is a way of thinking. It is something that needs to be taken into account in everything an organisation does. It is not just whole cost and whole life but whole enterprise too. It often calls into question traditional mindsets, vested interests in the boardroom, existing structures and competences, established decision making processes and supplier relationships. The experiences of early adopters of Asset Management strongly suggest these issues should be tackled sooner rather than later.

There is a two way relationship between **Asset Management Strategy** and organisational culture and capability. Each has implications for the other which need to be defined, sized and actively managed if the strategy is to be successful. This group of activities is concerned with ensuring there is clear line of sight between the **Asset Management Policy** and **Asset Management Strategy** and the activities and processes that support it, between the boardroom and the front line.

Effective Asset Management organisations are clear on what activities can be outsourced and what needs to be kept in house. Their approach to **Contract and Supply Management** reflects strategic objectives for

cost, risk and performance management. They develop and manage supplier and contractor capabilities and relationships with long term Asset Management goals in mind.

Asset Management Leadership is required at all levels to ensure Asset Management strategies and plans are not undone by conflicting perspectives amongst departments, professional functions or work groups on what constitutes best value or by a lack of clarity on organisational objectives and priorities.

Organisational Structure & Culture is important because it has a profound effect on what people perceive as good and believe is possible, how they behave and how committed they feel. A key role for senior management is to proactively shape organisational cultures, structures, roles and responsibilities that are both conducive to Asset Management thinking and tailored to their specific Asset Management goals.

The **Competence and Behaviour** of individual staff need to match the demands of their roles and each should understand the contribution expected of them. A systematic approach to defining competence and behavioural requirements, selecting and developing staff and managing their work is a hallmark of best practice Asset Management organisations.

The Organisation & People Enablers Group contains the following Asset Management Subjects:

- **Contract and Supplier Management**
- **Asset Management Leadership**
- **Organisational Structure & Culture**
- **Competence and Behaviour**

Each of these is described in more detail below.

5.5.1 Contract & Supplier Management

One of the challenges facing organisations that embrace whole life, whole cost Asset Management is how to embed this in the way they manage their suppliers. For many, the shift from short cycle contracts to longer-term relationships involves changing the habits of a lifetime. Collaborating with suppliers is nothing new. Even so, research indicates that organisations which use their supply chains strategically are still in a minority.

In the Asset Management organisation, Contract & Supplier Management is fully aligned with the **Asset Management Strategy**, objectives and cost-risk assumptions.

Effective Asset Management organisations work in partnership with suppliers to develop the capability maturity and efficiencies they need to succeed. The most successful regard their supply chains in the same way as any of their other critical assets. They apply the same principles and are focused on the same issues, such as making the relationship between supplier performance and asset value transparent.

Asset Management organisations are clear on what activities can, and should be, outsourced and what needs to be kept in house. In making these decisions, they:

- Consider the criticality of the work required relative to their Asset Management objectives, their volumes of work, management overheads and staff availability and competences.
- Identify and set objectives for their suppliers, and consider how best to deploy supplied staff and integrate them into their own workforce.
- Specify procurement requirements and service level agreements and assess the criticality of individual supplier relationships to their overall Asset Management strategy and plans.
- Ensure that Asset Management activities achieve organisational objectives.

- Engage in effective supplier recruitment activities, develop clear criteria and processes for choosing suppliers and design effective contracts that fit their Asset Management policy.
- Consider how best to incentivise suppliers and build sustainable relationships with their suppliers that ensure their capabilities meet service level needs.
- Use appropriate performance indicators to monitor and manage supplier contracts that minimise the introduction of risk into the business.
- Keep an eye on their suppliers' commercial circumstances and ownership to ensure that relationships are viable and ongoing.

Designing contracts that deliver these requirements is vital to aligning supplier expectations, obligations and rights with the Asset Management strategy and objectives. For example, in some circumstances it may be counterproductive for asset maintenance contracts to be shorter than the life of assets being maintained while in others the focus might be on aligning the contract term with service level requirements. Forms of contract which suit short term, adversarial relationships are unlikely to generate longer term relationships of the sort needed to underpin successful Asset Management.

5.5.2 Asset Management Leadership

To understand Asset Management Leadership, it is necessary to understand what it means to be an effective leader. There are many different ways to be an effective leader and people with quite different personalities, styles and approaches can be successful. However, all leaders need to be able to do the following things well:

- Give the group (organization, function, team, etc.) direction. In the context of Asset Management this means that leaders must have a clear personal vision of how the organisation can optimise the use of its assets and gain maximum benefit from them, be able to clearly articulate this vision and to communicate it in a persuasive and practical way.
- Make the difficult decisions. Difficult is not the same as complex. Difficult Asset Management decisions are those where the problem is ill defined and non-routine and where the decision requires tough choices to be made which affect both individuals and the organisation as a whole. The key here is that leaders need to be decisive in the face of ambiguity.
- Inspire staff to strive to attain the organisation's goals. This means that they have to be able to motivate staff. There are a number of ways in which leaders can motivate their staff. For example, they can act as a role model, provide the necessary organisational support, treat people as individuals, provide incentives, both psychological and tangible, which will work for each individual, and so on. The best leaders have an armoury of such techniques which they mix and combine as appropriate. However, more than that, they need to be trusted by their staff. To be trusted you need to be consistently fair and just and show that you are prepared to take the heat when problems arise.

Leading is not the same as managing or supervising. Managers and supervisors plan, organise, control and make sure that work gets done. They do this in situations where work and procedures are defined. Leaders are not needed in this situation. They are, however, important in defining, developing and implementing such procedures and systems in the first place.

Asset Management Leadership is therefore crucial in an organisation aspiring to deliver effective Asset Management. This leadership will set the direction and priorities for the development of the organisation's Asset Management capabilities, which are necessary to deliver the organisation's overall objectives.

5.5.3 Organisational Structure & Culture

There is no such thing as one correct Organisational Structure & Culture. Each organisation needs to decide which structure, culture, approach to incentivising and so on will best suit its needs.

The key to making these decisions is for the senior management team to have a very clear idea of what it is they are trying to achieve and why the approach they are adopting is likely to be effective. The structure, culture, approach to incentivising staff should clearly support both the **Asset Management Strategy** and the wider aims of the organisation. They should also take into account the constraints under which the organisation operates.

Some Asset Management organisations are organised around multi-disciplinary, cross-functional teams where all staff are empowered to make their own decisions. For some organisations this will work perfectly. For others it will be a disaster. In some organisations there will be logistical or geographical reasons why teams cannot be fully cross-functional because all functions cannot be co-located. There may also be legal or regulatory reasons why staff cannot be fully empowered. Even the notion of teams can be misunderstood. It is not unusual to find organisations which insist that teamwork is a key aspect of their business yet, when examined more closely, the organisation actually comprises a set of individuals who all, independently, perform the same role.

There are a number of best practice principles that senior managers need to apply when deciding on the appropriate Organisation Structure & Culture for their Asset Management activities which include:

- Be consistent across the whole organisation.
- Ensure everyone understands the boundaries of their responsibilities and accountabilities.
- Ensure everyone is motivated to accept their responsibilities and accountabilities.
- Ensure everyone is completely clear about the chain of command and how, and under what circumstances, issues are escalated.
- Ensure everyone is completely clear about the organisation's channels of communication and how information gets passed from the top to the bottom, sideways and back up again.
- Ensure communications get acted upon.
- Ensure everyone knows where, when and how decisions are made and who makes them.

5.5.4 Competence & Behaviour

One of the most widely used definitions of competence is the ability to perform activities to the expected standard. However, proven competence does not guarantee good performance. There are several reasons for this. Competence is a condition which tends to deteriorate if it is not practised. Competent people will struggle to perform well in a dysfunctional team or organisation. Some activities occur infrequently which makes it hard to maintain the competence of those who perform them. Attitudes, beliefs, lifestyles and work relationships all exert important influences on people's ability to perform.

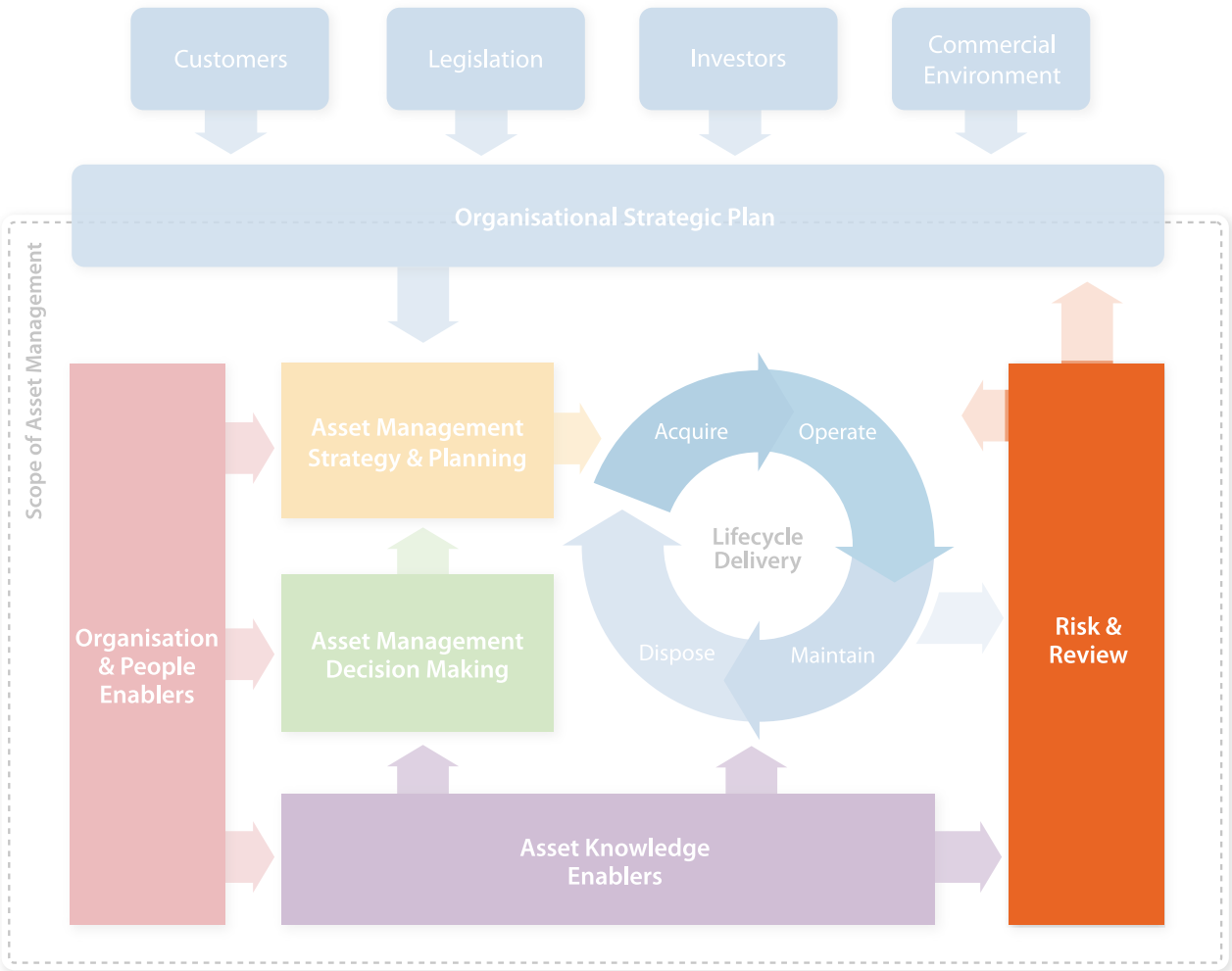
A fundamental task for all organisations is to make sure enough suitably competent people are available to undertake the activities their success depends on. To do this, senior management needs to understand the implications that the **Asset Management Strategy** and objectives have for the competence of their workforce. This means being clear about competence requirements at all levels and ensuring these are used to select, develop and review people and define roles and responsibilities and the relationships between them. At the same time, **Organisational Structure & Culture** needs to be shaped in ways that support effective work performance and behaviours. Incentives, management systems and management styles all play a part in this.

Bringing Competence & Behaviour into a structured approach does not need to be bureaucratic or

expensive. There is still no single formula which all organisations should be striving to adopt. Even where there is general agreement about the benefits of a particular approach, such as being risk based, there is no agreement about the best way to design and implement it. Nowhere can this be seen better than in the variety of guidance and practice promoted by regulatory bodies.

However, it is generally agreed in the research literature that organisations need to adopt a strategic approach to managing competence and behaviour and that this should cover both the development of individual competence and the development of organisational competence. People come to Asset Management from a range of different technical, operational and managerial backgrounds, bringing with them different concepts, perspectives, methodologies and networks. Knitting these together to form coherent and effective Asset Management teams should be a key component of Asset Management strategy and planning.

5.6 Risk & Review



The Risk and Review Group of this Asset Management Landscape is a fundamental building block to sustainable **Asset Management Decision-Making**. It facilitates the constant and evolving trade-off between performance, cost and risk whilst providing the feedback and review mechanisms to facilitate the adaptation of objectives and evolution of understanding of asset criticality to the delivery of the business aims.

This Group requires an understanding of the organisation's tolerance to risk in terms of safety, environmental, financial, reputational and performance risk in order that criticality can be appropriately defined and decision making processes informed. The development and ongoing management of stakeholder relations is key to understanding, describing and communicating these tolerances.

In addition to the key role that risk plays in informing Asset Management decision making, it is also the mechanism by which an organisation can prepare for significant events like accidents, incidents or the impacts of climate change to ensure that it has appropriate contingency planning in place and mechanisms for assuring business continuity.

Having understood tolerance to risk and thus the role the assets play in terms of criticality to business decision making it is important to ensure that feedback and review mechanisms are in place and appropriate. A strong understanding of asset performance and asset health informs the evolution of criticality and risk. The investigation of incidents and failures and associated management review processes provide mechanisms to bring together the understanding of asset performance and health in the context of criticality and business objectives thus ensuring that change is informed and appropriate. Change Management processes provide the necessary control.

Accounting Practices provide assurance that the thermometer of our financial performance is correctly calibrated and audit provides assurance that everything in the organisation is as it should be. Both of these elements provide additional feedback to inform the evolution of the Asset Management processes across the business.

The Risk & Review Group contains the following Asset Management Subjects:

- **Criticality, Risk Assessment and Management**
- **Contingency Planning and Resilience Analysis**
- **Sustainable Development**
- **Weather and Climate Change**
- **Assets & Systems Performance & Health Monitoring**
- **Assets & Systems Change Management**
- **Management Review, Audit & Assurance**
- **Accounting Practices**
- **Stakeholder Relations**

Each of these is described in more detail below.

5.6.1 Criticality, Risk Assessment & Management

Criticality, Risk Assessment and Management is an essential component that enables an organisation to benefit from optimized Asset Management decision making. It is part of the process that enables a disciplined approach for an organisation to maximise value and deliver its Organisational Strategic Plan.

The purpose of having a view of asset criticality is to inform the organisations **Asset Management Strategy** and decision making tools and processes. Assessing asset criticality requires the organisation to anticipate the consequences or impact of the failure of an asset, how the organisation assesses consequence or impact of asset failure depends on the organisations vision, mission, values, business policies, stakeholder requirements, goals and risk management criteria.

Once the consequences or impact of asset failure has been recorded by an organization it has to be put in a useful format that would enable an assessment of the information to take place.
The risk assessment criteria used by an organisation will typically reflect the key issue that the organisation is attempting to manage i.e. it may be cost based or could be another metric important to the organisation. However the purpose of the risk assessment is to enable the organisation to optimise their Asset Management decision making by providing a consistent methodology of assessment and reducing the levels of uncertainty.

Criticality, Risk Assessment and Management has to occur within a disciplined management framework and governance process. Often organisations will develop risk registers or logs and develop processes to support the opening, updating and closure of business risks. The management of risks would include both a system of review and escalation of the risk, with assessment taking place at the appropriate level within an organisation.

ISO 31000, *Risk Management Principles and Guidance*, provides further guidance on good practice approaches to Criticality, Risk Assessment and Management.

5.6.2 Contingency Planning & Resilience Analysis

The resilience of any organisation or its assets is essential to its operation. In the *Pitt Review, 2008*, Resilience was described as "The ability of a system or organisation to withstand and recover from adversity."

In the case of a transportation network, the ability to enable free passage to the ultimate customer, the user, is the resilience requirement. As such, this is not just about clearing up after an incident but providing continuity of business as well. To become resilient to unplanned and unexpected events, it is essential that a full awareness of the critical points of an organisation and its assets is captured. An understanding of the minimum requirements to ensure the organisation or asset can operate is developed and an assessment of all potential threats that could be faced completed, be they natural occurrences (flooding, wind and longer term climate change), accidental or deliberate events.

Once an understanding is attained and a detailed risk assessment process is completed, then Contingency Planning can be introduced to deal with a majority of the threats faced. A consistent methodology needs to be adopted to ensure that all threats and vulnerabilities are effectively captured, effectively risk assessed, responses, other mitigations and Contingency Plans developed, tested and exercised and a review process introduced. A cyclical process that captures this methodology is detailed within British Standard, BS25999; *Business Continuity Management – Code of Practice* as shown in the diagram below.

This process requires the following steps to be undertaken:

- Step 1 is to understand the organisation by completing a threat and vulnerability study (sometimes referred to as a Business Impact Analysis), looking at the entirety of the asset against all potential threats faced. This will need to be linked to the relevant **Risk Assessment & Management** processes to identify the key areas of vulnerability which need to be addressed.
- Step 2 is to determine the strategy to be adopted, looking at the risk assessment process and deciding processes to follow.
- Step 3 is to develop and implement the response, introducing identified mitigations where required and developing and implementing detailed Contingency Plans.
- Step 4 will be to regularly Test / Exercise, Maintain and Review the mitigations and plans and ensure that the responses are still fit for purpose and feed outcomes in the continual review process.

All of these aspects will need to be embedded within the Asset Management **Organisational Structure and Culture** to ensure that resilience is robust and up-to-date.

5.6.3 Sustainable Development

Sustainable Development highlights the need for consideration to be given to apply long-term perspectives to current Asset Management activities and their impacts. Underpinning the requirement for Sustainable Development is recognition of the need to safeguard the interests of future generations over the long-term while promoting short-term economic and environmental stability.

Some of the reasons Asset Management has an important impact on long-term sustainability is its effect in the following areas:

- The effective management of a nation's infrastructure and manufacturing base
- The impact on the environment
- Being a key enabler for many societal structures
- Whole life consideration of risks, costs and performance of assets.

Sustainable Development involves considering the environmental, social and economic aspects of activities (sometimes referred to as the triple bottom line approach). Rather than trading off one factor against another, all three factors should be optimised in the decision making process. Hence a Sustainable Development review within an organisation has to be supported by the broader **Asset Management Strategy** and the **Risk Assessment & Management** framework. However, these Asset Management related elements can only be influenced and managed with clear direction on an approach to Sustainable Development from the top management of the organisation.

Having an holistic **Asset Management Strategy** requires the incorporation of Sustainable Development review and the methodology surrounding the review can be adopted to meet the **Asset Management Policy** and **Asset Management Strategy** of the organisation. Further guidance concerning the implementation of a Sustainable Development approach can be found in BS 8900, *Guidance for Managing Sustainable Development*.

5.6.4 Weather & Climate Change

Weather & Climate Change poses diverse challenges to asset owners and operators in all sectors. Specialist knowledge and robust processes and procedures are required to make sure actual and potential impacts are well understood and can be controlled or mitigated, taking into account the impacts that assets themselves on the environment.

Whereas weather can be defined as the conditions experienced in the short term, climate is the weather averaged over a long period of time. Both have the

potential to seriously affect the availability and/or reliability of assets and the goods and services that depend on them.

In the immediate term, operations can be degraded by a range of common weather events, such as heavy rain leading to the flooding of electricity sub-stations; snow and frost preventing construction works; high winds bringing down overhead power lines and high temperatures causing rails to buckle. Events like these not only impact adversely on service provision but also make planned and reactive maintenance activities difficult to carry out effectively. Asset Management strategies and plans need to factor in these risks to continuity and performance and the costs of adapting procedures, information systems and infrastructures to lessen their effects.

Longer term Climate Change poses challenges of a different order. These range from increased frequency of occurrence of severe weather events to the emergence of new weather events not currently experienced or planned for. Asset Management organisations need to ask themselves whether current assets and those being installed are capable of coping with the predicted future climate and what implications these predictions have for current Asset Management planning assumptions and delivery practices.

Further to considering what the impact of future Climate Change is on the assets, organisations must consider what the impacts of the assets are on the environment. There is a careful balance to be struck between investment in future asset resilience and preventing future Climate Change. Preventing flooding through the construction of physical defences might increase resilience but its high carbon footprint would further add to the problem.

Once actual and potential impacts have been identified and calculated, structured processes can be put in place to manage the associated risk. While it is not possible to create an asset base which is completely resilient to any kind of threat, being able to demonstrate a proportionate response to the kinds of risk posed by Weather & Climate Change is considered good practice. For example, there are many instances where major technical or infrastructural changes have turned out to be less effective and many times more expensive than better organisational use of more carefully specified weather forecast data.

The implications of Weather & Climate Change should be taken into account during the development of **Asset Management Policy** and **Asset Management Strategy**. Organisations which do this are more likely to manage the associated risks and uncertainties and ensure resilience and continuity in the face of long-term climate change as well as helping address the root cause of a changing climate.

5.6.5 Assets & Systems Change Management

There is a wide range of changes that an Asset Manager needs to consider, for example new technology, new approaches, ageing assets, the workforce retiring or becoming more skilled, new legislation, new knowledge and data collection processes. Some of these are obvious, but the Asset Manager must also consider how these impact on changes in organisational objectives or tolerance to risk. Some of these changes are predictable but others are not and an appropriate Assets & Systems Change Management approach needs to reflect this.

The challenge for the Asset Manager is to define what constitutes a change that can impact their particular assets, in their particular industry and subsequently manage all of these changes in such a way as to optimise the risks to the lifecycle operation of the asset. **Criticality, Risk Assessment and Management** are key to narrowing down what is important and what is not, however, the Asset Manager should be wary of changes that can change criticality; potentially downgrading the criticality of an asset or system or making a previously unimportant asset very critical to the operation.

Having identified that change is required, or being implemented, it is important not to over-react. Appropriate management of change activities should not only utilise previous risk assessments to identify critical change, but should also use risk assessment and analysis to appropriately assess the proposed 'new-solution' to provide assurance that the new asset, technology, process or people do not introduce new and previously unconsidered risks that could be worse than the previous situation.

Change Management Planning is a growing subject that often involves the whole organisation. Changes to the operational circumstances or the risks associated with the assets should form a key input to the organisation's change management processes.

5.6.6 Assets & Systems Performance & Health Monitoring

Assets & Systems Performance & Health Monitoring necessary for good Asset Management can include both measures that relate to the performance and health of the physical assets and asset systems, and those that measure the performance of the Asset Management system itself, i.e. the effectiveness and efficiency of the processes and activities that the organisation has in place for Asset Management.

It is fundamental that performance measures and targets correlate to the business, vision, goals and stakeholder requirements as defined in an organisation's strategic plan and **Asset Management Strategy**. Performance measures need to provide feedback and understanding of the physical assets as they form an essential part of risk and business management and in providing feedback into the **Asset Management Decision-Making** processes.

The mechanism for setting required levels of service needs to be defined in the **Asset Management Policy & Asset Management Strategy** and objectives, which should set out desired future functional performance and condition of assets.

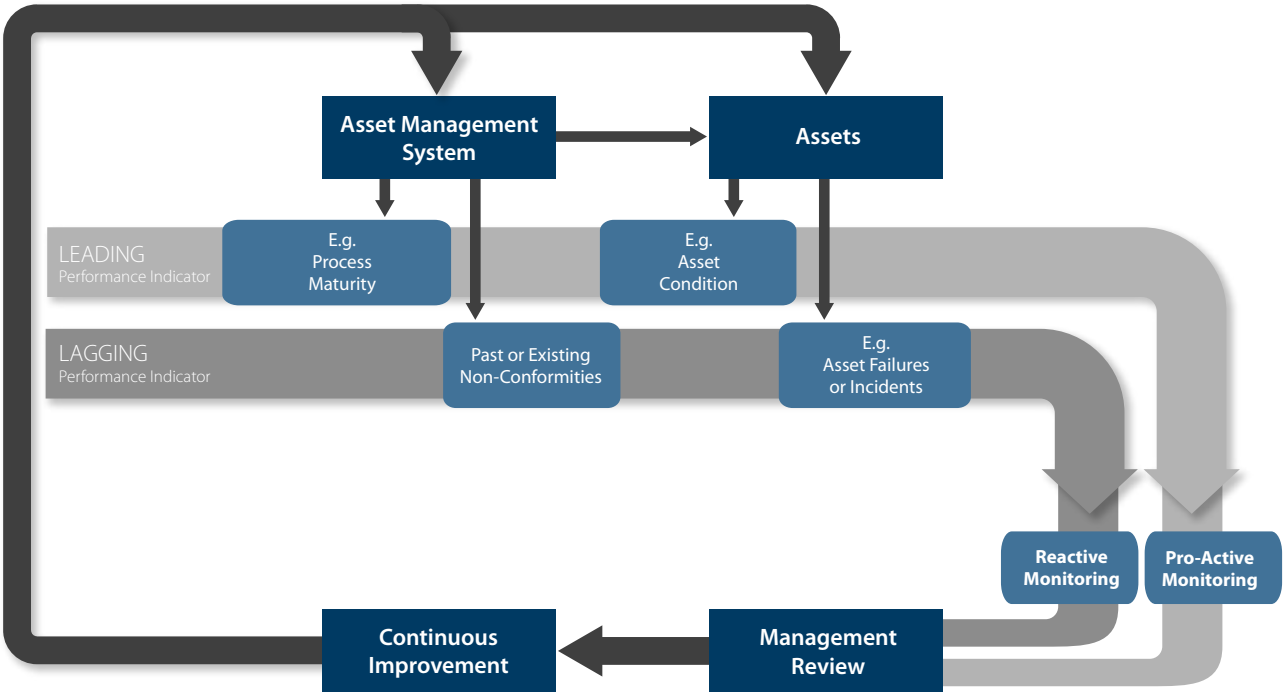
Asset systems are groups of assets that operate together to provide some function, for example an electrical circuit, a rail track, a process plant or a pipeline. In many cases whole plants, assembly lines or networks have required performance criteria. Good Asset Management requires a level of monitoring both at the asset system level and at the asset level in order to understand and manage performance and to be able to support decisions at the strategic and tactical levels.

Performance measures need to exist at various levels of granularity to support the business. At the highest level a management dashboard presents summary information to senior managers, and increasing levels of detail are provided through the organisation appropriate to the needs and decisions that are being managed. Good practice requires clear accountabilities for both the reporting of measures and acting on them, including managing performance. Most Asset Management organisations include performance measures in personal targets.

Performance measures and their management need to be integrated into processes and the documented Asset Management system. It is inevitable that this will include information system requirements, and performance measures are closely linked to the wider issue of data and information management. Good practice requires the ongoing monitoring and trending of performance measures, to enable control and prediction.

Good practice requires both lagging performance measures that monitor the past performance of assets and asset systems, and leading measures that predict the future performance of asset systems (PAS55:2008 requires the consideration of proactive, reactive, leading, lagging, qualitative and quantitative measures and also provides a useful description of them).

Internal efficiency measures monitor the efficiency of processes, and output measures provide a measure



of the actual delivery of the business such as 'system reliability' and 'delivered product'. These principles are shown in the diagram above.

Increasingly the term *asset health* is being used in relation to measures that monitor the current (or predicted) capability or condition of an asset to perform its desired function. This is a complex idea and can involve composite measures which combine various modes of failure. It is most frequently used as a measure for supporting **Capital Investment Decision-Making**.

5.6.7 Management Review, Audit & Assurance

Management Review, Audit and Assurance is part of the collection of processes that help to close the loop in the Plan Do Check Act cycle of management system design.

Audit is one of the processes (along with system performance monitoring, asset health monitoring and incident investigation) that provide an organisation with assurance that everything is occurring as intended. It is the process that an organisation uses to check that processes are being followed and standards or specifications adhered to. It provides comfort that processes (which are designed to manage risk) are both in place, and being effectively used. Audit is part of the 'Check' element of the Plan Do Check Act Cycle.

Management Review is the activity where an organisation takes stock of its Asset Management activity and reviews its:

- performance and whether it can be improved
- processes and whether they are doing what they are supposed to
- risk profile and whether it remains appropriate
- objectives and whether they remain appropriate, relevant and achievable.

Management Review should be far more than a mechanical activity. It should take account of all available feedback mechanisms (performance,

asset health, incident investigations, audit reports) and compare them with expected performance so that changes in the objectives and risk control measures can be made to fine tune the direction of the organisation.

5.6.8 Accounting Practices

The key elements of this Subject are covered by the following:

- Asset Valuations – the method of valuation used by the organisation, its appropriateness and the accuracy with which the valuations have been developed including schedules & rates. It also includes the methods used to update this information and the alignment of Asset Valuations with the financial balance sheet of the organisation.
- Depreciation – the method used to establish the residual or effective lives of the individual assets and if necessary their components and the accuracy of the depreciation calculations.
- Operational Costs – the method used by the organisation to assess the cost of operations of individual facilities and assets and the break-down of these operational costs in terms of labour, energy, chemicals and plant & equipment.
- Maintenance Costs – the method used by the organisation to assess maintenance costs (planned, predictive and unplanned) including the break-down of these costs into labour, materials, plant and equipment.
- Renewal Costs – the method used by the organisation to assess renewal costs in terms of the unit costs of individual renewal activities including the break-down of these costs into labour, materials, plant and equipment.
- Renewal Liabilities – the processes used to identify future capital expenditure renewal liabilities, including any backlog in maintenance.
- Social, Environmental, Safety and Reputational Costs – the method used by the organisation to quantify social, environmental, safety and reputational costs in monitory terms.

Organisations that are demonstrating good practice in this area would typically be able to demonstrate the following:

- The ability to recognise and adopt appropriate valuation practices that may be driven by local regulatory or legislative regimes.
- The ability to value assets at all levels of the hierarchical asset register structure & update this valuation cost effectively in both value, unit rates and effective residual lives.
- The ability to understand the operational costs of individual assets and/facilities in terms of the above break up, together with special costings for smaller plant or equipment that may consume high power costs, etc.
- The ability to identify the maintenance and renewal costs from the Asset Management information system or elsewhere for all levels of the hierarchy down to the chosen item.
- The ability of the organisation to identify its future renewal program, and the associated residual business risk exposure/s.
- The ability to include social, environmental, safety and reputational costs and risks in **Asset Management Decision-Making**.

5.6.9 Stakeholder Relations

This element of the Asset Management landscape relates to the methods an organization uses to engage with stakeholders to articulate different scenarios within its **Asset Management Plans**. The management of Stakeholder Relations needs to consider the costs and outputs associated with each scenario in order to understand their priorities and to select scenarios that most closely meet their aspirations.

It is critical to identify the stakeholders that have an interest in an organisation's physical assets which may include:

- Vendors / Suppliers of equipment and of spare parts
- Regulators

- Governments
- Board of Directors
- Owners
- Unions
- Influencers
- The Community and neighbours
- Customers, both strategic and non-strategic.

Each stakeholder type has an impact on how an organisation's assets perform. Introducing defective spare parts, withholding a license to operate, shutting down an operation due to a strike notice, imposing penalties for non-conformance to regulations, and reducing the operating budget resulting in deferred maintenance are but a few of the negative consequences external stakeholders can impose on an asset-centric organization.

External Stakeholder Relations reflect their interactions with your company. These interactions are measurable and can be used to monitor performance. The health of these Stakeholder Relations determines how well these stakeholders interact with an organisation and how well they support the **Asset Management Strategy** and objectives. External Stakeholder Relations support an organisation's ability to manage assets effectively, efficiently, and reliably. Although these stakeholders are outside the direct control of an organisation, Stakeholder Relations can be influenced by changing what an organisation does internally to align the outcomes of these interactions with the organisation's strategic objectives. An organisation can change business processes, introduce and enforce policies and procedures, develop incentives to drive employee behaviour to align with an organisation's vision of how that organisation wants external stakeholders to perceive it.

Taking the time to determine how an organisation wants external stakeholders to relate to the organisation requires a vision of how to position the organisation from the stakeholder's perspective. This vision will drive the necessary changes within the organisation to manifest the vision. Measuring the success of this vision will provide the visibility required to do business differently and redefine how the organisation relates to its external stakeholders.

We would appreciate your feedback, including any suggestions on how to improve the usefulness or readability of this document. Please complete the Feedback Form at www.theIAM.org/AMA

This document has been approved for publication by Richard Edwards, Chair, Faculty.

The IAM's Faculty is a Standing Committee of the IAM, which directs and prioritises the technical work of the Institute.

It is responsible for ensuring that the IAM's view of the discipline of Asset Management and all the standards, guidance, knowledge and other outputs produced by the Institute are developed within a common and evolving framework and are aligned with the aims of the Institute.

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