A Holistic Approach to the Management
of
Electrical Assets
within an
Australian Supply Utility.

Submitted for fulfilment of degree of Doctor of Business Administration to the
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DECLARATION OF ORIGINALITY

This is to certify that the research work reported in this portfolio is original and has not been submitted to any other university or institution for award of a higher degree. The originality of this portfolio is based on compiled literature reviews and interpretations made by the author to develop his understanding of a holistic view of asset management processes and models for utilities. The formation of the building blocks, processes, models, critical analysis, published papers, case studies and conclusions are all the work of the author.

Colin Brown MBA.
# A Holistic Approach to the Management of Electrical Assets within an Australian Supply Utility

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(Revised version of Paper 3 to suit editorial publication)
Abstract

Asset-rich organisations (utilities) within Australia have entered into an era of environmental change, imposed largely by successive Federal and State Governments wanting to exact financial returns from these State Owned Corporations (SOCs). These changes have created a shift in the paradigms within which these organisations currently operate. Long established principles are being revisited, and processes re-engineered, to allow them to implement the changes needed to obtain improved efficiencies and achieve overall business success.

It is this drive to break down the barriers and practices of the past that has led to the need to develop a fundamental understanding of what it means to take a holistic approach to the management of the physical assets owned by utilities.

This drive towards a holistic asset management approach will require utilities to integrate their organisation’s corporate objectives and business strategies into an asset-driven business culture that nurtures the assets through the distinct phases of their respective asset lifecycle. This fundamental approach will require the organisations to incorporate the distinct phases of an asset’s lifecycle to obtain full utilisation of the asset to achieve sustained business success.

The portfolio has been prepared in five distinct chapters that combine to provide a comprehensive document. These chapters provide the overall framework for the research undertaken incorporating background, research significance, adopted methodology, research objective and investigative issues, summary of published articles, an industry based project, conclusions and supporting publications, posters presented at conferences and associated references.

The overall intent of this portfolio is to provide an understanding of the benefits of implementing the fundamental principles of asset management for utilities by providing the principles, processes and framework to allow the asset management journey to commence following a holistic approach.
Executive Summary

This portfolio has been developed to provide a fundamental understanding of what it is to take a holistic approach to the management of physical assets owned and operated by utilities. This portfolio has a strong focus on Australian literature and assets owned and operated by an Australian utility.

The need for deregulation of the Australian domestic market place has been recognised for some time by both Government and business alike, due to the pressures of international trade. This recognition has led to fundamental changes in the Australian economy with a need to allow the gradual deregulation of previously closed monopoly markets. Requiring the opening up of competition across national boundaries by removing restrictive legislation and trade practices available to government utilities in such areas as gas, electricity, rail, water and waste industry.

An emerging theme that is being recognised in today’s ever-changing business environment is the driving need for these government utilities to increase their efficiency and effectiveness in order to improve the delivery of services to their customers. This recognition is driving these organisations to adopt an integrated, or holistic, asset management approach to achieve their overall corporate objectives, by optimising all available resources at levels of higher but manageable risk to improve shareholder value.

This growing recognition by Australia’s utilities of the need to improve efficiencies and overall operating performance requires a clear understanding of how to manage ageing assets in a way that allows their current performance to improve and be competitive, while ensuring that they are planning and re-investing for the future. This management portfolio has been developed to provide a clear understanding of what it is to take a holistic approach to asset management by using the assets of a publicly owned supply authority. It was this recognition of the gap that exists within Australian utilities that led to the development of the research objective:

Research Objective: To clarify the principles of Asset Management for utilities, enhance the existing knowledge and provide its applications.

The Research Objective established the specific parameters for the portfolio and provided direction for the research study. This objective was broken down into two definitive research issues that allowed the portfolio to progress and develop specific achievable goals.

Investigative Issue No.1

To review the available literature on Holistic Asset Management Processes & Models that is applicable to utilities; to understand the benefits of implementing the fundamental principles of asset management into these types of organisations.
The literature review identified a number of international and national asset management definitions, concepts and models that have been developed and published. This information provides either prescriptive processes or the building blocks/framework for the principles of asset management for any type of utility. The literature review provided the framework for the principles of asset management and how these principles are seen as an integrated business process. The literature review also recognises that Asset Management is a complex subject that has the possibility of impacting upon the structure, business processes and day to day working of a utility business.

This complex issue is further complicated by the recognition that Asset Management itself is still in the evolutionary phase internationally and that this will continue as utility businesses struggle to manage constant change in the areas of technology, market forces, political pressures and an ever changing customer expectation. Clearly a great number of utility businesses are struggling to come to terms with this question as the implications can be enormous and impact across the entire organisation. The implications of asset management as a core utility business process would potentially change every aspect of how that business operated in a changing and demanding business environment.

What can be seen from the literature review and the available International models and processes on Asset management is the need to break down this complex subject into distinct stages through a series of manageable building blocks. This approach allows all parties involved to obtain a clearer understanding of the key issues and be able to properly consider and manage the impact across the utility business, taking into account the organisation’s existing practices, processes and work culture. The literature review also examines the Australian philosophy of asset management principles and processes, published by both Federal and State Bodies, and review whether it was sufficient in content, design and detail for adoption by utilities within Australia.

Investigative Issue No.2
To apply the Holistic Asset Management Processes & Models to the assets owned by Integral Energy to improve its overall performance.

Three case studies were developed to provide better understanding of how to integrate the physical assets managed by Integral Energy into the framework developed for a holistic asset management process. This framework provides the flexibility and freedom to apply the broad principles of asset management that best suit an organisation’s existing business practices, processes and work culture.

The application of the model, using the assets owned by Integral Energy, shows how asset management as a process brings together all aspects of asset ownership. These can then be aligned to deliver the corporate objectives for the business and improve its overall performance. These corporate objectives are focused on the financial viability of the business as a whole and at times will conflict with the principles of managing long-term assets. Managing this perceived conflict in principle, however, is in fact the role of an asset manager, who aligns strategies for the assets, with the required corporate objectives for the business, at a defined level of risk.
The level of risk is essentially the variable, as changing strategies for short-term financial gains at a corporate level would raise the risk profile for the organisation, which would then be reflected in the increased risk rating in the corporate risk management plan compiled in accordance with AS4360. The issue for the asset manager is to ensure that the asset strategies are aligned with the corporate objectives at an appropriate level of manageable risk that is acceptable at a corporate level.

The benefit of a holistic asset management approach for a utility business is that transparency is apparent and accountability is clear at each stage of the asset’s life cycle. The case studies demonstrate these benefits through clear understanding and alignment of the corporate objectives, which are reflected in the strategies within the asset management model, through the asset’s distinct stages within the delivery phase of the asset management process. A holistic approach to asset management provides an organisation with the framework to manage a large number of complex assets through process controls that can be adjusted to align with the changing corporate objectives for the organisation. The case studies also demonstrate that the model is transportable to other utilities as it has been developed on a national basis with a strong focus on physical infrastructure such as roads, buildings, sewer systems, bridges, etc.

The type of physical asset is not an issue in the asset management process and models as they are generic in nature and applicable to any type of physical asset irrespective of size, location or complexity. The issue that the process does not specifically address is the type of assessment tools and techniques to be used which are very much asset-dependant. The need to perform conditional assessments is identified within the various stages of the process to determine the current condition and appropriate actions needed to rectify deterioration and under-performing assets. The type of diagnostic tools and techniques is a key variable as it is dependent on the type of asset being considered and available technology. The type of tools and techniques available to asset managers was demonstrated in the five papers. These include the life–cycle assessment to extend the utilisation of assets beyond their theoretical age and economic limits. The adoption of new technology to improve operating performance, to obtain design and construction flexibility while reducing overall operating costs for the business. The utilisation of condition based assessment of the assets as part of a maintenance management strategy to enhance effective use of assets by adopting appropriate refurbishment and/or replacement strategies and programs. The development of a holistic approach to the management of electrical assets and its integration into the core business processes of utilities.

A key issue that is paramount from the case studies and papers is the way the holistic asset management processes and models would be implemented into the business. The existing systems, structure and culture of the business will play a major role in how these systems are integrated into the everyday operational life of the business. A change management program directed at all levels of the business would be required to bring together the core competencies of the business while communicating the benefits of adopting a holistic asset management approach.
The case study identified the pitfalls of not having considered an appropriate change program for the introduction of the asset management model within *Integral Energy. The need to introduce an appropriate strategy to best suit the alignment of an organisation’s strategic competencies within a dynamic environment has been identified.

The implementation of this asset management model will raise issues associated with the in sourcing and outsourcing of various core activities within the organisation. The asset management model does provide an avenue to management at any time to implement this strategy for activities such as maintenance or capital works. This issue however will need to be carefully negotiated with the work force and unions to enable the strategy to be fully understood and justified for the long term benefits of the business. The business drivers to outsource internal activities are strongly influenced by the background and political climate that the organisation finds itself operating within. The ongoing international drive to corporatise and deregulate utilities has seen traditional government owned monopolies experience increased cost pressures to gain operational efficiencies. This pressure has also increased the move towards privatisation that places even greater pressure to deliver operational efficiencies to increase profits for the shareholders.

The decision to privatise or remain in government ownership is clearly outside the control of a utility business as this decision is determined by Federal and/or State government policies. The issue that is in the control of corporate management for utilities is to have in place the most efficient and effective utility structure, supported by asset management processes that will deliver the corporate strategies and objectives for the organisation. This would be best achieved by the implementation of the asset management processes and models that have been discussed within this portfolio.

* Integral Energy is one of NSW's largest State Owned Corporations, incorporated under the Energy Services Act, 1995.  Integral Energy’s network services more than two million people across 24,500 square kilometres in Greater Western Sydney, the Illawarra, and then Southern Highlands. In terms of customer connections, this involves the provision of electricity to 745,000 residential customers and 74,000 commercial and industrial customers. Integral's network is estimated to be worth in excess of $2b and is made up of 27,000 transmission zone and distribution substations, over 300,000 power poles and 175,000 streetlights bound together by 38,800 kilometres of overhead and underground lines.
A Holistic Approach to the Management of Electrical Assets within an Australian Supply Utility

Chapter 1: Overview of the Portfolio

1.1 Introduction

The historical evolution of global competition, as described by Porter (1986, p.29), gives an insight into how international competition has grown into the enormous global network known and operating today, that is demanding reform and change in every domestic market in the western world.

The need for deregulation of the Australian domestic market place has been recognised for some time by both Government and business alike, due to the pressures of international trade. This recognition has been conveyed in such literature as, Improving Australia’s International Competitiveness, by the Economic Planning and Advisory Council (1991), which has focused on the need to maintain Australia’s standard of living by improving its innovation and productivity.

The fundamental changes that have occurred in the Australian economy, with an international focus, have necessitated the gradual deregulation of previously closed monopoly markets. The introduction of the National Competition Policy (1993), known as the Hilmer Report, advocated the opening up of competition across national boundaries by removing restrictive legislation and trade practices currently available to government monopolies in such areas as gas, electricity, rail and water.

An emerging theme that is being recognised in today’s ever-changing business environment is the driving need for utilities to increase their efficiency and effectiveness in order to improve the delivery of services to their customers. These utilities are being forced to maximise the investments they have made in their existing assets in order to reduce their capital and operating expenditures and improve the organisation’s overall performance. This recognition is driving these organisations to adopt an integrated, or holistic, asset management approach to achieve their overall corporate objectives, by optimising all available resources at levels of higher but manageable risk to improve shareholder value.

1.2 Significance of the Portfolio

Utilities within Australia have historically been owned by Federal and State Government authorities. In the Australian National Audit Office Report No.27 (1995, p.27), the estimated total depreciated value of the physical assets controlled by the Commonwealth, as at 30 June 1995, was estimated to be $66 billion, which does not recognise the true replacement cost of these assets.

The fundamentals of asset management have not been fully appreciated or realised by a great number of Australian utilities in the past. This has been documented in two studies undertaken by the
Australian National Audit Office Report No.27 (1995) and Audit Report No. 41 (1997) of a study of over 56 government enterprises that identified a complete lack of implementation of the fundamentals of asset management by over 60% of these organisations reviewed. This lack of implementation of the basic fundamentals of asset management would imply that there is a tremendous opportunity to improve the efficiency and effectiveness of these asset rich organisations.

A great number of the utilities within Australia have been established through government funding, as these organisations have been developed as natural monopolies through government policy. There has, however, been a fundamental shift in the economic realities of what it means to be part of a global economy. The realisation that a government enterprise needs to be managed along the same fundamental lines as a private organisation capable of delivering returns to its shareholders is a reality that has only in recent times been recognised.

This shift in thinking has placed pressure on these utilities within Australia to better manage the economic reality that now exists, by improving methods of delivering services to the customer through any number of ways that have not been traditionally considered, or used, by these types of organisations. This environmental shift is placing pressure on these organisations to implement the fundamentals of asset management as a way of optimising the utilisation of the physical assets under their charter. This fundamental shift in thinking will require these organisations to align their corporate objectives with all available resources to optimise the organisation’s business success at manageable levels of risk.

This growing recognition by Australia’s utilities of the need to improve efficiencies and overall operating performance requires a clear understanding of how to manage ageing assets in a way that allows their current performance to improve and be competitive, while ensuring they are planning and re-investing for the future. This management portfolio has been developed to provide a clear understanding of what it is to take a holistic approach to asset management by using the assets of a publicly-owned supply authority.

1.3 Research Objective and Issues

It is this recognition of the gap that exists within Australian utilities that has led to the development of the following research objective that set the direction for this portfolio:

Research Objective: To clarify the principles of Asset Management for utilities, enhance the existing knowledge and provide its applications.

The Research Objective established the specific parameters for the overall objective and provided the direction for the research study. The issue was to break this objective down into definitive research issues that allow the portfolio to develop and demonstrate specific achievable goals. The research explores the concept of what it means for utilities to implement the principles of asset management in
order to optimise expenditure on their assets. The focus is on the development of a holistic approach to the management of large physical assets; to be able to fully optimise all available resources and deliver services to the customer, while still providing a commercial rate of return to shareholders at manageable levels of risk that are acceptable to the organisation.

The need to understand the benefits of implementing the principles of asset management requires a review of available literature on the subject, to allow the benefits of implementation to be fully recognised. This understanding has led to the development of the first investigative issue:

Investigative Issue No.1

To review the available literature on Holistic Asset Management Processes & Models that is applicable to utilities; to understand the benefits of implementing the fundamental principles of asset management into these types of organisations.

The literature review of available asset management processes & models was then applied to assets owned and operated by a State Owned Corporation, Integral Energy. The focus for this aspect of the portfolio was to demonstrate how the application of available holistic asset management processes and models would improve the efficiency and effectiveness of this organisation. This understanding and the desire to obtain best-practice asset management led to the development of the second investigative issue:

Investigative Issue No.2

To apply the Holistic Asset Management Processes & Models to the assets owned by Integral Energy, to improve its overall performance.

The portfolio also considers the transportability of holistic asset management processes & models to similar utilities. The level of integration required for the implementation of the model is a major factor in the impact on the organisation; how to integrate the processes and models throughout the organisation, to obtain the right mix, and still achieve the desired outcomes for the organisation. It is with this focus that the transportability of the model has been considered by taking a Holistic Asset Management Approach to other industries and enterprises such as telecommunications and manufacturing.

1.4 Research Limitations

UWS - DBA Portfolio extract:

In accordance with the UWS DBA requirements, the DBA portfolio asks the student to provide a collection of evidence based on their sustained research and publication within a defined focus area. The student is also to provide, within the portfolio, an overarching statement to show how the work included fits together in the candidate’s personal and professional development. The overarching statement will also indicate, in summary form, the content of
the various contributions and their inter-relationships. The guideline for candidates indicates that the portfolio is expected to contain at least four publishable research and scholarly papers. The definition of publishable includes refereed conferences.

It is also expected that the student’s portfolio will include papers, which demonstrate scholarship, as well as ones that report their own research. Hence it is feasible that the portfolio would contain a mix of articles, critical commentary on the research of others and research reports based on the candidate’s own research endeavours. Again, the overarching statement should explain how these various contributions fit together both in terms of their temporal sequence as well as in terms of their interdependence.

The case studies presented and conclusions derived are focused on the assets owned and operated by Integral Energy. No other organisations have been used within the research framework. The level and detail of information used within the case studies has been restricted to a level of commercial confidence that is acceptable by senior management within Integral Energy. The case studies chosen were specifically targeted to align with published papers written as part of this portfolio. The conclusions are those derived by the author based on interpretation and analysis of the data provided.

1.5 Outline and Contents of the Portfolio

The underlying theme of this research study is to demonstrate the benefits available to progressive organisations that wish to achieve and be recognised as having best practice in the field in which they do business. It is this recognition of the need to understand the benefits for utilities that has been the driving force behind the development of a Holistic Approach to the management of Electrical Assets within an Australian Supply Utility.

This portfolio has been developed in five (5) main chapters with each chapter forming an overall comprehensive document. Chapter 1 provides the overall framework of the research incorporating background, research significance, adopted methodology, summary of published articles and the industry-based project, conclusions and supporting references. Chapter 2 provides a literature review to support the research objective and investigative issues. Chapter 3 provides details on a Holistic Asset Management Process and Models developed by the author. Chapter 4 is the Industry-based project that applies the model of the portfolio to a variety of assets owned by Integral Energy. Chapter 5 provides the Research Outcomes of the portfolio as well as an explorative view of the linkage of the model to the published papers and detailed within the appendices that contribute to the overall portfolio.

1.6 Overview of the Articles and Publications

The papers were published in support of the overall objectives of this portfolio. The intent of each article was to provide an increased understanding and insight into the development of a holistic
approach to Asset Management for a supply utility. The papers are a mixture of both practical applications through case studies and ongoing refinement of the main theme of this management research work.

Each paper is designed to support the management objectives of this research by specifically identifying distinct phases of asset lifecycles and management processes that demonstrate the benefits of implementing the principles of asset management into supply utilities. The papers were developed to specifically target issues associated with an asset’s lifecycle. These include life extension practices, emerging new technologies, remaining life analysis and strategic and operational functions targeting the need for an integrated maintenance process, considered to be the largest single recurring cost for any utility.

The papers focus on the overall management issues associated with the objectives of this portfolio and do not attempt to delve too deeply into the fundamental engineering and scientific principles of the specific assets and technologies chosen within each paper.

**Paper No.1:**
**Realising Financial Investments In Existing Timber Pole Assets For Supply Utilities.**
Published Distribution 2000 Conference Brisbane 1999.

**Abstract:**
This paper is a case study of a supply utility on how to extract maximum returns from existing timber pole assets through a life extension practice utilising new technology that is economically justified in the short term, while taking into account the impact on reliability, work safety and public liability for the organisation. This case study demonstrates a potential opportunity to optimise existing investments in large number of timber pole assets that have reached the end of their useful life, by embracing technology that delivers economic returns while maintaining a very low level of risk to the public and increased returns to the shareholder. To provide better understanding of what it is to take a holistic approach to the asset management of a relatively simple asset. This paper examines the lifecycle cost of these assets and provides management with information that allows strategies to be implemented on ways to extend the life of these assets beyond their theoretical age and economic limits.

**Paper No.2:**
**Investments in Non-Ceramic Insulators: To Optimise the overall Performance of an Electrical Network**

**Abstract:**
This paper shows how new technology can provide supply utilities’ management with the opportunity to improve their overall operating performance, obtain design and construction flexibility while
reducing overall operating costs to the business. The key issue demonstrated by this paper is the importance of recognising one of the major variables in asset management today, new technology. This variable is cutting across many of the traditional boundaries and should be embraced by both manager and engineer to obtain the optimised performance improvements desired by any progressive organisation. Asset Management, as a process today, requires large investments in information technology (IT) in order to manage and maintain more detailed understanding of an asset. Advancements in new technology is a major variable that can provide an avenue to improve the overall operating performance and business risks for any organisation today and will continue to do so in the future. This view is a contributing factor to developing better understanding and harnessing the application of new technologies of what it is to take a holistic approach to asset management.

**Paper No.3:**  
**Condition Based Assessment of Existing Lattice Steel Towers “Field Pull Over Tests”**  
Published Distribution 2000 Conference Brisbane 1999.  

**Abstract:**
This paper established the remaining life of a long-term asset to obtain an appropriate level of confidence in the existing maintenance strategies employed for an expensive and complex engineered-type asset (steel towers). This paper focused on existing steel towers within Integral Energy’s electrical network recognising that a great number of these assets have been in service for more than 40 years and have a replacement value of over $400M. A steel tower is essentially maintained through a visual-routine inspection regime that identifies any deterioration of the galvanised steel structure.

The ageing populations of Integral Energy’s steel towers are the main support for the delivery of bulk power to the many transmission and zone substations within the franchise area of Integral Energy. The lattice steel tower’s strength capacity is assumed by engineering principles to not be significantly affected by age, providing the steel members are maintained in a rust free condition. An opportunity was identified by Integral Energy to challenge this industry wide assumption, through the upgrading of an existing 132kV steel tower transmission line between Regentville and Penrith. A number of the redundant lattice steel towers were set aside for field Pull Over Tests to determine the remaining strength of these redundant lattice steel structures.

This approach to lattice steel towers recognises the need for organisations to obtain data whenever possible, in order to develop and support progressive asset management practices and policies. This data will allow maintenance schedules to be refined and maintenance funds to be targeted to those locations identified by having a better understanding of the steel towers. This greater understanding will also play a major role in the development of the organisation’s corporate objectives as they
develop their refurbishment and/or replacement strategies and programs for these critical long-term assets.

**Paper No.4:**

**A Holistic Approach to the Management of Electrical Assets within Supply Authorities.**

*Published Distribution 2001 Conference Brisbane 2001*

**Abstract:**

This paper provides a management framework based on the principles of a holistic approach to asset management and shows how these principles could be integrated into the core business processes. This paper assesses whether Asset Management was a core business process for a utility. This process is broken up into two key management areas, essentially the Strategic and Delivery Roles, which combine to provide a Asset Management process.

The Strategic role considers all aspects associated with the service delivery of an asset to the customer. This aligns with the corporate objectives of the organisation in the areas of risk, performance, condition and specific strategies for a particular asset type. The Delivery role incorporates the operational phase of an asset, taking into account the asset’s lifecycle. The focus of the paper was to provide an overview of a holistic approach to asset management with a case study developed on the maintenance process for timber poles. This paper was designed to communicate what it is for utilities to take a holistic approach to asset management; an approach that requires its management to be integrated across the organisation to align corporate objectives and business strategies to obtain the most effective use of all of its resources to achieve business success.

**Paper No.5:**

**A Holistic Approach to Integrated Asset Management**

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**Abstract:**

This paper is an extract and an evolution of Paper 4, adapted to provide a framework on the principles of a holistic approach to asset management and how these principles are integrated into a core business process. This paper provided an overview of asset management as a core business process for utilities. This process was broken up into two key areas, essentially the Strategic and Delivery Phases that combine to provide the Asset Management process. The management focus for this paper was the maintenance process with a case study developed on timber pole assets. The case study incorporated the detailed operational implications of each stage of the process, including expenditures, reports and risks attributed to this specific asset-type owned by Integral Energy. This paper was designed to communicate how the model on maintenance management is applied in a practical sense and the levels of support systems required to deliver the desired outcomes for the organisation. The need to align maintenance strategies with corporate objectives reinforces the view of what it means for a utility to take a holistic approach to asset management to achieve overall business success.
1.7 Overview of Industry-Based Project

The industry-based project applies the management model of the portfolio to a variety of assets owned by Integral Energy. The application of the model identifies issues through case studies on a variety of asset types and provides the level of detail needed to apply a holistic approach to asset management. The case studies demonstrate the need to focus on the performance of the assets as these assets are delivering the corporate strategies and objectives. The process is continuous and can be adjusted not only to suit the changing needs of the organisation but also to suit the changing needs of the customer, the community and the political and competitive environments that currently exist for utilities today. A summary of the research outcomes of the portfolio is provided in Chapter 5.

1.8 Summary

This portfolio provides the framework and principles of a Holistic View to Asset Management and show how these principles can be integrated into a core business process. The information should be viewed as a series of building blocks that provide an organisation the flexibility and freedom to apply whichever of these broad principles best suit its own business practices, processes and work culture. The development and understanding of the Asset Management Model and the range of options available to an organisation require careful and planned consideration as the model chosen will impact greatly on the overall performance of the organisation at an operational and, ultimately, corporate level.

This view is supported by the findings and conclusions from the Australian National Audit Office Report No.27 (1995, p.2), which identified 2 major weaknesses in asset management practices common to the 24 organisations audited. These weaknesses related primarily to the lack of a strategic approach to asset management and inadequate management information systems. In particular the audit found that Asset management decisions are not well integrated into management planning processes. Byrne (1996, p.11) explains asset management should be implemented based on the principles of continuous improvement, in successive and manageable steps, to allow the complexities and dynamics of the process to be fully understood progressively.

This therefore requires management to be focused on the critical issues for the business and address them as a priority. This focus will allow those key areas to be addressed and provide the gains required by the organisation in the short term. It needs to be recognised however, that the implementation of a comprehensive asset management process will probably be so onerous on an organisation, that it is unlikely, in the short term, to provide the benefits desired for the effort involved. This thinking is based on the traditionally slow implementation rate of new concepts and principles, essentially due to existing workloads and operational issues within the organisation.

The transportability of the model of a holistic approach to asset management is not restricted to only supply authorities, as it is equally applicable to any form of utility business. The differences in types of
technology however will change to suit each type of industry; various diagnostic tools will be used to develop an appropriate asset strategy to manage the major risks for the selected business. These changes, however, are all catered for within the management processes themselves, as the framework is the principle factor that ensures alignment of the corporate objectives to the delivery of the services to the customer, at levels of manageable risk for the organisation with improved shareholder value.
Chapter 2: Literature Review

2.1 Introduction

The literature review on holistic asset management processes (systems), and models was undertaken using asset management publications and associated articles, associated industry publications, symposia and international conferences, particularly Distribution 2000, that support the focus and research objectives of this portfolio. This portfolio has a strong focus on Australian literature and assets owned and operated by Australian utilities. However, a review of international publications and papers has been included to provide a global perspective on asset management processes and models currently available.

This review of the literature available on infrastructure asset management has identified that a large number of utility (mainly public sector) organisations understand asset management generically as a business process that is developed into a comprehensive model to bring all aspects of asset management into a complete entity. This understanding of asset management as a continuous process or system is based upon the commercial realities placed on utilities to manage their physical assets through the various stages of an asset’s entire life cycle. This continuous process or system can be adjusted at any stage to align with changing corporate objectives to deliver optimum results and value to the owner (shareholder), while mitigating the organisation’s exposure to financial and public risk.

This understanding of asset management as a process or model will also extend to the contractual asset management relationships that exist within organisations and often referred to in references as the asset management contractual relationship (refer Figure 3.6). This relationship is to be defined as the contractual relationship between asset owner, asset manager and service provider to provide the appropriate range of services needed to deliver the desired outcomes for the key stakeholders. This view of these relationships is simplistic, as it does not reflect the intricacies of these complex relationships, which at times are blurred and dependent upon the skill base available, and the stage of evolution that the organisation has reached along the road to outsourcing or privatisation. This view, along with a number of alternative contractual relationships, is explored in detail within this chapter.

2.2 Definitions

The definitions used within this portfolio are detailed below to provide a clearer understanding of the terms used within this portfolio.

**Asset**

An asset, from an accounting perspective, is anything, which will provide the owner with some form of future benefit. Assets may be monetary, such as cash or bonds, physical such as inventory, land and buildings, or intangibles such as computer software or a legal right of enforcement which may be associated with a copyright or patent (Australian National Audit Office Report No.27 1995, p.30). This portfolio deals solely with physical assets which provide a benefit over a number of years ie, they have a useful life in excess of one year.
Asset - Life Cycle
The cycle of activities that an asset (or aggregation of assets) goes through while it retains an identity as that asset. These activities include planning, design, acquisition and support, including rehabilitation (refurbishment) and disposal (National Asset Management Manual 1994, p.13).

Asset Management/Integrated Asset Management
Asset Management is the process of guiding the acquisition, use and disposal of assets to make the most of their service delivery potential and manage the related risks and costs over their entire life (Asset Management Series 2002, p.1).

Asset Management - Contractual Relationship
This relationship is to be defined as the contractual relationship between asset owner, asset manager and service provider to provide the appropriate range of services needed to deliver the desired outcomes for the key stakeholders. The Asset Management contractual relationship separates the decision making process from the actions. The decision of what to do is not made by the group who will carry out the action of doing the work. The relationship between these groups is via Service Level Agreements or Service Contracts that are essentially financial arrangements between these key parties to deliver agreed performance metrics and/or service targets over a designated time period.

Asset Management Model/Asset Model
The same meaning as asset management process or system approach. A process that shows all aspects of asset management in a single model.

Asset Management Plan
To plan for, create or acquire, maintain, operate, rehabilitate, replace and dispose of assets in the most cost effective manner at the required level of service for present and future generations (National Asset Management Manual 1994, p.2.3)

Demand Gap Analysis
A planning tool which takes into account user groups and their preferences and identifies their needs and relative importance (the Gap) to ensure effective allocation of resources. The outcomes of the analysis is in the quality of the decision making (Upton & Pfaffle 1996, p.1).

Holistic Asset Management Process
A Holistic Asset Management Process or system brings together two distinct phases. These phases fall into either strategic or delivery roles that are connected by a Performance Management feedback loop to form what is termed a Holistic Asset Management Process (Refer Figure 3.1).

Integrated Asset Information Management System (IAIMS)
An IAIMS incorporates the data management and IT support system needs for the organisation to feed across divisional boundaries. Linkages to data management systems, Geographic Information Systems
(GIS), asset management databases, asset registers, financial accounts and cost tracking systems, and all forms of reporting are required to cater for the various needs across the business into an integrated system.

**Life Cycle Cost**
Also known as Whole of Life Cost as defined in Finance Regulation 44A & 44B.
The total cost of an asset throughout its life including planning, design, acquisition, operations, rehabilitation (refurbishment) and disposal costs (National Asset Management Manual 1994, p.13).

**Performance Monitoring/Management**

**Risk Management**
Risk management is performed in accordance with Australian and New Zealand Standard AS/NZ4360. Risk Management is essentially seen as a set of activities concerned with identifying potential risks, analysing their consequences and devising and implementing responses so as to ensure that proposal or project objectives and delivery goals are achieved. This includes management of ongoing risks associated with ownership of assets (Total Asset Management 2004, TAM04-12, p.3).

**Regulator**
By definition the term Regulate – means to adjust by rule; to put or keep in good order; to direct. This understanding of a Regulator for a monopoly business such as energy, waste, gas and water is managed through various Federal and State Regulators. The NSW’s regulator is known as the Independent Pricing and Regulatory Tribunal (IPART). The role of the regulator in NSW’s is to provide independent oversight of the price levels charges by monopoly service providers along with industry reviews and Arbitration. The principle functions of IPART is:

- *setting prices for regulated monopoly services.*
- *Ensuring regulated entities are meeting their licence requirements*
- *Undertaking pricing and industry reviews*
- *Facilitating the implementation of access regimes, where required.*
- *Providing similar services to assist jurisdictions on a fee-for-services basis*

IPART is made up of two NSW ’s Government appointed officers. (Independent Pricing and Regulatory Tribunal 2004,p.2)

**System Approach/Asset Management Process**
The System Approach/Asset Management Process is a process or framework: that integrates the Corporate Plan through each of the distinct asset life cycle phases. The short and long-term investments in the assets are designed and operated to support the service delivery to the end user (community) (Total Asset Management 2004, TAM04-1,p.3).
Total System Support Model
The same meaning as Integrated Asset Information Management System (IAIMS).

Utility
Also known as an Asset Rich Organisation. By definition a utility is a firm typically a natural monopoly that provides an essential service to the public and is either owned or regulated by the Government.

Value Management
Value Management is a structured, systematic and analytical process for developing innovative holistic solutions to complex problems (Total Asset Management 2004, TAM04-14,p.1).

2.3 Differing Perceptions of the Definitions of Asset Management as applied to Utilities

A number of interpretations of asset management are available in a number of industries, depending on the business purpose of the organisation. The definitions of asset management within this portfolio will be those used to describe large infrastructure or physical (utilities) and will exclude any reference to financial portfolios associated with the banking and financial sector.

The literature review identified a variety of definitions on asset management both internationally and domestically essentially by federal and state bodies that have been the traditional owners of Australia’s large infrastructure developments (capital funding) since Federation.

A definition as provided by the utilities business, EA Technology, United Kingdom is:
Asset Management optimises the financial and customer performance of the assets to provide maximum value to the asset owner in a consistent and predictable way (Walker 2001,p.1)

This UK definition of asset management is very focused on the asset owner, as the UK utility business has been fully privatised since the late 1980’s and has seen enormous changes to this once monopoly government owned business.

A similar definition as provided by Managing Consulting Firm KEMA, USA is:
One process, performing three functions, can inform most operating, maintenance and investment decisions in obtaining the knowledge needed to optimise tradeoffs among financial performance, operational performance, and risk exposure (Humphrey 2003,p.2).

An International perspective is provided by consulting firm The Asset Group (TAG), USA is:
Asset Management is a business discipline for managing the lifecycle cost of infrastructure assets to achieve a desired level of service and reliability while mitigating risk (Sklar 2004, p.2).

An alternative International perspective is provided by (International Council on Large Electric Systems) CIGRE Task Force 23.18, which details a broad range of definitions from its 27 members located across
five continents:

The definition of Asset Management ranges from a narrow focus on operating and maintaining existing network assets to minimise costs and maximise asset performance, through to a broader definition of managing all aspects of the network business to long term profitability (Bartlett 2002, p.1).

The definition as per the Institute of Municipal Engineering Australia is broken into two distinct areas:

Asset Management:
The integration of the asset utilisation and the performance with the broader business requirements of those whom it is intended to serve. It includes consideration of procurement, ongoing support, rehabilitation and disposal and the markets the asset is intended to serve.

Asset Management Strategy:
A strategy for asset management covering, at a strategic level, the development and implementation of plans and programs for asset creation, operation, maintenance, rehabilitation/replacement, disposal and performance monitoring. To ensure that the desired levels of service and other operational objectives are achieved at minimum cost (National Asset Management Manual 1994, p.10).

The definition as per the NSW Total Asset Management:
Asset Management provides a structured and systematic resource allocation approach to infrastructure and physical asset management so that resources are aligned with the service objectives of agencies (Total Asset Management 2004, p.1)

The definition as per the Victorian Government – Asset Management Series:
Asset Management is the process of guiding the acquisition, use and disposal of assets to make the most of their service delivery potential and manage the related risks and costs over their entire life (Asset Management Series 2002, p.8).

The definition as per the Auditor General’s Report No.27:
Aims to provide an approach to the management of assets, encompassing the principles of Integrated Planning, Asset Planning, Asset Accountability, Asset Disposal and the Internal Control Structure (Australian National Audit Office 1995, p.30).

The definition as per the NSW Government Capital Works Investment – Total Asset Management:
Total Asset Management is defined as:
In a system wide context, the sum of all those activities leading to infrastructure appropriate to the cost efficient delivery of Government services, those activities having the following major strands:

- identification of need for the asset.
- provision of the asset including its refurbishment.
• operation of the asset including its maintenance.
• Disposal and thus effective removal of the asset from an agency's portfolio


It can be seen from these interpretations that different perspectives have been taken by these bodies to align their corporate objectives with their own asset management practices. The desire to achieve improved financial control of the capital and operating expenditures by these organisations is apparent to them all, along with the requirement to recognise the distinct phases of an asset's life cycle.

The definition of asset management that is to be used by an organisation is an important one as this understanding plays a major role in how the organisation ultimately implements the associated asset management processes and models within the organisation. This impact could be felt at either a divisional level or possibly across the entire organisation depending upon the importance placed on the business drivers to implement an integrated asset management approach for the utility. This understanding for the utility of asset management would have an impact on the issues associated with the contractual/service level relationships between asset owner, asset manager and the service providers for the utility.

These relationships are the foundations that allow work to happen and therefore that require clear lines of responsibility and the associated accountability at the points of hand over. This understanding of clear responsibility within the framework of asset management is not fully understood as has been identified in a recent international survey by Bartlett (2002). This survey confirmed that asset management is still an evolving concept and that the roles and organisational arrangements varied widely that requires further development and ongoing refinement (Bartlett 2002,p2). A common theme that is confronting all utilities around the world today is the issues associated with replacing old out dated and often run down networks. These issues require significant injections of capital funding to bring these old networks up to modern day standards that meet acceptable levels of service and risk for their key stakeholders. It is this understanding and recognition by all utilities that will require them to adopt and implement the fundamentals of asset management into the way they do business. It is this clear understanding of what asset management means to the utility that will ultimately determine just how these fundamentals will be implemented across all levels of the business.

2.4 Systems Approach

A review of literature associated with asset management flows naturally into an understanding of organisational systems which then raises the need to clearly define and understand the distinction of this term and that used within the context of a systems approach for asset management within this portfolio. Many scholars have debated the traditional systems approach for many years in association with organisational development. The organisation has been seen by Parsons (1956) to be like an organism which has values and goals, with a unitarist perception that it is working for the good of all. The organisation is perceived to be an entity, which moves along without need for the inputs of people or for that matter the interactions of management. It is held in mystic proportions like some kind of perpetual
motion in which people either get on or get off, without slowing down this unstoppable wheel known as the organisation (Carr & Leivesley 1992,p.18).

This dualism that organisations are a distinct entity to people does not shape up to reality in the light of day. This perception that it is the organisation that oppresses people who do not meet its expectations or values has evolved from the earliest forms of organisations and is commonly termed a systems approach derived from Taylor’s Scientific Management principles of the early 1900’s (Carr 1989,p.4). The scholars of this theory such as Fayol in 1949, Barnard in 1938, Follet in1920 all focused on efficiency, de-skilling of the workforce and the administration of the organisation to improve management’s right for decision making (Stern et al 1996,p.4). The reality of organisations is that individual, groups and resources are brought together to “do work” in a social order of interaction, to achieve the goals of the organisation. These goals of the organisation are the theoretical intentions of the upper management of the organisation, which is itself made up of people as discussed by Greenfield (1975, p.155).

These theoretical intentions by management are the perceived goals that are set by management, usually without the direct input of individuals within the organisation. The systems approach to organisations was founded at a time when the 'one best way' principle to do work was perceived to be the best way to achieve efficiency. This approach to the workforce was a prescription which was right for the time, however the use-by-date has expired (Carr & Leivesley 1992,p.6). Zimbalist (1979,p.15) perceived that the climate of that day was such that management could manipulate and control the worker by whatever means it wished (usually limited monetary incentives), to enforce productivity for profit. The make up of the worker was considered to be simple, and the level of education and skill base of the worker low, with an abundance of substitute workers available within the labour market. Should a deviant appear within the workforce then she/he was removed and another slotted in to carry on the work for the organisation (Fincham & Rhodes 1988,p.191).

Since the days of the industrial revolution, there have been distinct eras of change within the market place and organisations. These eras, such as the two, world wars and the social upheaval of the early 1960’s, have brought about changes, to the way management has perceived the worker. There has been a move away from the enforced management style associated with systems theory; however the bottom line has always been favoured by management control, or manipulation of the worker by management (Fincham & Rhodes 1988,p.78). The era of change started in the 1950’s with the concepts of social systems, socio-technical systems that looked at the social processes and psychological impacts associated with work relationships (Grieves 2000,p.56).

The 1980’s produced a new crisis for organisations as the skill base and technology levels of business significantly changed the focus for success. The Information Technology revolution changed the workplace into a global marketplace and massive change has resulted. The skill level and education of the worker could be at a level of equal standing with management. The worker is being seen to have needs which require attention by management other than the monetary incentives which were used in the past. Thus the perspective of organisations having to change as the worker is being seen to impact on the
performance of the organisation. Under the systems approach of organisations this recognition of the worker is not possible, as the organisation is the all important entity which makes things happen, almost mystically, and the worker is secondary or irrelevant to its success (Fincham & Rhodes 1988,p.183).

Greenfield (1975,p.159) provides an alternative perception of the organisation known as phenomenology, which is one interpretive perspective among many. In this interpretive perspective it is recognised that it is people within organisations that make decisions and not the other way around. This pluralist perspective recognises the reality that individuals are complex organisms who have their own perceptions and past histories, which dictate how they perceive and invent what is happening around them. Thus the social interactions of distinct individuals is a very complex affair and requires some forms of negotiation to arrive at a satisfactory solution for all. The concept of a negotiated order within the workforce is an area clearly identified in research carried out in two psychiatric hospitals in which the informal rules of understanding are created by the individuals that make up the organisation and the formal rules are only used when this ‘negotiated order’ is under transition, such as when new members enter the work group or in times of crisis (Strauss et al. 1990,p.147).

Thus work is performed at a personal level in which the complexities of people at work must learn to deal with each other to arrive at a compromise that both parties can live with. Fulop et al. (1992,p.17) explains that this recognition of the complex individual has been evolving for a great many years from many scholars such as Bennis, Maslow, McGregor, Herzberg, and Schein trying to get a true perspective of just what it is that makes this individual tick.

It could be argued that if one had a true understanding of just what a complex individual is, then the right buttons could be pushed to activate what might be perceived by the individual or group, to motivate and perform. This is a cynical view of Industrial Psychology; however it may explain why the focus has been on the inner workings of the individual and the group at work and outside of work. The perception of reciprocity between work and non-work is being considered as part of the make up of the complex individual as a further extension of what motivates these individuals to increase their performance in organisations (Katzell & Austin 1992,p.818).

An inter-actionist view recognises that an organisation is made up of the continuing interactions of complex individuals, who negotiate and influence each other to establish a working relationship through conflict and compromise to form a level of understanding that is acceptable to all parties for a specific period of time, or until a crisis occurs that requires a renegotiation of this understanding. The images of the complex man (sic) have been portrayed as unique to the individual with the complexity of variables and motives which are time and situation dependent (Carr 1989,p.49). This relatively new perspective of individuals within the organisation has meant that the hierarchy of the old pyramid system is no longer valid, as this system of the past, with its focus on control and manipulation. It is readily seen to become oppressive to the complex individuals within the organisation and stifles their innovation, creativity and motivation. Recognising this new perspective of organisations as social units or culture-bearing milieux
with a set of common understandings for organisational action, has led to a recognition that productivity within the workplace can be significantly improved by focusing on satisfying the needs of the worker for social interaction within the workplace (Louis 1987, p.421). Thus in the last 10 years management has been introducing programs such as shared decision making, team building and power equalisation, quality and project teams which are allowing the individual within the workforce to be considered as a mature person with his/her own needs being considered (Pascale 1990, p.19).

This recognition of the complex individual and the increased productivity which has come about, due to the motivational aspect of satisfying the individual’s needs (other than economic), has led management to recognise the practical problems facing a competitive changing global environment demanding high skill levels, innovation and creative design. The recognition that the worker needs to be more involved in the decision-making process in order to improve the overall productivity of the organisation has led to the development of group working. The systems approach of the past has focused on the individual and has not recognised the importance of social interaction, as is happening at all levels of the organisation at work and outside of work. The dynamics of groups has a great number of advantages over the individual, fragmented task allocation which has been so prevalent in the past, as the cooperative approach between individuals within the organisation provides each member with a much wider perception of the organisation and provides the additional benefit of job enrichment that comes from working within collective work groups. Job tasks taken on by groups can be more complex and the group can be self regulating, thus there is no need for unnecessary supervision (Fincham & Rhodes 1988, p.159).

The benefits of group dynamics are being recognised not only within an organisation but also across multiple organisations as a form of collaboration. Organisations within the same industry are forming collaborative alliances to contend with crisis situations that impact across the boundaries of organisations. These collaborative alliances are in effect a form of ‘negotiated order’. However the negotiated order is loose in form as the end result of these collaborations is to arrive at strategies to contend with options and common responses by all players within specific industries. They have to contend with crisis situations such as product tampering, which may involve a great number of organisations such as law agencies, government departments and the media. This inter-organisational collaboration is recognising a negotiated order. However it is important to recognise that the organisations are forming into groups to best generate ideas and understanding. This would not have normally happened in the past between market place competitors (Mitroff & Nathan 1991, p.163).

The benefits of group thinking to management is the cohesiveness and synergy associated with group behaviour which may create high quality decisions and increased levels of performance. The down side of this philosophy is that groups can have a tendency to get caught up into group-think and group-polarisation, which can be counter productive and risky to the organisation; this risk however is considered to be small in comparison to the overall gains obtained by the individuals in the group and the organisation (Fincham & Rhodes 1988, p.122).

The emerging organisations are shaping up as being a radically new forum from that which has evolved
from past mass production eras. Individuals within these organisations are being given the opportunity to develop their own skills, with the flexibility, responsibility and trust, often termed by management as ‘empowerment’, to be able to fulfil their individual needs. The hierarchy within these emerging organisations is reduced and kept to a minimum, to be just sufficient to maintain the administration required to carry out the corporate and financial control functions needed to achieve market success. The need for these types of organisations will encourage the innovation and creativity and allow organisations to grow and compete globally with a focus on fast responses to market conditions and customer service dependent on the type of industry that the organisation is pursuing (Porter 1986, p.13). The shape and form of the next generation of emerging organisations is described by Grieves (2000) as likely to lead to a search for new organisational forms, usually referred to as the learning organisation, the virtual organisation and the knowledge-intensive company. These types of organisations will be searching for improvements in operational efficiency while seeking more fluid approaches to innovation and creativity in order to adapt to constant change (Grieves 2000, p.66).

The question of whether the organisation is in need of change or what type of change program should be adopted to best suit the organisation’s fit within its business environment, is usually not fully understood or properly assessed. The need to introduce an appropriate strategy to best suit the alignment of an organisation’s strategic competencies within a dynamic environment is a sentiment supported by Stace & Dunphy (1991, p.68) in which they suggest that what is appropriate for one organisation may not be appropriate for another. So what is needed is a model of change that is essentially a situational or contingency model, that is, one that indicates how to vary change strategies to achieve optimum fit with the changing environment. An international perspective on work systems and models identified 5 key models along national boundaries; Swedish socio-technical systems; Japanese lean production; Italian flexible specialisation; German diversified quality production and an American Human Resource model. This perspective on work systems and models demonstrates an alternative way of understanding how organisational development has evolved across international boundaries (MacDuffie 2003, p.593).

The development of organisations from a systems perspective has been evolving since the 19th Century and to this day is still recognised as playing a part in organisational development, although in a different form. This understanding of a systems approach is not to be used within the context of asset management. A systems approach within the boundaries of Asset Management and this portfolio is defined as: a process or framework that integrates the corporate plan through each of the distinct asset life cycle phases. The short and long-term investments in the assets are designed and operated to support the service delivery to the end user (community) (Total Asset Management 2000, p.2).

2.5 Systems and Models

One of the major issues confronting large utilities is the need to integrate the concept of asset management into the framework of the organisation. This concept is a major paradigm shift in thinking for these organisations, as their assets have historically been driven by a build mentality based on the supply and demand principles that existed in the marketplace at the time. Hope (1996, p.58) explains that the
dominant culture in the public sector has been one of asset creation rather than asset management. The development of a Holistic Asset Management Plan for one type of organisation, although transportable, would need to be adjusted to suit a similar type of organisation. Each organisation, although similar in function, will have alternative processes, work practices and decision-making criteria that are unique to each organisation: These will play a major role in how the overall plan is adopted and implemented within the organisation.

The system approach or Asset Management Process is well understood within both Federal and State government agencies and a growing number of private organisations. The NSW Government Total Asset Management (2000), for example, developed an overall model known as the Total Asset Management Process that integrates the corporate plan through each of the distinct asset life cycle phases. The short and long-term investments in the assets are designed and operated to support the service delivery to the end user (community). Young & Azavedo (1998,p.2) support this view of a systems approach to asset management, as a systems approach to asset management is an inter-disciplinary approach to provide an integrated solution. It focuses on optimising the whole system (global approach) instead of improving only individual components. Gabb & Bell (2001,p.2) also support this view of a systems approach through a case study on Powerlink that demonstrates an integrated business approach to asset management. The case study demonstrates the need to have an integrated business approach that involves consideration of business drivers and the subsequent coordination of information, design, maintenance and operating strategies necessary for meeting industry demands. Bickell & Godau (1999,p.3), argue that the Victorian Gas Industry highlights shortfalls in current asset management practices which have developed along the lines of functional responsibility that is constrained to departmental boundaries. The current practices do not adequately address the systems issues arising from an aging infrastructure, increasing interdependencies arising between system elements, and from the growing fragmentation and shortfalls of technical knowledge, commercial demands and community expectations.

Bickell & Godau (1999,p.4) propose that to rectify this functional asset management approach will require the integration and use of suitable business information systems, and development of management decision processes, appropriate to the complex issues and relationships that are necessary for effective Asset Management Plans. A Systems view is essential, to develop suitable information systems and decision making processes. Hope (1996,p.57) has a similar view of a system approach to asset management in which it is important that a holistic approach is adopted. Buying an asset is not simply a purchasing decision, but a decision that should be undertaken as part of the overall strategic planning process. There is a growing and clear recognition of the need for utilities to adopt an integrated (systems) or holistic approach to asset management. This recognition, however, brings with it some barriers to it being adopted as a preferred philosophy, as a system approach would impact on the way these organisations currently operate. A systems approach would reach across traditional divisional boundaries within an organisation, which would impact on the way the organisation currently functions. This would then put pressure on the need for structural change to the organisation, to allow the systems approach to be integrated into the way the business operates to ensure clear accountability resides with the appropriate (responsible) group (Jones 1997,p.2).
Allen (1999, p.2) advocates the separation of the decision making process from the action process with an asset manager and a service provider having clear accountabilities through a service level agreement or contractual arrangement. Humphrey (2003, p.2) also advocates that the complexity of managing an asset intensive infrastructure business such as electricity distribution is reduced by dividing responsibility among three key entities: the asset owner, the asset manager, and the service provider. This approach provides a clear separation between making the decision and carrying out the action, and allows each entity to specialise and thereby focus on specific capabilities and responsibilities. The UMS Group also support this view from their 1996 study that identified that the best performers had made a strategic decision to separate the decision making processes from the action processes and have incorporated this strategy into their core process designs (UMS Group 1999, p.2.3).

CIGRE Task Force 23.18, made up of 27 members primarily drawn from transmission businesses across Europe, North America, South America, Japan, America, South Africa, Australia and New Zealand obtained a similar view in a survey conducted on Asset Management practices and experiences. The results from the survey identified a growing trend by these businesses, in a deregulated environment, to separate the functions of Asset Ownership, Asset Manager and Service Provider in the belief that the role separation will lead to greater efficiencies. This survey also identified that asset management is still very much an evolving concept and that the roles and organisational arrangements varied widely from the responses received (Bartlett 2002, p.2).

Utility businesses around the world are experiencing enormous pressure for change, due to the political agenda for deregulation and privatisation to obtain increased performance and financial returns to the shareholders. These pressures for change require these businesses to have structures and processes in place that can drive the corporate objectives through to every level and part of the business. In order to deliver this mandate clear accountability and understanding is required between the functional groups that make up the organisation, to avoid duplication and ensure they understand their respective roles within the business to achieve deliverable outcomes. This understanding is becoming clearer through the development of a number of documented asset management definitions, processes and models. This clarity however is still evolving as no process or model has yet been established that provides all the answers for these complex organisations. There is a constant search for nirvana, the ultimate process or mode that in reality can never be achieved due to the many variables that make up these complex entities. The issue for utilities however is to continue to strive to enhance available asset management systems and models that work for their business to deliver the efficiency and performance outcomes required by their key stakeholders.

2.6 A Core Business Process

Asset Management within Australia has been developed with a focus on public sector organisations, as they are the traditional owners of most of Australia’s large utilities as detailed in Total Asset Management Manual (1992, p.1). All development within these utilities has been driven in recent times by the Auditor
General’s Department to align public-owned infrastructure with modern day accountancy practices. This approach is based on a fundamental understanding of achieving those cost drivers for the organisation that will allow the right business decisions to be made to deliver optimum value and service to the end user, while improving shareholder value (National Asset Management Manual 1994, p.1.2).

The need to apply the philosophy of Asset Management to all utilities is an area that has been historically ignored by both Federal and State government agencies. The drive in today’s changing business environment is to optimise the existing infrastructure and alleviate the financial drains on these organisations to allow a better distribution of the available financial resources to more strategic locations (Australian National Audit Office 1995, p.27).

The importance of introducing the fundamental principles of asset management in any organisation cannot be overstated, as this process will ensure that full accountability of the asset’s condition, use and performance is recognised by management to support the program delivery for the organisation. These fundamental principles will require that the whole of life costs be considered from the start of the asset planning phase to allow investment decisions to be made based on an asset’s entire life cycle, rather than the asset’s initial purchase price (Total Asset Management Manual 1992, p.1).

One of the fundamental issues not fully appreciated with asset ownership is the liability that is imposed on any utility, as asset ownership requires it to be managed and maintained for its entire serviceable life. This recognition alone necessitates that utilities adopt the fundamentals of asset management and put in place measures and controls to appropriately manage the risks and liabilities associated with owning and operating an asset (Total Asset Management 2004, TAM04-10, p.1). A number of government owned utilities have adopted the fundamentals of asset management into the way they operate as a business. This thinking recognises asset management as an overarching business process that integrates into all aspects of the way the business functions to deliver its comprehensive corporate plans (Total Asset Management 2004, TAM04-1, p.6).

A number of utilities have developed the building blocks for an asset management process. These building blocks have been arranged and developed to best suit the way they wish to deliver their corporate objectives. It is important to recognise that the way the asset management process is incorporated into any business will not be the same, as the intent and purpose of each phase of the asset management process will need to be adapted to best suit the utility’s way of doing business. A number of government bodies and large utilities have produced readily available literature on the philosophy of asset management and the business processes needed to deliver the outcomes desired from the process for their organisations. One such organisation that has produced literature on the asset management process is the Auditor General’s Department, with a publication titled the Asset Management Handbook. This document addresses the key areas required for asset management in a global perspective, providing the basic building blocks and framework for the asset management process.

An alternative approach taken to the asset management process has been developed by the Public Works
Department in their manual titled Total Asset Management Manual (1992), in which an integrated approach is taken to consider any number of alternative solutions to the ever-changing needs of the end-user or customer. This integrated approach discusses the need for an understanding of the changing needs of the users, utilising tools such as ‘gap analysis’ to identify the desired service needs of the customer. Alternatives such as Non Asset Solutions are considered that will deliver the desired services in new infrastructure developments in a far more cost-effective manner than the traditional approach used by the Public Works Department. This process provides an insight into the rationale for considering alternative approaches other than the capital investment solutions traditionally favoured by the majority of government owned organisations in the past (National Asset Management Manual 1994,p.9).

Upton & Pfaffle (1996,p.6), support this view of non-asset solutions in which they demonstrate through case studies the benefits of performing Demand Gap Analysis to look at a range of options and to measure customers’ needs and priorities against these various options. This process is seen as a decision making tool that can be used to support, defer or avoid capital investment decisions for any service industry (utility). A third view and process on asset management has been developed by the Institute of Municipal Engineering Australia (IMEA), titled the National Asset Management Manual (1994). The approach taken is to develop an asset management process with a strong emphasis on the technical aspects of the assets. The philosophy of the IMEA process is to take into account the whole-of-life costs of the asset, in particular the maintenance costs for large capital infrastructures such as roads and buildings etc, owned by government enterprises. These costs are typically as high as five times the initial purchase price of the asset. This recognition of the financial burden imposed on these organisations plays a major part in the decisions to be made during the planning and acquisition phase of an asset.

A fourth view is presented in Asset Management Series (2002) the framework for an Integrated Approach to Asset Management. This framework is similar in content to the NSW - Total Asset Management (2004) framework developed for its integrated asset management template. A fifth view of a detailed asset management process is the Total Systems Support Model that provides a detailed view of an integrated asset management process. This model identifies the framework and specific support processes that are required to manage the complex issues associated with managing infrastructure and physical assets (Eerens 2002,p.40). The work by Bickell & Godau (1999,p.1), details a generic Asset Management Plan Decisions Model that identifies all the significant asset planning, system and sub-system issues that balance the key business drivers of managing safety, performance and cost for an organisation. Gabb & Bell (2001,p.3) discuss an integrated Asset Management Framework that shows how Powerlink has optimised its transmission asset performance using an interdependent group of strategies that address the relationship between their business, plant and information system requirements. This approach by Powerlink provides an integrated business approach by capitalising on the relationships between business, plant and system strategies respectively.

On an international level a great deal has been achieved with models developed by benchmarking studies compiled by companies such as the UMS Group. The UMS Group identified, through its findings from its International Strategic Asset Management (ISAM) study, the need to expand asset management principles
into the entire organisational structure (UMS Group 1995). The framework developed by UMS Group from this study was incorporated into an Asset Strategy Development Process within a paper presented at the Risk Management Workshop at UNSW (Allen 1999,p.2). This process was developed to provide the framework for the development of Risk Based Asset Management Strategies that allow utilities to mitigate risk while providing acceptable returns to the shareholder for multiple projects. Sidney (2003,p.4) explains how the UMS Group have further enhanced their framework and understanding from their Strategic Asset Management study 1995, by incorporating an Optimisation Portfolio/Process to assist in the selection of competing projects that needs to satisfy multiple corporate goals such as financial cost benefit, customer impact, business and strategic implications and risk mitigation.

Craig & Parrish (2003,p2) have produced a Transmission & Distribution asset management model for utility companies as they argue that these types of companies have always stuck to the basics as their core business has always been asset management. They see this as fundamental for transmission and distribution utilities irrespective of the external pressures placed on these utilities by industry deregulation, corporatisation and privatisation. The fundamentals of asset management are performed by, determining the work that should be done, as well as in work completion.

Asset management is being recognised by the majority of utilities around the world as one of the fundamental core functions for their business. There is a wide range of options available to utility businesses to either evolve into an integrated asset management business or establish asset management as a part of their business. This is a strategic decision that needs to be determined at a corporate level to deliver the performance objectives and efficiencies for the business. It should be recognised however that nearly 80% of all utility profits (electricity, gas, and water) are generated from their core network business (Geoghegan 2003,p.1). This recognition alone is a key business driver for utilities to integrate the fundamentals of asset management into their business systems, as their future income streams and long term success are critically tied to their physical assets and how these assets are performing for their key stakeholders. This issue is particularly important considering that the age of most utility’s assets around the world means they have negligible depreciated value and therefore require capital investment for either their replacement or full refurbishment work. This understanding of the overall condition of these assets requires a commitment of funds to ensure the long-term profitability of the business is maintained at a level of manageable risk.

This need for a commitment to capital funding will require a trade-off between the existing operating (maintenance) expenditures to provide the right mix to provide the optimum value for stakeholders. This approach, I believe should be taken with a long-term view of the assets and not be compromised by the short term corporate benefits of reducing overall capital expenditure for the business. This aspect of asset management for utilities is critical to their long term success, particularly as regulatory changes continue that have an impact on the ability of these utilities to manage their risk profile and fund their long-term replacement/refurbishment programs.
The current thinking on asset management has been growing at an exponential rate over the last ten years, with a great number of international practitioners and theorist now available to provide insight into the many ways of introducing and integrating the concepts of asset management into an organisation. A web search (January 2004) on the current literature available on utility infrastructure asset management has identified over one million separate articles on the subject worldwide. There is clearly a growing recognition that this subject has a rigour or science all of its own within the business community, with the potential to drive corporate objectives throughout an organisation and deliver increased performance, while managing the risks associated with asset ownership on an enterprise-wide basis.

2.7 Processes

There are available a wide range of asset management processes that can be used to provide an organisation with alternative approaches that best suit their own business objectives and understanding of asset management. Some of these are detailed below to provide an overview. A documented Australian asset management process is available through the NSW Public Works Department Total Asset Management Manual (1992,p.9) known as the Total Asset Management Process as shown Figure 2.1 below.

![Figure 2.1: Total Asset Management Process](Total Asset Management Manual 1992,p.9)
An alternative asset management process is available from Americans Craig & Parrish (2003,p.2) who have developed a process specifically for Transmission & Distribution utilities, as shown Figure 2.2 below.

T&D ASSET MANAGEMENT MODEL

STRATEGY

T & D Asset Management Strategy

ENGINEERING PLANNING AND RELIABILITY

Load Forecast  Capacity Planning  Reliability Planning

Detailed KPI's & track process level

MAINTENANCE PLANNING

Condition Assessment  Equipment Evaluation

Detailed KPI's & track process level

WORK MANAGEMENT

Equipment Maintenance/Replace Program

Long Range Plan (5 - 10 years)

Detailed Budget (1 - 2 years)

Project Priority (1 - 5 years)

Project Executed

Figure 2.2: Transmission & Distribution Asset Management Model
(Craig & Parrish 2003,p.2)

An alternative Australian asset management process is available from Eerens (2002,p.12), as shown in Figure 2.3 below.

Figure 2.3: Asset Management Process (Eerens 2002,p.12)
A review of the NSW Public Works Department’s Total Asset Management Process as shown Figure 2.1 is all encompassing in its design although simplistic in nature. This system is supported by a detailed manual that provides a more comprehensive understanding behind each of the aspects of each phase of this process. The manual provides the outcomes required for these phases but lacks the detail in the area of tools required to deliver the outcomes discussed. This lack of detail in the application of the tools would place at risk the desired outcomes as the wrong application or tool could easily be incorrectly used.

The process developed by Americans Craig & Parrish (2003,p.2) specifically for Transmission & Distribution utilities, as shown in Figure 2.2 provides a more comprehensive outline for the delivery of the services required for a growing utility business. This process is tailored to meet the network needs for a utility business with a back to basics approach described by the authors for utility businesses generally. The process covers all key issues with a strong focus on the operating and maintenance aspects of these business to manage the key cost areas. The authors pay particular attention to the need to keep tight control on operating expenditures with the flexibility to respond to changing market conditions particular peak loads requiring the need for additional infrastructure. The issues not fully detailed within the model are the inputs associated with the customer needs, regulatory issues, demand management options, non-asset solutions and how all these aspects feed into the asset management strategy of the process at a corporate level. The process does not directly address all the aspects associated with the asset lifecycle on such issues as refurbishment and disposal of existing assets. This detail may well be within the author’s understanding of what is the asset management strategy phase of their process, however this detail is not discussed.

The asset management process developed by Eerens (2002 p.12), as shown Figure 2.3 is a comprehensive system which details the appropriate inputs in the areas of business needs and asset planning required to formulate an appropriate asset management strategy. The support manual developed by the author provides the next level of detail to understand the issues not readily identified within the process. The types of issues include life cycle analysis that is incorporated within the asset design framework; reliability centered maintenance analysis incorporated within the asset management reference plan etc. All these key aspects are covered in the next layer of detail within the support manual provided by the author incorporating the tools and workflow diagrams to ensure a comprehensive understanding is obtained and understood. The one issue that does appear to raise concern is in the area of asset disposal, as this is incorporated within the framework of asset performance monitoring. This arrangement caters for the gradual replacement of single items rather than catering for an event requiring a strategic replacement program as is the current case for existing utilities. This issue would be recorded through the asset performance monitoring process within the process however this would take considerable time and prolonged poor performance before a major replacement program was instigated at a strategic level. The process in its current form is comprehensive in its design and detail and would provide a utility business a solid start on the road to sound asset management.

These are some of the available asset management processes available on the marketplace that range in their level of complexity, design and specific detail but provide the framework of what is required within an
asset management process. The key aspect for a utility business is that an asset management process is adopted that best suits their specific needs. The issue however is that a large number of utility businesses around the world are working without a clear understanding of what benefits an integrated asset management process would provide to their bottom line particularly in the areas of stakeholder management, safety and risk mitigation. The real benefits at a corporate level is that their objectives and strategies are being effectively managed and delivered through a transparent process and measured against common metrics for program delivery.

2.8 Strategic Planning

The principles of asset management are soundly based upon the alignment and fit of the organisation’s resources, to best meet the needs of the customer within the environment in which it is required to compete to maximise returns to its shareholders. This concept is not uncommon and is often referred to as an organisation’s ‘strategic fit’. There is a great deal of literature that recognises the need for an organisation to align its business competencies (competitive advantages) with the changing environment, which will ultimately determine the long-term success of the organisation. Stace & Dunphy (1991.p.40) describe strategic fit as a dynamic search that seeks to align the organisation with its environment and to arrange resources internally in support of that alignment.

By recognising that the external environment is continually changing, organisations can then continually assess and consider change as an ongoing process to obtain a strategic fit for the organisation. It is worth noting that the need to continually audit the external and internal environments is essential for organisations to recognise the style of change needed to obtain strategic realignment. Keesler & Judson (1991.p13) identified the changing environment of the supply utilities within America in five key areas: regulation, competition, the environment, technology and the workforce. This article recognises the need to shift the traditional thinking of supply utilities (Case Study: Florida Power Corporation), to move from a strategic planning concept to more of a strategic management concept. The need to design and implement any strategy requires continuous planning at all levels of an organisation to ensure alignment and desired outcomes are obtained by all parties that are involved in the planning process. This understanding is of critical importance for utility businesses that are required to manage long-term assets design to last 40 years and more while maintaining annual forecast and programs on an annual basis all within a dynamic environment of change. The planning process within the framework of the asset management model for a utility business needs to consider all aspects of what it means to manage complex and diverse network systems. The planning process for a utility business is traditionally broken up into three distinct levels to ensure key goals and objectives are clearly understood to obtain alignment throughout the organisation. The three hierarchal levels of asset management planning traditionally used include; corporate management, Middle management and Line management (shop floor).

Corporate Management:
This level of planning usually includes senior managers such as the Chief Executive Officer, Chief Financial Officer, the General Managers from Engineering, Operations, Policy, Finance and Regulatory
along with the Corporate Risk, Safety and Environmental managers. The issues covered at this level of asset management planning for a utility business would include the forecast capital and operating expenditures for the next 3 to 5 years detailing the key performance outcomes for the organisation. These objectives would incorporate agreed forecast regulatory capital and operating expenditures for the next 5 years, along with agreed forecast levels of network reliability and documented levels of corporate risk in the areas of safety, environment and the public. The outcomes from this corporate planning process would feed into the organisation’s document of corporate intent that is designed to improve shareholder value. These approved outcomes would flow on to the next level of the planning process.

**Middle Managers/Supervisors:**
This level of planning would involve the relevant Branch managers and appropriate section managers/supervisors from within the relevant division. The types of areas would include the asset managers, Engineers, Production & Operations Supervisors and division accountants. The intent is to now take on the high level objectives developed by senior management and approved by the Board for the next 12 months and develop the Branch Plans for the Division. The Branch plans are formulated from the developed Section plans to form a clear objective for the entire. The type of plans produced would detail specific asset management capital and operating programs and identified projects that are prioritised for completion over agreed timeframes for reporting and tracking, incorporating forecast expenditures and high level resource needs for each item. These plans become the Key Performance Indicators for the associated Branch and Section Managers for the next 12 months. These plans are finally approved by the General Manager of the Division for implementation to ensure alignment with the corporate objectives for the next 12 months.

**Line management (shop floor).**
This level of planning would involve the engineers, supervisors and leading hands along with selected operational staff to fully understand the objectives of the plans for the group. At this level the focus is on ensuring the plans are achievable taking into account a working perspective along with known operational constraints and available resources. The plans are reviewed to take into account alternative options and choices to drive extra benefits to achieve the desired objectives of the plan. This three tier planning process is broad in nature and does not necessarily reflect the often additional internal planning layers of an organisation that all play an integral part of delivering the strategic objectives and operational plans for the organisation across different planning horizons and often changing business environments.

**2.9 Asset Strategies**

The deployment of appropriate asset strategies is the hub for the management of an organisation’s assets. The asset strategies adopted by an organisation will determine the level of financial return to be achieved for the organisation, based on the direction of the business objectives of the organisation. These strategies, adjusted to suit both the long and short term, deliver the desired outcomes in a competitive external environment at an agreed level of risk. The Australian National Audit Office has published an Asset Management Handbook (1996,p.11) that describes Asset Strategy as *that which complements the*
Information System, Human Resources and Financial Management Strategies in the Operational or Business Plan for the agency. It is important to remember that asset strategies, within the context of the Asset Management framework, are in fact processes in which an asset is effectively managed throughout its entire lifecycle, incorporating acquisition, maintenance, operational, refurbishment and disposal plans. This process effectively delivers the organisation’s business objectives to match the corporate direction for the organisation within a predetermined planning horizon (National Asset Management Manual 1994,p.10).

Corporate objectives, in a regulated income system established under the National Electricity Code, are designed to encourage capital investment while promoting efficient operation and maintenance expenditures on the system. The corporate objectives for long-term assets therefore need to recognise the high-level performance outcomes desired for the assets that ensure all investment decisions deliver improved shareholder value (Crisp 2001,p.6). The key issue that is addressed within the strategic phase of the asset management process is the alignment of the corporate objectives. These objectives are established taking into account a diverse group of competing bodies, interests and influences. These objectives are formed through government policy and regulations, regulatory financial framework, customer needs and expectations, competitors and benchmarking best practice, shareholder expectations, safety and environmental targets to name just a few of the key stakeholder issues.

The UMS Group (1999,p.3.5), explains that the strategic phase of the asset management process is to align these corporate objectives into the asset model as shown Figure 2.4 below.

![Figure 2.4: Asset Strategy Development Process: Strategic Phase](UMS Group 1999,p.3.5)

The asset model within this framework can also be expressed as an Asset Management Plan, developed to communicate the organisation’s long-term strategic plan for an assigned asset. This plan is regarded as being dynamic in nature to allow it to be easily adjusted to align with changing environmental, shareholder or customer needs. EDF-Reseau Transport Electricity and AEM Electricity (Italy) use a similar Asset Management Strategy process to optimise maintenance and refurbishment programs by identifying new constraints (customer and system requirements) and the need for cost reductions across the network.
The National Asset Management Manual (1994,p.2.3) describes an asset management plan, at a corporate level as to plan for, create or acquire, maintain, operate, rehabilitate, replace and dispose of assets in the most cost effective manner at the required level of service for present and future generations. Boyd (2001,p.2) explains an asset management plan as a set of objectives relating to an asset, that focus on what the assets can deliver, in line with the needs of the business, rather than what the assets are inherently capable of delivering, or designed to achieve, individually. The scope of the asset management plan is to take a long-term view of the assets, to document and communicate within the organisation the decisions that have been made to achieve these corporate objectives at designated levels of manageable risk.

Bickell & Godau (1999,p.2) explain that an asset management plan should be all encompassing by:

• providing plans and controls for the technical efforts for the asset management of the infrastructure.
• providing plans and controls for the operational efforts for the asset management of the infrastructure system.
• Reflecting an integrated approach by balancing all the factors associated with meeting the infrastructure life cycle requirements. That integration addresses such areas as the business plan, safety management plan, environmental management plan, emergency management plan, human factors development plan, organisation plan, asset performance monitoring plan, logistics support and regulatory plan.

There are differences in the level of detail an organisation may wish to place into an asset management plan as can be seen by the contrasting views of the definitions detailed above. However a key issue for any utility business is the need to have a clear documented asset strategy for the management of its assets, detailing their intended purpose (financial return, service delivery, performance) through all the phases of the asset's lifecycle.

2.10 Regulatory Environment

One of the biggest issues facing utilities around the world today when formulating asset strategies is directly associated with the regulatory environment in which they are required to operate. The regulator, and the rules by which utilities are allowed to obtain return on assets, need to provide the appropriate stability, incentives and cost drivers to ensure the business is sustainable for the long term. The regulatory environment, if not right, can become a barrier to utilities as they face the need to manage old networks that require injections of capital to replace their under-performing assets at unmanageable levels of risk.

This issue appears to be not only a major issue in Australian utilities today but one that is recognised internationally. Orchison (2003,p.14) details results from a 2003 survey of a large number of European
utilities as well as over 100 US utilities on their issues associated with industry regulation. This survey identified similar views between both the European and US utilities particularly on the issues that will have the most impact on them over the next 5 years. This survey identified that while the vision of deregulation remains the same, achieving the balance between price signals and regulatory concerns is a common major problem. Further many US utilities are now less certain than before over which direction regulation will take and thus regulatory uncertainty remains a key factor clouding US market attitudes.

This view on regulatory uncertainties is also a key issue within Australia as detailed in responses to the Electricity Supply Association of Australia (ESAA) focus group for distribution service providers, in which the utility network concerns included the following key points:

- The current regulatory model does not provide (Australian) distributors with any incentive to upgrade the networks and to use technological change to reduce cost.
- The regulatory model does not encourage distributors to undertake research and development expenditure.
- The model does not allow close interaction with customers, necessary to develop innovative price/service options (Orchison 2003, p.14).

Within Australia the regulatory issues have been very strongly focused at the National Electricity Market (NEM) level to resolve issues of wholesale electricity markets and transmission pricing, along with retail and distribution regulation. The PARER Report was prepared to review the regulatory issues associated with the NEM to be addressed at a Federal and State level by the CoAG Ministerial Council on Energy (MCE). Nethercote (2003, p.2) explains that the objective of the MCE for the national energy market is to streamline and improve that quality of economic regulation across energy markets to lower the cost and complexity facing investors, to enhance regulatory certainty and to lower the barriers to competition. Ward (2003, p.7) discusses a common issue for utilities at all levels is the need to have a regulatory system that is stable and transparent with the right framework to allow long term investment decisions to be made with a level of certainty. Breheny (2003, p.9) also supports this view for long term investment decisions within a regulatory framework as he explains that the Victorian Essential Services Commission, recognises the age of the state’s distribution assets and the investment needed to replace them, and has been receptive to arguments put by CitiPower and Powercor for increased expenditure, linked to improved performance, to accommodate such investments.

What is clear for utilities is that investment decisions, irrespective of public or private ownership, requires the right regulatory environment to be put in place to encourage investment for the long term, while maintaining cost controls and agreed standards of service to the consumer. The ability to put in place such a system is the challenge that is facing every Government and utility business around the world today. This view is supported by the Federal Government in a speech on Australia’s Energy Policy, by Prime Minister John Howard, in which he explains his Government remains committed to creating the right economic and regulatory environment for further development of the energy sector, (Orchison, 2004, p.8).
The clear message that is being canvassed at all levels of business and governments is that without the right incentives and stability within the energy sector that investments in long-term projects will not be taken due to the financial risks of not receiving appropriate rates of returns to the shareholders. This approach by any business is considered appropriate financial risk management when taking into account all of the other options available to divest in more secure markets.

2.11 Asset Life Cycle Costing

The definition of Life Cycle Costing (LCC) of an asset as defined by the National Asset Management Manual (1994,p.13) is the total cost of an asset throughout its life including planning, design, acquisition, operations, rehabilitation and disposal costs. This definition recognises that investment decisions need to consider all costs associated with asset ownership, to ensure decisions on acquisition, maintenance, refurbishment or disposal are made based on full cost implications. The LCC is a process in its own right and has matured into an Australian Standard (AS4536) that provides examples of the applications for Life Cycle Costing (The Australian Standard 1998,p.12). The asset life cycle is essentially made up of a number of sequential plans that are interrelated and flow naturally from one phase to another as shown in Figure 2.5 below.

![Figure 2.5: Life Cycle Cost Reduction Elements](National Asset Management Manual 1994,p.3.6)

The major opportunity to derive financial savings within the asset management plan is made at the initial planning and acquisition phase for the asset. This is achieved by taking into account the whole-of-life costs for the asset’s entire life cycle. This approach will allow the organisation to make informed decisions, recognising the financial implications imposed on the organisation in the long term (National Asset Management Manual, 1994,p.3.6). An understanding of the asset life cycle is an important aspect when considering the financial implications of acquiring an expensive item that is to be managed for a considerable period of time. This strategy has been utilised as an appropriate technique by utilities. However, it should be recognised that the operational period of an asset’s life can contribute to more than
90% of the total time the asset is managed, and can contribute to many more times the initial purchase price of the asset as shown in Figure 2.6 below.

![Asset Life Cycle Profile](image)

**Figure 2.6: Asset Life Cycle Profile**
(National Asset Management Manual 1994,p.4.23)

An example of this financial relationship is the operating cost of a hospital that will typically consume an equivalent of 3 times the capital cost outlay every 2 to 3 years and continue to do so for another 40 years (Total Asset Management 2004,TAM04-10,p.1). This understanding also raises a number of key issues associated with the development of an appropriate whole-of-life model for a long-term asset. The life expectancy for a long-term asset is typically in excess of twenty years, which, when factored into a Net Present Value (NPV) model, makes allowance for maintenance costs to have only a minor impact on the initial purchase price for an asset. This realisation raises the question of how the organisation should determine the appropriate purchase options for a long-term asset. Birtwhistle (1999,p3), also supports this view as demonstrated through a review of the financial implications of assessing the life cycle costs of acquiring long-term assets for utilities. He has specifically identified that the financial issues are neither easy to identify nor to obtain for most acquisitions, however the goal is to develop and consider the implications rather than spend extensive periods of time trying to ascertain the accuracy of the model. Hastings et al. (1999,p.4), also expresses similar views regarding the value of the LCC model. Undue risks that are not factored into the LCC analysis, are placed on the organisation due to increasing maintenance cost for ageing assets over forty years of life, and the consequences of failures or technology advancements. They further discuss that the conventional economic life approach is either not applicable at all, or, due to the long life involved, does not lead to clear cut financial conclusions. Boss et al. (2002,p.5), discusses the use of the LCC analysis to provide asset managers in the USA and Switzerland with an opportunity to identify windows or time spans in the life of an asset that will justify the economic refurbishment and/or replacement of an expensive aging asset, such as large transformers. The LCC analysis is used to take into account the technical, economic and political aspects associated with these assets, to provide the user with the tools necessary to make intelligent asset management decisions.

The development of an appropriate asset life cycle model should be seen as a decision tool that provides a way for an asset manager to distinguish between similar products during the planning phase of asset acquisition. The LCC analysis is used to evaluate alternatives and options via Economic Appraisal, Financial Appraisal, Value Management, Risk Management and Demand Management (Total Asset
Management 2004,TAM04-10,p.1). Although this decision tool has limitations, for long-term assets it still has a very worthwhile role to play when considering the whole-of-life financial burden on an organisation wanting to consider the alternatives for the acquisition/renewal of a number of long-term assets.

2.12 Risk Management

The need to manage risk is a legislative requirement for all organisations and has become an Australian and New Zealand Standard – AS/NZS 4360. The strategic phase of the asset management process identifies the need to perform risk assessments for all proposed strategies developed within the asset model. This philosophy for risk assessment goes well beyond the corporate objectives for an asset. The need to manage risk at all levels of the business does not exist solely as a corporate objective but in fact permeates throughout the entire organisation. Risk, by definition, arises because of limited knowledge, experience or information and uncertainty about the future.

Risk Management is essentially a set of activities concerned with identifying potential risks, analysing their consequences and devising and implementing responses so as to ensure that proposal or project objectives and delivery goals are achieved (Total Asset Management 2004,TAM04-12,p.3). The liability of ownership of long-life assets requires sound risk management as a fundamental for the organisation. Boyd (2001,p.7), supports this understanding in which he advocates that asset management, by definition, is in fact a form of risk management in itself. Drye (1997,p.2.1.4) also supports this view for asset management by recognising that good data management would support the use of analytical tools and techniques by introducing a program to establish risk analysis based decision making for utilities. Allen (1999,p.4) also supports this view by advocating risk-based decision making for all aspects of asset ownership and investment, based on qualitative and quantitative data, to support a risk-based methodology for an organisation. The philosophy of managing risk at the highest level within a utility business is well documented by the Hydro-Electricity Commission in Tasmania. By implementing risk management techniques, and taking additional, but acceptable and manageable levels of risk, the HECT has realised major savings in capital expenditure (Houbaer & Seddon 1995,pp.1-16). The commercial realities that are being imposed on utility businesses are demanding that additional risk be taken in a managed way. Walker (2001,p.3), discusses the competitive nature of the UK utility business has required risk management to be incorporated into most areas of the business to ensure that assets are fully utilised, managed, maintained and replaced for performance purposes based on managed levels of acceptable risk determined by senior management for the key stakeholders.

The Australian Standard AS/NZS 4360 is not prescriptive in nature but provides the framework for the development of an appropriate risk management plan. The specific industry is required to develop tools or specific guidelines to manage risks within the business as risks and mitigation measures are very much industry specific (Carmen 2001,p.4). Bodrogi et al. (2002,p.6) discusses the results of an International survey on Operational Risk Management covering Australian and Western European utilities that identified all respondents were willing to accept additional operational risks to the point of exceeding asset
limitations to avoid short term loss of supply to the customer. The findings from this survey also identified that privately owned utilities (making up nearly half of the utilities surveyed) are more risk averse than publicly owned utilities in relation to risks for which they can be held legally and financially responsible.

An integrated asset management process also requires an integrated approach to risk management that is communicated and managed across the business. Risk management techniques and strategies are considered fundamental tools in managing recognised financial, political and operational risks to the business; at both a corporate and functional level, to provide value-management in today’s business environment. Utilities all around the world are endeavoursing to come to terms with the need to provide a service of the highest order that meets both regulatory requirements and customer expectations while battling with the increased corporate risks associated with managing old networks. The opportunity is available to these utilities to take an integrated approach to asset management that allows risk management decisions to be made based on knowledge and traded off against the full range of risks faced by utility businesses. One area that does provide opportunities for utilities today is in the development of ongoing research and development that provides new technologies for utilities to be able to manage their networks in more cost effective ways than were previously available. Advancements in telecommunications, microprocessors, IT systems, diagnostic techniques and tools etc. are all designed to support the decision-making process for managing risks associated with asset management.

2.13 Summary

The literature review identified a number of international and national asset management definitions, concepts and models that have been developed for utility organisations. This information provides both prescriptive processes along with the building blocks to apply the principles of asset management for any type of utility business. The literature review has also provided the framework for the principles of asset management and how these principles are seen as an integrated business process. Clearly Asset Management is a complex subject that is still evolving and has the capacity to radically transform the structure, business processes and day to day workings of any utility business around the world. This complex issue is further complicated by the recognition that Asset Management itself is still in the evolutionary phase and that this will continue as utility businesses struggle to manage constant change in the areas of technology, market forces, political pressures and an ever changing customer expectation.

What can be seen from the literature review and the available models and processes on Asset management is the need to break down this complex subject into distinct stages through a series of manageable building blocks. This approach allows all parties involved to obtain a clearer understanding of the key issues and be able to properly consider and manage the impact across their utility business, taking into account their existing practices, processes and work culture. The literature review has also identified that the Australian philosophy on the principles and processes of asset management, published by both Federal and state bodies, is more than sufficient in content, design and detail to be adopted by utilities within Australia, without the need to adopt available international publications on the subject matter. The research and development of these new asset management building blocks will be provided in greater
detail in Chapter 3, to provide a road map for a better understanding and implementation of a holistic asset management process.
Chapter 3: A HOLISTIC ASSET MANAGEMENT PROCESS

3.1 Introduction

The literature review has provided the framework for the principles of asset management and how these principles are seen as an integrated business process. The literature review also recognises that asset management is a complex subject matter that has the possibility of impacting upon the structure, business process and day to day working of a utility business. This complex issue is further complicated by the recognition that Asset Management itself is still in its evolutionary phase and that this will continue as utility businesses struggle to manage constant change in the areas of technology, market forces, political pressures and an ever-changing customer expectation. This evolutionary phase of asset management is recognised from a survey performed by Bartlett (2002) for the CIGRE TF23.18 working group on Asset Management. The findings from this survey identified a wide range of variations in the very understanding of what Asset Management is and how this understanding impacted on the Asset Management Models adopted within organisations across a large cross-section of countries around the world.

The issue that appears to be coming paramount from the literature review is the fundamental question for a utility business: What is asset management? Clearly a great number of utility businesses are struggling to come to terms with this question, as the implications can be enormous and impact across the entire organisation. The implications of asset management as a core utility business process would potentially change every aspect of how that business plans to operate in a changing and demanding business environment. The implications of how far reaching asset management can impact across a utility business is discussed by Vashishtha (2004, p.31), in which he explains it can be much more than managing maintenance, refurbishment and capital investment to minimise costs and meet performance targets. Asset management encompasses revenue optimisation, stakeholder management, risk management and legal compliance to optimise the technical and commercial performance of the network and to meet the expectation of the key stakeholders.

The literature review has shown that there are a number of asset management processes and contractual relationship models available that have been developed internationally and domestically. These processes have been developed to best suit a utility business to align and deliver on the corporate objectives established for their organisation. It is important to recognise that the way an asset management process is incorporated into any business will not necessarily be the same, as the intent and purpose of each phase of the asset management process needs to be adapted to best suit the utility’s way of doing business. A number of government bodies and large utilities have produced readily available literature on the philosophy of asset management and the business processes needed to deliver the outcomes desired from the process for their organisations. One such organisation that has produced literature on an asset management process is the Australian National Audit Office, with a publication titled the Asset Management Handbook (1996). This document addresses the key areas required for asset management in a global perspective, providing the basic building blocks and framework for an asset management process.
On an international level a great deal has been achieved with processes developed by benchmarking studies compiled by companies such as the UMS Group. An alternative international asset management process has been produced by Craig & Parrish (2003,p2) who argue that utility companies have always stuck to the basics as their core business has always been asset management. They see this as fundamental for transmission and distribution utilities irrespective of the external pressures placed on the utilities by industry deregulation and privatisation. These are just some of the available asset management processes that have developed and refined to obtain a better understanding on how to implement the fundamentals of asset management into and across utility businesses around the world today.

What can be seen from the literature review and the available processes on asset management is the need to break down this complex subject into distinct stages through a series of manageable building blocks with a clear understanding of the strategic and delivery (operational) needs within each stage. This approach allows all parties involved to understand their key objectives and what part they play in being able to properly consider and manage the impact of the process across the utility business. The findings from the literature review on asset management have been used to formulate and develop a new series of building blocks to provide a better understanding of a holistic asset management process for utilities. These building blocks expand in detail as each layer of the process is explored to reveal sub-processes within that demonstrate the complexity and level of detail as each phase of the process is considered.

### 3.2 Asset Management Process

The available literature on asset management provided a research path towards an emerging theme that brings together two distinct phases of what is asset management. These two distinct phases fall into either Strategic or Delivery roles that are connected by a Performance Management feedback loop to form a new process known as a Holistic Asset Management Process (Figure 3.1 below).

![Figure 3.1: A Holistic Asset Management Process (Appendix 5.10.5)](image)
3.2.1 Strategic Phase

The Strategic Phase of a holistic asset management process considers all aspects associated with the strategic planning of the asset, incorporating those issues associated with service needs and asset strategy. The strategic function is very much focused on satisfying the short and long-term needs of the organisation in the areas of service, managed risk and shareholder value.

This understanding is illustrated in Figure 3.2 below, in which the linkages between market forces and specific asset strategies are considered, to ensure acceptable returns on investments for the shareholder.

![Figure 3.2: Asset Strategy Development Process: Strategic Phase](UMS Group 1999,p.2)

The UMS Group identified, through its findings from its International Strategic Asset Management (ISAM) study, the need to expand asset management principles into the entire organisational structure (UMS Group 1999,p.25). The framework developed by the UMS Group from their ISAM study is incorporated into the strategic phase known as an Asset Strategy Development Process. Sidney (2003,p4), explains that the UMS Group has further enhanced their framework and understanding from their ISAM study by incorporating an Optimisation Portfolio Process to assist in the selection of competing projects that takes into account the need to satisfy multiple corporate goals such as financial cost benefit, customer impact, business and strategic implications and risk mitigation. The UMS Group’s asset model, as shown in Figure 3.2, is a process that is not meant to be prescriptive but is designed to take into account the external and internal influences which need to be considered to develop an asset model that aligns the corporate business objectives, through both the short and long-term asset strategies, for an individual group or type of asset.

This process was specifically chosen as it has been developed and refined from hundreds of international benchmarking studies of utility businesses and is considered by the UMS Group as best practice. An
alternative asset strategy development process could just as easily be substituted into the strategic phase of a holistic asset management process to suit the individual needs of a utility businesses to allow integration with their current internal planning processes and procedures. The key issues here is to ensure all external and internal inputs are considered to develop the specific asset strategies that align with the corporate objectives for their business at agreed levels of manageable stakeholder risk. These strategies are then communicated, through performance targets and metrics to the delivery side of the holistic asset management process to obtain alignment of the desired corporate outcomes at all levels of the business.

3.2.2 Delivery Phase

The Delivery (Operational) Phase of a holistic asset management process considers all aspects associated with implementing the asset strategies developed from the strategic phase. This aspect of a holistic asset management process involves the planning creation, maintenance, operating and monitoring of the assets to ensure they are fit for service. This is illustrated in Figure 3.3 below, developed to provide the building blocks for continual improvement on the condition and performance of the asset and deliver the strategic corporate outcomes desired. Within each building block (stage) are the internal processes and sub-processes required to deliver the corporate outcomes on managed risk, while delivering service and improved shareholder value. The amount of detail within each building block, a process in its own right, is dependent on the complexity of the issue and its importance in delivering the desired outcomes for the organisation. The development of each of the building blocks that make up the delivery phase will be explored individually to provide an understanding of the relationship that exists within each stage of this process.

Figure 3.3: Delivery (Operational) Phase (Appendix 5.10.5)
### 3.2.2.1 Asset Planning Process

The asset planning process takes on the asset strategies developed from the strategic phase of the holistic asset management process and considers what assets are needed to deliver these outcomes for the business. The Asset Planning Process is fundamentally designed to consider the gap between the performance of the existing assets and those required for delivering the minimum services needed by the business in the area of growth. The acquisition of new assets should consider non-asset solutions along with demand management strategies to moderate the demand for the service to mitigate or reduce the need to build new assets. The solution to build new assets requires consideration of the long-term ongoing expenditures for the business associated with annual maintenance and operational expenditures along with future refurbishment or replacement programs for the new asset. It needs to be understood by agencies that the major opportunity to derive financial savings long-term for a new asset is at this planning phase. This is achieved by taking into account the whole-of-life costs for the asset’s entire life cycle. This approach will allow an organisation to make informed decisions, recognising the financial implications imposed on them for the long term (National Asset Management Manual 1994, p.3.6).

This understanding also raises a number of key issues associated with the development of an appropriate whole-of-life model for a long-term asset. The life expectancy for a long-term asset is typically in excess of twenty years, which, when factored into an NPV model, makes allowance for maintenance, refurbishment and operational costs incorporated into the initial purchase price for an asset to allow informed decisions to be made. The development of an appropriate asset life cycle model should be seen as a decision tool that provides a way for an asset manager to distinguish between similar products during the planning phase of asset acquisition. The life cycle cost (LCC) analysis is used to evaluate alternatives and options via Economic Appraisal, Financial Appraisal, Value Management, Risk Management and Demand Management (Total Asset Management 2004, TAM04-10, p.1). The Asset Planning phase would need to also incorporate the development of a Strategic Asset Management Plan (SAMP) over a planning horizon of at least 3 to 5 years or longer that takes into account the current maintenance, refurbishment and capital growth needs for the business over this period. This plan would forecast future capital expenditures for new and replaced assets along with expected maintenance and operating costs to allow financial plans to be put in place to deliver the strategic outcomes for the business over a defined period. These plans are often used to justify to a regulator the prudent financial expenditure for a utility business over a known regulatory planning period.

### 3.2.2.2 Asset Creation Process

The asset creation phase of the process involves the planning, acquisition, construction and commissioning of a new asset for a utility business. This part of the process requires the development of project management plans that take into account all aspects for good project management. The construction projects are scheduled for the current year taking into account financing, tendering & contracts, construction, procurement of all the associated materials and obtaining the skilled human
resources required to ensure program delivery. The asset creation process needs to consider all aspects associated with the risks of planning, constructing, commissioning, operating and maintaining new or refurbished assets for the long term benefit of the organisation. The extent and depth of documentation and analysis in the asset creation process will depend on the value and importance of the asset to be acquired to the business. The asset creation process is typically no longer than 1 to 2 years in total time from the time of ordering to complete installation and commissioning for large assets.

3.2.2.3 Maintenance Process

The development of the maintenance process as shown in Figure 3.3 is one of the key processes associated with an asset’s life cycle. However it must be recognised that the Acquisition, Operation and Disposal phases of an asset’s life cycle all require the same level of process design and review as is demonstrated in the maintenance process that are all key inputs into the Delivery Phase of a Holistic Asset Management Process. The delivery of the Maintenance program is considered to be one of the most important activities on the operational side of any business. It is among the most costly recurrent contributors to an organisation’s operating expenditure. Management of the maintenance process is one of the primary functions of asset management and is usually the longest phase of the asset’s life cycle, as it is typically required from the moment the asset has been constructed and fit for service (Total Asset Management Manual 1992,p2). Maintenance costs are driven by the constraints of functional design specification, detailed design, construction, installation and operating practices, such that maintenance can only be conducted within the inherent capabilities, and practical limitations, of the systems or equipment. The maximum opportunity to reduce maintenance expenditure exists within the area of maintenance planning of the overall maintenance process (Total Asset Management 2004,TAM04-3,p.3). Platfoot 1 (1999,p.11), also supports this view, as a detailed and planned maintenance program will minimise the maintenance effort for the organisation. The need to deliver maintenance is a fundamental requirement for any utility business.

The ability to be able to deliver the required maintenance is becoming more and more an increased cost impact and operational constraint for utility businesses, particularly at the bulk supply (transmission) levels, with large customer demands dictating the operational constraints for maintenance delivery. This is recognised at all levels of the industry and is becoming a key business driver to the introduction and implementation of new techniques and strategies to allow maintenance to be performed. The types of operational strategies being employed by utility businesses include the increasing use of live-line procedures, taking advantage of outage windows or non-peak loading periods, utilising synchronised generators to mitigate any potential loss of supply and grouping and coordinating maintenance activities with major customer down times. These are just some of the strategies being used by utility businesses to allow maintenance to be performed as regulators, customers and markets are dictating the availability of the network for maintenance. This impediment to the ability to deliver maintenance is becoming an important input to the asset strategies for a utility business. The selection of equipment and the configuration of the network require due consideration in the asset strategy phase of the asset
management process, to allow core activities such as maintenance to be performed without the need for loss of supply. The goal is to deliver effective maintenance management that guarantees optimised equipment performance at the least cost, ensuring, throughout its entire service life, the productive availability of that equipment that delivers the desired performance outcomes for the business.

The maintenance process is designed to ensure assets are adequately maintained and protected to deliver the desired levels of service, condition and performance for the assets. The underlying philosophy of this process is to:

- Enhance the link between service outcomes delivered to the community and the maintenance of the assets involved in the delivery
- Establish clear links between maintenance objectives and asset performance
- Resolve uncertainty regarding the disposal of assets; and
- Gain the commitment of operational maintenance managers and staff to Maintenance Planning. (Total Asset Management 2004, TAM04-3, p.2).

To determine the appropriate levels of maintenance for any organisation in a competitive environment requires Asset Managers to conduct rigorous reviews of the levels of assessed risk that can be sustained in order to deliver the right outcomes for the business; outcomes that will align with the corporate objectives set by the organisation (Total Asset Management 2004, TAM04-3, p.4).

The outcomes of maintenance planning are in fact a true reflection of how effective the maintenance strategies have been in delivering the performance criteria that have been set for the business. The performance criteria for this part of the process will require rigorous review and analysis, to ensure the right mix of maintenance activities are delivering the improvements needed to provide sustained business success. It is a business objective for any asset manager to focus on investing the minimum levels of maintenance dollars to deliver the services desired by the organisation, while meeting statutory obligations for the organisation’s risk management and public liability. These desired goals should be achieved through the use of diagnostic tools and techniques to ensure the well being of the asset is assured without significantly increasing the risk profile to the organisation.

There is a variety of diagnostic tools currently available to assist asset managers in determining the maintenance regime required to deliver the appropriate levels of service at an accepted level of risk. Ackerman & Smit (1997, p.40), detail ways in which Dutch Utilities are managing to incorporate a blend of maintenance programs across their asset base, to obtain improved business performance and be able to optimise the maintenance dollar invested in their assets. This trend is continuing, with pressure on progressive organisations to develop and implement a continual improvement program for their current maintenance regimes. A number of organisations are recognising the need to move away from the traditional time-based-maintenance (TBM) approach to a more pro-active condition-based-maintenance philosophy (CBM). Jarrell & Brown (1999, p.1), also support a CBM approach in which they describe four distinct evolutionary steps in reaching a proactive CBM goal, that provides benefits to the organisation in the areas of efficiency, reliability, and safety of the plant maintenance process. A variety of new
maintenance tools is being considered by a growing number of organisations such as Reliability Centred Maintenance (RCM) methods, Failure Mode Effect and Criticality Analysis (FMECA), on line monitoring systems (OLM), batch testing (BT), statistical analysis using age profiles (AP), along with a failure and repair mode for those items not considered to be sensitive or critical to the overall operation of the service delivered to the customer (Eby & Bush 1996,p.95).

The development of statistical analysis of very large asset types and numbers has become a worthwhile tool for utilities to use to determine their level of risk exposure. This approach to the development of maintenance policies uses the sampling of a relatively small number to population size to determine the overall condition of the asset base. Brailsford (2000,p.3), applied statistical research methods using normal, logarithmic, exponential, Weibull and Binomial distribution curves to assess the condition of a large population base. The variability in the sample mean and standard deviations needs to be taken into account when estimating the sample size. This statistical analysis technique was applied to recorded transformer oil samples to test for degradation and provide the utility with an appropriate maintenance policy for the management of a very large transformer population. Speairs (2001,p.3), discussed the use of RCM to deliver cost-effective maintenance solutions at Agility (Vic.) by integrating this maintenance technique with their Geographic Information System (GIS) and Work Management System (WMS). This has now been established as the backbone of their maintenance management program.

Douglas et al. (2001,p.4), details an innovation in maintenance management by ENERGEX to redefine the CBM approach to establish a more proactive Action Based Maintenance (ABM) approach by allowing the field operator to make condition assessment decisions at the time of actual inspection and assessment. This approach significantly improves the quality of maintenance data, reduces cycle times and operating costs and assists to effectively manage the risk of failure on the network. Balzer et al. (2002,p.3) identified the importance of RCM techniques to develop appropriate maintenance strategies to cater for aging equipment and the critical nature of failure of the asset to the organisation. It is recognised that the primary effect of aging equipment is a declining reliability of supply caused by increased asset failure rates or the unreliable condition of the network to allow operational replacement to be performed. The conclusion drawn from this RCM/Age/Risk Based technique is the necessary to provide a priority list of multiple aging assets that can be used to quantify annual budgets for maintenance, replacement and refurbishment activities for the organisation.

These are some of the more popular maintenance programs, readily available within the marketplace, to suit the specific requirements of a wide range of organisations. It is important to recognise that maintenance process improvements should be seen as continual in nature, as there are always new and innovative techniques being developed to optimise the way maintenance is delivered. The utilisation of all, or some, of these maintenance techniques will enable an organisation to dictate how the maintenance dollar is to be best spent. This approach to maintenance improvement programs, although touted as being the general trend by most utilities, is not necessarily being practised in their current maintenance programs.
A recent survey, performed by the Institute of Electrical and Electronics Engineers (IEEE) Task Force (2001), on the present status of Maintenance Strategies performed by 53 utilities across 6 different countries (Austria, Canada, Germany, Italy, Saudi Arabia, USA), as shown in Table 3.1, confirms this level of uptake.

<table>
<thead>
<tr>
<th>Maintenance Strategy</th>
<th>Responses (N)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheduled Maintenance Only</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>Condition Based Maintenance (CBM)</td>
<td>36</td>
<td>68</td>
</tr>
<tr>
<td>Reliability Centred Maintenance (RCM)</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Probabilistic Modelling</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>53</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source Data: IEEE TRANSACTIONS ON POWER SYSTEMS Vol.16, No.4 November 2001

The IEEE/PES Task Force (2001), findings identified that maintenance practices have not progressed beyond those of scheduled maintenance, or empirical forms of predictive maintenance based on periodic inspections. For all their advantages, probability-based maintenance policies are particularly slow in being considered for implementation. This is despite the recognition that optimised probabilistic maintenance models would provide the highest savings and greatest flexibility in assessing the effects of changes to any of the parameters. The results from the survey would suggest that maintenance strategies have not evolved towards RCM based strategies, let alone towards the more complex probabilistic modelling techniques recommended by the task force. In its view, in a competitive business environment, the future direction for utility maintenance strategies will inevitably involve a move towards more complex probabilistic modelling techniques in order to provide optimum solutions to the complicated situations that can result from ageing assets.

Irrespective of the level of diagnostic techniques used to develop a maintenance strategy, the delivery of the strategy requires a comprehensive maintenance program in order to achieve and record the desired outcomes for the maintenance strategy employed. The delivery of maintenance provides the organisation with a level of assurance that the assets are fit for service. This assurance provides the organisation with a way of minimising risk to the business while providing a level of service to the customer. The need to optimise service delivery should be a primary goal for the organisation while ensuring assets are adequately maintained and protected to deliver desired levels of service, value and performance. The only effective way to ensure this is achieved is through a comprehensive maintenance process that considers all the needs for maintenance from strategy through to program delivery.
Detailed below in Figure 3.4 is a maintenance process that has been developed and designed to demonstrate how to deliver a maintenance strategy through a logical sequence of activities, to achieve the desired outcomes for the organisation.

This maintenance process is divided into two distinct parts, maintenance planning and maintenance delivery. This relationship is considered best practice by the UMS Group as it allows the organisation to split the decision and the do components of maintenance. The UMS Group considers it best practice to provide the opportunity to a utility business to use internal resources or outsource to external maintenance service providers as being available to the organisation at anytime (UMS Group 1999,p.9.5). This separation between internal and external service providers is highlighted by a dotted line in Figure 3.4 above and this issue will be further explained under the heading of Asset Management Contractual Relationships. This separation between the planning and delivery for maintenance provides operational flexibility while ensuring the maintenance planning (strategy) needs for the organisation are maintained internally. The development and ownership of the maintenance approach and strategies employed are very much organisational specifics and therefore a core business competency not to be out-sourced.
The key issue addressed in this maintenance process is the clarity between the planning and the delivery side of the maintenance program. This arrangement avoids the confusion that may otherwise exist while ensuring clear functional boundaries are established for each part of the maintenance process. The maintenance process is not dependent on in-sourcing or out-sourcing; it merely provides a means, or avenue, to allow this strategy to take place should this approach be considered necessary or warranted by the maintenance manager to meet changing priorities and volumes of maintenance works.

3.2.2.4 Refurbishment Process

The refurbishment process is designed to identify when assets have become uneconomical to own and operate in their current state. A decision is required to determine the merits of either the full rehabilitation, augmentation or replacement of the assets through an appropriate optimised evaluation process. This decision needs to consider a number of issues such as:

- *The cost of rehabilitation versus replacement versus augmentation*
- *The relevant increases possible in effective life following the different treatment options*
- *The benefits to the customers as derived from the different levels of service that each option offers*
- *The amount of capital to be invested and when that capital will be needed*
- *The annual and periodic maintenance and operating costs?* (National Asset Management Manual 1994, p.3.9)

The decision to invest large sums of capital for a refurbishment program needs to be made prudently as the future profitability of the business will depend on this long term investment decision that will have a direct impact on the delivery of the services to the key stakeholders. This issue is attracting significant attention both domestically and internationally as there is a growing recognition that the age profile for most utility major assets around the world today are all approaching this critical point for refurbishment. Graine et. al. (2002, p.1) explains that transmission networks particularly in Western Europe underwent significant development in the 1960’s to the mid-1970’s that now puts their plant approaching the end of its economic and technical life. This now places owners and operators of these networks with the difficult decisions in relation to the renovation and refurbishment of these installations against more severe economic, environmental and competitive constraints. Hastings et. al. (1999, p.3) discusses the optimised replacement policy for transmission assets under the revenue guidelines of a National Electricity Market. The decision to replace or refurbish assets is not only dictated by pure economic criteria, as there are other factors that may warrant the replacement of an asset. These include such factors as technical obsolescence where the old technology can no longer be supported or meets the requirements of the equivalent modern day standards, unacceptable risk due to consequential failure, safety or capacity driven needs that make replacement or refurbishment justified.

The decision to refurbish or replace an asset is a decision that requires significant data and therefore knowledge on the condition of the assets to determine what best meets the appropriate mix of technical,
financial, environmental and stakeholder issues. Boyd (2001,p.4) suggests that the purpose of an asset replacement program is to record all the thinking and decisions on replacements over a relatively long time frame. This is based on a rigorous analysis of all aspects of an asset’s ability to continue to provide capability required and a projection of when the asset is expected to no longer meet the needs of the business. Impelluso (1999,p.1) discusses the use of a Capital Asset Life Extension Spreadsheet known as (C.A.L.E.S.) to determine the appropriate point in time to replace assets. This process is developed into four major sections inspection, evaluation, results and graphical. The final solution provides an organisation with a risk profile based on weighting and variation analysis to suit the risk profile of the organisation to predict future replacement expenditures for individual assets or entire networks. The need for software support for such a large-scale data management exercise is needed along with the analytical tools to support asset managers in making the appropriate refurbishment decisions that align with the corporate objectives in the areas of forecast capital financial expenditures, risk and stakeholder management issues. The outcomes and requirements of the refurbishment process requires that same level of planning and delivery as detailed in the maintenance process to ensure program delivery.

### 3.2.2.5 Disposal Process

The disposal of an asset is an area not fully appreciated or appropriately planned by most organisations. It is inevitable that at some stage the refurbishment effort will not be viable or economical to allow the wasting of valuable resources and effort by a utility that should otherwise be more wisely spent on alternative programs. An asset disposal process should address the criteria for disposal and plan the time for its eventual removal and replacement. There should not be any major shocks to the organisation in respect to cash drain or loss of service to the end user as the asset disposal should be well planned and properly thought through to mitigate and comply with the respective legislative or environmental constraints. The disposal or retirement of assets is an area that is generally not given the level of thought needed to allow the organisation to allocate funds and manage the transition of the asset out of the organisation. The monitoring and assessing the condition of the assets for disposal should be recognised as a normal stage of the asset management process to ensure the delivery of the desired levels of service are maintained, while at the same time minimising the level of operational risk and public liability for the organisation.

The NSW Treasury (2004) published the Asset Disposal Strategic Planning Guidelines (TAM04-4) for state bodies and entities under the framework of Total Asset Management (TAM) 2004. The asset disposal guidelines involve two separate and distinct elements: the detailed assessment of assets identified as surplus by the asset strategy followed by an analysis of the physical disposal of the asset. The issues associated with identifying surplus assets are:

- **The asset is not required for the delivery of services, either currently, or over the longer planning time frame**
- **The asset becomes uneconomical to maintain and/or operate**
- **The asset is not suitable for service delivery**
The issues associated with identifying surplus assets are:

- Whether there are net disposal benefits, either in financial or other terms
- Whether there are secondary service obligations associated with the asset which dictate retention
- Whether a disposal can be carried out without adverse impacts on the physical environment (Asset Disposal Strategy & Planning Guideline 2004, TAM04-4,p.1).

The issue for the disposal of redundant assets is ensuring the disposal process is managed in an effective and transparent manner as any other aspect of the asset management process. In this way the liability placed on a utility in the areas of due diligence and corporate governance are assured and not left to chance or miss appropriation.

### 3.2.2.6 Contractual Relationship Approaches for Asset Management

Asset management for a utility business is dependent on the support of a large range of services to deliver the required programs to meet the corporate objectives for the business. The engagement of these services is essentially seen as a contractual relationship between an asset manager and a service provider. This view is simplistic in nature, as it does not reflect the intricacies of this relationship for long term asset management. The use of the organisation’s traditional internal service providers (staff) and/or to what extent the organisation has out-sourced these services will play a critical role in the way the contractual relationship model is integrated into the business and ultimately just how successful it will be in delivering the desired outcomes. This fundamental contractual relationship between client (asset manager) and service provider (contractor) is reflected in a typical short-term arrangement employed for any form of construction project, as shown in Figure 3.5 below.

![Figure 3.5: Typical short term Contractual Relationship between Client & Service Provider (Allen 1999, p.2)](image)

This arrangement is focused on delivering three fundamentals for the client (dollars, time and quality) on a project. This contractual relationship however is not suited to long-term maintenance-type service providers, as there is no incentive for the service provider to deliver long-term value-add for the client. This fundamental is an essential ingredient when considering the management of long term assets over a
designated period of time.

This type of long term asset management contractual relationship is shown in Figure 3.6 below.

![Figure 3.6: Typical Long Term Asset Management Relationship](Allen, 1999,p.2)

This long term Asset Management relationship separates the decision from the action. The decision of what to do is not made by the group who will carry out the action of doing the work. This separation is achieved through the formation of separate divisions or companies, one side taking on the Asset Manager role and the other side taking on the role of Service provider (contractor). The relationship between these two groups is via a Service Level Agreement (internal relationship) or a formal maintenance contract for the delivery of the required services to the company (Allen 1999,p.2). A key component for best practice Asset Management identified by the UMS Group (1999,p.9.5), is contestability for all new work performed, which is underpinned by a strategy to partner first class service providers. This strategy is supported in today’s environment by a number of contract options along the lines of strategic alliances, joint ventures, preferred suppliers etc. This relationship is then monitored similarly to business outcomes that deliver the desired levels of service with a strong focus on financial efficiencies connected to performance-based incentives. The relationship is focused on mutual performance rather than the traditional master-servant contractual relationship (UMS Group 1999,p.9.5).

Having a financial tracking and monitoring system in place allows for benchmarking studies to be engaged to establish the service delivery of the assets against other similar industry bodies. These types of studies provide useful information back to the asset manager on the strategies employed to deliver the level of service and value demanded by the shareholder. The types of strategies that are often debated by industry bodies with asset managers are the benefits of internal versus external service providers, particularly as regulators are being driven by government policy demanding increased levels of open competition (Allen 1999,p.3). The use of external services does raise a number of issues, particularly in the area of control, requiring the right controls to deliver the outcomes desired by the asset manager. This dilemma requires the right balance between maintaining control over the contractor and giving the contractor enough flexibility to truly add value. Tight controls are often seen as necessary to address cost and quality concerns, however they may also entail high overheads in contract management and limit the
contractor to standard solutions. At the other end of the spectrum, an open arrangement can give the contractor more flexibility to get the job done but also leaves the asset manager more vulnerable to financial extras (Allen 1999,p.4).

The trade-off between these conflicting influences is dependant upon the type of work to be performed and the skill-base required by the contractor to perform the works. This is particularly relevant in the area of maintenance, as a large array of standard tasks are required that can lead to the generation of additional work tasks, identified at the original maintenance activity or inspection. This type of complex arrangement of maintenance activities requires a smart contractor to be engaged through a Performance Based Contract that rewards or provides incentives to the contractor for improvements in the overall system, rather than the number of tasks performed or hours spent on an activity (Platfoot 2 1999,p.36). This level of flexibility however does come at a price, as will the right contractor to achieve the desired outcomes for an organisation. The selection of which specification to use will essentially depend on the ability to be able to understand and scope the works required, as detailed in Figure 3.7 below (Platfoot 2 1999,p.40).

![Figure 3.7: Task Based Contracts versus Performance Based Contracts](Platfoot 2 1999, p.39)

Organisations that do not have a documented history of their assets will require a specification that can provide them with a contractor with an appropriate skill-level to cater for and provide the diagnostic and investigative techniques necessary to determine the scope of the maintenance works required. This trade-off between specification types is illustrated in the figure 3.7 above. This understanding plays a major part in the type of contractor and controls to be employed to ensure the overall business objectives are appropriately addressed (Platfoot 2 1999,p.39). An important issue identified by the UMS Group (1999,p.9.5), in their findings on best practice Asset Management is the underpinning strategy to partner with best-in-class service providers. If these are not available internally, then external sources should be found.

The decision to in-source or outsource services for any part of the asset management functions should be
dependent on the organisation’s need to drive for greater efficiencies. This philosophy is espoused by management theorist and practitioners who try to answer the question: How to make organisations more efficient? (Clarke & Clegg 2000, p.380). This view is further emphasised by the fact when considering that the allowable revenue for regulated businesses, such as utilities, is dependant upon forecast efficiency gains being achieved by the respective companies. These efficiency gains, if not achieved, are taken directly off the bottom-line by the appropriate industry regulators, which provides clear incentives for these businesses to achieve improved operations (Crisp 2001, p.3).

The asset management contractual relationship is designed to cater for a relationship involving either full outsourcing, insourcing or a combination of both dependant upon the needs of the organisation. What is recognised within this complex relationship is the separation between the asset manager and service provider. This understanding is based on the need to have clear accountability between the asset strategy/outcomes and the service delivery/work outcomes to obtain improved performance and efficiencies. This separation between the asset manager and service provider has become a recognised way of managing a utility business. The asset management contractual relationship has replaced the previous informal communication links that once existed between field maintenance staff and the asset manager for the overall management of maintenance activities. The relationship is now formally recognised through either service level agreements or contractual arrangements with clear accountabilities placed on both parties (Wells & O’Reilly 1999, p.4).

A similar trend has been experienced in the United Kingdom with separation extended to include Asset Owner, Asset Manager and Service Provider. The relationship between asset owner and asset manager is clearly defined to ensure the overall corporate performance objectives and metrics for the assets are achieved, leaving the asset manager with the responsibility to deliver these outcomes. The relationship between asset manager and service provider is established on the principles of the recognised long term asset management relationship (Walker 2000, p.1). This relationship is detailed in Figure 3.8 below based on best practice principles developed by UMS Group (1999, p.3).

![Figure 3.8: Asset Management Contractual Relationship](UMS Group, 1999, p.3)
The strategic decision to separate the asset owner/manager/service provider functions within a utility business provides clear lines of accountability with the key goal of providing greater efficiencies across the business (Bartlett 2002, p.2). The relationships within the UMS Group’s asset management contractual relationship shows clear separation between the asset owner and the asset manager/service providers that does not recognise the interdependence on one another to obtain the opportunity to achieve optimised outcomes for the business. A truly optimised asset management outcome for a utility business could only be achieved with the alignment and recognition of this inter-dependence between these three key groups. The evolving nature of this complex inter-dependence of these three key groups is shown in Figure 3.9 below described as a Holistic Asset Management Contractual Relationship.

![Figure 3.9: Holistic Asset Management Contractual Relationship](image)

This contractual relationship has evolved to provide a utility business with the opportunity to strive for an optimised solution through its corporate objectives that are formulated and delivered by the asset manager through the service provider to achieve optimised outcomes for all three groups.

The restructuring of utilities businesses in New Zealand has also seen the separation of the strategic and operational needs of these utilities businesses. The restructuring of Vector, Auckland’s electricity network operator, has seen the separation of its strategic planning and standards groups from the operational functions of the business. This separation removed conflicts of interest between strategy and delivery and thus provided clearer lines of accountability and service delivery outcomes (McDonald 2001, p.3). Although there is an ongoing trend by utilities to outsource more and more services for efficiency gains it should be recognised that there are implications for the overall business if this is done for short-term cost reduction reasons only. Norton (2001, p.19), supports this view as he explains that it is critical to ensure that pursuing short-term cost reduction objectives does not weaken on-going business performance for the long term.

The decision to structurally change an organisation to obtain operational efficiencies is the very core of
good management. This decision however needs to factor in the overall impact across the organisation. There can be no doubt that a utility business needs to be aligned both structurally and operationally to deliver both the corporate objectives and the clear lines of accountability necessary at all levels for a utility business. This understanding would therefore see the implementation of an appropriate asset management contractual relationship that would have a major impact across a utility business not currently structurally aligned with one of the asset management relationships shown in either Figures 3.8 or 3.9. The impact of any major structural change across an organisation causes major upheavals and requires an appropriate change management program to ensure all parties understand why the change is being implemented. A change management program should be driven for the right reasons based on operational efficiencies and not political gain. The involvement of unions is a critical issue, as the fear factor will play a major role in how well the structural changes are implemented, whether they be wholesale or through progressively smaller steps. The implementation of an asset management contractual relationship model would raise the issues associated with the insourcing and/or outsourcing of various core activities within the organisation. The asset management contractual relationship model does provide an avenue for management to implement this strategy at any time for activities such as maintenance or capital works. This option however would need to be carefully negotiated with the work force and unions to provide a common understanding of why this strategy is justified for the long-term benefits of all key stakeholders.

The business drivers to outsource internal activities are strongly influenced by the background and political climate that the organisation finds itself operating within. The ongoing international drive to corporatize and deregulate utilities has seen traditional government owned monopolies experience increased cost pressures to gain operational efficiencies. This pressure has also increased the move towards privatisation that places even greater pressure on organisations to deliver operational efficiencies to the bottom line for the shareholders. In Australia this approach was clearly evident with the privatisation of the Victorian electricity utilities due to the State’s poor financial position. However the overall performance of the five Victorian utilities since privatisation in 1995 has seen a steady improvement in customer service across the State. In the Victorian Regulator’s 2002 Performance Report for the industry, it was acknowledged by the Victorian Electricity Supply Commission, Chairman Mr John Tamblyn (2003,p.4) that four of the five utilities AGL, Citipower, Powercor and United Energy performed better than the supply reliability targets the commission set them for 2002, while TX Utilities exceeded its minutes-off-supply target by one percent. All distributors in 2002 also surpassed the forecast return on assets set out in the regulator’s 2001-2005 price determination. ESAA managing director Keith Orchison (2003,p.17) explains that the steady improvements achieved by all five privatised state utilities since their formation in 1995, does not get the same media airplay or headlines that any criticism would instantly achieve.

A key issue that has not been fully appreciated until recent times is the acknowledgment that an electricity utility business is an essential service that provides the critical services that customers have come to expect as a day to day way of life. This growing understanding of our standard way of life has been well documented over the last few years with the loss of electricity supply to over 100 million people in the cities of Auckland, London, New York and Italy to name but a few. Clearly Federal and State governments,
regulators, businesses and customers see electricity not only as a commodity but more and more as an essential service that sustains the standard of living we have all come to accept. This recognition has fostered the very strong political/social sentiment now associated with the privatisation of an essential service, such as electricity utilities, that is felt at all levels of the community. This political/social sentiment was well demonstrated in the NSW State election in 2001, when the Carr labour government was supported by a union campaign which opposed the Chikarovski Liberal oppositions plan to privatise NSW electricity utilities. This campaign provided the Carr government with an increased mandate and a history making third term. The decision to privatise or remain in government ownership is clearly outside the control of a utility business as this decision is determined by Federal and/or State government policies. The issue that is in the control of corporate management for utilities is to have in place the most efficient and effective utility structure possible, supported by asset management processes that will deliver the corporate strategies and objectives for the organisation. This would be best achieved by the implementation of the asset management processes and contractual models that have been discussed within this portfolio.

3.3 Performance Management

Performance management is a process that measures the strategic objectives against the operational outcomes of a holistic asset management process. The feedback and monitoring requirements of a performance management process requires considerable Information Technology (IT) development and reporting capabilities. This part of the process incorporates the data management and support system needs for the organisation to feed across divisional boundaries. Linkages to data management systems, Geographic Information Systems (GIS), asset management databases, asset registers, financial accounts and cost tracking systems, and all forms of reporting are required to cater for the various needs across the business. This area has seen tremendous growth over the last ten years, with a great number of international and national companies competing to both develop and provide the state-of-the-art Asset Management (support) Systems now available. The asset management support system is the structure necessary for seamless applications to facilitate the sharing and additional use of important data (UMS Group 1999,p.7.3).

The two questions most organisations ask when it comes to IT support systems are:

Question 1: What have we got?
Question 2: Can we extend it?

The existing applications requiring extended functionality include:

- Work Management
- Maintenance Management
- Work Scheduling
- Time and attendance
- Inventory & Purchasing
Performance Management is an extremely important aspect of any organisation, particularly utilities spread across large geographic areas. The continual improvement philosophy of the Quality Management Systems emphasises the need to track, monitor, measure and assess in order to be able to optimise a system. These are essentially what are needed for the Performance Management of any organisation.

Performance Management:
- Must be defined in detail and measured comprehensively if it is to be managed.
- Key Values: Customers Wants – Customer Needs (A balance)
- Key Measures: Cost, Quality, Internal effectiveness and Asset Utilisation.

Performance Measures:
- Asset Performance
- Organisation Performance
- Business Performance

Performance Development Approach:
- Define mission
- Convert mission to performance objectives at all levels of the enterprise
- Develop cost effective performance measures
- Performance Indicators – measure & report
- Take action to improve performance

The usefulness of Performance Indicators is a function of their ability to drive performance improvement (UMS Group 1999,p.7.3). This view of Performance Management expressed as Asset Performance is also supported in the NSW Total Asset Management (2004,TAM,p.22), as a monitoring strategy defined as a plan of action to continuously monitor through performance indicators the quality of service, efficiency, productivity or cost effectiveness of an agency. The performance indicators are designed to compare existing performance to a standard, target or norm for management purposes. The key issues for the agency are to define:
- Outcomes to be monitored for effective planning and control
- Identify success factors – that which happens when things are going well
• Identify those areas that are under-performing
• Ascertain the reasons for performance deficiencies
• Identify corrective action to correct a deviation to achieve program delivery

Gabb & Bell (2001,p.4), in their recent publication on the development of Powerlink's Integrated Business System Project, which incorporated a new IT system provide an example of the importance placed on integrated business support systems for asset management. This integrated business approach by Powerlink has been based on the philosophy of a seven-layer data information framework. The essence of this strategy is to develop a pyramid that is underpinned by raw information. After interpretation and validation this information is then refined and filtered through layers across the organisation to provide the Performance Management and Reporting mechanisms on the infrastructure. The layers of the Information Pyramid are:

Powerlink Data to Information Framework:
  Layer 1: Data Capture
  Layer 2: Communications Infrastructure
  Layer 3: Data Management
  Layer 4: Manual Data Interpretation
  Layer 5: Automatic Data Interpretation
  Layer 6: Systems Integration
  Layer 7: Management Information System

Powerlink developed this integrated business management system to provide feedback on their assets to maximise their performance in the key areas of technical expertise, reliability for the customer and financial returns to the shareholders. Gabb & Bell (2001,p.15) describe the Powerlink approach as a process of maximising asset performance is an iterative one relying on the feedback of asset performance information into the decision making process. A similar approach to the needs for good supporting IT systems for an integrated asset management process was adopted by Yorkshire Electricity. Their project was known as Distribution Asset Management System (DAMS) with the system developed to provide risk analysis based decision making on their aging assets. This multi-million pound project was designed over four years to provide an integrated suite of applications to support their business systems (Drye 1997,p.2.1.2). Walker & Williamson (2000,p.4), also supports this view as data is an essential ingredient for cost-effective asset management. The asset management process adds value by converting this data into knowledge, which becomes the basis for decisions for reducing the overall life cycle costs of the network. Accurate and reliable data significantly reduces the risk exposure of business decisions. The major issue associated with an integrated asset management process is its dependence on IT support systems to collect the enormous amounts of asset data required to be analysed and assessed to support the decision making processes for the business. This heavy reliance on IT systems is a two edged sword as these IT systems have their own lifecycles which need to be managed appropriately and so require continual hardware and software support.

Sefke (2000, p.10) acknowledges this reliance on IT systems for asset management as he discusses the
complexity of IT asset lifecycles, the strategic importance of IT and the importance of IT asset information for IT service management require a view of IT asset management beyond a project focus but along a system wide framework. The ongoing reliance on Integrated Asset Management (IT) Systems for utilities will not diminish as the continual need for accurate and timely knowledge on the condition of the assets is a core requirement for good asset management. This reliance on IT systems therefore needs to be considered in a strategic way to ensure the IT functions continue to deliver value for money to the asset management process.

3.4 Summary

Asset management is a complex subject matter that has the possibility of impacting upon the structure, business processes and day to day working of a utility business. This complex issue is further complicated by the recognition that Asset Management itself is still in its evolutionary phase and that this will continue as utility businesses struggle to manage constant change in the areas of technology, market forces, political pressures and an ever-changing customer expectation. This evolutionary phase of asset management is recognised from a survey performed by Bartlett (2002,p.2) for the CIGRE TF23.18 working group on Asset Management. The findings from this survey identified a wide range of variations in the very understanding of what Asset Management is and how this understanding impacted on the Asset Management Processes and Models adopted within organisations across a large cross-section of countries around the world.

The available processes and contractual models on Asset management have shown a wide range of definitions of asset management from a very narrow focus to an all-encompassing integrated or holistic approach for a utility business. The wide ranges of interpretations of asset management however do not fully recognise or appreciate the distinct and separate issues associated with the strategic and operational phases of asset management. The strategic phase requires clear strategies of what is required to achieve the corporate objectives through the asset model, while the delivery phase is designed to deliver how to achieve the corporate objectives through the asset model strategies. The development of a holistic asset management approach taken within this portfolio has been based on recognising the importance of fundamentally treating the strategic and operational phases as completely different entities that form to become a holistic asset management process. The recognition of this separation between the strategic and operational phases that form to make up a holistic asset management process is further strengthened through the evolution of a holistic asset management contractual model. The asset management contractual model recognises the benefits of providing clear accountability and separation between the asset owner, asset manager and service provider while ensuring a strong support linkage between these key groups is professionally maintained. Bartlett (2002,p.3) acknowledges the benefits of this need for separation between these three key groups to provide clear accountability and avoid conflicts that may otherwise arise. This conflict is managed through the recognition of the need for continued close teamwork to exist between these three key groups that are reliant on one another to achieve the optimised outcomes for the business.
The evolution and development of the structure of a holistic asset management process was developed through the recognition of two distinct phases developed through a series of manageable building blocks with a clear understanding of the strategic and delivery (operational) needs within each phase. This approach also extends to the development of the asset management contractual model developed within this portfolio. This contractual relationship model recognises the respective parts that the key groups play in being able to properly consider and manage the impact of a holistic asset management process across a utility business. These two distinct phases within a holistic asset management process fall into either Strategic or Delivery roles that are connected by a Performance Management feedback loop to form a Holistic Asset Management Process as detailed in Figure 3.10 below.

Figure 3.10: Holistic Asset Management Process  (Appendix 5.10.5)

The Strategic Phase of the asset management process considers all aspects associated with the strategic planning of the asset, incorporating those issues associated with service needs and asset strategy. The strategic function is very much focused on satisfying the short and long-term needs of the organisation in the areas of service, managed risk and shareholder value. The Delivery (Operational) Phase of the asset management process considers all aspects associated with implementing the asset strategies developed from the strategic phase. This aspect of the asset management process involves the planning creation, maintenance, operating and monitoring of the assets to ensure they are fit for service. The Performance Management loop is an extremely important aspect of any organisation, particularly utility businesses spread across large geographic areas. The continual improvement philosophy of the Quality Management Systems emphasises the need to track, monitor, measure and assess in order to be able to optimise a system.
The development of a holistic asset management contractual model as detailed below in Figure 3.11 below recognises the strategic decision to separate the asset owner, asset manager and service provider functions within a utility business. This provides clear lines of accountability with the key goal of providing greater efficiencies across the utility business (Bartlett 2002, p.2).

![Figure 3.11: Holistic Asset Management Contractual Relationship](image)

This contractual model will continue to evolve as the relationships mature and recognise the dependencies that exist between each of these key groups to achieve the desired optimised outcomes for the utility business through a holistic asset management process. The importance of taking a holistic view to asset management through integrated processes and contractual relationship models provides a utility business the opportunity to develop optimised solutions that are driven by the overall corporate objectives established for the business. These key corporate objectives are essentially optimised trade-offs between the financial performance, operational performance and overall risk exposure for a utility business that is managed through holistic asset management processes and contractual relationship models.

The development of the industry-based case studies detailed within Chapter 4 provide specific examples of the application of a holistic asset management process and contractual relationships along with the issues associated with the implementation of these processes. The case studies demonstrate how asset management as a process is applied and identifies a number of the key issues arising from adapting the process to suit any type of utility business. The outcomes from the case studies provide a better understanding and benefits of implementing the fundamentals of a holistic asset management process into other utility businesses.
CHAPTER 4: INDUSTRY BASED PROJECT

4.1 Introduction

The literature review provides the framework for the principles of asset management and how these principles are seen as an integrated business process. The development of a series of building blocks for a holistic asset management process provides an organisation with the flexibility and freedom to apply the broad principles that best suit existing business practices, processes and work culture. The latest thinking, and development of the current practices, processes and contractual models associated with asset management, provides the framework required for the first investigative issue of the portfolio. This framework and understanding is applied to a number of selected assets owned by Integral Energy as detailed in the second investigative issue of the portfolio:

Investigative issue No.2

To apply the Holistic Asset Management Processes & Models to the assets owned by Integral Energy, to improve its overall performance?

The development of the case studies considers the transportability of holistic asset management processes & contractual relationship models to similar utilities. The level of integration required for the implementation of the model is a major factor of the impact on the organisation; to integrate the processes and models throughout the organisation, to obtain the right mix, and still achieve the desired outcomes for the organisation.

4.2 Research Consideration

The industry-based project of this portfolio is specifically targeted at transmission and distribution assets owned and operated by Integral Energy. The Asset Management processes developed in chapter 3 of this portfolio have been expanded to explain the key issues that need to be addressed when considering a variety of ageing assets in the public arena. The research was designed to consider the respective asset types and explore the variety of business options available to an organisation wanting to address all of the competing stakeholder issues to a level of manageable risk.

The variety of assets explored includes the following three types:

1. Timber Poles
2. Steel Transmission Towers
3. The Asset Management Contractual Model within Integral Energy

The research considered all aspects of these assets, from a corporate and regulatory perspective through the various stages of the asset’s lifecycle, to provide a dirt to dirt perspective of a holistic asset management process.
4.3 Research Design and Methodology

4.3.1 Research Design
The research design was based on developing three (3) case studies of a selected group of assets owned by Integral Energy. These case studies were developed using the framework obtained through the literature review. The intent of the case studies was to challenge the framework and provide greater insight into the portfolio’s investigative issues. The physical, financial and statistical data for each case study was obtained from raw data available within Integral Energy. The qualitative and quantitative data was obtained through the development of the supporting published papers that were used to assist in the development of the overall research objective for this chapter of the portfolio.

4.3.2 Research Methodology
Statistical research methods were used in a select number of the research papers, utilising traditional statistical analysis tools incorporating standard distribution curves and standard deviations. The development of age profiles, risk and economic models play a major part in demonstrating the overall benefits and returns expected by applying the principles of a holistic approach to asset management. These economic models were developed from existing raw data available within Integral Energy. A total of 7 key staff (2 General Managers and 5 Branch Managers) were surveyed to provide their experience, ideas and insights into the benefits of applying asset management processes and contractual relationship models within Integral Energy. These surveys provided an overall understanding of the attitudes of senior management on issues associated with processes, function and structure within an asset management business such as that owned and operated by Integral Energy.

4.3.3 Validity of the Research Methodology
The research design and methodology chosen for this industry project are considered appropriate when taking into account the wide range of options available to any similar type of utility business wanting to implement an integrated asset management process. The literature review identified specifically that every organisation has its own strategic fit and direction and therefore the fundamentals need to be applied that suit the specific competencies of each organisation.
4.4 Case Studies and Analysis

4.4.1 Case Study 1: Timber Poles

This case study examines the strategies and life cycle practices employed by Integral Energy for its 300,000 timber pole assets. The case study reviews each stage of these strategies and how they are applied in accordance with the holistic asset management framework developed from the literature review.

Strategic Phase

The strategy employed by Integral Energy (IE) for the management of its timber pole assets is broken up into three main areas in accordance with the strategic framework developed from Integral Energy’s Strategic Business Plans Years 1999/0 – 2003/4. (Table 4.1)

- Market Model
- Asset Model
- Risk Assessment

Market Model

The market model was designed to ensure alignment of the external and internal business drivers for the needs of the services or products provided by the organisation. The market model is focused on meeting stakeholder expectations in service, quality and value. In this case study the major driver identified through customer surveys and interaction is the expectation of a safe, reliable and environmentally friendly service. Community views of overhead powerlines however has not changed, as a number of local councils are petitioning the NSW government for a retrospective undergrounding policy in all existing overhead areas. This expectation from the customer base is recognised and conveyed in new developments only at this point in time, until an appropriate financial model is approved and developed through the NSW Treasury to provide appropriate funding. These needs and wants of the customer are reflected in the corporate objectives for Integral Energy.

Corporate Objectives

The high level corporate objectives for a large organisation are specifically targeted at selected divisions within the business but are not specifically targeted at any one asset. These corporate objectives are diffused into the strategies employed by the appropriate asset management group. These strategies for asset management issues are conveyed by way of a Strategic Asset Management Plan (SAMP) that is reported at a corporate level but managed by an asset management group.
**High Level Corporate Objectives**

Meet Customer Expectations  
Customer Satisfaction Index  
Target Figure: 85

Improve Shareholder Value  
Improve Economic Profit  
Target: NOPAT - $136M

Network Reliability  
Reliability Index  
Target: 100min/cust.

Develop a SAMP  
Completed Plan  
Target: March 2000

These objectives are developed from customer research studies, monthly reviews with the Industry Regulator (IPART) and, as a State Owned Corporation shareholder, NSW State Treasury. The major focus in the implementation of the market model for the asset management business is to ensure these targets and objectives are achieved through strategies employed within the SAMP.

**Asset Model: Asset Management Plan: Timber Poles**

The asset model can also be expressed as an asset management plan that brings together the condition and asset performance issues that are aligned with the corporate objectives for the business. The specific strategies employed for the asset model will need to take into account the various risks that need to be managed to achieve the specific objectives chosen. The asset model takes into account lifecycle costing, along with financial evaluations and forecasts of the benefits for each specific strategy that makes up the asset model.

**Specific Strategies**

The pole population and age profiles of the timber pole assets (Tables 4.2 & 4.3) owned by Integral Energy show a significant percentage of the timber pole assets to be approaching their forecast economic life of 35 years. This forecast shows a rising trend in operating expenditure to cater for their replacement over the next 10 years. The rising trend of pole failures (Table 4.4) is also a worrying public liability issue, as this small number of poles has failed despite the asset management policies and practices employed by Integral Energy. Corporate objectives have identified in the next five year financial forecast that operating expenditure is to remain constant, with a concurrent increase in capital expenditure over the entire system to cater for an ageing asset base in transformers and increased load growth.

The asset management strategy employed for this specific asset model is to introduce a life cycle extension program by the use of pole reinstatement technology. This technology provides an additional ten years to the age profile of a timber pole and delays the inevitable replacement costs in operating expenditure, while providing a pole safety support mechanism for a pole failure. The regulator sees this life extension strategy as a capital expenditure as the asset life has been increased from its original life cycle forecast of 35 years. This strategy has been preferred to delay the inevitable need to replace the ageing timber pole assets. This strategy serves the corporate objectives for the business by maintaining current operating costs without increasing the risk profile for the business. The budget forecast expenditure for timber pole replacements in the next IPART review will be increased to cater for the inevitable rise in expenditures.
A number of forecast models (Tables 4.5, 4.6 & 4.7) for pole reinstatement and replacement costs are provided to monitor the success of the selected strategy over the coming years. The first-year review of the pole reinstatement strategy and program (Tables 4.8 & 4.9) is showing a significant number of poles requiring the use of this new technology. These would normally have been replaced as part of the normal pole management strategy employed by Integral Energy.

**Risk Assessment**
The risk assessment management plan for timber poles is reviewed on an annual basis to consider such issues as rising trends in both actual/forecast expenditures, pole failure reports, age profiles and defect reports for this type of asset. A variety of strategies is considered that includes both pro-active and reactive responses to the available data on the performance of the timber pole assets.

**Proactive Strategies:**
- New Technology – Pole Reinstatement
- Non-Destructive Evaluation of timber
- Increased inspection cycles
- Pole treatment strategies (Wedding Bells)
- IPART review of increased forecast pole replacement budgets
- Lobby local councils for planning policies for new developments to include using undergrounding, selected corridors and special zonings.

**Reactive Strategies:**
- Replace failed poles
- Emergency response plan for pole failures
- Using temporary pole supports for 48-hour poles. (temporary bracing)
- Benchmarking current practices with other utility businesses for risk mitigation.

The level of risk is quantified and assessed to determine the level of exposure that the organisation will face over the next 12 months. The decisions taken will determine whether the risk is accepted, managed through mitigation or transferred to an appropriate insurance agency or body specifically designed to cater for this type of corporate exposure.

**Strategic Function**
The Strategic Function for Timber Pole Assets that incorporates the Market Model, the Asset Model and Risk Assessment Strategies employed by Integral Energy as detailed in Table 4.1. These strategies are then transferred through the Delivery Phase of a holistic Asset Management Process.
Delivery (Operational) Phase
The delivery phase employed by Integral Energy (IE) for the management of its timber pole assets is broken up into five main areas in accordance with the delivery (operational) phase framework.

- Asset Planning
- Asset Creation
- Maintenance
- Refurbishment
- Disposal

This type of asset is simple in design and nature and is therefore not greatly affected by either the asset planning or asset creation issues that a more complex asset type would be exposed to in its life cycle development. The major issues for this specific type of simple asset are reflected in the key areas of maintenance, refurbishment and disposal relative to a timber pole asset’s lifecycle.

These areas are reviewed in more detail below.

*Source Data obtained from Integral Energy Power Asset Database and Operating Reports.*

Asset Planning
The strategies developed for the management of timber pole assets as detailed in Table 4.1, provides a wide variety of options that will both suit the asset model and align with the corporate objectives for the asset management business. Asset planning will now take these strategies into account and consider the most cost-effective option for the business. The lifecycle costs for each scenario are assessed to ensure financial viability is achieved to meet the corporate guidelines for financial acceptance and approval. The life extension strategy for a timber pole asset, using pole reinstatement technology, provides a win/win scenario for financial payback within one inspection cycle while providing a risk failure mechanism in the process. (Tables 4.10, 4.11 & 4.12)

The use of alternative pole types is also considered during the planning phase, as the option of installing concrete poles to replace existing timber poles is becoming normal practice in high risk scenarios such as bushfire and restricted access areas in national parks and state forests. Concrete poles also have financial benefits by not requiring cyclic ground-line maintenance as compared to timber poles. A life cycle costing is required to compare the purchase price and ongoing maintenance costs for these two types of materials to determine the payback period for the initially more expensive concrete pole option. The life cycle forecast for these two materials shows that a minimum payback period of 25 years is required before breaking even for the use of a concrete pole compared to a timber one (Tables 4.13, 4.14 & 4.15). A payback period of 25 years is not considered viable based on the current corporate financial guidelines. This decision, however, may well change over time, based on Federal and State Policies of imposing financial levies on the use of natural resources such as timber obtained from natural growth forests or the risk to security of supply in bushfire prone areas.
The use of life cycle costing allows an organisation to determine the short- and long-term benefits of considering various strategies during the planning phase of the delivery process, recognising the financial risks associated with owning and operating long term physical assets.

Asset Creation
Asset creation for this type of simple asset is not considered a major issue, as the management of the product is essentially achieved through the maintenance process. The issue of establishing period contracts, however, for the supply of goods and services such as external maintenance contractors, concrete pole suppliers or pole reinstatement contractors would be examined at the asset creation stage of the delivery process. This would require the testing of the market place to obtain an appropriate supplier who would meet the needs of the business and align with corporate policies on the engagement and procurement of external goods and services.

Maintenance Process
The maintenance of timber poles within Integral Energy is regarded as one of the highest priorities in its asset management plan. The reason for this focus is that timber poles are the single largest operating expense in the maintenance budget, with over 316,000 individual poles that need to be maintained within a maximum 4.5 yearly inspection cycle to comply with the regulatory criteria imposed on this type of asset. Timber poles are considered to have the highest public liability exposure of all the assets owned and operated by Integral Energy as they are meshed within the public domain.

The pole failure report is showing an increasing trend in pole failures. The organisation therefore requires a more judicious approach be taken to change this increasing trend. The introduction of pole reinstatement is considered to be a positive step towards reducing this trend and limiting financial expenditure on the replacement of an increasingly large number of condemned poles (Appendix –1 Paper No.1). The success of this program is seen in the large numbers of poles that have been reinstated over a 12month period. These poles would normally have been replaced with a significantly higher operating expenditure (Tables 4.8 & 4.9). The various stages of the maintenance process for timber poles, detailing the maintenance plan and program, appear in Table 4.16.

Refurbishment
The refurbishment options for a simple asset such as a timber pole are very limited. The major opportunity to refurbish a timber pole is to cut away the decayed timber at ground level (nom. 2.0m) and re-size the entire pole to a smaller height and strength capability. This option is one of the few strategies available to a supply utility to reutilise an existing timber pole for the use it was originally intended. This refurbishment strategy provides cost savings in stores purchases for a new similar sized product. The financial savings are justified based on a new for old value being provided for the reused timber pole.
Disposal
Disposal strategies for timber poles have changed dramatically over the last decade, driven by environmental legislation in the areas of pollution and waste management. The decayed and contaminated pole butts are not viable for any purpose other than to be cut away from the timber pole and disposed of as construction waste at landfill sites. The remainder of the timber pole can then be used in a number of alternative ways including recycling and reuse in alternative industries that were once considered not financially viable, such as recycled timber planks and palings for furniture and fences. The intent of this disposal path is compliance with environmental legislation in waste management and sustainability while reducing direct expenditure in waste disposal practices. This strategy is a win/win outcome for all parties involved. A summary of the operational stages for a timber pole asset is detailed in Table 4.17.

Summary
The overviews of the strategic and operational functions, as detailed in Tables 4.1 & 4.17, show the working models of the asset management framework developed in the key areas for a timber pole asset. The alignment of the corporate objectives and their performance is reflected in the feedback in the Performance Management reports. These reports are managed weekly and monthly by the asset management group who report their monthly compliance to the balanced scorecard to senior management. The ability to ramp up or down compliance-to-program is available at anytime to senior management should there be a need due to any number of changing external or internal factors. These factors may be caused by political necessity, such as major bushfires or storms, that may have occurred within or outside of Integral Energy’s franchise area.

The case study demonstrates how a holistic asset management approach provides an organisation with the framework to adjust and monitor the outcomes of an asset’s strategy to align with changing corporate objectives in the areas of financial returns, corporate risk and stakeholder management. This ability has traditionally not been the case as conventional asset management practices have not been holistic in nature and therefore fail to consider the flow on effects of changing asset management strategies to align with often changing corporate objectives for a utility business.
Case Study 2: Steel Transmission Towers

This case study examined the strategies and life cycle practices employed by Integral Energy for its Steel Tower assets. The case study reviewed each stage of these strategies and how they are applied in accordance with the holistic asset management framework developed from the literature review.

Source Data obtained from Integral Energy Power Asset Database and Operating Reports.

Strategic Phase

The strategy employed by Integral Energy (IE) for the management of its steel tower assets is broken down into three main areas in accordance with the strategic framework developed from Integral Energy’s Strategic Business Plans Years 1999/0 – 2003/4. (Table 4.18)

- Market Model
- Asset Model
- Risk Assessment

Market Model and Corporate Objectives

The Market Model and corporate objectives for Integral Energy are the same as in Case Study No.1. The major change to the strategic function of a holistic asset management process was in the areas of the asset model (Asset Management Plan) and risk strategies as detailed below.

Asset Model: Specific Strategies: Steel Towers

Population and age profiles (Table 4.19) of steel tower assets owned by Integral Energy show a significant percentage of the steel towers as having only 15 years of remaining economic life relative to their forecast economic life of 45 years. This forecast would require a rising trend in operating expenditure to cater for their replacement over the next 15 years. The failure of these types of assets is extremely rare as they are an engineered man-made asset and if properly maintained/refurbished will be sustainable well past their current forecast economic life. The only known cause of tower failure in NSW is through violent storms, known as downbursts that are localised and occur in known corridors. However they are extremely rare. Integral Energy has never experienced a failed steel tower in its history to date and does not have many of these assets in known downburst areas.

The corporate objectives specify in the next five year financial forecast that operating expenditure is to remain constant with a concurrent increase in capital expenditure over the entire system, to cater for an ageing asset base in transformers and an increased load growth requiring new zone substations. The asset management strategy traditionally employed for this specific asset type is through a visual routine inspection regime that identifies any defects or deterioration of the galvanised steel structure above ground. The deterioration of a lattice steel tower’s strength capacity is assumed by engineering principles to not significantly be affected by age, providing the steel members are maintained in a rust free condition. The visual inspection, used to provide a condition profile of these ageing assets, provides feedback into an appropriate refurbishment strategy involving steel tower painting programs and below ground assessment of footings.
The below ground condition of steel tower grillage footings is an area that cannot be visually inspected easily, as major work is required to assess the deterioration below-ground. The footings with the highest risk of deterioration, however, can be detected using new technology, known as polarisation resistance measurements and half-cell readings, on all steel tower footings. The use of this simple non-destructive practice allows a profile of the below ground condition of these ageing assets to be obtained. This data is then used to perform batch testing of those towers identified as suspect, by using high levels of DC current flow, and performing field excavations to determine the actual condition of these specifically identified steel tower footings.

The use of this new technology is considered appropriate considering the age profile of the steel towers and their importance to the integrity of the entire electrical system. This pro-active condition assessment would provide input for the inevitable development of a steel tower refurbishment program to offset the need for significant future investments in these critical assets. This strategy, however, would increase the operating budget by only a small degree as this simple pro-active maintenance strategy could be phased in over a 5 year period. The proposed refurbishment strategy would be seen by the regulator as a capital expenditure, as the steel towers’ life span would be extended beyond their original forecast of 45 years.

A financial forecast (Table 4.20) in steel tower refurbishment costs was developed to provide future capital expenditure budget allocations for these specific assets. This strategy is designed to eliminate the need to consider the funding of a full-scale steel tower replacement program in the foreseeable future. This option would require a financial commitment of over $300M over 15 years based on current replacement values for the ageing steel tower population. This pro-active maintenance/refurbishment strategy serves the corporate objectives for the business by essentially maintaining the current operating costs without increasing the risk profile to the business. The forecast budget allocation for the steel tower refurbishment program would be included in the next IPART 5 yearly review to cater for this condition assessment refurbishment strategy.

**Risk Assessment**

The risk assessment management plan for steel towers is reviewed on an annual basis to consider such issues as rising trends in both actual/forecast expenditures, tower condition assessment reports and defect reports for this type of asset. A variety of strategies are considered that includes both pro-active and reactive responses to the available data on the performance of the steel tower assets.

**Pro-active Strategies:**

- Non-Destructive Evaluation of grillage footings
- Cyclic inspection program to assess above ground condition
- IPART review for increased revenue for a strategic steel tower refurbishment program
Reactive Strategies:
   Emergency response plan for a failed steel tower
   Benchmarking current practices with other utility businesses for risk mitigation.

The level of risk was quantified and assessed to determine the level of exposure that the organisation will face over the next 12 months. The decisions taken determine if the risk is accepted, managed through mitigation, or transferred to an appropriate insurance agency or body specifically designed to cater for this type of corporate risk. The risk rating for the failure of a steel tower was considered very low overall and does not lie within the top priority of risks identified by the business.

Strategic Function
The Strategic Function for the Steel Tower Assets, incorporated in the Market Model, Asset Model and Risk Assessment employed by Integral Energy is detailed in Table 4.18. These strategies were then transferred through to the Delivery Phase of the Asset Management Process.

Delivery (Operational) Phase
The delivery phase employed by Integral Energy (IE) for the management of its steel tower assets is broken up into five main areas in accordance with the delivery (operational) phase framework.

   - Asset Planning
   - Asset Creation
   - Maintenance
   - Refurbishment
   - Disposal

This type of asset is complex in design but is essentially managed in a relatively simple manner. These assets are required to be integrated into all phases of a holistic asset management delivery process without being affected by either the asset planning or asset creation issues that a more complex asset type would be exposed to in its life cycle development. The major issues for this specific type of asset are reflected in the key areas of maintenance, refurbishment and disposal relative to a steel tower asset’s life cycle. These areas are reviewed in more detail below.

Asset Planning
The strategies developed for the management of steel towers as detailed in Table 4.18 provides only a limited number of options that suit the asset model and align with the corporate objectives for the asset management business. Asset Planning takes these strategies into account and considers the most cost-effective option for the business. The life cycle costs for each option are assessed to ensure financial viability is achieved to meet the corporate guidelines for financial acceptance and approval.
The life extension strategy for a steel tower asset, using condition assessment and painting techniques, provides financial scenarios that recognise that these types of assets are strategic in nature and require pro-active maintenance and refurbishment strategies to manage the risk profile for the business (Table 4.20). The use of financial evaluations and life cycle costing allows an organisation to determine the short-and long-term benefits of considering various strategies during the planning phase of the delivery process, recognising the financial risks associated with owning and operating long term physical assets.

**Asset Creation**
Asset creation for this type of asset is only performed by a select group of companies and needs to be well defined in engineering design and specification to ensure compliance to industry codes and standards. The construction of a new series of steel towers would involve the testing of the market place to obtain an appropriate contractor capable of meeting the specified needs of the business, who aligns with corporate policies on the engagement of external services.

**Maintenance Process**
The maintenance of a strategic asset such as a steel tower is based on an annual inspection regime designed to identify hardware defects and deterioration of the galvanised steel members. All steel towers are physically climbed on a six year cyclic program to ensure the integrity of the structure is maintained as a whole. This includes such items as bolts, nuts, washers, steel members, attachment plates etc. The visual inspection of these assets provides a condition profile of the ageing assets which then provides input into an appropriate refurbishment strategy.

The below ground condition of steel tower grillage footings was assessed using new technology, known as polarisation resistance measurements or half-cell readings, performed on all steel tower footings over a three year cycle. The use of this simple non-destructive practice provides a profile of the below ground condition of these aging assets to be obtained. This data is used to perform batch testing of those towers identified as suspect, using high levels of DC current flow, and field excavations to determine the actual condition of these specifically identified steel tower footings (Appendix -2 Paper 3). The various stages of the maintenance process, that reflect the maintenance plan and program for steel towers, are detailed in Table 4.21.

**Refurbishment**
The two major refurbishment strategies recognised for existing steel towers are determined from a condition profile identified from an above and below ground condition assessment. These refurbishment strategies are detailed below:

- Steel tower painting program based on cyclic painting on a minimum 10 year cycle
- Below ground tower footing concrete encasement and stub leg replacement program
- A positive anode may be required, as part of this strategy, for those tower legs not seriously corroded
The refurbishment program for steel towers was considered to be the most cost-effective way of deferring a full steel tower replacement program, offsetting the need for significant future investments in these critical assets. The financial modelling of this refurbishment strategy is justified in the short- and long-term based on full steel tower replacement costs (Table 4.20). This steel tower refurbishment strategy was also considered a pro-active risk management strategy for the low risk probability of a steel tower failure.

Disposal
The disposal strategies for steel towers are not a major issue as all waste is recycled in accordance with environmental legislation and the company-wide waste management policy and standards. Steel towers do not generate pollution or waste products and therefore are managed on a needs basis only.

A summary of the operational stages for a steel tower asset is detailed in Table 4.22.

Summary
The overviews of the strategic and operational functions detailed in Tables 4.18 & 4.22, show the working models of a holistic asset management framework developed in the key areas for a steel tower asset. The alignment of the corporate objectives and their performance is reflected in the feedback in the Performance Management reports. These reports are managed weekly and monthly by the asset management group who report their monthly compliance to the balanced scorecard to senior management. The focus of senior management is to ensure compliance to the yearly inspection program along with the pro-active management of any outstanding defects and refurbishment works for these critical strategic assets.
4.4.3 Case Study 3: Asset Management Contractual Relationship within Integral Energy

This case study examines the importance of the asset management contractual relationship and how it impacts on an organisation’s structure, with the adoption and integration of a holistic asset management process across the organisation. The case study examines the asset management contractual relationship within Integral Energy and how it was applied into its Asset Management Business. This case study was compiled based on findings from an internal management report of which the author was a team member.

Background: Integral Energy’s Asset Management Contractual Relationship

The asset management contractual relationship as detailed in chapter 3, is recognised as a formal relationship between an asset manager and a service provider. This view is simplistic in nature, as it does not reflect the intricacies of this relationship. The arrangement between an asset manager and the service provider is designed to provide clear accountability between the groups while ensuring they are working in synergy. This relationship is detailed in Figure 4.0 below. The structural implications of this contractual relationship are wide-ranging and continue to be a major issue within both privately and publicly owned utilities.

![Figure 4.0: Typical long term Asset Management Contractual Relationship](Allen, 1999,p.2)

This Asset Management contractual relationship separates the decision from the action. The decision of what to do is not made by the group who will carry out the action of doing the work. This split has been achieved by the formation of separate divisions or companies, one side taking on the Asset Manager role and the other side taking on the role of Service provider (contractor). The relationship between these two groups is via a Service Level Agreement (internal relationship) or a formal maintenance contract for service external to the company.

A key issue identified within Integral Energy after two years of working with the asset management contractual relationship was the conflict between asset manager and service provider through documented specifications. The relationship was perceived as being a master/servant arrangement that did not recognise the value-add of the service provider. This conflict was emphasised in the specification types that existed at that time through the service level agreement between the two
groups. This conflict was real in nature and a review was established to determine a way forward which would remove this area of conflict from the business.

The final report incorporated the following issues:

**Scope**

- To investigate the nature of how Integral Energy Networks (IEN) specifies the suite of current services from Integral Energy Contracting (IEC), then determine the time required to move from any identified input specified services to either become output or outcome specifications.

- To highlight the implications of input specified, output specified or outcome specified services on risk sharing between service provider and asset manager, which includes the type of risk and where the risk rests.

**Research Sources**

**Primary**

Interviews were conducted with four key IEN senior managers, identified as IEN1, IEN2, IEN3 & IEN4 to determine a proposed time-frame for the move from input specified services. Interviews were conducted with three key IEC senior managers identified as IEC1, IEC2, & IEC3 to assist to drive the IEN timeframe.

**Secondary**

Documentation and environmental scanning was completed which included a review of:

- Training documentation
- IEC procedures
- IEN standards and specifications
- Service Level Agreements
- IEC’s exposure to the external market
- Knowledge bases
- Competencies

**Definitions**

**Outcome-based specifications**

Outcomes are the broad high-level requirements of the asset owner. Outcomes can be financial (such as return on investment), safety, risk or reliability objectives, and address both today’s and future’s requirements of the asset. In order to deliver these long-term requirements, a partnering approach is typically developed between the service provider and the asset manager. Contracts or service level agreements based on outcomes necessitate both the service provider and the asset manager having common objectives.
**Output-based specifications**

Outputs are specific objectives that have been developed to meet the outcomes required of the asset owner. Output specifications specifically address the questions of what and where. Output specifications are typified by quantities, performance standards, timeliness etc. Risks for the effectiveness of the strategic-end-result rests with the asset manager and the operational risk in performing the tasks to the specified technical standards rests with the service provider.

**Input-based specifications**

Input-based specifications require an asset manager to specify the who, how and by when of the task to be performed by a service provider. The service provider is merely required to do what he or she is told with the majority of risk of the inputs, output standards and outcomes resting with the asset manager or specifier. A typical example of this is where IEN might ask IEC to provide a certain number of community service officers to undertake inspections of private electrical installations. Input based specifications provide the service provider with relatively little freedom for innovation compared to output or outcome specifications in the area of service delivery and rarely provide any financial driver to improve productivity.

**Constraints, limitations and technical standards**

These are prepared by the asset manager and establish the required technical standards, environmental precautions, limits for working hours, noise etc that the asset manager expects from any service provider. These requirements reflect the legal, social, quality and ethical standards that the owner, on the advice of the asset manager, expects from a service provider.

**Introduction**

Any form of work contract typically has three generic segments:

**Commercial conditions** under which the contract will be managed. These include such provisions as payment terms, dispute resolution mechanisms, provisions for extensions of time, latent conditions etc. and relate to contractual terms and conditions. The commercial conditions need to relate to, and match, the third section as detailed below.

**Technical standards** for the works. These dictate to the service provider the minimum standards of work required to ensure compliance with applicable legislation, social obligations and quality systems. For example, specific-working conditions may be insisted on to minimise erosion or noise in certain areas.

The third section determines whether the contract is input, output or outcome specified. It will include the **schedules** which typically call for strategic results in outcome based contracts, contain the schedule of rates or lump sum schedules for output based specifications or dictate how a job will be done for input based specifications. IEN generally have good technical standards in place. In relation to the quality of work, it is a requirement that all service providers are quality accredited or moving to
same. Commercial conditions have been written for only a few products and are largely untested in the contestable market place. At present, within the SLAs with IEC, the commercial conditions tend to be superficial and require enhancement to flesh out the appropriate arrangements between a premier asset manager and its service provider. Schedules of rates exist only for a few products and are limited to maintenance products whilst most construction works are quoted on a lump sum basis. To expand the numbers of products that are specified by a schedule of rates, a significant amount of work will be required, of IEN in terms of the collection of data, and IEC in terms of operational practice and reporting. IEC should actively support IEN in their definitions of appropriate unit rate items and associated data.

**Services and Specification Methods Matrix**

Figure 4.1 below provides a snapshot view of where input, output and outcome specified products and services are currently specified on the continuum and the view of IEN business managers on where they should move to and the time frame for this move.

**Figure 4.1: Service Provision Matrix**

*Note 1:* The present and proposed position on the continuum is a consolidation of views from interviews between IEC/IEN business managers and this team.

*Note 2:* Time frames for movement along the continuum is a consolidation of views of the IEN managers interviewed
Current Business Competencies

Integral Energy Contracting
Current competencies in commercial project management are limited. Transmission staff had most exposure to commercial contract management but this is clearly an area targeted for improvement. IEC prepared a tender and quotation manual that sets out the procedures and standards for the establishment and management of contractual arrangements with subcontractors and clients. There is a limited understanding of what goes into an output or outcomes type specification, which is also the case with the management of long-term-relationship type contracts.

Integral Energy Networks
The majority of the staff in Asset Services and Network Projects received training in contract management however, there is limited experience in managing such contracts. There is a limited understanding of what is required in output or outcomes type specifications, which is also the case with the management of long-term relationship type contracts.

Risk Implications
A premier asset manager employs a generic partnering approach with service providers wherever practicable. This partnering approach provides an environment of shared risk where the service provider understands and is committed to aligned goals with the asset manager and owner. Reliable and effective key performance indicators linked to performance rewards are a vital component of effective partnering and serve to spread the risk of poor outcomes and the rewards for good outcomes. The number of services and the degree to which they can be moved from input to output to outcome based specifications is dependent on the nature of outsourcing employed; eg. should small packets of work be out-sourced in a competitive-tender situation where partnering relationships would be difficult to establish? Output-based specifications, including schedule of rates or lump sum contracts, would be most effective in these circumstances. If large packets of work were out-sourced over long contract terms, there would be more opportunity for outcome-based relationships? Under output based contracts, the risks associated with the strategic outcomes of services remain with the asset manager. The service provider carries the risk to ensure services meet the technical specifications.
Summary of Interviews

Key Issues
Detailed below is an extract of the key issues raised by the seven (7) IEN & IEC senior managers interviewed on the issues of specifications and the existing asset management model:

Interviews
Integral Energy Network 1
Although it has been stated that it is desirable to move towards an “Outcome” based strategy in the contractual arrangement between IEN and IEC, there are major philosophical issues involved in a move to such a position. It is very difficult to write an SLA which can be realistically outcome-based when an SLA is for a term which is short relative to the expected life of the asset. Where an asset has a long life, failure to carry out adequate maintenance, either in content or in quality, may not become evident until well after the SLA period. Failure to carry out adequate work can incur large costs for the network manager in future years without redress being available to the network manager against the contractor.

Outcome-based SLA's can be successfully produced in areas of short-term activity where there is a linkage between the activity and the outcome. Even so, measurement of the "outcome" is very difficult without an accurate and detailed Asset Information System that has a comprehensive history and ability to be responsive in the results. Examples of these areas include vegetation management, street light replacement. With an outcome-based relationship, the risks associated with the activity need to be shifted towards the supplier. In any relationship between a supplier and purchaser, there is a vital need to ensure that there is a good and clear understanding of the mutual objectives (both stated and unstated) of both parties. Generally, the supplier seeks to minimise costs, maximise sales volume and gross margin. Where a contract is fixed price, the objective is to minimise the work that needs to be done for the fixed price. Where the price is linked to output, the objective is to maximise the work that can attract the highest gross margin. On the other hand, the purchaser seeks to maximise the amount of work undertaken, minimise the net costs and ensure that a superior standard of work is undertaken on time and on budget. It is a very special contract construction that can be arranged so that both the supplier and the purchaser have a coincident alignment of objectives. It is possible, but very difficult.

Where an outcome based structure is developed, it is necessary to have a structure where the supplier is required to carry risk associated with failure to meet objectives. With short-term contracts and long-life assets, this is very difficult to achieve. When a failure occurs, the cost of carrying out the repairs need to be borne by the supplier. However, when the value of the assets involved is much greater than the value of the services provided and when the life of the asset is much longer than the contract period, it is unrealistic to expect the supplier to make a provision in the contract price to cover all contingencies.
Where faults occur and it is deemed to be a contractor’s responsibility to repair, there is potential for conflict to occur as to who is to accept responsibility for the failure (environment, abnormal storms, poor condition of the asset at the start of the contract, not being in alignment with contractor’s understanding). If an outcome-based arrangement is established, it could well be argued that there is no role for IEN. The asset owner could engage the supplier directly. For a large network with a wide variety of equipment, there is a need to ensure some standardisation of equipment that is being installed. Outcome-based strategies would seek to break down such standardisation. ‘I see great difficulty in Networks moving away from input based specifications associated with the key high value assets.’

**Integral Energy Network 2**

I am a firm believer in the Asset Manager/Service Provider model, the Asset Manager being responsible for outcomes and the Service Provider responsible for outputs. I support the argument that recognises that the life of electrical assets is far beyond the duration of the service contract and hence the inappropriateness of basing commercial contracts on outcome.

If the service provider is to assume responsibility for outcomes in relation to core activities then it would need to employ asset management strategists and that function within IEN would then become redundant. Hence rather than be talking outcomes IEC should be focused on outputs, leaving the asset managers to ensure that appropriate asset management decisions are made to deliver the outcomes agreed with the owner. ‘To give as an example, pole maintenance, the role of the asset manager is to research the topic, influence regulations etc and so determine the key life cycle parameters. These key parameters are frequency of inspections, the type of ground line treatment, criteria for replacing or nailing of poles and the data collection specification. An outcome-based specification would say, We want less than five pole failures per year. This would require all the technology development/asset management analysis to be undertaken by IEC. I do not believe this is the (best practice) asset management model adopted by Integral Energy.’

‘For non-core activities, for example building maintenance or vegetation management, IEN might well decide not to possess asset management expertise in such areas and so totally outsource these functions in an outcome based contract. There already exist vegetation management companies who “do the whole thing”, based on outcomes.’

‘I see “partnering”, then, as depicting the situation where IEN elects to give work to IEC without competitive tendering, albeit in a commercially based arrangement. A partnering agreement implies that the asset manager is reasonably happy with the level, quality and cost of service provided by the partner and is seeing the arrangement as beneficial in the long term.’
Question: What response does the above require from IEN and IEC?

‘Ensure all core activities are provided through output based specifications (eg fault and emergency). Embrace “outcome” based contracts for non-core activities (eg building maintenance and vegetation management). Continue the partnering relationship with IEC where mutually agreed.’

The current culture within both IEC and IEN has seen a number of opportunities to develop good partnering relationships fall short of the mark. The following are just some examples of issues associated with partnering that have eventuated in the recent past and drive home the importance of change to the business. There is the need for a proactive push to change all processes from input based specifications to output based specifications and to evolve partnering arrangements in order to achieve Integral Energy’s goal of being a premier asset manager.

**Building Maintenance** - Presently Commercial Services submits a wish list of zone substation building maintenance work each year with a cost alongside each item. This allows Asset Services to select a program according to budget and need. Commercial Services compiles the program, undertakes the work and gives regular reports. We should be trying to replicate this process in other areas involving IEC.

**Zone Subs/Transmission Subs** - Despite IEC being the service provider for zone substation maintenance, IEN had occasion to draw attention to the poor housekeeping situation that had developed. This is an example of lack of ownership by IEC, which a partnering relationship would aim to overcome.

**Reporting** - IEC’s monthly reporting is a good basis for a partnering relationship. Each portfolio is reported in detail and this fosters ownership by the service provider.

**Voltage Complaints** – Maintenance & Lighting Solutions, in recent times, restructured to enable them to handle voltage complaints in an expeditious and efficient way. Partnering should result in IEN having very little involvement, with monthly reports providing details and analysis for feedback to the asset management process and area studies being undertaken, as required, to guide future strategies.

**Vegetation management** - External proposals for this contract highlighted that all vegetation management complaints are fed direct to the contractor, once again with monthly reports. ‘Another example where IEN should not get involved at the operational level, particularly in non-core activities’

**Red and Green Books** - IEN endeavoured to contract this project as a whole project, seeking an all-up price. This failed for two successive years as IEC would not accept any risk and as a price was required before the detailed designs were done, the price was loaded to cover risk. This naturally
resulted in the overall price being unacceptable and hence the proposal floundered. In a partnering relationship IEC would not seek to pad the price but benchmark the projects based on previous years.

**Defect Management** - Another opportunity for IEC to manage a significant activity by output specification. This activity is currently consuming a huge amount of IEN time.

**Essential Spares** - Another example where IEC is missing an opportunity to help Networks and themselves, by being proactive with essential spares. Once again, Commercial Services have been successful in this area.

**Maintenance Programming/Program** - IEC could play a much more involved role in Network Maintenance. Currently they contribute little to the evolvement of the annual maintenance program and then are reluctant to program their maintenance activities for the year ahead (which would allow outages to be coordinated etc). The team should explore how IEC could develop more ownership of maintenance.

**Integral Energy Network 3**

Move to outcome based would be quite a difficult exercise due to trust, such that the premier asset manager performs the right work, provides correct reports, ensures defects are corrected on time, provides intelligence and adds value, is on budget, does no more than specified, and completes the program.

In relation to essential spares there is a need for standardisation and not a “hotch-potch” arrangement, thus there needs to be some control and philosophy to prevent this.

In relation to preventative maintenance the West Liverpool example was raised which highlighted IEC going off and doing their own thing.

**Vegetation Management** - is predominantly output based with little input and it is believed it will move to outcome within 3 years

**Inspections** - in IEN 3’s view they do not add or release value to the organisation. Data would need to be collected and analysed to support. Competency and history demonstrates the ability to move to outcome-based specification would be in excess of five years.

**Condition Based** – Delegates authority based on an input specification (basically input). Possibility of moving to output specification based on standard and penalty provisions. Potential for asset manager to institute differing strategies which will remove the need to replace assets eg poles and distribution substations. Presently the competency to perform this is not apparent. Move to output approx two years
**Fault and Emergency** – firmly believes that this can move to outcome based within two to three years as IEC have the potential to provide and realise value.

**Refurbishment** – Huge contractual difficulties for contractor to provide satisfactory risk profile to asset manager. Move to output three to five years

**Essential Spares** – Not possible to move to output (similar to refurbishment). Standardised components are the philosophical strategy for network compatibility. Move maybe to output in three to five years

**Construction** – consider move to output based on turnkey projects and standardised components are the philosophical strategy for network compatibility. Move to output for transmission construction would be within 12 months however other construction services would be in approximately two to three years.

**Integral Energy Network 4**

Generally, IEN 4 feels that most of what is described below can occur within three years.

**Preventative Zone substation & Transmission substation** – Existing specifications or standards are a mixture of input and output. Migration to outcome based would be simple to specify but perhaps involve IEC in too much asset management.

**Preventative Distribution Substation, Transmission Mains, Distribution Mains** – very little, if any, preventative maintenance performance on distribution assets.

**Preventative Vegetation Management** – Migration to outcome-based for these areas would be relatively easy to specify.

**Inspections** – would not be specifically required if full outcome-based specifications were adopted. The current mixture of input/output based inspections would require revision, dependent on the degree of outcome based specifications adopted.

**Condition Based** – Migration from mainly input based to outcome based would involve handover of standards (and people involved in establishing standards) to IEC.

**Fault & Emergency** – generally F&E is output based, ie when it’s “broke” IEC is instructed to fix-it in accordance with an allocated priority. Network currently gets involved in significant resource allocation issues. Migration to outcome-based would involve IEC in asset management. Preferred would be to fine-tune output-based specifications to ensure IEC does resource management and IEN the asset management.
Refurbishment and essential spares – with detailed knowledge of asset condition IEC could be asked to recommend refurbishment of particular equipment.

Customer service functions - migration to outcome would involve IEC in asset management.

Construction – migration to outcome based would involve transfer of standards (and people involved in asset services)

Interviews

Integral Energy Contracting 1

Inspections – These are input specified services. As the relationship moves up the continuum towards outcome-based, an asset manager will not specify inspections. Inspections will be an internal process of the service provider conducted in order to deliver the strategic outcomes required by the asset manager.

Condition based maintenance - is currently input-based but should progress up the continuum to eventually become outcome-based. IEC1 supports cross IEC/IEN teams to review the process to achieve and gather the appropriate data, determine the critical value of various assets and investigate what other companies have done in this area. ‘Contracts need to be developed that complement this direction and provide for risk and reward sharing based on the achievement of mutual goals. Alliances with suppliers should be developed to minimise costs. The smart contractor working in a partnership with the asset manager should retain the technical intelligence to provide the commercial strategic outcomes of the asset manager.’

Question: Should some of the technical intelligence currently sitting in IEN be transferred to IEC in order to facilitate this principle?

Fault and Emergency – Common IEC/IEN teams should be formed to similarly promote the shift up the continuum towards outcome based specifications in the same way as condition based maintenance.

Refurbishment - This program is now output-based and is probably the easiest to move to an outcome-based contract. IEC 1 supports this program perhaps being a pilot in developing the appropriate contracts and standards etc. to shift to outcome.

Construction – IEC 1 is happy to contribute resources to assist IEN to review technical and commercial specifications and data to allow the shift from input to output-based contracts.

In promoting the advantages of shifting up the continuum towards outcome-based specifications, one must recognise the current reality of the cultural norms existing in both IEC and IEN. IEC tends to ask
for lots of input instruction from IEN and IEN tends to want to provide it. This can be changed but must be recognised as an issue to be addressed in any overall strategy.

**Integral Energy Contracting 2**

IEC2 supports the move from input-based specifications in construction projects to become output-based. He feels that construction staff could add much more value if they were allowed to function as a “smart contractor” and should be encouraged to pursue delegated authority to make some of those input based specification decisions currently made by IEN. IEC are currently training key staff in commercial contract and project management practices which will facilitate IEC being able to support IEN in their move towards output-based contracts. It is recognised that one must pass through good commercial output-based contract management practices on the journey to becoming effective partners in an outcome-based relationship.

Typically, distribution construction projects are one-off short-term commercial arrangements with the client. The allocation of risk to the service provider under such arrangements is a matter of preparing tight output-based specifications. The associated technical specifications must necessarily be prescriptive in order to ensure a degree of standardisation of network materials and therefore essential spares. It is only in this way that construction activities can align with the typical whole-of-life goals of a premier asset manager.

Providing the service provider with the greater flexibility of output- and outcome-based specifications allows the smart contractor to provide innovative solutions to contracting briefs. This would facilitate potentially better solutions for the asset manager at reduced prices. Output-based specifications would also provide the flexibility to better drive productivity gains in IEC, through encouraging innovative work practices and processes and enhancing staff ownership of the products and services they provide. IEC would need to work on developing a culture shift in staff attitudes to help them understand their role as a value-adding contractor, as opposed to a “dumb contractor” who does as they are told by the asset manager. Some form of profit sharing with the asset manager needs to be considered in order to establish a common set of goals and drivers between IEC and IEN. The goal of profit maximisation for IEC needs to be complemented with KPIs that reflect IEN’s goals and objectives.

**Integral Energy Contracting 3**

The existing SLA between IEN and IEC is designed and intended to be an output arrangement. However the technical specifications that underpin the SLA can be classified as follows:

- Preventative Maintenance – input specifications
- Inspections – input specifications.
- Vegetation Management – output specifications.
- Condition Based Maintenance – input specifications.
- Fault and Emergency  - outcome specifications, however the payment arrangements are on disbursement costs and are classified as an input arrangement.
Findings & Observations

The findings from the interviews show that the two groups are well apart in their current thinking. IEN has taken the role of the Asset Manager as the contractual relationship requires and reinforces the need to keep the strategies and objectives for the assets on their side of the asset management contractual relationship. The IEC view is focused on moving the decision component of the asset management role onto their side of the asset management contractual relationship and argue that outcome-based specifications are all that the asset manager is required to be concerned about. These differing and conflicting views of the two key groups involved in the asset management contractual relationship appear to be based on a lack of understanding of the intent and objectives of the asset management relationship. The original decision to establish this asset management relationship within Integral Energy was introduced without any history or understanding by all parties involved, as the contractual relationship was adopted directly from benchmarking practices identified by the UMS Group without consideration of the existing relationships and roles within Integral Energy.

The Asset Management contractual relationship is designed for the asset manager to develop strategies and objectives that align with the corporate objectives of the business. The service provider has an overlapping role in delivering the services required by the asset manager by providing value-added insight and knowledge on the condition of the assets. The relationship is established on trust that has evolved over years with a common understanding that is reflected in a performance-based service-level agreement. This relationship however requires both parties to understand their respective roles. The issue here is not the roles of each party but the history and learning required to understanding and embracing the unique operational relationship that also needs to evolve overtime. The decision to implement this asset management contractual relationship into a business like Integral Energy with many years of regional management experience requires a great deal of communication and workshopping to ensure a common alignment in respective roles is understood and taken on by the respective parties. The dysfunctional relationship at a senior management level between the two key internal management groups could not be allowed to continue in its current form without change. Otherwise, communication from senior management down through the respective levels of middle management will continue to emphasise the misalignment of the core business objectives, to the detriment of the business.

Structural Change
Alignment

The findings from the review of the conflicts in the asset management contractual relationship identified the dysfunctional nature of the relationship existing between IEN/IEC, which would require realignment with the corporate intent for the asset management business. This realignment was achieved by removing the contractual relationship between these two groups and restructuring them into a much larger and combined Asset Management Group with a new smaller Engineering Performance Group, designed to ensure the larger Asset Management group is delivering the objectives for the business as a whole.
This arrangement removes the fear of out-sourcing the service provider (contractor) role within the business and communicates a United – One Integral Approach that removes conflict and ensures a common set of objectives for the asset management business and Integral Energy as a whole. The clear agenda for all works is now very much internally focussed on the assets owned and operated by Integral Energy and no longer on the goal of obtaining additional income from external works to minimise the threat of being replaced by an alternative premium service provider. The strategy to outsource the Service Provider side of the business was aligned with the political agenda of privatising the NSW electricity industry. This political agenda would have required the business to demonstrate best practice asset management as identified by the UMS Group (1999,p.9.5) by testing the external market for these asset management services. This political agenda no longer prevailed and therefore a more inwardly focussed corporate strategy and organisational structure was adopted that aligned with the more traditional regional based management team and existing workforce.

4.5 Discussion and Managerial Implications

4.5.1 Asset Management Implications

The case studies demonstrate that the implementation and application of the asset management processes and contractual relationship models take considerably more effort than simply introducing or directing alignment of the interested parties. Integral Energy is perceived as a progressive utility within the electricity industry in a number of areas and has won both the silver and gold quality awards for a medium size enterprise over the last five years. Even with these credentials the implementation of the asset management processes and contractual relationship models has proven to generate dysfunctional behaviour between the various parties required to work together within the framework of a asset management contractual relationship.

The implementation of the asset management processes and contractual relationship models requires clear understanding and commitment by all the parties involved. The full implementation of the asset management processes and contractual models has proven to be too onerous on the operational side of the business in the short term, and would have been more successful if implemented in a staged approach, with a focus on the more critical issues to be addressed for the asset management business. This understanding is supported by Williamson (1996,p.6), in her case study of Air-services Australia, in which she concludes to achieve best practice in Asset Management, the list of tasks would be too onerous and therefore recommends that the critical issues be identified and worked upon to achieve the long term outcomes desired for the business. This view is also supported by Byrne (1996,p.11), also supports this view and emphasises that Asset Management is a program of continuous improvement and should be implemented in successive steps, by addressing the critical issues first with the fleshing-out undertaken over time.

4.5.2 Transportability of the Asset Management Processes & Contractual Models

The issue that needs to be considered is the transportability of holistic asset management processes
& contractual relationship models to other industries other than supply utilities. The case studies demonstrate that the processes and contractual models are transportable as they have been developed on a National basis with a focus on physical infrastructure such as roads, buildings, sewer systems, bridges etc.

A definition for an asset is:

\[ \text{service potential or future common benefit controlled by an entity as a result of past transactions or other past events} \] (National Asset Management Manual 1994, p.10).

The type of physical assets is not an issue in a holistic asset management process and contractual models as they are generic in nature and applicable to any type of physical asset irrespective of size, location or complexity. The issue that the process does not specifically address is the type of assessment tools and techniques to be used which are very much asset-dependant. The need to perform condition assessments is identified within the various stages of the process to determine condition and appropriate actions to rectify deterioration and under-performing assets. The type of diagnostic tools and techniques is a key variable as it is dependent on the type of asset being considered and the available technology. Advances in technology are providing opportunities to obtain new tools and diagnostic techniques to assess the condition of physical assets. Some examples of these new tools and techniques are seen in the use of remote videos in sewer systems to determine the extent of damage or decay, vibration monitors and heat sensors on rotating machines and on line partial discharge monitors for insulation decay which are all very much asset dependent. The output from these tools and techniques feeds into the asset management process to be assessed, and decisions are then made to align with the asset management strategies for the business. The transportability of the asset management process is not asset dependent and therefore is available for use by any form of utilities such as telecommunications, manufacturing plants, power stations, hydro system etc.

The issue that is paramount is the way a holistic asset management process and associated contractual relationship model is implemented into the business. The existing systems, structure and culture of the business play a major role in how these systems are integrated into the everyday operational life of the business. A change management program directed at all levels of the business would be required to bring together the core competencies of the business while communicating the benefits of adopting a holistic asset management approach. Kanak (2002,p.29), supports this view through the smooth introduction of an organisation-wide integrated maintenance information system at Sydney Water, due to a well planned change management program identified early in the project’s initial planning stage.

The case study identified the pitfalls of not having considered an appropriate change program for the introduction of the asset management contractual relationship model within Integral Energy. The need to introduce an appropriate strategy to best suit the alignment of an organisation’s strategic
competencies within a dynamic environment is a sentiment supported by Stace & Dunphy (1994,p.81) in which they explain **what is appropriate for one organisation may not be appropriate for another. So we need a model of change that is essentially a situational or contingency model, that is, one that indicates how to vary change strategies to achieve optimum fit with the changing environment.**

The case study also identified that the existing culture of the business was not conducive to organisational change designed for the asset management decisions to be made at a central head office location rather than the historical regional level. Legge (1995,p.198) discusses the failure to manage the culture of an organisation through change programs by such commentators as, Peters and Waterman (1982): Kanter (1983,1989,1995), in which they have expressed the belief that organisational culture can be manipulated through organisational change programs. This argument recognises that culture is developed by the social interactions of the people that do work within the organisation and validated over a period of time. Thus the concept of cultural change would need to follow along the same lines that these individuals have learned over time, otherwise the cultural will not change and the program will fail or lose credibility.

Identifying the appropriate change program to best suit the realignment of the organisation is only part of the equation, as it is the people within the organisation that will make it happen. This can only occur when the need to change is well communicated throughout the organisation from the top down and by utilising the appropriate human resource strategy. In research compiled by Stace & Dunphy (1991,p.132), of thirteen Australian organisations which had introduced change programs they found that Human Resource Management strategies are vital elements in the successful re-positioning of organisations undergoing strategic change. The need for an appropriate change management program before implementing an integrated asset management process or contractual relationship model into a utility requires careful thought and planning to ensure the change program is successful in the long term for the business and its people.

**4.5.3 Managing the Business**

The case studies have provided an understanding of how to integrate the physical assets managed by Integral Energy into the framework developed for a holistic asset management process and contractual relationship models. The asset management process provides the flexibility and freedom to apply the broad principles of asset management that best suit an organisation’s existing business practices, processes and work culture.

The objective of the industry project was to apply the asset management processes and contractual models in practice to validate the projected outcomes as detailed in the second investigative issue of this portfolio:
Investigative Issue No.2

To apply the Holistic Asset Management Processes & Models to the assets owned by Integral Energy, to improve its overall performance?

The application of the asset management process and contractual relationship models, using the assets owned by Integral Energy, shows how asset management as a process brings together all aspects of asset ownership. These can then be aligned to deliver the corporate objectives for the business and improve its overall performance. These corporate objectives are focused on the financial viability of the business as a whole and at times will conflict with the principles of managing long-term assets. Managing this perceived conflict in principles, however, is in fact the role of an asset manager who aligns strategies for the assets with the required corporate objectives for the business, at a defined level of risk. The level of risk is essentially the variable, as changing strategies for short-term financial gains at a corporate level would raise the risk profile for the organisation, which would be reflected in the increased risk rating in the corporate risk management plan.

This short-term corporate strategy is acknowledged by Kingdom (1995, p.23), in which he uses the term Asset Stripping as a corporate management tool to utilise the maintenance dollar to fund the organisation’s short term business objectives. This practice is reported as being wide-spread in large utilities as a short-term measure; exploiting the organisation’s assets at the cost of future generations.

The issue for the asset manager is to ensure the asset strategies are aligned with the corporate objectives at an appropriate level of manageable risk that is acceptable at a corporate level. The benefits of a holistic asset management approach within a utility is that transparency is apparent and accountability is clear at each stage of the asset’s life cycle. The case studies provide this clear understanding of the alignment of the asset management strategies and the corporate objectives, which are reflected in the asset model, through the distinct stages of the delivery phase of the asset management process. The issue of implementing comprehensive asset management processes and contractual relationship models into an organisation requires an appropriate change management strategy that considers the disruption and trauma caused to the existing operational needs of the business. This strategy would be required to factor in the impact on the key assets that make up the business, its people, as without their commitment the overall objectives and outcomes for the business will not be fully achieved.

4.6 Summary

The industry based project demonstrated the application of a holistic asset management process for timber pole and steel tower assets that align with the documented 5 year business plans for Integral Energy. The ability to document and manage this alignment through the performance of a particular asset base is a critical issue for a utility business recognising the need to demonstrate due diligence in all aspects of operating a utility business in the public domain while providing both shareholder
value and customer expectations. These complex issues require a holistic approach be taken on asset management that allows all aspects of an asset’s lifecycle be managed in a documented, factual and considered way that then allows alignment of the corporate objectives with the condition of the assets to provide the optimised solution for the organisation at any point in time.

The need for a utility to align with the asset management process is appropriate. However, the case studies show that this alignment causes concern and at times dysfunctional behaviour to occur if the desired structural outcomes to align with the asset management process and contractual relationship models are not fully communicated to all key stakeholders. The decision to implement gradual change or across the board change is an issue that is very much utility dependant and needs to be therefore considered on a case by case basis depending on the business imperatives to achieve optimum outcomes for the shareholders and corporate management. The issue for the decision to implement a holistic asset management process into a utility will require careful and prudent consideration to ensure the right change management strategy is chosen that suits the outcomes and timeframe required for the organisation.
4.7 LIST OF TABLES
Strategic Function-Timber Poles

Table 4.1
Integral Energy Pole Population and Types

Total Pole Number - 315,429

- Concrete: 303,352
- Steel: 2,620
- Wood: 5,457

Table 4.2
Number of Failed Poles Inside Integral Energy Area

As at: 28 February 2002
Prior to 1994 no data was available for the South Coast

Table 4.4
Projected Pole Repacements (distributed)

Table 4.5
Projected Pole Replacements
(50% replaced/nailed, distributed)

Table 4.6
Projected Pole Replacement Costs (distributed)

Table 4.7
Table 4.8

Integral Energy Reinstated Pole Number

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poles</td>
<td>309,334</td>
</tr>
<tr>
<td>Reinstated Poles</td>
<td>6,095</td>
</tr>
</tbody>
</table>
## Pole Reinstatement Program Yr 1999/2000

### Table 4.9

<table>
<thead>
<tr>
<th></th>
<th>WALL THICKNESS</th>
<th>TOTAL</th>
<th>OVERHEAD INSPECTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WT Actual Mth</td>
<td>Proj</td>
<td>Actual Cum</td>
</tr>
<tr>
<td>Jul-99</td>
<td>54</td>
<td>54</td>
<td>0</td>
</tr>
<tr>
<td>Aug-99</td>
<td>97</td>
<td>151</td>
<td>0</td>
</tr>
<tr>
<td>Sep-99</td>
<td>114</td>
<td>265</td>
<td>0</td>
</tr>
<tr>
<td>Oct-99</td>
<td>81</td>
<td>346</td>
<td>0</td>
</tr>
<tr>
<td>Nov-99</td>
<td>79</td>
<td>425</td>
<td>0</td>
</tr>
<tr>
<td>Dec-99</td>
<td>25</td>
<td>450</td>
<td>0</td>
</tr>
<tr>
<td>Jan-00</td>
<td>63</td>
<td>513</td>
<td>0</td>
</tr>
<tr>
<td>Feb-00</td>
<td>89</td>
<td>602</td>
<td>0</td>
</tr>
<tr>
<td>Mar-00</td>
<td>131</td>
<td>733</td>
<td>0</td>
</tr>
<tr>
<td>Apr-00</td>
<td>114</td>
<td>847</td>
<td>0</td>
</tr>
<tr>
<td>May-00</td>
<td>160</td>
<td>1007</td>
<td>0</td>
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<tr>
<td>Jun-00</td>
<td>82</td>
<td>1089</td>
<td>0</td>
</tr>
</tbody>
</table>

- WT: Wall Thickness
- OLI: Overhead Inspector

### Graph

- WT Actual Mth
- Total
- OLI Actual Mth

**Table 4.9**
Assumptions:
1. Average Pole Replacement Cost- $1500
2. Reinstatement Cost : $440
3. Timber Pole Life Expectancy 35 years

Table 4.10
Fig 2: High Voltage Mains

Assumptions:
1. Average Pole Replacement Cost - $2500
2. Reinstatement Cost: $490
3. Timber Pole Life Expectancy 35 years

Table 4.11
Fig 3: Transmission Mains

Assumptions:
1. Average Pole Replacement Cost - $7500
2. Reinstatement Cost: $650
3. Timber Pole Life Expectancy 35 years

Table 4.12
Concrete Versus Wooden Poles
11.0 metre/ 4kN Poles

![Graph showing the comparison between wooden and concrete poles over years](image)

Table 4.13
Concrete Versus Wooden Poles

12.5 metre / 8kN Poles

Table 4.14
Concrete Versus Wooden Poles
14.0 metre/ 12kN Poles

Table 4.15
Maintenance Process-Timber Poles

STRATEGIC PHASE
MAINTENANCE PLANNING

- Asset Performance Data & Monitoring
  - Impact on reliability
  - Failure Report
  - Defect report
  - Financial tracking

- Maintain Asset Data Base
  - Update maintenance compliance/program defects

- Analysis of Asset Profile & Performance
  - Assessing Trends
  - Expenditure
  - Failure rates (types, locations etc)
  - Fault & emergency
  - Reliability
  - Audit reports
  - Age profile

- Review Asset Management Strategies
  - Inspection regime (time/type etc)
  - New technologies
  - Financial implications
  - Forecast improvements

- Reconcile Business Objective with Asset Management Objectives
  - Reducing failure trends
  - Financial Management - R.O.I.
  - Asset Model Objectives

- Review Asset Management Standards & Technical Specifications
  - Modify to suit desired strategy
  - Period of inspection
  - Type of inspection
  - Reporting
  - Treatments

- Maintenance Plan
  - No of inspections
  - Period of inspections
  - Type of inspections
  - Approved Budget

- Reconcile Business Objective with Asset Management Objectives
  - Reducing failure trends
  - Financial Management - R.O.I.
  - Asset Model Objectives

- Review Asset Management Strategies
  - Inspection regime (time/type etc)
  - New technologies
  - Financial implications
  - Forecast improvements

- Reconcile Business Objective with Asset Management Objectives
  - Reducing failure trends
  - Financial Management - R.O.I.
  - Asset Model Objectives

- Review Asset Management Standards & Technical Specifications
  - Modify to suit desired strategy
  - Period of inspection
  - Type of inspection
  - Reporting
  - Treatments

- Maintenance Plan
  - No of inspections
  - Period of inspections
  - Type of inspections
  - Approved Budget

OPERATIONAL PHASE
MAINTENANCE DELIVERY

- Contractor Performance Review (KPI’s)
  - Compliance to program
  - Financial Expenditure to Budget
  - Customer response
  - Data entry
  - Defect reporting
  - Quality of audits
  - Response to fault and emergency
  - Innovation

- Maintenance Delivery
  - Inspection
  - Replacement
  - Fault & emergency
  - Value add (investigations)
  - Expenditure

- Project Management
  - Scheduling/Program

- Established SLA/Contract
  - Program
  - Budget
  - Contract/Conditions

- Inventory Management
  - Location
  - Response/emergencies
  - Quality
  - Contingencies

- Warehouse Management
  - Logistics
  - Maintenance response
  - Fault and emergency response
  - Replacement

Table 4.16
Table 4.17
A STRATEGIC FUNCTION - STEEL TOWERS

**MARKET MODEL**
- Regulated Returns - IPART
- Environmental Implications - Passive
- Social Expectations
- Industry Practice

**ASSET MODEL**
Steel towers Assessing the Needs
- Financial returns
- Environmental performance
- Period of Service - Life extension
- Refurbishment strategy

**RISK ASSESSMENT**
- Duty of Care
- Anti-climbing danger signs
- Public Risk
- Quantitative/Qualitative Assessment
- Level of acceptable risk

**Risk Analysis**
- Level of exposure
- Implication - accept risk
- Mitigate risk
- Transfer risk

**Customer Expectations**
- Financial returns (regulated)
- Licence compliance
- Quality of supply
- Reliability
- Safety (public)
- Environment
- Duty of care

**Regulatory Direction**
- Financial returns
- Safety
- Reliability
- Environment
- Easement management

**Asset Condition**
- Age profile - species/durability
- Defect reports
- Status - rust/deterioration
- Half cell rating
- Cathodic losses

**Cost Implications**
Life Cycle Costs/Refurbishment/Life Extension
- I.R.R.
- R.O.I.
- Cashflow

**Asset Performance**
- Reliability
- Quality of supply
- Defects report

**Table 4.18**
Table 4.19
Assumptions

Refurbishment Costs -

Full Tower Painting every 10 years
7% Rate of Return
Tower Footing Concrete encased first year
Break Even 40 years

Table 4.20
Assumptions

Refurbishment -

- Full Tower Painting every 10 years
- 7% Rate of Return
- Tower Footing encased first year
  
Break Even Not Achieved.

Table 4.21
Strategies
See Diagram
(Asset Strategy Development Process)

Strategic Phase

Asset Planning
- Lifecycle costs
- Pole types
- Treatments
- Disposal criteria
- Assessed risk profile

Asset Creation
- Industry specifications
- Supplier accreditation
- Procurement

Maintenance
- Inspections - ground line
- CBM
- Treatments

Refurbishment
- Life extension
- Pole re-instatement

Disposal
- Recycle
- Timber supplier
- Controlled waste stream
- EPA approval

Operational Plan
- Statistic Asset
  (not operationally driven)

Performance Management
- Reducing failure trends
- Inspection costs
- Compliance program
- Defect reports
- CBM - costs/types
- Failure reports

Delivery (Operational) Phase - Timber Poles

Asset Life Cycle

Table 4.23
Chapter 5: Research Outcomes and Recommendations

5.1 Introduction

The research outcomes and recommendations of this portfolio are summarised below to provide an overall understanding of the issues identified from the literature review on the current status of asset management for utilities within and outside of Australia. The literature review provided a research path of what it is to take a holistic approach to asset management. The research and evolution of a holistic asset management process, sub-processes and integrated asset management contractual models are the foundations of this overall management portfolio. The industry based case studies and associated papers were all developed to provide a greater insight into what it is to take a holistic approach of asset management for a utility business, along with the implementation issues, future extension and further direction for the research work.

The key aspects associated with the research outcomes are detailed below;
- Findings from the literature review
- The Development of a Holistic Asset Management Process
- Asset Management Contractual Relationship Models

These research outcomes are explained in greater detail below.

5.2 Findings from the Literature Review

The literature review provided the framework on the principles of asset management and how these principles are seen as an integrated business process. The literature review also recognised that asset management is a complex subject matter that has the possibility of impacting upon the structure, business process and day to day working of a utility business. This complex issue is further complicated by the recognition that Asset Management itself is still in its evolutionary phase and that this will continue as utility businesses struggle to manage constant change in the areas of technology, market forces, political pressures and an ever-changing customer expectation. The literature review provided a number of asset management processes and models available on the marketplace that were developed internationally and domestically. These processes were developed to best suit a utility business to align and deliver on the corporate objectives established for their organisation.

What can be seen from the literature review of the available models and processes on asset management was the need to break down this complex subject into distinct stages through a series of manageable building blocks with a clear understanding of the strategic and delivery (operational) needs within each stage. This alternative approach allows all parties involved to understand the key objectives and what part they play in being able to properly consider and manage the impact of these processes across the utility business.
5.3 The Development of A Holistic Asset Management Process

The research on asset management was used to formulate and develop a new series of building blocks on asset management to provide a better understanding of the definitions and concepts of a holistic asset management process for a utility business. These building blocks expand in greater detail as each layer of the process is explored to reveal sub-processes within that demonstrate the complexity of each phase of the process as it is considered. The developments of the holistic asset management process evolved taking into account the importance of the asset management contractual model located within the operational side of the holistic asset management process. The integration of the contractual model into the operational side of the asset management process recognises the critical importance of this aspect of the process. The need for clear accountability and responsibility is needed at all levels of the asset management process to deliver the corporate objectives and goals for the utility business. This aspect of a holistic asset management process is unique as the currently available asset management processes and models on the market place have traditionally separated this aspect of asset management from the asset management process. The evolution of the asset management contractual model and its integration into the asset management process is an area that needs to be clearly defined and fully appreciated in particular the roles of the asset owner, asset manager and service provider. This is a critical success factor for a holistic asset management process in order to deliver the optimum outcomes for the business.

The evolution of a holistic asset management process was developed from the research based on an emerging theme that brought together two distinct phases of what is asset management. These two phases fell into either Strategic or Delivery roles that are connected by a Performance Management feedback loop to form a Holistic Asset Management Process (Figure 5.1 below).

![Figure 5.1: Holistic Asset Management Process (Appendix 5.10.5)](image)

The Strategic Phase of the holistic asset management process considers all aspects associated with the strategic planning of the asset, incorporating those issues associated with service needs and asset strategy. The strategic function is very much focused on satisfying the short and long-term needs of the organisation in the areas of service, managed risk and shareholder value. This understanding is illustrated in Figure 5.3 below, in which the linkages between market forces and
specific asset strategies are considered, to ensure acceptable returns on investments for the shareholder. The clear aspect of this role is in the recognition that the corporate objectives are transferred through the specific strategies for the assets to deliver the overall corporate objectives.

![Diagram: Strategic Phase - Asset Strategy Development Process](image)

**Figure 5.2: Asset Strategy Development Process: Strategic Phase**

(UMS Group 1999, p.2)

The Delivery (Operational) Phase of the holistic asset management process considers all aspects associated with implementing the asset strategies developed from the strategic phase. This aspect of the asset management process involves the planning creation, maintenance, operating and monitoring of the assets to ensure they are fit for service. This is illustrated in Figure 5.3 below, developed from the research to provide the building blocks for continual improvement on the condition and performance of the asset and deliver the strategic outcomes desired.

![Diagram: Delivery (Operational) Phase](image)

**Figure 5.3: Delivery (Operational) Phase** (Appendix 5.10.5)

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Within each building block (stage) are the internal processes and sub-processes required to deliver the corporate outcomes on managed risk, while delivering service and improved shareholder value. The amount of detail within each building block, a process in its own right, is dependent on the complexity of the issue and its importance in delivering the desired outcomes for the organisation. The development of each of the building blocks that make up the delivery phase is summarised below and detailed within Chapter 3 to provide an understanding of the relationship that exists within each stage of this process. The ongoing development and research on this aspect of a holistic asset management is an area that will continue to evolve due to changes in new technologies, techniques and process improvement. The integration of the asset management contractual model is identified within the delivery process which is a key aspect to the successful outcomes for the utility business overall. The industry case study detailed within chapter 4 on the implementation of an asset management contractual model within Integral Energy is an example of what can go wrong if this aspect of an integrated asset management process is not fully understood and communicated across the board.

### 5.4 Asset Management Contractual Relationship Models

The research identified that asset management for a utility business is dependent on the support of a large range of services to deliver the required programs to meet the corporate objectives for the business. The engagement of these services is essentially seen as a contractual relationship between an asset manager and a service provider. This view is simplistic in nature, as it does not reflect the intricacies of this relationship for long term asset management. The use of the organisation’s traditional internal service providers (staff) and/or to what extent the organisation has out-sourced these services will play a critical role in the way the model is integrated into the business and ultimately just how successful it will be in delivering the desired outcomes.

The asset management contractual relationship is designed to cater for a relationship involving outsourcing, insourcing or a combination of both, dependent upon the needs of each organisation. What is recognised within this complex relationship is the separation between the asset manager and service provider. This understanding is based on the need to have clear accountability between the asset strategy/outcomes and the service delivery to obtain improved performance and efficiencies. This separation of asset manager and service provider has become a recognised way of managing a utility business. The asset management contractual relationship has replaced the previous informal communication links that once existed between field maintenance staff and the asset manager for the overall management of maintenance activities. The relationship is now formally recognised through either service level agreements or contractual arrangements with clear accountabilities placed on both parties (Wells & O’Reilly 1999, p.4)
The strategic decision to separate the asset owner/asset manager/service provider functions within a utility business provides clear lines of accountability with the key goal of providing greater efficiencies across the business (Bartlett 2002,p.3). The relationships within the UMS Group’s asset management contractual relationship as shown in Figure 5.4 shows clear separation between the asset owner and the asset manager/service providers which does not recognise the interdependence on one another to obtain the opportunity to achieve optimised outcomes for the business. A truly optimised asset management outcome for a utility business from the research could be achieved with the alignment and recognition of this inter-dependence between these three key groups. The research identified an evolving nature of this complex inter-dependence of these three key groups that transpired into a new model as shown in Figure 5.5 below known as a Holistic Asset Management Contractual Relationship.

Figure 5.4 Asset Management Contractual Relationship
(UMS Group 1999,p.3)

Figure 5.5 Holistic Asset Management Contractual Relationship

This holistic asset management model developed from the research provides a utility business with the opportunity to strive for an optimised solution through its corporate objectives that is formulated
and delivered by the asset manager through the service provider to achieve the right outcomes for all three groups. The decision to structurally change an organisation to obtain operational efficiencies is the very core of good management. This decision however needs to factor in the overall impact across the organisation. There can be no doubt that a utility business needs to be aligned both structurally and operationally to deliver both the corporate objectives and the clear lines of accountability necessary at all levels for an asset management business. This understanding would therefore see the implementation of appropriate asset management contractual model for a utility business that would have a major impact across a utility business to structurally align with one of the asset management models shown in Figures 5.4 or 5.5.

The asset management contractual model does provide an avenue for management to implement this strategy at any time for activities such as maintenance or capital works. However this needs to be carefully negotiated with the workforce and unions to ensure the understanding that this strategy would be justified for the long-term benefits of the business. The findings from Case Study 3, Chapter 4, identified the need to clearly communicate the roles and responsibilities of each respective group and how these groups are required to work together to deliver the corporate objectives for the organisation.

5.5 Articles, Publications and Industry Based Projects in Support of the Research Objective

The research linkage of each paper was designed to demonstrate the application of distinct phases of select aspects in support of what it is to take a holistic approach to asset management. The issues that the papers were developed to demonstrate was the application of the type of assessment tools and techniques required to be used within a holistic asset management process. The types of diagnostic tools and techniques to be used are a key variable and are based on the type of asset being considered and what technology is available. The type of tools and techniques available to asset managers was demonstrated in the five papers and are explained in greater detail below to show the research linkage to the processes and models developed from the research that were developed to form a holistic asset management process.

Paper No.1:

Realising Financial Investments In Existing Timber Pole Assets For Supply Utilities.
Published Distribution 2000 Conference Brisbane 1999.

This paper was prepared to provide a linkage between the development of an appropriate asset management strategy for a long-term depreciating asset by introducing a life extension strategy to improve a utility’s bottom line and reduce its overall corporate risk. This paper recognises the regulatory framework in which a utility is required to operate and consider an alternative asset management strategy that would allow current annual operating expenditure to be capitalised through an approved capitalised life extension strategy. The investment in appropriate technology such as pole splinting provides an opportunity for a utility to reduce its overall operating expenditure while
increasing its capital expenditure.

The test for this specific management strategy is to ensure the regulatory balance is maintained to provide real financial returns to the utility by extending these degrading assets with an appropriate technology that mitigates overall corporate risk and reaps the financial returns expected by the regulator. This strategy meets the regulatory guidelines of improving the overall asset's age profile and therefore provide the opportunity to capitalise the investment in the asset to provide improved overall operating performance for the utility while mitigating the public liability and corporate risk of premature pole failure. This strategy explores the issues associated with an asset's lifecycle and provides management with the appropriate information that allows the asset to be optimised beyond its current theoretical life and economic limitations.

The paper discussed the existing flaws in the current way the value of timber pole assets are being fully utilised to their maximum financial and operating capability. The employment of a new strategy utilising available technology provides a life extension strategy for corporate management that was not being fully realised. The financial modelling clearly supported the use of the available technology and provided the added benefits of reducing corporate risk and public liability in the process. The paper emphasises the benefits of reviewing and assessing opportunities in all aspects of a utility business particularly in the maintenance process as a great deal of time and money is expended during this phase of an asset's lifecycle. This paper also demonstrated the linkage of aligning the strategic and delivery phases of an integrated asset management process as detailed in Chapter 4, Tables 16 & 17. The performance monitoring of this strategy is achieved through the management reporting in reduced operating expenditure, reduced numbers of condemned poles and reduced pole failures on an asset base typically in the 100,000’s with a maintenance expenditure in the millions of dollars for a typical supply authority within Australia today.

**Paper No.2:**

**Investments in Non-Ceramic Insulators: To Optimise the overall Performance of an Electrical Network**


This paper was prepared to show how new technology provides supply utilities with the opportunity to improve their overall operating performance, obtain design and construction flexibility while reducing overall operating costs to the business. The key issue demonstrated by this management paper was the importance of recognising one of the major variables in asset management today, new technology. This variable is cutting across many of the traditional boundaries and should be embraced by both manager and engineer to obtain optimised performance and efficiency desired by any progressive organisation. Asset Management, as a process, requires large investments in new information technology (IT) in order to manage and maintain a more detailed understanding of an asset. This recognition also extends to new technologies, as this is one of the major variables that can provide an avenue to improve the overall operating performance, while providing a better way to
manage the many associated business risks of any organisation operating in today's litigious environment.

This management paper addresses the issues associated with a new technology of a material that can be constructed in the form of a new product to compete against the oldest form of insulating material used by electrical utilities since their formation in the middle part of the last century. This paper addresses the issues associated with introducing a new product and the rational and benefits to a utility for its introduction. The science and engineering of the non-ceramic material and its use and development into a commercial product is a given, based on Internationally recognised research institutes and bodies (CIGRE) that continue to examine, test and refine the performance and behaviour of the material. The material has become revolutionary in the utility industry and accepted around the world as a viable product that is now manufactured to International Standards such as IEC 61109, ANSI 29.11, IEEE Std.1024, AS 4435.4, etc.

This paper covered off the advantages of implementing a new product to revolutionise uses and configurations that were once restricted by the existing materials. This new material provides significant benefits in the areas of cheaper construction, superior electrical performance and improved aesthetics while reducing both corporate risk and public liability. The paper provides the practical applications of this new material and how it can be utilised to provide flexibility for a utility in the area of construction and maintenance to obtain increased levels of reliability and increased operating performance. This paper also demonstrated the linkage of aligning the market needs with the asset model to provide a range of options as part of the Asset Management Process-Strategic Phase, refer Chapter 3, Figure 3.2. The issue with any new technology is that it can ripple across the business in all aspects of an assets lifecycle not just new constructions but also maintenance, refurbishment along with the operating side such as fault & emergencies. Therefore the introduction of any type of new technology should be considered in a controlled manner to ensure all aspects are properly considered. These aspects would include issues such as the economic benefits, improved performance, work practices and worker safety along with a roll out plan to communicate the applications and limitations of the new technology to the user groups. This controlled approach ensures the technology is understood and communicated at the right levels to ensure the appropriate parties embrace it.

There can be no doubt that new technologies will continue to be developed to provide utilities with opportunities and techniques to improve their overall operating performance. An integrated asset management process provides a mechanism to support the introduction of new technology through all aspects of an asset’s lifecycle to align with the corporate objectives in the areas of service delivery, improved operating performance and increased shareholder value.
This management research paper was developed to establish the remaining life of a long-term asset, and obtain an appropriate level of confidence in the existing maintenance strategies employed for an expensive and complex engineered-type asset (steel towers). The research paper focused on existing steel towers within Integral Energy’s electrical network recognising that a great number of these assets have been in service for more than 40 years and have a replacement value of over $400M. A steel tower is essentially maintained through a visual-routine inspection regime that identifies any deterioration of the galvanised steel structure. The ageing populations of Integral Energy’s steel towers are the main support for the delivery of bulk power to the many transmission and zone substations within the franchise area of Integral Energy. The lattice steel tower’s strength capacity is assumed by engineering principles to not be significantly affected by age, providing the steel members are maintained in a rust free condition.

An opportunity was identified by Integral Energy to challenge this industry wide assumption, through the upgrading of an existing 132kV steel tower transmission line between Regentville and Penrith. A number of the redundant lattice steel towers were set aside for field Pull Over Tests to determine the remaining strength of these redundant lattice steel structures. The Pull Over Tests are designed to determine the existing steel towers’ remaining, above and below ground, strength capabilities. These field tests, and associated findings, would be compared with theoretical structural analysis figures obtained on these towers using the latest available computer simulated modelling techniques, and design and fabrication data obtained on these towers from available records.

A joint venture was developed between Integral Energy and Transgrid to nurture this unique opportunity and provide benefits to the wider electricity supply community. The tests were performed by Integral Energy and analysed by Transgrid’s structural experts, to determine the relationship between the age and remaining strength of aged lattice steel towers. These test have been used to coordinate the half-cell readings performed on the below-ground part of the steel tower to ensure the steel tower is assessed as a complete entity and not only that part of the tower seen above ground.

This approach to lattice steel towers recognises the need for organisations to obtain data whenever possible, in order to develop and support progressive asset management practices and policies. This data will allow maintenance schedules to be refined and maintenance funds to be targeted to those locations identified by having a better understanding of the steel towers. This greater understanding will also play a major role in the development of the organisation’s corporate objectives as they develop their refurbishment and/or replacement strategies and programs for these critical longterm assets.

This paper also demonstrated the linkage of aligning the strategic phase of an integrated asset management process to implement appropriate refurbishment strategies based on the condition of the
assets as detailed in Chapter 4, Tables 18-23. The importance of feedback on the performance of assets is one of the fundamentals of an integrated asset management process. The performance loop is the mechanism that allows analysis to be performed to justify and then implement appropriate maintenance and refurbishment strategies for a utility business. This aspect of asset management has become the main focus for utilities today as they strive to improve overall financial and operating performance at a level of manageable risk for an asset base approaching the end of their economic life.

**Paper No.4:**

**A Holistic Approach to the Management of Electrical Assets within Supply Authorities.**

Published Distribution 2001 Conference Brisbane 2001

This paper was prepared to provide the management framework on the principles of an holistic approach to asset management and how these principles could be integrated into a core business process. This paper provided the view that Asset Management was a core business process for utilities. This process was broken up into two key management areas, essentially the Strategic and Operational Roles that combine to provide the Asset Management process. The *strategic role* considers all aspects associated with the service delivery of an asset to the customer. This aligns with the corporate objectives of the organisation in the areas of risk, performance, condition and specific strategies of a particular asset type. The *operational role* incorporates the delivery phase of an asset taking into account the asset’s lifecycle with a strong emphasis on maintenance. The focus of the paper was to provide an overview of an holistic approach to asset management with a case study developed on the maintenance process for timber poles.

This paper was designed to communicate what it is for utilities, to take an holistic approach to asset management; an approach that requires it to be integrated across the organisation to align corporate objectives and business strategies to ensure the most effective use of all its resources to achieve business success. This paper also demonstrated the linkage of aligning the strategic and delivery phases of an integrated asset management process and the feedback performance management loop of the theory as detailed in Chapter 3, Figure 3.1. The practical application of this process is demonstrated through the strategic phase to the maintenance phase of timber poles assets. The application of the theory is a critical issue for utilities to ensure they understand how to apply and utilise the asset management process to cater for all aspects of the financial and operating performance of the asset strategies adopted at a manageable level of corporate risk.

**Paper No.5:**

**A Holistic Approach to Integrated Asset Management**

Published MAINSTREAM2002, Sydney 2002

This paper was an extract and an evolution of Paper 4 to provide a framework on the principles of a holistic approach to asset management and how these principles are integrated into a core business process. This paper provided an overview of Asset Management as a core business process for
utilities. This process was broken up into two key areas; essentially the Strategic and Operational (Delivery) Phases that combine to provide the Asset Management process. This paper brought together a greater dimension and a more detailed insight into the strategic and operational phases of the asset management process. The delivery phase identified the framework for the asset lifecycle and the relationship between each asset phase to provide a better understanding of the asset management process in its entirety. A strong focus was placed on the maintenance process and the types of performance reporting required to manage the implementation of the strategies employed for the specific asset model (timber poles).

The management focus for this paper was the maintenance process with a case study developed on timber pole assets. The case study incorporated the detailed operational implications at each stage of the process, including expenditures, reports and risks attributed to this specific asset-type owned by Integral Energy. This paper was designed to communicate how the theory on maintenance management is applied in a practical sense and the levels of support systems required to deliver the desired outcomes for the organisation. The need to align maintenance strategies with corporate objectives reinforces the view of what it means for asset-rich organisations to take a holistic approach to asset management to achieve business success. This paper also demonstrated in greater detail the linkage of aligning the strategic and delivery phases of an integrated asset management process and the feedback performance management loop of the theory as detailed in Chapter 3, Figure 3.3. The practical application of this process is demonstrated to show the application and provide a greater understanding of how to apply the asset management process. The outcome of the process is delivered through the performance reporting that is the feedback loop on how the assets are performing in the key areas of financial performance, service delivery and overall risk mitigation.

The ability to adjust the strategy can be taken as required based on the performance feedback of the asset model (type) and how this actual performance is the delivering the targets set for the outcome of the strategy. There is a need to allow any strategy an appropriate length of time to bear fruit particularly assets made of large numbers such as poles as these assets would need to be assessed on a trend basis established over a number of successive years to determine if the strategy was implemented effectively and ultimately worthwhile. The implementation of an integrated or holistic Asset Management Process for a utility business is one that can deliver the appropriate levels of service, at identified levels of expenditure and manageable risk to improve shareholder value. This statement is utopian as there are to many variables that dictate the real outcomes for a utility business. What can be said is that the best opportunity for improved performance across a utility business with so many variables would be best achieved through an integrated asset management process that caters for the long term care of the asset while providing the framework to adjust the performance of the business to cater for the shorter term corporate and shareholder objectives.

**Industry Based Projects**
The industry based projects demonstrated the application of a holistic asset management process for
timber pole and steel tower assets that align with the documented 5 year business plans for Integral Energy. The ability to document and manage this alignment through the performance of a particular asset base is a critical issue for a utility business recognising the need to demonstrate due diligence in all aspects of operating a utility business in the public domain while providing both shareholder value and customer expectations. These complex issues require a holistic approach be taken on asset management that allows all aspects of an asset's lifecycle be managed in a documented, factual and considered way that then allows alignment of the corporate objectives with the condition of the assets to provide the optimised solution for the organisation at any point in time. The need for a utility to align with the asset management process is appropriate. However, the case studies show that this alignment causes concern and at times dysfunctional behaviour to occur if the desired structural outcomes to align with the asset management process and contractual relationship models are not fully communicated to all key stakeholders. The decision to implement gradual change or across the board change is an issue that is very much utility dependant and needs to be therefore considered on a case by case basis depending on the business imperatives to achieve optimum outcomes for the shareholders and corporate management.

5.6 Application of the Asset Management Processes and Contractual Relationship

The three case studies, as detailed in Chapter 4, provide a better understanding of how to integrate the physical assets managed by Integral Energy into the framework developed for a holistic asset management process and contractual relationship models. The process provides the flexibility and freedom to apply the broad principles of asset management that best suit an organisation's existing business practices, processes and work culture. The application of a holistic approach to asset management through the assets owned by Integral Energy shows how asset management as a process brings together all aspects of asset ownership. These can then be aligned to deliver the corporate objectives for the business and improve its overall performance. These corporate objectives are focused on the financial viability of the business as a whole and at times will conflict with the principles of managing long-term assets. Managing this perceived conflict in principles, however, is in fact the role of an asset manager, who aligns strategies for the assets with the required corporate objectives for the business, at a defined level of risk. This defined level of risk is essentially the variable, as changing strategies for short-term financial gains at a corporate level would raise the risk profile for the organisation, which would then be reflected in the increased risk rating in the corporate risk management plan. The benefits of a holistic asset management approach within a utility business is that transparency is apparent and accountability is clear at each stage of the asset’s life cycle. The research from the case studies provide a clear understanding of how to obtain the alignment of the corporate objectives, that are ultimately reflected in the strategies within the asset model, through the asset’s distinct stages within the delivery phase of the holistic asset management process.

The Asset Management contractual model is designed for the asset manager to develop strategies and objectives that align with the corporate objectives of the business. The service provider has an overlapping role in delivering the services required by the asset manager by providing value-added
insight and knowledge on the condition of the assets. The relationship is established on trust and a common understanding that is reflected in a performance-based service-level agreement. This relationship however requires both parties to understand their respective roles. The issue here is not the roles of each party but the history and learning required to understanding and embracing the unique operational relationship that needs to evolve. The decision to implement this asset management contractual relationship into a utility requires a great deal of communication and workshopping to ensure a common alignment in respective roles is understood and taken on by the respective parties. Any dysfunctional relationships between the key internal management groups can not be allowed to continue as it will cause the misalignment of the core business objectives, to the detriment of the business overall.

The case study also identified that the existing culture of the business was not conducive to organisational change designed for the asset management decisions to be made at a central head office location rather than the historical regional level. The issue of implementing a holistic asset management process or contractual model into an organisation requires an appropriate change-management strategy that considers the disruption and trauma caused to the existing operational needs of the business. This strategy would be required to factor in the impact on the key assets that make up the business, its people, as without their commitment to the change process then the overall objectives and outcomes required for the business would not be achieved.

5.7 Transportability of the Asset Management Process & Contractual Relationship

The literature review along with the case studies, as detailed in Chapters 3 & 4, answer the question of the transportability of the available asset management processes and contractual relationships as they have been developed on a national basis for both Federal and state bodies empowered with the responsibility to manage utility infrastructure such as roads, buildings, sewer systems, bridges, gas, telecommunications, water etc. The type of physical asset is not an issue in the asset management process as it is generic in nature and applicable to any type of physical asset irrespective of size, location or complexity. The issue that the process does not specifically address is the type of assessment tools and techniques to be used which are very much asset-dependant. The need to perform condition assessments is identified within the various stages of the process to determine condition and appropriate actions to rectify deterioration and under-performing assets. The type of diagnostic tools and techniques is a key variable as it is dependent on the type of asset being considered and the available technology.

Advancements in technology are providing opportunities to obtain new tools and diagnostic techniques to determine the condition of physical assets. Some examples of these new tools and techniques are seen in the use of remote videos in sewer systems to determine the extent of damage or decay, vibration monitors and heat sensors on rotating machines and online partial discharge monitors for insulation decay which are all very much asset dependent. The output from these tools
and techniques feeds into the asset management process to be assessed, and decisions are then made to align with the asset management strategies for the business.

The transportability of the asset management process is not asset dependent and therefore is available for use by any form of utility such as telecommunications, manufacturing plants, power stations, hydro system etc. The issue that is paramount from the research is the way the holistic asset management process and contractual model would be implemented into a utility business. The existing systems, structure and culture of the business will play a major role in how the process and contractual model are integrated into the everyday operational life of the business. A change management program directed at all levels of the business would be required to bring together the core competencies of the business while communicating the benefits of adopting a holistic asset management approach.

The decision to structurally change an organisation to obtain operational efficiencies is the very core of good management. This decision however needs to factor in the overall impact across the organisation. There can be no doubt that a utility business can be aligned both structurally and operationally to deliver the corporate objectives and clear lines of accountability at all levels for an asset management businesses. This understanding would therefore see the implementation of an appropriate asset management contractual model for a utility business that would have a major impact across a utility business to structurally align with one of the asset management models shown in Figures 5.4 or 5.5. The separation of each of the key functions, Asset Owner, Asset Manager and Service Provider, allows the greatest opportunity to obtain clear direction and alignment of these objectives while delivering the greatest operational efficiencies for the business.

The implementation of this asset management contractual model will raise issues associated with the in sourcing and outsourcing of various core activities within the organisation. The asset management contractual model does provide an avenue to management at any time to implement this strategy for activities such as maintenance or capital works. This issue however will need to be carefully negotiated with the work force and unions to enable the strategy to be fully understood and justified for the long term benefits of the business. The business drivers to outsource internal activities are strongly influenced by the background and political climate that the organisation finds itself operating within. The ongoing international drive to corporatise and deregulate utilities has seen traditional government owned monopolies experience increased cost pressures to gain operational efficiencies. This pressure has also increased the move towards privatisation that places even greater pressure to deliver operational efficiencies to increase profits for the shareholders.

In Australia this approach was clearly evident with the privatisation of the Victorian electricity utilities due to the State’s poor financial position. The overall performance of the five Victorian utilities since privatisation in 1995 however has seen a steady improvement in customer service across the State. The Victorian Regulator’s 2002 performance report for the industry, was acknowledged by the
Victorian ESC Chairman Mr John Tamblyn (2003,p.4) who points out that four of the five utilities AGL, Citipower, Powercor and United Energy performed better than the supply reliability targets the commission set them for 2002, while TXU exceeded its minutes-off-supply target by one percent. All distributors in 2002 also surpassed the forecast return on assets set out in the regulator’s 2001-2005 price determination. ESAA managing director Keith Orchison (2003,p.17) explains that the steady improvements achieved by all five privatised state utilities since their formation in 1995, does not get the same media airplay or headlines that any criticism would instantly achieve.

A key issue that has not been fully appreciated until recent times is the acknowledgment that an electricity utility business is an essential service that provides a critical service that customers have come to expect as a way of life today. This growing understanding of our standard way of life has been well documented over the last few years with the loss of electricity supply to over 100 million people in the cities of Auckland, London, New York and Italy to name but a few. Clearly Federal and State governments, regulators, businesses and customers see electricity not only as a commodity but more and more as an essential service that sustains the standard of living we have all come to expect. This recognition has fostered the very strong political/social element now associated with the privatisation of essential services such as electricity utilities, that is felt at all levels of the community. This political/social element was well demonstrated in the NSW State election in 2001 when the Carr labour government supported a union campaign against the Chikarovski Liberal opposition to privatise NSW electricity utilities. This campaign failed and provided the Carr government with an increased mandate and a history-making third term.

The decision to privatise or remain in government ownership is clearly outside the control of a utility business as this decision is determined by Federal and/or State government policies. The issue that is in the control of corporate management for utilities is to have in place the most efficient and effective utility structure, supported by asset management processes that will deliver the corporate strategies and objectives for the organisation. This would be best achieved by the implementation of the holistic asset management processes and contractual models that have been discussed within this portfolio.

5.8 Future Extension of the Work
The research has shown that there are available a number of asset management processes that will provide utilities with the building blocks to incorporate asset management within their organisation. The challenge however for these utilities is their ability to implement these holistic processes and contractual models while working within their current dynamic business environment. The key issue being the upheaval caused by major changes to the way business currently operates and the catastrophic impact on the business in the short term. Clearly implementation is an area requiring significant work as change management programs need to be fully considered and tailored to suit each utility on a case by case basis. Alternative ways of implementing the fundamentals of a holistic asset management process need to be fully considered taking in the practical realities of the pressures imposed on the organisation, the workforce within and impact on key stakeholders.
Another area requiring further work is in the development and understanding of the asset management contractual model. This area requires further clarity of the roles and responsibilities of each distinct group that make up the asset management model for utilities; asset owner, asset manager and service provider. Some of the issues facing these groups is the need for clear hand over points between each of the groups and the associated decision making processes that are often blurred and misunderstood. The issue here is to remove the misunderstanding and eliminate the confusion that will impact on how the asset management process is to be implemented into the organisation. The case study identified the many issues that impacted on Integral Energy as it strived to implement its own understanding of the contractual model across traditional divisional boundaries that caused misunderstanding at all levels of management within the organisation. This contractual model requires further enhancement to ensure its implementation does not rob the asset worker of the motivational drivers of taking their sense of ownership of the assets that has caused the build up of tension with the asset manager that leads to large scale inefficiencies or total rejection of the asset management contractual model. (Bartlett, 2002,p.4)

Another area that requires further consideration is the issue of designing and implementing Information Technology (IT) systems for a utility to perform the data management and asset decision making “tools” required for a holistic asset management process. The implementation of an Integrated Asset Information Management System (IAIMS) needs to be made in a considered way particularly a utility business, that has the challenges of managing large scale and diverse networks in a changing political and business environment. The key issue here is the need to consider implementing standard or customised hardware and software packages. This decision however needs to also consider the financial drain on the organisation along with the ability have an IT platform that provides flexibility to the organisation to change its IT needs as the business environment changes over time.

When you consider most utilities require asset information to determine investment decisions and revenue streams, along with outage management systems, geographical information systems, works management systems, customer information systems and billing services. All this coupled with the mandatory network financial, reliability and performance reporting in a transparent format for the regulator, then it is no wonder that any future the decision to implement an IAIMS system is probably the biggest single issue facing utilities today as they move forward for tomorrow.

The findings from the survey provided by Bartlett (2002,p.5) identified the following issues requiring further development through a set of guidelines for asset managers:

- Effects of institutional change on Asset Management.
- Managing networks to minimise their adverse impacts on electricity markets by increasing maximum network capabilities, coordinating outages and maximising network availability.
- Life extension of transmission assets, replacement/refurbishment decisions for aged plant.
- Managing risk to transmission plant and minimising potential liabilities.
- Strategic importance of new technology and innovation.
- Managing the interface with engineering, construction and maintenance service providers.
The future findings from the survey performed by Bartlett are specific to transmission networks, but they do identify a number of the key issues associated with asset management processes and contractual models that have been identified through the literature reviews and case studies within this portfolio. Clearly utilities need to adopt the fundamentals of what it means to take a holistic approach to asset management to provide them with the best opportunity to deliver the appropriate levels of service, at identified levels of expenditure and manageable risk to improve shareholder value.

5.9 Further Research – Asset Management Principles & Processes

What can be seen from the survey results provided by Bartlett (2004) is that asset management as a theory means different things to different utility managers. The principles of asset management and what it means to adopt them within a utility business is an area that further research is required as the pressure on utilities will continue to grow and require improved management processes to achieve optimal solutions to changing stakeholder needs. A review of asset management theorists, practitioners and utility managers demonstrates that there is a wide and varying understanding of this term within the electricity supply industry. This wide variety is demonstrated by an interpretation provided by Burton (2004) who describes asset management as a new concept based on a decision making process that seeks to find optimum balance between safety, capacity, service delivery and cost. The outcome of asset management is to minimise cost, maximise return, manage risk and align corporate and regulatory objectives throughout the entire business. Humphrey (2004), Yanco & Macqueen (2004) both support similar views on asset management as a business process designed to obtain knowledge needed to optimise trade offs between financial performance, operational performance and risk exposure. This process is holistic in nature and designed to align corporate objectives to operational delivery through clear responsibilities between the asset owner, asset manager and service providers.

Craig & Parish (2004), Brown (2004) and Sklar (2004) all support a holistic view of asset management as an integrated business process designed to optimise the use of a utility’s assets while balancing the varying needs of key stakeholders. Peterson & Holbus (2004) take a more structured approach for asset management founded on the philosophy of quality systems. Their interpretation is known as Strategic Asset Management (SAM) business processes based on three key issues; lead, execute and enable. The SAM is an integrated business process that allows continuous process improvements to be achieved to provide operational excellence. Sarfi & Tao (2004) see asset management not so much as a new business process but more of an enabling process that allows more to be delivered through the effective use and deployment of the organisation’s existing scarce resources. This stronger focus on the assets will then be able to deliver higher levels of customer service and reliability while balancing off the financial objectives for the business. Tichelman (2004) and Palovchik (2004) both take a very strong focus on the IT requirements for a utility business that provide the knowledge to allow asset management decisions to be made to deliver improved reliability, operational flexibility and financial gains for the organisation.
What can be seen from these varying interpretations is that asset management as a theory is evolving and will continue to do so as utilities strive to maintain a balance between often contradictory business objectives demanding of a number of key stakeholders both within and outside of these organisations. The continued research of asset management principles and processes is an area worth pursuing as the pressure on critical infrastructure continues to build within developed economies around the world at an exponential rate.
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Network Asset Value Projections – Financial Projections
7.0 APPENDICIES
APPENDIX 1

Realising Financial Investments in Existing Timber Pole Assets for Supply Utilities.

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REALISING THE FINANCIAL INVESTMENTS
IN EXISTING TIMBER POLE ASSETS
FOR SUPPLY UTILITIES

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ABSTRACT

The electricity supply industry in New South Wales has entered into a new era of environmental change, imposed largely by the State Government, to extract financial returns from these State Owned Corporations. These changes are creating a fundamental shift in the existing paradigms in which these organisations operate. Long established principles are being revisited and processes re-engineered, to allow them to make the necessary strides forward to achieve business success.

The supply authorities of today need to obtain improved utilisation of their existing assets, as they can no longer afford to invest the large sums of capital into infrastructure development that they readily did in the past. This reduction in financial expenditure is being achieved, with an emphasis on the need to rethink the way work is currently being performed, with a new financial focus on how returns in the short term can be made for the organisation.

This paper has been prepared to show how progressive Supply Utilities, such as Integral Energy, can extract maximum returns from their existing timber pole assets through life extension practices and technology that are economically justified in the short term. While taking into account the impact on customer reliability, work safety and public liability for the organisation.
1.0 INTRODUCTION

1.1 Reforming Government Owned Monopolies

The need for change of Australian organisations is being driven by the accelerating world economy, due to multinational and global companies expanding into enormous trading concerns ever since the early 1960s. The once regulated domestic trading agreements, owned and protected by Australian Governments through tariffs and trade agreements, have been removed by consecutive Australian Governments since the early 1970's, as they shift their focus on international competition (Stace & Dunphy 1991: 15).

The need for deregulation of the Australian domestic marketplace has been recognised for some time by both Government and business alike. This recognition has been conveyed in such literature as, 'Improving Australia's International Competitiveness', by the Economic Planning and Advisory Council, January 1991, which has focused on the need to maintain Australia's standard of living by improving its innovation and productivity. Another document which reflects this urgent need for reform is the 'National Competition Policy', August 1993. In which barriers to international competition need to be removed such as, the restrictions in the Trades Practices Act for foreign competition, the reforming of Government Monopolies, providing third party access to certain infrastructure, restraining monopoly pricing behaviour, as well as fostering neutrality between government, and private business ventures in the areas of tax-equivalent payments.

This fundamental change to the Australia economy, with a new international focus, has necessitated the gradual deregulation of previously closed markets such as crude oil, gas and wheat markets, along with the gradual reduction of tariff protection for the agriculture and manufacturing industries. These changes have introduced increased international competition within the Australian domestic marketplace, as improved foreign goods at now competitive prices, introduced strong competition against locally made products. This has forced Australian organisations to reconsider how they do business and in which markets they will compete, in order to be successful and remain in business (Stace & Dunphy 1991: 27).

The introduction of the "National Competition Policy" known as the 'Hilmer Report' in August 1993 advocated the opening up of competition across national boundaries, by removing restrictive legislation and trade practices currently available to government monopolies in such areas as gas, electricity, rail and water.

2.0 The Road to Privatisation

The fundamental changes that are occurring within the electrical supply industry of Australia are not unique, as a number of other countries such as New Zealand and the United Kingdom have already progressed along the road to 'Privatisation'. This drive within Australia towards the privatisation of the electrical supply industry has been well demonstrated, with the break up of the supply utilities in Victoria into five individual entities, for their sale to overseas investors.

In Victoria the privatisation of the five (5) major supply authorities has occurred at a rapid rate of knots, since the election of the Liberal 'Kennett' Government in 1992. The drive for privatisation of these supply authorities has occurred as part of the economic reality of the Victorian State being in a financial crisis with debts of $33 billion, of which more than $9 billion was directly owed by the electrical supply industry. This debt led to the demise of the State's credit rating, by Moody's, which increased the repayments to service this huge state debt.

The privatisation and sale of the electrical industry by the Kennett Government has led to a reduction of the state's debt by $8 billion and resulted in a direct improvement in the State's credit rating by two points within 12 months. It is widely recognised that the drive to privatisation within Victoria has resulted from the direct need for strong economic management, by the state Liberal Government, to balance the books for the long term prosperity of Victoria (Reuters Business Briefing, 1995).

The NSW Government has with the election of a Labor 'Carr' Government, allowed for the progressive reform of the electrical supply industry over a planned period of time. The need for economic reform in NSW is not as critical and thus does not need the 'fire sale' as introduced by the Kennett Government. The political debate
between states is such that the NSW Labor party is recognising, that the sale of the electrical supply authorities in Victoria has meant a downsizing of staff by more than 40% and thus would not be as favourable within the labour state of NSW. This situation has led to the statement by the State Premier Mr R Carr in which he said, "Jeff Kennett wants to privatisate everything that moves. I don't. I am protecting the public interest" (Reuters Business Briefing, 1995).

The re-election of the Carr Government in February 1999 was on a platform of maintaining state owned corporations under government ownership, as a direct alternative to the liberal opposition’s agenda of privatisation.

3.0 **Realising the Investments in existing Timber Pole Assets**

3.1 **Background**

This changing business environment requires, that all investments made by supply utilities in their electrical networks, provide the necessary return on investment (ROI) to its single shareholder. This focus places enormous pressures on the functional branches within the organisation, to recognise every opportunity to obtain financial savings through better utilisation for their existing assets, while achieving reductions in capital expenditure.

This recognition has led Integral Energy to ask a few basic questions. Why are its timber poles being replaced? Is there a better way of reducing financial expenditure for the organisation? These fundamental questions have lead Integral Energy to re-engineer the management of its existing timber pole assets, through the use of life extension practices and technologies that give improved financial returns back to the organisation which would have otherwise been lost.

3.2 **Managing a Timber Pole Population**

The existing timber pole population managed by Integral Energy is more than 370,000 strong. The age profile for this existing asset is not accurately known, due largely to the inability to effectively manage this data in the past. Traditionally, this data would have been used to determine the asset’s maintenance regime, based on an understanding of its age profile to assist asset managers to make informed decisions on the long term maintenance requirements for their assets. The supply industry in NSW has considered the development of pole survival curves for hardwood timber poles based on the Weibull family of statistical curves, designed specifically for lifetime estimation and replacement strategies (Connel Group, 1988), due largely to the absence of actual data on pole survival rates. The development of pole survival curves has allowed financial models and replacement strategies to be developed for the supply industry. These models do serve specific purposes and needs for the long term investment decisions made by the electrical supply industry.

This traditional asset management approach is not utilised by Integral Energy for its timber pole population, as it is not the life survival rate that is considered the critical issue. Rather the yearly trend in the pole condemnation rate that is a function of the cash flow for the organisation’s major maintenance activities. This new direction taken for these perishable assets is justified in the recognition that the pole’s serviceable life is determined by a number of distinct variables. Such as the pole’s environmental location, its hardwood durability rating and strength, but more importantly, the ground line and internal treatment practices that retard the effects of the environmental decay through fungal and termite attack.

This recognition requires supply utilities to fully appreciate and implement life extension strategies in the area of effective ground line treatment practices, as well as the range of pole reinforcement techniques that extend the serviceable life of these existing assets.

The current condemnation rate within Integral Energy has been trending upwards over the last five years to the current level of 0.004% per annum for its total timber pole population. This upward trend has been recognised as an unacceptable financial drain on the organisation, requiring immediate action to ensure it remains at a manageable level. This recognition created a business driver for Integral Energy to identify and utilise different
ways to extend the serviceable life of its timber pole population, through the introduction of pole reinstatement techniques that deliver positive financial returns to the organisation, in the short term.

The development of pole reinstatement techniques is not new and has been available within the NSW supply industry for more than 10 years. The conservative nature of the electrical supply industry however has meant that this technology has not been used to the full extent that it should have been. The savings made available from the use of this technology would allow supply utilities to invest these available funds into the strategic maintenance of their electrical networks.

3.3 Existing Timber Pole Management Practices

The serviceable life of timber hardwood poles, as an asset controlled and managed by a supply utility, gives a history of the asset as approaching the end of its useful economic life after 35 years. The existing timber pole assets owned by Integral Energy are managed on a routine cycle, usually every 4.5 years, in accordance with the NSW Code of Practice and Industry Guidelines, using computer aids (Ground Line Inspection-GLI) to determine the timber poles internal and external condition.

This is a thorough and detailed process, which incorporates the need for remedial action through ground line and internal treatment, to retard deterioration of the existing timber pole. This process will also assess and determine the need to replace any timber pole considered to be structurally unsound or dangerous for its serviceable life.

Routine inspection of timber poles has been performed by every Supply Utility within NSW for a great many years. It has only been after the development of the Reinforced (RFD) Pole Nailing System and its approval for use in 1985 by the Energy Authority of NSW, that the existing practice of replacing hardwood timber poles has been challenged. Since this time a number of similar systems (OS-C-SPLINTS, POWER BEAM etc.) have been developed and used by a small number of supply authorities within NSW, although surprisingly not fully recognised or adopted as a routine timber pole maintenance strategy.

3.4 Timber Pole Reinforcement Technology

The process of reinforcing a timber pole is a simple one, in which a 6mm thick steel stake (nail) is installed in the ground next to the suspect timber pole. This steel stake is usually driven to a depth greater than the existing pole embedment depth. Once the steel stake is in place steel bands or bolts are attached at the top and bottom of the steel stake. This process of reinforcing timber poles can be used in most locations in less than one hour, with a minimum of disturbance to the surrounding environment or community.

The life expectancy of a galvanised steel reinforcing member attached to a timber pole is generally 15 years of serviceable life. It is recognised that there are other forms of pole reinforcement technologies available on the market. However, these systems have not been included during the assessment process, due to their poor short term economic modelling.

4.0 Economic Analysis for Pole Reinforcement Technology

The inevitable move towards Privatisation has changed the focus within Integral Energy from capital expenditure to investment planning, requiring any financial decision to realise positive returns to the organisation in the shortest possible term. This approach has not always been the focus by supply utilities, as whole of life costing models have usually dominated financial decisions with redundant assets usually being refurbished or replaced, without too much consideration being given to life extension practices.

The decision to invest in pole reinforcement technology for existing structurally flawed timber poles is a scenario that would not have been considered seriously in the conservative era of government owned monopolies. This is no longer the case when considering the positive returns that can be realised by reinforcing suspect timber poles.
The economic model that has been adopted by Integral Energy is based on obtaining positive financial return before the structure is reinspected as part of its routine inspection cycle. The inspection cycle for a fully reinstated timber hardwood pole is exactly the same frequency as that for sound timber poles, which negates the need to perform additional costly inspection cycles for reinstated poles.

The philosophy behind this decision is that the structural support, even after the remaining timber has been reduced to less than a 10-mm average wall thickness at ground level, will have a steel reinforcement member with a load factor of 50 percent of the actual dynamic loading requirements for the structure.

The Economic Model has been prepared to take into account the three major types of poles that are used for pole reinforcement technology within Integral Energy and compared to the cost for complete pole replacement. The model is made up of (Fig.1) Low Voltage mains, (Fig.2) High Voltage mains and (Fig.3) Subtransmission and Transmission mains, which detail the financial returns that can be obtained, in the short term, by progressive supply utilities.

A Sensitivity Analysis for each of these cases has also been included in the models to assist in justifying the decision to invest in pole reinforcement technology as compared to pole replacement, with a positive and negative full two percentage points variation in the average weighted cost of capital for this short term analysis.
**Assumptions:**
1. Average Pole Replacement Cost- $1500
2. Reinstatement Cost: $440
3. Timber Pole Life Expectancy 35 years
Assumptions:
1. Average Pole Replacement Cost- $2500
2. Reinstatement Cost: $490
3. Timber Pole Life Expectancy 35 years
Assumptions:
1. Average Pole Replacement Cost - $7500
2. Reinstatement Cost: $650
3. Timber Pole Life Expectancy 35 years
The financial models show that positive financial returns are realised by Integral Energy in less than 4.5 years for all cases. The Low Voltage pole model identified the only case that the organisation may not obtain a positive return in the desired 4.5 year inspection cycles. This one case is considered to be the simplest form of pole replacement type and is not considered to be of any real risk to the organisation, when considering the major gains obtained in the other more complex types of pole arrangements being considered.

It is this financial justification and sound understanding of the pole reinforcement technology that has allowed Integral Energy to aggressively pursue the use of this practice for its existing timber pole Network.

It is anticipated that Integral Energy will see a net reduction in the order of 80%, or $1.5million in its current maintenance budget for timber pole replacements annually. These savings should be recognised as real windfalls to the organisation, which will allow these savings to be channelled strategically into the management of the electrical network to obtain even greater business success for the organisation.

5.0 Environmental Considerations

The environmental constraints imposed by Government Legislation within Australia are demanding and at times onerous for an organisation to comply and work within. However these demands are recognised and met by Integral Energy as it strives to meet its core values of being a corporate citizen to the community. The selection of which pole reinforcement technology an organisation wishes to use will need to allow for the impact that the process will have on the surrounding community. These considerations need to take into account the loss of supply to the customer, the impact of the process on the immediate customer, the control of the ground line treatment to the surrounding environment, as well as the aesthetics of the completed works.

The environmental considerations by any supply authority within NSW play a major part in the way that work is performed, which can have significant financial implications to the organisation, should a customer raise objections to the work site during or after the works have been completed.

The reinstatement of Integral Energy’s timber poles has not received any real criticism from any member of the general public, other than during the immediate installation of the steel stake. This minor disturbance to the general public is a short time impact when compared to the alternative of replacing the timber pole all together.

6.0 Work Safety

Climbing poles to perform connections and repairs is an everyday event for any supply utility. This practice usually requires a line worker to climb and attach to the structure to perform the necessary works. This work practice requires the integrity of the timber pole to be sound, to ensure that the works can be performed in a safe manner. This requirement is the key driver for the need to routinely inspect and assess the condition of timber poles within NSW.

The use of pole reinforcement technology has gained both worker and union approval for the work environment, as the steel member will support the timber pole in a vertical position even after full collapse of the entire timber wall, thus ensuring the worker’s safety under a worst case scenario.

The use of pole reinforcement technology, when applied in a sound and correct method is considered to be risk free for a large percentage of the working applications within Integral Energy.

7.0 Public Liability

The major area of concern for Integral Energy in respect to public liability is the likelihood and consequence of death or injury to the public as a result of negligence or failing to meet its duty of care. The overhead transmission and distribution network make up more than 65% of Integral Energy’s entire electrical network. It is this part of the network that is the most prone to public liability, as it is readily accessible to the general public on a day to day basis.

It is the recognition that the pole reinforcement technology will support the deteriorating timber pole assets under the worst case scenario of a complete timber fibre failure that this process has so readily been adopted by
the Network Asset Services Branch, as a sound and justified way of reducing Integral Energy’s public liability risk for its overhead assets.

8.0 Customer Reliability

The business environment within NSW is demanding a 100% reliable supply under normal circumstances, with no acceptance by the customer, or tolerance for outages, to perform any maintenance activities by the supply utility.

The customer’s expectations are key performance indicators within Integral Energy and are paramount in ensuring that the organisation maintains its market share during the ever-increasing competitive environment.

This recognition clearly supports the introduction of pole reinforcement technology, as these works can be performed without the need for outages or delays due to unforeseen complications during pole replacement works.

The pole reinforcement technology allows the timber pole to be fully supported and reinstated without the need for costly repairs, loss of electrical supply or real disturbance, during the installation process of the steel member.

9.0 SUMMARY.

The drive by Integral Energy is to aggressively introduce pole reinforcement technology as a timber pole maintenance strategy to provide significant savings to the organisation in the short term, is one way that progressive organisations are expected to behave in today’s ever-changing business environment.

It should be recognised that supply utilities are no different from any other form of organisation in the modern era, which need to recognise that change is becoming the norm. This constant drive for change is pushing organisations to challenge old paradigms and to test what is not known, rather than rely on the safety zone of the past. This concept is what Dunphy & Stace term "Beyond the Boundaries", in which organisations that are to be 'leading edge' in their industry must redesign, challenge and lead the organisations into the unknown future. Kanter also supports this view when she refers to this concept as "Stretching the Limits" beyond the known safe horizons of the organisation. This push into unsafe and unknown areas by organisations requires them to embrace change and thus be responsive to the new and dynamic business environment they find themselves having to operate within.

The issue for leading edge organisations, such as Integral Energy, will be one of maintaining the most productive and economically viable solutions for its key business processes as it moves into an era with a strong commercial focus. The returns on investment (ROI) need to be in step with the current private business environment to demonstrate the efficiency and effectiveness of a State Owned Corporation, as it strives to perform like a private sector company and embrace the inevitable road to privatisation.

Footnote:
Three of the more common types of pole reinstatement practices available within Australia are:

TYPE 1: The "ELTEK" Pole Nail (Victorian origins)

TYPE 2: The "OS-C-Splint" (Ausmose Pty Ltd, USA origins)

TYPE 3: The ΑPOWER ΒEAM System (POWERCOR Vic. Australia)
Reference Documents:


APPENDIX 2

Investments in Non-Ceramic Insulators: To Optimise the overall Performance of an Electrical Network

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INVESTMENTS IN NON-CERAMIC INSULATORS:

To Optimise the overall Performance of an Electrical Network

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ABSTRACT

The electricity supply utilities in New South Wales are entering an environmental where change is the norm, imposed largely by the State Government, which is seeking to extract financial returns from these State Owned Corporations. These changes are creating a shift in the existing paradigms in which these organisations operate. Long established principles are revisited and processes reengineered, to allow them to make necessary strides forward to achieve business success.

The supply utilities of today need to obtain improved utilisation of their existing assets, as they can no longer afford to invest the large sums of capital into infrastructure development that they readily did in the past. This reduction in financial expenditure is being achieved, with an emphasis on the need to utilise and introduce new technology and processes that improve the operating performance of their electrical networks, while also improving the efficiency and effectiveness of the network to give the cost reductions required in today's competitive economic environment.

This paper has been prepared to show how progressive Supply Utilities, such as Integral Energy, are obtaining outstanding operating performance, design flexibility and improved construction capabilities, while reducing overall costs through their investments in non-ceramic insulator technology for their entire electrical networks.
1.0 Introduction

Since the formation of the electricity supply industry, porcelain has been used as the main electrical insulation on overhead power lines of all voltages. A significant development, which has accelerated over the last decade, has been the introduction of non-ceramic insulation products that exceed the performance of porcelain technology of the past.

This new technology has progressed at such a rapid rate that manufacturers are now offering all forms of electrical apparatus manufactured from non-ceramic insulating material. The benefit of this new technology is that it allows the development of far lighter, compact and simpler constructions than that offered by the equivalent porcelain alternative.

This new technology has been designed to provide outstanding operating performance and reliability, while allowing real opportunities, through its flexibility, to produce innovations in design and construction arrangements that were once considered to be impractical with the more rigid ceramic insulating mediums, used around the world.

A variety of new applications and maintenance strategies have been developed within Integral Energy that exploit the opportunities this new technology provides, at all voltages, for both overhead and underground applications.

2.0 Integral Energy in Profile

Integral Energy is one of the largest energy services corporations in Australia, grossing annual electricity sales income of more than $1.08 billion. It distributes and retails electricity to more than 1.7 million people in 706,000 households and businesses across 24,500 square kilometres in Sydney’s Greater West, the Blue Mountains, the Illawarra and the Southern Highlands regions and beyond.

As a major player in the now competitive energy market, Integral Energy retails energy services and products throughout Australia to industrial, commercial and residential customers. It is a quality organisation accredited to ISO 9000, and was the winner of the prestigious 1995 Australian Quality Award for large organisations.

The transmission network within its franchise area consists of 1,218 km of 132kV transmission lines, 2,146 km of 33/66kV Subtransmission lines and over 10,858km of 11/22kV distribution lines.

3.0 The Changing Environment

The fundamental changes that are now occurring within the electrical supply industry of Australia are not unique, as a number of other countries such as New Zealand and the United Kingdom have already progressed along the road to 'Privatisation'. This drive within Australia towards the privatisation of the electrical supply industry has been well demonstrated, with the recent break up of the supply utilities in Victoria into five individual entities, for their eventual sale to overseas investors.

The privatisation and sale of the electrical industry by the Kennett Government have led to a reduction of the State's debt by $8 billion and resulted in a direct improvement in the State's credit rating by two points within 12 months. It is widely recognised that the drive to privatisation within Victoria has resulted from the direct need for strong economic management, by the new State Liberal Government, to balance the books for the long term prosperity of Victoria (Reuters Business Briefing, 1995).

The NSW Government has, with the election of a Labor 'Carr' Government, allowed for the progressive reform of the electrical supply industry over a planned period of time. The need for economic reform in NSW is not as critical and thus does not need the 'fire sale' as introduced by the Kennett Government. The political debate between states is such that the NSW Labor party is recognising that the sale of the electrical supply authorities in Victoria has meant a downsizing of staff by more than 40% and thus would not be as favourable within the
labour state of NSW. This situation has led to the statement by the State Premier Mr R Carr in which he said, "Jeff Kennett wants to privatise everything that moves. I don’t. I am protecting the public interest" (Reuters Business Briefing, 1995).

The position of the State Government has now changed, with the announcement on Friday 23rd May 1997, by the Minister for Energy Mr M Egan, of the proposed sale of NSW generating and distribution assets to the private sector (Business Review Weekly 1997). A White Paper has been circulated throughout the electricity supply industry and the affected government departments, to clearly state the new position of the Carr Government to privatise these State Owned Corporations, within the next two years.

4.0 Non-Ceramic Insulator Technology

The electricity supply industry around the world is slowly coming to terms with what is recognised as a significant advancement in insulating technology, commonly known as polymeric or non-ceramic insulators.

This technology has progressed to the stage that any insulator can be produced suitable for any application or the harshest environments. This development in the manufacture of non-ceramic insulators, is strongly supported, by the very low failure rates that these insulators have experienced in actual service, along with the move by every major insulator manufacturer around the world to offer non-ceramic insulators as an alternative to their more traditional porcelain products.

4.1 A Simple Design Philosophy - Non-Ceramic Insulators

The construction of a non-ceramic insulator consists of a central fibreglass reinforced rod for strength, encapsulated by a non-ceramic outer sheath for electrical integrity and capped at each end by crimped metallic end fittings to suit its application.

Generally, these non-ceramic insulators are designed on one simple fundamental philosophy: To treat the insulator as if it were a sealed vessel. A strong focus is placed on the bonding of the polymer outer sheath to the central fibreglass rod, along with the sealing of the metal end fittings to the insulator, to prevent any moisture ingress. Providing these fundamentals are properly considered, then the major concerns on the integrity of the non-ceramic insulator are significantly reduced (Cherney, 1996).

The remaining issue that attracts major debate on non-ceramic insulators is the type of material of the outer sheath. The most commercially available types are either Silicone Rubber or EPDM (Ethylene Propylene Diene Monomers). These materials have characteristics that require a supply utility to choose the appropriate insulation to suit its particular application. The decision on which material to choose is usually based on the environment in which the insulator is to be used, along with the level of confidence and history the supply utility has had with a particular type of non-ceramic insulator.

It should be understood that any choice of insulator, for use on an electrical network, is determined through performance testing of the insulator to comply with recognised (international) standards. This compliance through rigorous testing, will ultimately give a supply utility the level of confidence required in its choice of insulator to be used on its electrical network.

A great deal of information on the research and development of non-ceramic insulation technology is available. This was well demonstrated at the recent Symposium on Non-Ceramic Insulator Technology held in Singapore, June 1996, attended by leading research scientists and world renowned experts. It gave a small insight to the depth of understanding and knowledge of this insulating technology, now commercially available around the world.

5.0 Investments in Non-Ceramic Insulators

The changing business environment is placing enormous pressure on Integral Energy to maintain an efficient and cost effective electrical network, with a focus on providing improved energy services to its customers. This
pressure has led Integral Energy to invest in new technologies such as non-ceramic insulators, which will help it to obtain these business objectives. It is recognised throughout the world that supply utilities traditionally have had a conservative nature, particularly when considering the risk of introducing new technology onto their electrical networks. This traditional approach however has not restrained Integral Energy from introducing this new technology over the last decade, as a standard insulating medium across its entire electrical network (11kV to 132kV) to produce exceptional business success.

5.1 Overhead Transmission Line Applications (33-132kV)

The first non-ceramic line post and long rod insulators were installed on the 132kV electrical network within Integral Energy in 1988. This initial installation gave the organisation the opportunity to consider what advantages this new technology had to offer. This trial project consisted of a compact single concrete pole 132kV line post construction. The simplicity of design, ease of construction and overall environmental benefits of the completed project, demonstrated to Integral Energy that this new technology had a great deal to offer.

The strong community acceptance of the completed project proved that this insulating medium can add real value to new overhead construction projects, while providing real savings in the total project construction costs.

Integral Energy has installed more than 3000 non-ceramic insulators on its transmission network.

The electrical performance of non-ceramic insulators and their ease of installation have proven to be very successful for Integral Energy, as there have been NO electrical or mechanical failures of the specified (Reliable Power products) non-ceramic line post or long rod insulators on the electrical network, since their initial installation.

* Typical Transmission Overhead Constructions, refer Figures 1, 2 & 3.

Footnote:
The use of non-ceramic insulators has been adopted as the preferred insulating medium by Integral Energy for all overhead transmission construction and maintenance projects, since 1991.

5.2 Overhead Distribution Line Applications (11-22kV)

The changing business environment requires, that all investments made by supply utilities on their electrical networks, provide the necessary return on investment (ROI) to their respective shareholders. This focus places enormous pressures on the Asset Branches within the organisation, to recognise every opportunity to obtain financial savings through better utilisation for their existing assets and to achieve reductions in capital expenditure.

It is this fundamental economic requirement (price), that has traditionally held back non-ceramic insulators in competing, at distribution voltages, against porcelain insulators. This area is now being challenged with the increased production of non-ceramic insulators in the international marketplace, which is driving the price down to be an attractive alternative, for high voltage distribution networks.
**Long Rod** non-ceramic insulator applications for 11kV & 22kV distribution voltages are currently being considered for the first time within Integral Energy as a standard insulating medium. This decision to consider the use of non-ceramic insulators has been determined, by taking a holistic approach to the financial investments in non-ceramic insulators for a single commodity. This approach takes into account such issues as the initial capital outlay, cost savings in the ease of installation, savings in live line maintenance practices, along with the increased benefits with having a superior insulating medium on the overhead network during times of transient conditions, caused by storms or high winds.

There is a world trend towards the increased volume in production and reduced prices for non-ceramic insulators. It is anticipated, that it will only be a matter of time before these non-ceramic insulators become the standard insulator, for all forms of construction and maintenance activities on the distribution network, for Integral Energy.

### 5.3 Distribution Overhead to Underground Applications (11-22kV)

Traditional ceramic insulator type cable terminations have been successfully used for many decades. The materials and designs used in this type of termination however generate several disadvantages such as heavy and physically large designs, inflexible, shatter failure modes, are time consuming to install and requires specialised skilled staff for installation.

The alternative is to use polymer type terminations, available in two basic types:

* **Flexible** This termination construction consists of a series of tubes that are shrunk, by various methods, over the prepared cable end. Terminations installed externally are designed with a tube, having in built sheds, to provide tracking resistance. The controlled impedance stress control approach is used in this termination.

* **Rigid** This termination construction is achieved essentially by replacing the ceramic insulator in older style terminations with a self supporting polymer equivalent. The conventional stress cone is used for stress control in this termination (Gilbert, 1993).

Polymeric terminations overcome the disadvantages of ceramic terminations and provide additional benefits:

* A lighter material providing a termination that requires less physical support and is easier to handle during construction. Nett weight reduction is in the order of 50%.

* Rapid installation using modern jointing skills that reduce the time and cost of this operation.

* The rigid style polymeric terminations still provide load bearing capacity for connections.

* The inherent nature of the material provides flexibility and can withstand shock loads and impacts.

* Low surface energy of material naturally discourages contamination and wetting. This enables more compact design of the termination structure as opposed to ceramic insulators that require a higher creepage path to allow for contamination and wetting during service.

* The cost of polymeric terminations is lower particularly for commercially proven products at lower voltage levels.

* Flexible polymer terminations can be operated in a horizontal or inverted position.

* Removal of insulation material due to abrasion or electrical activity is less critical as the material is homogenous throughout, as opposed to ceramics that rely on a thin glaze.
Generally, polymer style terminations have been available for many years up to 33kV and the service performance has been well proven. Progressively, this has also been occurring for similar terminations at higher voltages.

Integral Energy has taken maximum advantage of the properties of polymeric terminations in the development of standard underground transition designs for use on the distribution system. A typical 11kV polymeric flexible heat shrink termination is shown in Figure 4, has been in use for many years with proven satisfactory service performance. In this design the surge diverters are also constructed of polymeric material and serve a dual role as stand off insulators to provide a firm mounting point for connection to the termination (CEPSI, 1995).

### 5.4 Transmission Overhead to Underground Applications (33-132kV)

Non-ceramic technology has allowed for the increased use of polymeric cable terminations, surge diverters and insulators within Integral Energy. It is proving to be cost effective and allows far more aesthetically pleasing designs than any other form of overhead to underground cable termination system available.

An example of the tremendous benefits this non-ceramic technology can produce has been well demonstrated in a project conceived, designed and constructed by Integral Energy in 1995, for supply to the Arndell Park 132kV Zone Substation (Transmission & Distribution World, 1995).

The challenge to Integral Energy was to economically install two underground to overhead (UG/OH) connections, to an existing 132kV overhead steel tower transmission lines, using innovative designs to address the concerns of the local community and the Public School that will host this new tee connection. It was imperative that all connections within the schoolyard were designed of a material that would not shatter under excessive electrical or mechanical loads.

The project required the development of an innovative design that would give a win/win solution for all parties. This solution devised, by Integral Energy, was to remove the existing steel tower within the public school and install specially designed slim line, multi piece, prestressed concrete poles to mount the UG/OH connection.

This final solution to utilise a polymer connection was determined only after world wide investigations, which revealed that a suitable polymer technology was available through the West German cable accessory manufacturer known as DATWYLER Pty Ltd. All overhead line connections were constructed from non-ceramic (Reliable) line posts along with ASEA Brown Boveri polymer surge diverters.

The use of this non-ceramic insulator technology has allowed Integral Energy to obtain nett saving of more than $1.0 million when compared to alternative solutions which would have involved locating UG/OH connections outside the schoolyard. The success of the project was also measured by the positive response from the community and the school’s Parents & Citizens Committee which totally endorsed the completed project.

The development of polymer overhead to underground connections to 132kV is proving to be extremely advantageous to Integral Energy. Innovative designs that are functional, cost effective and meet community expectations and concerns are being incorporated into the electricity system infrastructure.

* Construction Stages of the Arndell Park Project, refer Figures 5,6,& 7.

### 5.4.1 The New Generation in Transmission Terminations.

The development of a series of polymer termination arrangements for Integral Energy’s entire transmission and subtransmission network has progressed from a unique concept, to a generic series of streamlined, low profile minimalist underground to overhead terminations, that are an obvious aesthetic improvement.

* The New Generation of Transmission Terminations, refer Figures 8,9,& 10.
6.0 Customer Reliability

The business environment within NSW is demanding a 100% reliable electricity supply under normal circumstances, with no acceptance or tolerance for planned or unplanned outages, by the customer, to perform any repair or maintenance activities by the supply utility.

The customer's expectations are key performance indicators within Integral Energy and are paramount in ensuring that the organisation maintains its market share during the ever increasing competitive environment.

These expectations clearly support the introduction of non-ceramic insulator technology which lends itself to higher levels of reliability and the stronger use of live line techniques that meet service level agreements with Integral Energy’s major customers.

7.0 Summary

Integral Energy has taken every opportunity to introduce non-ceramic insulator technology for the development of its entire electrical network, to produce innovative designs and constructions that have proven to be cost effective while exceeding the performance and reliability criteria for the organisation. The drive by Integral Energy to aggressively introduce new technology, such as non-ceramic insulators, is one way it hopes to gain an edge over its competitors, in today’s ever changing business environment.

It should be recognised that supply utilities are no different from any other form of organisation in the modern era, which need to recognise that change is becoming the norm. This constant drive for change is pushing organisations to challenge old paradigms and to test what is not known, rather than rely on the safety zone of the past. This concept is what Dunphy & Stace term "Beyond the Boundaries", in which organisations that are to be 'leading edge' in their industry must redesign, challenge and lead the way into the unknown future. This view is also supported by Kanter when she refers to this concept as "Stretching the Limits" beyond the known safe horizons of the organisation. This push into unsafe and unknown areas by organisations requires them to embrace change and thus be responsive to the new and dynamic business environment they find themselves having to operate within.

The challenge for leading edge organisations, such as Integral Energy, will be one of maintaining the most productive and economically viable solutions for its key business processes as it moves into an era with a strong commercial focus. The returns on investment (ROI) need to be in step with the current private business environment to demonstrate the efficiency and effectiveness of a State Owned Corporation, as it strives to perform like a private sector company and embrace the inevitable road to privatisation.
Reference Documents:


APPENDIX 3

Condition Based Assessment of Existing Lattice Steel Towers Field
Pull Over Tests

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INVESTMENTS IN LATTICE STEEL TOWERS:
AField Pull Over Tests≈

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ABSTRACT

The electricity supply utilities in New South Wales has entered into an environment where change is the norm, imposed largely by the State Government, which is seeking to extract financial returns from these State Owned Corporations. These changes are creating a fundamental shift in the existing paradigms in which these organisations operate. Long established principles are revisited and processes reengineered, to allow them to make necessary strides forward to achieve business success.

The supply utilities of today need to obtain improved utilisation of their existing assets, as they can no longer afford to invest the large sums of capital into infrastructure development that they readily did in the past. This reduction in financial expenditure is being achieved, with an emphasis on the need to utilise and introduce new technology and processes that improve the operating performance of their electrical networks, while also improving the efficiency and effectiveness of the network to give the cost reductions required in today’s competitive economic environment.

This paper has been prepared to show how progressive Supply Utilities are recognising their investments in their existing steel tower assets through the use of new technology and field-testing programs. This strategic approach to aging critical assets will provide ways to obtain practical data to determine the remaining life of these assets, to allow the organisation to maintain high levels of customer reliability and public risk in an ever demanding competitive environment.
1.0 Introduction

1.1 Reforming Government Owned Monopolies

The need for change of Australian organisations is being driven by the accelerating world economy, due to multinational and global companies expanding into enormous trading concerns ever since the early 1960s. The once regulated domestic trading agreements, owned and protected by Australian Governments through tariffs and trade agreements, have been removed by consecutive Australian Governments since the early 1970’s, as they shift their focus on international competition (Stace & Dunphy 1991: 15).

The need for deregulation of the Australian domestic marketplace has been recognised for some time by both Government and business alike. This recognition has been conveyed in such literature as, 'Improving Australia’s International Competitiveness', by the Economic Planning and Advisory Council, January 1991, which has focused on the need to maintain Australia's standard of living by improving its innovation and productivity. Another document which reflects this urgent need for reform is the >National Competition Policy', August 1993, in which barriers to international competition need to be removed such as, the restrictions in the Trades Practices Act for foreign competition, the reforming of Government Monopolies, providing third party access to certain infrastructure, restraining monopoly pricing behaviour, as well as fostering neutrality between government, and private business ventures in the areas of tax-equivalent payments.

This fundamental change to the Australia economy, with a new international focus, has necessitated the gradual deregulation of previously closed markets such as crude oil, gas and wheat markets, along with the gradual reduction of tariff protection for the agriculture and manufacturing industries. These changes have introduced increased international competition within the Australian domestic marketplace, as improved foreign goods at now competitive prices, introduced strong competition against locally made products. This has forced Australian organisations to reconsider how they do business and in which markets they will compete, in order to be successful and remain in business (Stace & Dunphy 1991: 27).

The introduction of the "National Competition Policy" known as the 'Hilmer Report' in August 1993 advocated the opening up of competition across national boundaries, by removing restrictive legislation and trade practices currently available to government monopolies in such areas as gas, electricity, rail and water.

2.0 The Road to Privatisation

The fundamental changes that are occurring within the electrical supply industry of Australia are not unique, as a number of other countries such as New Zealand and the United Kingdom have already progressed along the road to 'Privatisation'. This drive within Australia towards the privatisation of the electrical supply industry has been well demonstrated, with the break up of the supply authorities in Victoria into five individual entities, for their sale to overseas investors.

In Victoria the privatisation of the five (5) major supply authorities has occurred at a rapid rate of knots, since the election of the Liberal 'Kennett' Government in 1992. The drive for privatisation of these supply authorities has occurred as part of the economic reality of the Victorian State being in a financial crisis with debts of $33 billion, of which more than $9 billion was directly owed by the electrical supply industry. This debt led to the demise of the State's credit rating, by Moody's, which increased the repayments to service this huge state debt.

The privatisation and sale of the electrical industry by the Kennett Government have led to a reduction of the state's debt by $8 billion and resulted in a direct improvement in the State's credit rating by two points within 12 months. It is widely recognised that the drive to privatisation within Victoria has resulted from the direct need for strong economic management, by the new state Liberal Government, to balance the books for the long term prosperity of Victoria (Reuters Business Briefing, 1995).

The NSW Government has with the election of a Labor >Carr=Government, allowed for the progressive reform of the electrical supply industry over a planned period of time. The need for economic reform in NSW is not as critical and thus does not need the 'fire sale' as introduced by the Kennett Government. The political debate between states is such that the NSW Labor party is recognising that the sale of the electrical supply authorities in Victoria has meant a downsizing of staff by more than 40% and thus would not be as favourable within the labour state of NSW. This situation led to the statement by the State Premier Mr R Carr in which he
“Jeff Kennett wants to privatise everything that moves. I don’t. I am protecting the public interest” (Reuters Business Briefing, 1995).

The re-election of the Carr Government in February 1999 was on a platform of maintaining state owned corporations under government ownership, as a direct alternative to the Liberal opposition’s agenda of privatisation.

3.0 Realising the Investments in existing Steel Tower Assets

3.1 An overview: ALattice Steel Towers≠

This changing business environment requires that all investments made by supply utilities in their electrical networks, provide the necessary return on investment (ROI) to its single shareholder. This focus places enormous pressures on the Afunktional branches≠ within the organisation, to recognise every opportunity to obtain financial savings through better management of their existing assets.

The need to obtain data on the condition of aging assets, such as lattice steel towers, needs to be constantly challenged and is a key driver when considering the maintenance practices and refurbishment programs for asset rich organisations, such as Integral Energy.

The age profile of steel lattice towers within Integral Energy recognises that a great number of these assets have been in service for more than 40 years. A lattice steel tower has historically been maintained through a visual routine inspection regime that identifies any deterioration of the galvanised steel structure, above ground.

The aging population of Integral Energy’s 1,073 steel towers are the backbone to the delivery of bulk power to the many transmission and zone substations, within the franchise area of Integral Energy. The deterioration of a lattice steel tower’s strength capacity is assumed by engineering principles to not significantly be affected by age, providing the steel members are maintained in a rust free condition.

An opportunity was identified by Integral Energy to challenge this industry wide assumption, through the upgrading of an existing 132kV steel tower transmission line between Regentville and Penrith. A number of the redundant lattice steel towers were set aside for field APull Over Test≠ to determine the remaining strength of these now redundant lattice steel structures.

The field APull Over Tests≠ were considered to be the best solution to demonstrate the integrity of these steel towers as a complete entity, taking into account their remaining strength, both above and below ground. The results from the field tests would then be compared with the structural analysis performed on the towers, using the latest computer modelling techniques, based on the original design and fabrication details for these towers.

A joint venture was established between Integral Energy and Transgrid Pty Ltd, who is the state’s bulk power distributor, to nurture this unique opportunity and provide benefits to the wider electricity supply industry. The field tests would be managed and sponsored by Integral Energy, with all structural analysis being performed by Transgrid’s steel tower structural experts.

The goals of these field pull over tests is to obtain useful data on the physical condition of these aging assets. This useful information will then be used too more accurately target the funding for the maintenance and refurbishment requirements of these aging assets and support the organisation’s risk management policies in respect to quality of supply and public liability.
3.2 Field APull Over Tests≈

The field APull Over Tests≈ on these redundant steel towers were considered to be the most cost effective way of obtaining useful real life data on a series of lattice steel towers, found to be common throughout Integral Energy’s 132kV steel tower population. The field tests would need to recognise the structural complexities of a lattice steel tower, as these tests would be a one off opportunity as the tower would be destroyed once the test had been completed.

This critical structural requirement necessitated the need to establish a joint venture with Transgrid Pty Ltd, who are recognised throughout the NSW’s supply industry as the leader in the structural analysis of lattice steel towers. This joint venture required Integral Energy to manage and sponsor the field APull Over Tests≈, with Transgrid defining the appropriate locations and tower loading limitations for the field tests. Transgrid would also perform a post mortem of the results from the field tests, to compare the actual field results with the theoretical model.

3.3 Field Tests: ALayout≈

The selection of one series of double circuit lattice steel towers, would allow a level of consistency to be established for the field tests being performed. Of the redundant lattice steel towers available three (3) -DS2 suspension lattice steel towers were selected to allow a realistic model to be derived on the status of these aged lattice steel towers.

A structural analysis was performed by Transgrid’s representative, Mr D Dempsey, which allowed the field test Rigg to be configured to fail the selected series of lattice steel towers.

A commercial contractor, Transfield Pty Ltd, was engaged to provide the appropriate labour and equipment to perform the field APull Over Tests≈. This equipment consisted of a DC-9 Caterpillar, 140 metres of high tensile steel cable (120kN/Failing load), a fabricated pulling assembly bar, an in line dynameter capable of recording tensile pulling loads from (1-20kN) in increments of (0.2kN), a ground anchor sled with three six-tonne portable concrete loading blocks and one pulling wheel.

The field layout was designed to allow consistency during the application of the tensile pulling loads. The pulling assembly bar is to be attached to the bottom crossarm of the steel tower to allow the pulling loads to be evenly spread across the tower members. The steel pulling rope is then attached to the assembly bar, which runs through the pulling wheel at a designated angle. This pulling wheel is then attached to the weighed down anchor sled which runs at right angles to the tower and is attached to the DC-9 caterpillar with the dynameter in line, some 100 metres away from the tower.

- The Field Test Layout, refer Figures 1, 2, & 3.

Fig 1. Pulling assembly bar is prepared.
The initial structural analysis on the selected towers showed the majority of the towers members would be loaded with an applied load to the towers transverse face, offset by 10 degrees, with a pulling angle to the horizontal of 45 degrees. The theoretical failing load on the towers with a load applied under these conditions was calculated to be 9.0kN, (∀0.2kN), with failure occurring at the second horizontal brace member below the bottom crossarm.

A survey team was established to support the field Pull Over Tests. Their role is to record tower deflections and movements at designated critical locations, while the tower is being loaded up in 0.5kN increments. This data will be used to support the post mortem structural analysis of the failed steel towers.

The actual field Pulls Over Tests will also be recorded on video, to support the post mortem analysis, to identify the Aspecific sequence of steel member and brace failures, for each tower being tested.

4.0 Field Test Results

Detailed below is a summary of the field test results, for the three(3) DS2- lattice steel towers tested:
**TOWER No.1**

The unknown factor played a major part in the field test of this tower. The contractor was asked to locate the spreader bar below the *second crossarm*, as the members would be loaded to an even larger bending moment and allow the same result to be obtained. This assumption, made in the field to speed up the test results, neglected to take into account the local buckling that may result, which did occur in this test, resulting in the steel tower failing well below the designated theoretical load.

* Applied Failing Load: **6.3kN**  
* Mode of Failure: **Local Buckling**

* Tower No.1 Failure, refer *Figures 4, 5, & 6.*

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**Fig 4.** Side View of Tower No.1, showing ground anchor sled, concrete loading blocks and pulling wheel.

**Fig 5.** Linesman climbs to inspect failure points on Tower No.1.
The failure mode of Tower No. 1 necessitated the need to follow the original analysis performed on the towers, with the spreader bar attached to just below the bottom crossarm as originally intended. This adjustment to the location for the applied loads, strongly supported the theory of the structural analysis, with the tower failing at the specified location and at the designated pulling tension.

# Applied Failing Load: 9.3kN  
# Mode of Failure: Column member & brace buckling.

* Tower No.2: Failure, refer Figures 7 & 8.
Fig. 8. Tower No. 2 failed as structural analysis predicted.

**TOWER No.3**

The successful failure of Tower No. 2 provided a comfortable feeling on just what would be expected during the testing of Tower No.3. The failure mode for Tower No.3 however did not follow the expected, as the tower leg under compression failed at the $\alpha_k \approx 0$ point, just above ground level. This failure mode left the tower in an unstable state, which caused the entire structure to fall, controlled only by the DC-9 caterpillar.

# Applied Failing Load: 8.6$kN$  
# Mode of Failure: *Leg member & braces at $\alpha_k \approx 0$ Point.* 

* Tower No.3: Failure, refer **Figures 9 & 10.**

Fig. 9. On Tower No. 3, initial failure began at the bottom.
Samples of the actual failed steel members were taken on all towers tested, for analysis to determine the actual grade of steel, for each of the failed towers.

5.0 Review: ATower Failures

The failure modes for the towers tested showed the complexities of analysing lattice steel towers. Tower numbers 1 and 2 can be readily explained using conventional structural analysis modelling techniques. The failure mode for Tower No.3 however will require far more riggers, as the tower failed well outside the structural model developed and at a location not considered being the first node of failure.

The samples of the steel members taken from Tower No.3, will be analysed and used to provide additional data in identifying the cause for this particular tower failure.

This data is still being processed at the time that this article has been written. However, all theory leads to the steel members being below the assumed 250-grade steel for these types of structures. This may well be due to the processing and quality control methods used to fabricate steel members, more than 40 years ago.

6.0 Below Ground Assessment

The below ground condition of the footings for each of the towers tested were assessed after excavating the footings. These excavations found the grillage footings to be in a good condition with very little corrosion to have occurred, after 43 years of serviceable life. These findings were supported by polarisation resistance measurements and half cell readings performed on these steel tower footings prior to their excavation.

The confidence gained by using this simple non-destructive practice will allow utilities, with steel towers, to easily obtain a profile of the below ground condition of these aging assets. This data can then be used to perform batch testing of those towers identified as Asuspect, high levels of DC current flow, to perform field excavations and determine the actual condition of these specifically identified steel tower footings.

This form of pro-active maintenance will provide the utility with the level of confidence needed in today’s competitive business environment, by targeting the available maintenance funds to those parts of the electrical network that is genuinely in need of repair.
7.0 A Critique

The test results are supporting the historical approach to the strength relationship of lattice steel towers, above ground. Providing the towers major structural members are maintained in a relatively rust free environment, then the towers integrity would not be under question. These findings would support the current maintenance practice of performing visual inspections of the above ground condition of all lattice steel towers, to determine the level of corrosion that has occurred to the tower.

The level of corrosion that does occur to existing steel tower needs to be controlled through proactive maintenance strategies, in particular those located in hostile corrosive environments, through such practices as tower painting or steel member replacement programs to ensure the integrity of the steel tower is maintained.

8.0 Summary

The field APull Over Tests on these redundant lattice steel towers in the Penrith area, have provided practical data on the condition of these aged lattice steel towers for Integral Energy. This data will now be used to review the current maintenance strategies for these aging assets, for Integral Energy=s entire steel tower population. The review of the maintenance practices by Integral Energy will all assist in improving the management of these aging assets and play a major role in reducing the organisation=s exposure to public risk and liability.

It should be recognised that supply utilities are no different from any other form of organisation in the modern era, which need to recognise that change is becoming the norm. This constant drive for change is pushing organisations to challenge old paradigms and to test what is not known, rather than rely on the safety zone of the past. This concept is what Dunphy & Stace term "Beyond the Boundaries", in which organisations that are to be 'leading edge' in their industry must redesign, challenge and lead the way into the unknown future. This view is also supported by Kanter when she refers to this concept as "Stretching the Limits" beyond the known safe horizons of the organisation. This push into unsafe and unknown areas by organisations requires them to embrace change and thus be responsive to the new and dynamic business environment they find themselves having to operate within.

The challenge for leading edge organisations will be one of maintaining the most productive and economically viable solutions for its key business processes, as it moves into an era with a strong commercial focus. The returns on investment (ROI) need to be in step with the current private business environment to demonstrate the efficiency and effectiveness of a State Owned Corporation, as it strives to perform like a private sector company and embrace the inevitable road to privatisation.
Reference Documents:


APPENDIX 4


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A HOLISTIC APPROACH TO THE MANAGEMENT OF ELECTRICAL ASSETS
WITHIN
SUPPLY AUTHORITIES.

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This paper is an extract from a research DBA with the University of Western Sydney, Nepean.

ASSET MANAGEMENT

Executive Summary

The electrical supply industry has entered into an era of environmental change imposed largely by State Governments to extract financial returns from these State Owned Corporations. These changes are creating a shift in the existing paradigms in which these organisations exist. Long established principles are being revisited and processes re-engineered to allow them to make necessary strides forward to obtain business success.

It is this drive to break down the barriers and practices of the past that has led to the development of this paper to take a Holistic Approach to the Management of Electrical Assets within Supply Authorities.

This drive towards a holistic asset management approach will require supply utilities to integrate with the organisation’s corporate objectives and business strategies to ensure the effective use of all of its resources. This approach will need to consider the whole of life costs attributed to the distinct phases of the Asset’s Life Cycle, to obtain full utilisation of the asset to ensure business success.
Reforming Government Owned Monopolies

The need for change of Australian organisations is being driven by the accelerating world economy, due to multinational and global companies expanding into enormous trading concerns ever since the early 1960s. The once regulated domestic trading agreements, owned and protected by Australian Governments through tariffs and trade agreements, have been removed by consecutive Australian Governments since the early 1970's, as they shift their focus on international competition (Stace & Dunphy 1991: 15).

The need for deregulation of the Australian domestic marketplace has been recognised for some time by both Government and business alike. This recognition has been conveyed in such literature as, 'Improving Australia’s International Competitiveness', by the Economic Planning and Advisory Council, January 1991, which has focused on the need to maintain Australia’s standard of living by improving its innovation and productivity. Another document, which reflects this urgent need for reform, is the ‘National Competition Policy’, August 1993. In which barriers to international competition need to be removed such as the restrictions in the Trades Practices Act for foreign competition, the reforming of Government Monopolies, providing third party access to certain infrastructure, restraining monopoly pricing behaviour as well as fostering neutrality between government and private business ventures in the areas of tax-equivalent payments.

This fundamental change to the Australia economy, with a new international focus, has necessitated the gradual deregulation of previously closed markets such as crude oil, gas and wheat markets, along with the gradual reduction of tariff protection for the agriculture and manufacturing industries. These changes have introduced increased international competition within the Australian domestic marketplace, as improved foreign goods at now competitive prices introduced strong competition against locally made products. This has forced Australian organisations to reconsider how they do business and in which markets they will compete, in order to be successful and remain in business (Stace & Dunphy 1991: 27).

The introduction of the "National Competition Policy” known as the ‘Hilmer Report’ in August 1993 advocated the opening up of competition across national boundaries, by removing restrictive legislation and trade practices currently available to government monopolies in such areas as gas, electricity, rail and water.

The fundamental changes that have been progressively introduced into government owned monopoly enterprises has changed the way these organisations function, with a clear stride towards a privately owned organisation delivering commercial rates of return to agreed standards in the quality of goods and services to the customer.
**An Emerging Theme**

The reform of government monopolies and the ever-changing business environment are placing enormous pressure on asset-rich organisations to provide overall improvements in the way they do business. These organisations are recognising that in order to compete and be successful in the international community they will need to improve their overall efficiency and effectiveness in delivering services to their customers while providing increased value to the shareholder.

These organisations are focussing on the benefits of realising the investments they have made in their existing assets in order to reduce their capital and operating expenditures to improve the organisation’s overall operating performance. This recognition is driving these organisations to adopt an integrated or “holistic” asset management approach to achieve the organisation’s overall business objectives through improved utilisation of all the resources available to these asset-rich organisations.

This recognition has been well documented, by Federal and State Government authorities, as they have historically owned these types of asset rich organisations within Australia. In the Auditor General’s Report No.27 the estimated total depreciated value of the physical assets controlled by the Commonwealth, as at 30 June 1995, was estimated to be worth $66 billion, which does not recognise the true replacement cost for these assets.

The fundamentals of asset management have not been fully appreciated or realised by a great number of Australian asset rich organisations in the past. This understanding has been documented in two studies performed by Australian National Audit Office (ANAO) in Audit Report No.27- (1995/96) and Audit Report No. 41- (1997/98). A study of over 56 government enterprises identified a complete lack of implementation of the fundamentals of asset management by over 60% of the organisations reviewed.

The findings from this audit review concluded:

* "the sound principles of asset management dealing and strategic planning, acquisition, operation and disposal are not being applied in most agencies and, where they are, they can be significantly improved"*(Audit Report 1990, No.27, p.vii).

The drive by the Federal Government towards the principles of asset management used within the public sector was to assess how these assets are being managed to deliver the customer’s expectations on service and value with an emphasis on optimising additional public funds into new infrastructure development.
One of the key statements made within the Auditor General’s Report was item No.1.4, which states:

* "Scope exists for significant improvement in asset management practices. Adherence to the principles of asset management discussed in this report will result in benefits to the Commonwealth in the form of reduced demand for new assets, optimisation of the performance of existing assets, and disposal of surplus and under performing assets." (Audit Report 1996/97, No.27, Item No.1.4).

This lack of implementation of the basic fundamentals of asset management would imply that there is a tremendous opportunity to improve the efficiency and effectiveness of these organisations.

This paper will provide an insight on the concept of what it means for asset rich organisations to implement the principles of asset management to optimise expenditure on their assets. This approach will explore the benefits of an integrated holistic approach by these organisations to optimise all of the available resources and deliver the services to the customer while providing a commercial rate of return to their shareholders.

A review of the literature available on infrastructure Asset Management has identified that a large number of asset rich (mainly public sector) organisations understand asset management generically as a business process. This understanding is based upon the need by these asset rich organisations to manage their physical assets through the various stages of an asset’s entire life cycle to deliver optimum results and value to the owner (shareholder), while mitigating the organisation’s exposure to financial and public risk.

This understanding of asset management raises the need to consider the dependency of the appropriate asset management “model” considered to be an intricate part of delivering the services and benefits derived by introducing an integrated asset management process.

The asset management model is essentially seen as a contractual relationship between an asset manager and a service provider. This view is simplistic in nature and does not reflect the true intricacies of this relationship as at times it is blurred and dependent upon the skill based required and stage of evolution that the organisation has progressed along the road to privatisation. This issue however will not be explored within this extract of the main research paper.

2.0 IDENTIFYING THE “GAP”

(Literature Review - extract from main paper)

A number of interpretations on asset management are available depending on the business purpose of the organisation. A variety of definitions on asset management have been detailed below to give a broad understanding of this term.
The definition of as per the Auditor’s General Report No.27:

* "Aims to provide an approach to the management of assets, encompassing the principles of Integrated Planning, Asset Planning, Asset Accountability, Asset Disposal and the Internal Control Structure."

The definition as per the Public Works Department (PWD):

* “In a system wide context, the sum of all those activities leading to the infrastructure appropriate to the cost efficient delivery of Government services, those activities having the following strands:
  * Identification of need for the asset.
  * Provision of the asset including its refurbishment.
  * Operation of the asset including its maintenance.
  * Disposal and thus effective removal of the asset from an agency’s portfolio.”

The definition as per the Institute of Municipal Engineering Australia (IMEA) is broken into two distinct areas:

**Asset Management:**

“The integration of the asset utilisation and the performance with the broader business requirements of those whom it is intended to serve. It includes consideration of procurement, ongoing support, rehabilitation and disposal and the markets the asset is intended to serve.”

**Asset Management Strategy:**

“A strategy for asset management covering, at a strategic level, the development and implementation of plans and programs for asset creation, operation, maintenance, rehabilitation/replacement, disposal and performance monitoring to ensure that the desired levels of service and other operational objectives are achieved at minimum cost.”

It can be seen from these interpretations that different perspective’s have been taken by these organisations to align their corporate objectives with their own asset management practices. The desire to achieve improved financial control of the capital and operating expenditures by these organisations is apparent, along with the requirement to recognise the distinct phases of an asset’s life cycle.

One of the major issues “Gap” that is confronting large asset rich organisations is the need to integrate the concept of asset management into the framework of the organisation. This concept is a major paradigm shift in the thinking for these organisations, as their assets have historically been
driven by a “build mentality” based on the supply and demand principles that existed in the marketplace at the time.

The development of a Holistic Asset Management Plan for one type of organisation may not be applicable to another similar type of organisation. Each organisation will have alternative processes, work practices and decision-making criteria that are unique to the organisation, which will play a major role in how the overall plan is adopted and implemented within the organisation.

3.0 Asset Management: - A Core Business Process

Asset Management within Australia has been developed with a focus on public sector organisations, as they are the traditional owners of most of Australia's large asset-based infrastructure. All development within these specific types of organisations has been driven in recent times by the Auditor General's Department to align public owned infrastructures with modern day accountancy practices. This approach is based on a fundamental understanding of obtaining the cost drivers for the organisation that will allow the right business decisions to be made to deliver optimum value and service to the end user, while improving shareholder value.

The need to apply the philosophy of Asset Management to all asset-rich organisations is an area that has been historically lacking by both Federal and State government agencies. The drive in today’s changing business environment is to optimise the existing infrastructure and alleviate the financial drains on these organisations to allow a better distribution of the available financial resources to more strategic locations.

The importance of introducing the fundamental principles of asset management by any organisation cannot be overstated, as this process will ensure that full accountability of the asset's condition, use and performance is recognised by management to support the program delivery for the organisation. These fundamental principles will require that the whole of life costs be considered from the start of the asset planning phase that allows investment decisions to be made based on an asset's entire life cycle, rather than the asset's initial purchase price.

One of the fundamental issues not fully appreciated with asset ownership is liability that is imposed on any large asset based organisation, as asset ownership requires it to be managed and maintained for its entire serviceable life. This recognition alone necessitates that organisations adopt the fundamentals of asset management and put in place measures and controls to appropriately manage the risks and liabilities associated with owning and operating an asset.

A number of government owned asset rich organisations have adopted the fundamentals of asset management into the way they operate as a business. This thinking recognises asset management as an overarching business process that integrates into all aspects of the way the business functions to deliver its business mission and purpose.
A number of organisations have developed the building blocks for an asset management process. These building blocks have been arranged and developed to best suit the way they wish to deliver their corporate objectives. It is important to recognise that the way the asset management process is incorporated into any business will not be the same, as the intent and purpose of each phase of the asset management process will need to be adapted to best suit the organisation’s “way of doing business”.

A number of government bodies and large organisations have produced readily available literature on the philosophy of asset management and the business processes to deliver the outcomes desired from the process for their organisations. One such organisation that has produced literature on the asset management process is the Auditor Generals Department titled the Asset Management Handbook. This document addresses the key areas required for asset management in a global perspective providing the basic building blocks and framework of the asset management process.

An alternative approach taken of the asset management process has been developed by the Public Works Department in their manual titled Total Asset Management, in which an integrated approach is taken to consider any number of alternative solutions to best deliver the ever changing needs of the public.

This model discusses the need for an understanding of the changing needs of the public utilising tools such as “gap analysis” to identify the desired service needs of its customer. Alternatives such as Non Asset Solutions are considered that will deliver the desired services in a far more cost-effective manner than the traditional approach used by the Public Works Department in new infrastructure developments.

This process provides an incite of the rational for considering alternative approaches other than capital investment solutions traditionally favoured by the majority of government owned organisations.

A third view and process on asset management has been developed by the Institute of Municipal Engineering Australia (IMEA), titled the National Asset Management Manual. The approach taken is to develop an asset management process with a strong emphasis on the technical aspects of the assets.

The philosophy of the IMEA process is to take into account the whole of life costs of the asset. In particular the maintenance cost for large capital infrastructures, such as roads and buildings etc, owned by government enterprises that are typically as high as five times the initial purchase price of the asset. This realisation of the financial burden imposed on these organisations play a major part in the decisions to be made during the planning and acquisition phase for an asset.
Alternatives to these documented Asset Management processes can be found in the open market place. The current thinking on asset management has been growing at an exponential rate over the last 10 years with a great number of international practitioners and theorist now available to provide insight in the many ways of introducing and integrating the concepts of asset management into an organisation.

This paper has been produced to provide a road map on asset management and what it is designed to achieve for an organisation in the early stages of understanding and implementing the concepts of an integrated asset management process.

From the available literature on asset management there appears to be an emerging theme that brings together two distinct phases on “what is” asset management. These two distinct phases fall into either a Strategic or Operational role that combine to form an integrated asset management process.

The Strategic Role of the asset management process considers all aspects associated with the planning phases of the asset, incorporating those issues associated with service needs and asset creation. The strategic function is very much focussed on delivering the long-term needs for the organisation in the areas of service, risk and shareholder value.

This understanding is illustrated in the figure below in which the linkages between market forces to specific asset strategies are considered to ensure acceptable returns on investments are returned to the shareholder. (Allen, J 1997)

![Diagram of Asset Strategy Development Process]

A Strategic Function - Asset Strategy Development Process
The **Operational Role** of the asset management process considers all aspects associated with implementing the asset strategies developed. This aspect of the asset management process involves the construction, operation, maintenance and monitoring of the assets to ensure they are “fit for service”

This understanding is illustrated in the figure below of a maintenance process developed to provide continuous improvement on the condition and performance of the asset to deliver the strategic outcomes desired.

The development of the maintenance process is one of the key processes associated with an asset’s life cycle. However it must be recognised that the Acquisition, Operation and Disposal phases of an asset’s life cycle all require the same level of process design and review as is demonstrated in the maintenance process.

**The Maintenance Process**
The program to deliver **Maintenance** is considered to be the most important activity on the operating side of any business. It is among the most costly recurrent contributor to an organisation's operating expenditure.

Management of the Maintenance process is one of the primary functions of asset management and is usually the longest phase of the asset's life cycle as it is typically required from the moment the asset has been constructed and is *fit for service*. Maintenance costs are driven by the outcomes of functional design specification, detailed design, construction, installation and operating practices such that maintenance can only be conducted within the inherent capabilities and practical limitations of the systems or equipment. The maximum opportunity to reduce maintenance expenditure exists within the maintenance *planning stage* of the overall maintenance process.

The faithful conduct to deliver effective maintenance management is the “goal” to guaranteeing optimised equipment performance at least cost, ensuring the productive availability of that equipment throughout its whole service life, that delivers the desired performance outcomes for the business.

The maintenance process needs to ensure assets are adequately maintained and protected to deliver desired levels of service, condition and performance for the assets. The underlying philosophy of this process is to:

- Identify under performing assets that do not deliver capacity or functionality.
- Identify assets that have excess capacity or functionality to prescribed standards.
- Identify assets that require refurbishment and/or disposal.

The appropriate levels of maintenance for any organisation in a competitive environment requires a rigorous review of the levels of assessed risk that can be sustained, by the asset managers, to deliver the “right” outcomes for the business that align with the corporate objectives set by the organisation.

The outcomes of maintenance planning is in fact the true test of how *effective* the maintenance strategies have been to deliver the performance criteria that has been set for the business. The performance criteria for this part of the process will require rigorous review and analysis to ensure the right mix of maintenance activities are delivering the improvements needed to provide sustained business success.

The strategic and operational roles associated with the asset management process require a high level of *flexibility* so that they can be implemented and tailored to the specific needs and applications for any type of asset rich organisation.

**Case Study** – *(Timber Pole Assets - Refer APPENDIX 1)*
A case study has been prepared to demonstrate how the strategic and operational roles of an integrated asset management process would be applied. This case study has been produced on Integral Energy's timber pole assets. The case study has been specifically targeted at a large asset base population.

The focus of the study is to demonstrate the implications of integrating an Asset’s Strategy into the maintenance process for what is seen as a relatively simple asset.

5.0 CONCLUSION

The intent of this paper is to provide the framework on the principles of asset management and how these principles are integrated into a core business process. The information presented should be viewed as a series of building blocks that provides organisations the flexibility and freedom to apply these broad principles that best suits their own business practices, processes and work culture.

This view is supported by the findings and conclusions from the Auditor’s General Report No.27 identified a number of weaknesses in asset management practices common to the organisations audited:

“*The weaknesses related primarily to the lack of a strategic approach to asset management. In particular the audit found:*

- *Asset management decisions are not well integrated into management planning processes*”(Audit Report, 1995-96.No.27, item No.1.9).

It needs to be recognised however that the implementation of a **comprehensive** asset management process will probably be so onerous on an organisation that it is unlikely to provide the benefits desired for the effort in the short term. This thinking is based on the traditionally slow implementation rate of new concepts and principles essentially due to the existing workload and operational issues that exist within the organisation.

Therefore as identified by Bryne, 1996, asset management should be implemented on a program based on the principles of continuous improvement and implemented in successive and manageable steps to allow the complexities and dynamics of the process to be fully understood.

This realisation therefore requires management to be focussed on the **critical issues** for the business and address them as a priority. This focus will allow those key areas to be addressed and provide the gains required by the organisation in the **short term**.
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A Strategic Function

Customer Expectations

Regulatory Direction

Market Model
- Regulated Returns
- Environmental Implications
- Social Expectations
- Industry Practice

Market Needs
- financial returns
- reliability
- environment

Asset Performance
- reliability
- quality of supply
- failure reports

Cost Implications
Life Cycle Costs
- I.R.R.
- R.O.I.
- Cashflow

(RISK ASSESSMENT)
- Duty of Care
- Public Risk
- Quantitative/Qualitative Assessment
- Level of acceptable risk

(RANGE OF OPTIONS)
- replace
- status quo
- new technology
- underground

Range of Options

Risk Analysis
- Level of exposure
- Implication - accept risk
- mitigate risk
- transfer risk

Asset Condition
- treatment
- age profile - species/durability
- failure rates
- defect reports
- heart rot report

Specific Strategy
- underground new urban areas
- life extensions
- inspection periods
- treatments
- C.B.M.
STRATEGIC PHASE
MAINTENANCE PLANNING

Maintain Asset Data Base
- update maintenance compliance/program
- fault & emergencies - defects

Asset Performance Data & Monitoring
- Impact on reliability
- Failure Report
- Defect report
- Financial tracking

Analysis of Asset Profile & Performance
- Assessing Trends
- expenditure
- failures (types, locations etc)
- fault & emergency
- reliability
- Audit reports
- Age profile

Reconcile Business Objective with Asset Management Objectives
- Reducing failure trends
- Financial Management - R.O.I.
- Asset Model Objectives

Review Asset Management Strategies
- Inspection regime (time/type etc)
- New technologies
- financial implications
- forecast improvements

Maintenance Plan
- No of inspections
- Period of inspections
- Type of inspections
- Approved Budget

Review Maintenance Standards & Technical Specifications
- modify to suit desired strategy
- period of inspection
- type of inspection
- reporting
- treatments

Contract Management
- Expenditure - Program - Audits

Contractor Performance Review (KPI’s)
- Compliance to program
- Financial Expenditure to Budget
- Customer response
- data entry
- defect reporting
- quality of audits
- response to fault and emergency
- innovation

Operational Phase
MAINTENANCE DELIVERY

Maintenance Delivery
- inspection
- replacement
- fault & emergency
- value add (investigations)
- expenditure

Project Management
- Scheduling/Program

Established SLA/Contract
- Program
- Budget
- Contract/Conditions

Inventory Management
- Location
- Response/emergencies
- Quality
- Contingencies

Warehouse Management
- Logistics
- Maintenance response
- Fault and emergency response
- Replacement
APPENDIX 5

A Holistic Approach to Integrated Asset Management

Published MAINSTREAM2002, Sydney 2002- (Full Text)
A HOLISTIC APPROACH TO INTEGRATED ASSET MANAGEMENT

Colin Brown  
Transmission Mains Manager  
Asset Management  
Integral Energy

This paper is an extract from a research DBA with the University of Western Sydney, Nepean.

Executive Summary

All industries are entering an era of environmental change imposed by progressive Government Policies by promoting tree trade at a national and domestic level by the reduction of trade barriers. These changes are creating a shift in the existing paradigms in which these organisations exist. Long established principles are being revisited and processes re-engineered to allow them to make necessary strides forward to obtain business success.

It is this drive to break down the barriers and practices of the past that has led to the development of this paper to take a Holistic Approach to Integrated Asset Management.

This drive towards a holistic asset management approach will require organisations to integrate corporate objectives and business strategies to deliver the effective use of all of their available resources. This approach will need to consider the whole of life costs attributed to the distinct phases of the Asset’s Life Cycle, to obtain full utilisation of the asset to ensure business success.
**Asset Management: - A Core Business Process**

Asset Management within Australia has been developed with a focus on public sector organisations, as they are the traditional owners of most of Australia’s large asset-based infrastructure. All development within these specific types of organisations has been driven in recent times by the Auditor General’s Department to align public owned infrastructures with modern day accountancy practices. This approach is based on a fundamental understanding of obtaining the cost drivers for the organisation that will allow the right business decisions to be made to deliver optimum value and service to the end user, while improving shareholder value.

The need to apply the philosophy of Asset Management to all asset-rich organisations is an area that has been historically lacking by both Federal and State government agencies. The drive in today’s changing business environment is to optimise the existing infrastructure and alleviate the financial drains on these organisations to allow a better distribution of the available financial resources to more strategic locations.

The importance of introducing the fundamental principles of asset management by any organisation cannot be overstated, as this process will ensure that full accountability of the asset’s condition, use and performance is recognised by management to support the program delivery for the organisation. These fundamental principles will require that the **whole of life costs** be considered from the start of the asset planning phase that allows investment decisions to be made based on an asset’s entire life cycle, rather than the asset’s initial purchase price.

One of the fundamental issues not fully appreciated with asset ownership is **liability** that is imposed on any large asset based organisation, as asset ownership requires it to be managed and maintained for its entire serviceable life. This recognition alone necessitates that organisations adopt the fundamentals of asset management and put in place measures and controls to appropriately manage the risks and liabilities associated with owning and operating an asset.

A number of organisations have developed the building blocks for an asset management process. These building blocks have been arranged and developed to best suit the way they wish to deliver their corporate objectives. It is important to recognise that the way the asset management process is incorporated into any business will not be the same, as the intent and purpose of each phase of the asset management process will need to be adapted to best suit the organisation’s “**way of doing business**”. 
This paper has been produced to provide a road map on asset management and what it is designed to achieve for an organisation in the early stages of understanding and implementing the concepts of an integrated asset management process.

From the available literature on asset management there appears to be an emerging theme that brings together two distinct phases on “what is” asset management. These two distinct phases fall into either a Strategic or Operational role that combine to form an integrated asset management process (as per diagram 1).

**Diagram 1**

The **Strategic Phase** of the asset management process considers all aspects associated with the planning phases of the asset, incorporating those issues associated with service needs and asset creation. The strategic function is very much focussed on delivering the long-term needs for the organisation in the areas of service, risk and shareholder value.

This understanding is illustrated in Diagram 2 below in which the linkages between market forces to specific asset strategies are considered to ensure acceptable returns on investments are returned to the shareholder. (Allen, J 1997)
The **Delivery (Operational) Phase** of the asset management process considers all aspects associated with implementing the asset strategies developed. This aspect of the asset management process involves the construction, operation, maintenance and monitoring of the assets to ensure they are “fit for service”

This understanding is illustrated in Diagram 3 below developed to provide continuous improvement on the condition and performance of the asset to deliver the strategic outcomes desired.

The development of the **maintenance process** is one of the key processes associated with an asset's life cycle. However it must be recognised that the Acquisition, Operation and Disposal phases of an asset’s life cycle all require the same level of process design and review as is demonstrated in the maintenance process.

![Diagram 3](attachment:image.png)
The Maintenance Process

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Management of the Maintenance process is one of the primary functions of asset management and is usually the longest phase of the asset’s life cycle as it is typically required from the moment the asset has been constructed and is fit for service.

Maintenance costs are driven by the outcomes of functional design specification, detailed design, construction, installation and operating practices such that maintenance can only be conducted within the inherent capabilities and practical limitations of the systems or equipment.
The maximum opportunity to reduce maintenance expenditure exists within the area of maintenance planning of the overall maintenance process.

The faithful conduct to deliver effective maintenance management is the “goal” to guaranteeing optimised equipment performance at least cost, ensuring the productive availability of that equipment throughout its entire service life, that delivers the desired performance outcomes for the business.

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The outcomes of maintenance planning is in fact the true test of how effective the maintenance strategies have been to deliver the performance criteria that has been set for the business. The performance criteria for this part of the process will require rigorous review and analysis to ensure the right mix of maintenance activities are delivering the improvements needed to provide sustained business success.

The strategic and operational roles associated with the asset management process require a high level of flexibility so that they can be implemented and tailored to the specific needs and applications for the specific asset rich organisation.

**Case Study – (Timber Pole Assets - Refer APPENDIX 1)**

A case study has been prepared to demonstrate how the strategic and operational roles of an integrated asset management process would be applied. This case study has been produced on Integral Energy’s timber pole assets. The case study has been specifically targeted at a large asset base population.
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Therefore as identified by Bryne, 1996, asset management should be implemented on a program based on the principles of continuous improvement and implemented in successive and manageable steps to allow the complexities and dynamics of the process to be fully understood.

This realisation therefore requires management to be focussed on the critical issues for the business and address them as a priority. This focus will allow those key areas to be addressed and provide the gains required by the organisation in the short term.
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Market Model
- Regulated Returns
- Environmental Implications
- Social Expectations
- Industry Practice

Market Needs
- Financial returns
- Environmental performance
- Zero failures
- Replacement strategy
- Period of Service

(ASSET MODEL)
Timber Poles Assessing the Needs
- Financial returns
- Environmental performance
- Zero failures
- Replacement strategy
- Period of Service

Asset Performance
- reliability
- quality of supply
- failure reports

Cost Implications
- Life Cycle Costs
- I.R.R.
- R.O.I.
- Cashflow

(RISK ASSESSMENT)
- Duty of Care
- Public Risk
- Quantative/Qualitative Assessment
- Level of acceptable risk

Range of Options
- replace
- status quo
- new technology
- underground

Specific Strategy
- underground new
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- life extensions
- inspection periods
- treatments
- C.B.M.

Asset Condition
- treatment
- age profile - species/durability
- failure rates
- defect reports
- heart rot report

Customer Expectations
- safety
- reliability
- environmental
- visual
- underground (remove)

Regulatory Direction
- financial returns (regulated)
- licence compliance
- quality of supply
- reliability
- safety (public)
- environment
- duty of care

Risk Analysis
- Level of exposure
- Implication - accept risk
- mitigate risk
- transfer risk

A Strategic Function
APPENDIX 6

(Revised version of Paper 3 for Publication)

Squeezing Dollars out of Towers

Transmission & Distribution World

GIS Streamlining A World Of Information

Also in This Issue...
- Telecommunications Roundtable
- Distribution Automation
- Substation Integration

http://www.idworld.com
Squeezing Dollars Out of Steel Towers

Field tests reveal remaining tower life.

As Australia’s electric utilities privatize, they are looking to better manage their existing assets in order to save costs. At Integral Energy (IE), Huntingwood, New South Wales, Australia, the condition of aging assets, such as lattice steel towers, had to be determined so that future maintenance practices and refurbishment programs could be appropriately managed.

Many of these towers have been in service for more than 40 years. Historically, they have been maintained by a visual inspection program that identifies any deterioration of the galvanized steel above ground. The aging population of IE’s 1073 steel towers are the backbone for delivery of bulk power to many transmission and zone substations. A lattice steel tower’s strength is not significantly affected by age, providing the steel members are maintained in a rust-free condition.

IE identified an opportunity to challenge this industry-wide assumption through the upgrading of an existing 132-kV steel tower line. A number of these redundant lattice steel towers were set aside for field “pull-over tests” to determine their remaining strength.

The field pull-over tests were the best way to demonstrate the integrity of these steel towers as a complete
entity, taking into account their remaining strength, both above and below ground. The results from the field tests were then compared with the structural analysis performed on the towers, using the latest computer modeling technique based on the original design and fabrication details for these towers. The goals of these field pull-over tests were to obtain useful data on the physical condition of these aging assets. This useful information was then used to more accurately target the funding for the maintenance and refurbishment requirements of these aging assets. The information supported the organization’s risk-management policies with respect to quality of supply and public liability.

Pull-Over Tests a Joint Venture

The field pull-over tests on these redundant steel towers were considered the most cost-effective way of obtaining useful real-life data on a series of lattice steel towers common throughout IE’s 132-kV steel tower population.

A joint venture was established with the state’s bulk power distributor, Transgrid Pty Ltd, who are recognized throughout the New South Wales’ supply industry as the leader in the structural analysis of lattice steel towers. This joint venture required IE to manage and sponsor the field pull-over tests. Transgrid defined the appropriate locations

and tower loading limitations for the field test. Transgrid also performed a post mortem of the field test results to compare the field results with the theoretical model.

Selected Three Towers

The selection of one series of double-circuit lattice steel towers offered consistency to the field tests. Of the redundant towers available, three DS2 suspension lattice steel towers were selected to allow a realistic model to be derived on the status of these aged structures.

A Transgrid representative performed a structural analysis, which allowed the field test rig to be configured to fail the selected series of lattice steel towers.

IE hired a commercial contractor, Transfield Pty Ltd, to provide the appropriate labor and equipment to perform the tests. This equipment consisted of a DC-9 Caterpillar, 140 m (460 ft) of high tensile steel cable of 120 kN (26,978 lb/failing load), a fabricated pulling assembly bar, an in-line dynamometer capable of recording tensile pulling loads from 1-20 tonnes (44,000 lb) in increments of 0.2 tonnes (440 lb), a ground anchor sled with
Fig. 9. On Tower No. 3, initial failure began at the bottom.

three six-ton portable concrete loading blocks and one pulling wheel (Figs. 1 & 2).

The field layout was designed to allow consistency during the applica-

tion of the tensile pulling loads. The pulling assembly bar was to be attached to the bottom crossarm of the steel tower to allow the pulling loads to be evenly spread across the
tower members. The steel pulling rope was then attached to the assembly bar, and run through the pulling wheel at a designated angle. This pulling wheel was then attached to

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Transmission & Distribution World May 1998
the weighed down anchor sled, which ran at right angles to the tower and is attached to the DC-9 Caterpillar with the dynamometer in line, some 100 m (328 ft) from the tower (Figs. 3 & 4).

A survey team was established to support the pull-over tests. The team recorded tower deflections and movements at designated critical locations while the tower was being loaded up in 0.5 tonne (1100 lb) increments. This data would be used to support the post mortem structural analysis on the failed towers.

The actual pull-over tests were also recorded on video to identify the “specific sequence” of steel member and brace failures for each tower being tested.

Additional Information

Ideally, the tower should be loaded in a manner that produces similar stresses to those produced by extreme in-service loads. However, the restraints of a single load and the site restrictions meant that this was not possible. Consequently, the load position and direction was selected to maximize the stress on several groups of steel members simultaneously.

Member loads were calculated using a linear elastic (first order) computer program. Member capacities were based on formulae in the Australian Standard “Guide to the Design of Steel Transmission Towers” (Manual 52).

Field Test Results

A summary of the field test results for the three DS2 lattice steel towers follows:

Tower No. 1 — The unknown factor played a major part in the field test of this tower. As the test was being set up, it became apparent that the available equipment would not restrict the pull direction to the extent previously assumed. The contractor was asked to locate the spreader bar below the second crossarm. This load position would cause more members of interest to be loaded to their theoretical load limit.

The highest stressed member was the corner leg which had a calculated capacity equivalent to a 6.8-tonne (14,960 lb) load applied to the tower, or 8.2 tonnes (18,040 lb), depending on the assumed influence of the staggered bracing on the effective length of these members. The diagonal bracing members in the superstructure below the second crossarm had an equivalent load capacity of 7.5 tonnes (16,500 lb). These braces were single members with no cross brace to provide partial restraint. The load to cause tower failure was 5.2 tonnes (11,440 lb) and the mode of failure, local buckling, in the diagonal brace in compression below the middle crossarm (Figs. 5 & 6).

Tower No. 2 — Following the unexpected failure mode of the tower in test 1, the spreader bar was attached to just below the bottom crossarm, as originally intended. The predicted failure load was 9.3 tonnes (20,460 lb) in the corner member, or 9.5 tonnes (20,900 lb) in a diagonal brace. The diagonal bracing geometry at this location formed a compression-tension system. The tower failed in the diagonal brace at 10.2 tonnes (22,440 lb) applied load (Figs. 7 & 8). This adjustment to the location for the applied
lattice steel towers, to determine the level of corrosion that has occurred.

The level of corrosion that does occur to existing steel towers needs to be controlled through proactive maintenance strategies, in particular those located in hostile corrosive environments through such practices as tower painting, or steel member replacement programs to ensure the integrity of the steel tower is maintained.

**Conclusion**

IE’s field pull-over tests have provided practical data on the condition of its aged lattice steel towers. This data is being used to review the current maintenance strategies for these aging assets, for IE’s entire steel tower population. These maintenance practices will help improve the management of these aging assets and play a major role in reducing IE’s exposure to public risk and liability.

Remember, supply utilities are no different from any other form of organization in the modern era, which need to recognize that change is becoming the norm. And, their returns on investment need to be in step with the current private business environment to demonstrate the efficiency and effectiveness of a state-owned corporation as it strives to perform like a private sector company and embrace the inevitable road to privatization.

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