Engineering Asset Management Review

Joe E. Amadi-Echendu · Kerry Brown
Roger Willett · Joseph Mathew
Editors

Definitions, Concepts and Scope of Engineering Asset Management

Springer

Editors
Professor Joe E. Amadi-Echendu
University of Pretoria
Graduate School of Technology
Management
Pretoria 0002
South Africa

Professor Kerry Brown
Southern Cross University
Tweed Heads NSW 2485
Australia

Professor Roger Willett
University of Otago
Department of Accountancy
and Business Law
Dunedin 9015
New Zealand

Professor Joseph Mathew
Queensland University of Technology
CRC for Integrated Engineering Asset
Management (CIEAM)
Brisbane QLD 4001
Australia

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Foreword

Engineering Asset Management is emerging as a major concept under which well established principles and innovative practices are being assembled, coalesced and developed towards advancing the management of engineered physical assets.

This inaugural issue of *Engineering Asset Management Review* Series is timely and pertinent. It is timely because of the ongoing efforts to develop and adopt standards that will not only direct the prevailing ambiguities in the academic subject matter, but also minimize the perplexities experienced by organizations attempting to implement their own asset management policies, strategies, tactics and practices. It is pertinent as economies seek to recover from the latest world-wide recession caused by the recent debilitating global financial crisis. The importance of cost containment, value creation based on 'real' assets, and sustainability of global financial systems demands innovative ways of managing both engineered physical and natural assets.

The International Society of Engineering Asset Management (ISEAM) (www.iseam.org) has initiated the publication of the *Engineering Asset Management Review* Series through Springer-Verlag as a global quality journal that appeals to academia, as well as the public sector and private industry. The Review Series arises from ISEAM's successful annual World Congress on Engineering Asset Management (WCEAM) (www.wceam.com) which began in Australia in 2006 and has since been held in UK in 2007, China in 2008 and Greece in 2009. The formation of both ISEAM and WCEAM has been influenced through the efforts of the Cooperative Research Centre for Integrated Engineering Asset Management (CIEAM), Australia.

I commend this first issue of the *Engineering Asset Management Review* to you as we embark on establishing a coherent body of knowledge to guide further education, training, certification, research, policy, strategy, tactics and practice in the management of engineered physical assets upon which real value creation is based.

Australia, August 2010

Professor Joseph Mathew
Chair, Board of Directors
The International Society
of Engineering Asset Management

Preface

Engineering Asset Management Review (*EAMR*) Series is a publication of the International Society for Engineering Asset Management (ISEAM) dedicated to the dissemination of research by academics, professionals and practitioners in engineering asset management. *EAMR* complements other emerging publications and standards that embrace the wide ranging issues concerning the management of engineered physical assets.

The theme of Volume 1, as befits the inaugural issue of EAMR Series, is dedicated to the Definitions, Concepts and Scope of engineering asset management (EAM). The term "engineering" in the title of the *Review* indicates that it focuses on the management of engineered physical assets used in the "real" economy. EAM is a multidisciplinary endeavor involving traditional science, engineering and technology disciplines, logistics and operational research; business management disciplines including risk, economics and financial accounting; and psychology disciplines such as human and organizational behavior.

The articles published in this volume are but a small number that reflect the multidisciplinary nature of EAM. Whilst a plethora of definitions exist, the first article, comprising Section 1, reviews the common threads from a wider pedagogical viewpoint. The following section on Concepts includes articles illustrating the typical industry approach, where the tendency is to apply frameworks and simplified models in a highly dedicated manner. Section three comprises a number of articles that illustrate the wide ranging scope of EAM, while section four includes articles on the vexatious issue of condition monitoring, asset data, information and decision making. Section five contains articles on the challenging issues of sustainability and safety confronting every organization and often treated with high trepidation. The vital issue of human dimensions in EAM is discussed in the final two articles of this volume.

The Editors wish to thank all the contributors for their effort and patience through the review process. To all readers, we invite your comments and further critique, so that we all may benefit from the ongoing debate that should provide a useful body of knowledge relevant to the management of engineered physical assets.

Australia, New Zealand, August 2010

Joe E. Amadi-Echendu, Editor-in-Chief
Kerry Brown, Senior Editor
Roger Willet, Senior Editor
Joseph Mathew, Senior Editor

Introduction to Engineering Asset Management Review Series

Engineering Asset Management Review (EAMR) is published by Springer-Verlag under the auspices of the International Society of Engineering Asset Management (ISEAM). Engineering asset management (EAM) focuses on life-cycle management of the physical assets required by a private or public firm, for the purpose of making products, and/or for providing services in a manner that satisfies various business performance rationales. In exploring the wide ranging issues involved in the management of engineered assets constituting our built environment, EAMR takes a broad view of the inter- and multi-disciplinary approach which combines science, engineering, and technology principles with human behavior and business practice.

The purpose of EAMR is to publish research and opinions which explore strategic and tactical issues, as well as technical data, and information involved in the creation (formulation and design), acquisition (procurement, installation and commissioning), maintenance, operation, decommissioning, disposal and/or rehabilitation of physical assets. The range of articles covers all industry sectors and physical asset types (infrastructure, plant, equipment and facilities).

The aim of EAMR is to provide a forum for:

- the assembly of a body of knowledge in this emerging field of EAM;
- knowledge transfer between researchers and practitioners;
- cross-disciplinary interaction between engineers, technologists, economists, environmental practitioners, behavioural scientists and business managers;
- the presentation of a wide spectrum of viewpoints and approaches from designers, developers, project managers, owners, operators, users and vendors.

The content of EAMR is structured within a scope that includes the following generic areas of interest/expertise and themes:

Scope

- Investment Issues:
  - Funding/financing
  - Public private partnerships
  - Due diligence
  - Valuation
  - Technology transfer
  - Innovation
- Technical:
  - Project management
  - Risk management
  - Operations
  - Maintenance
  - Procurement
  - Decommissioning
  - Rehabilitation
  - Human dimensions
- Decision Support:
  - Data warehousing
  - Modelling
  - Standards
  - Prognostics
  - Life-cycle assessments
  - Benchmarking
- Education:
  - Curriculum development
  - Accreditation
  - Training
- Technologies:
  - ICT
  - Sensors/condition monitoring
  - ERP/transactional
  - Component technologies

Generic Themes

- Concepts and theory covering any of the headings above: A key requirement is that the contribution provides an extensive review and critique of existing literature plus the formulation of unambiguous new knowledge or insight. Theory building.
- Applications: A key requirement is that the contribution provides a considerable review of existing literature plus empirical data that demonstrates the application of theory. Theory testing.
- Case Studies: A key requirement is that the contribution provides empirical data that validates a concept, theory or model in practical industry or public situations. Reflexive in-practice.

Electronic Editorial Procedure

EAMR maintains an open call for papers in addition to pre-selecting papers from accredited conferences (*e.g.*, World Congresses on Engineering Asset Management). Guest Editor(s) may propose special issues on approval from the Editor-in-Chief before sending a call for papers.

Manuscripts submitted in accordance to the submission guidelines at Springer-Verlag website (see www.editorialmanager.com/eamr) shall receive a minimum double-blind review. Manuscripts for revision and re-submission may be subjected to further refereeing.

Contents

Part III Scope (Investment and Cost Control)

Part IV Scope (Asset Data and Condition Monitoring)

Part I
Definitions

What Is Engineering Asset Management?

Joe E. Amadi-Echendu, Roger Willett, Kerry Brown, Tony Hope, Jay Lee,
Joseph Mathew, Nalinaksh Vyas and Bo-Suk Yang

Abstract Definitions of asset management tend to be broad in scope, covering a wide variety of areas including general management, operations and production arenas and, financial and human capital aspects. While the broader conceptualisation allows a multifaceted investigation of physical assets, the arenas

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J.E. Amadi-Echendu
University of Pretoria, South Africa
e-mail: joe.amadi-echendu@up.ac.za

R. Willett
University of Otago, New Zealand
e-mail: roger.willett@otago.ac.nz

K. Brown
Southern Cross University, Australia
e-mail: kerry.brown@scu.edu.au

T. Hope
Southampton Solent University, UK
e-mail: Tony.Hope@solent.ac.uk

J. Lee
University of Cincinnati, US
e-mail: jay.lee@uc.edu

J. Mathew
CRC for Integrated Engineering Asset Management (CIEAM), Australia
e-mail: j.mathew@cieam.com

Nalinaksh Vyas
Indian Institute of Technology, India
e-mail: vyas@iitk.ac.in

Bo-Suk Yang, Pukyong National University, South Korea
e-mail: bsyang@pknu.ac.kr

J.E. Amadi-Echendu, K. Brown, R. Willett, J. Mathew,
Definitions, Concepts and Scope of Engineering Asset Management,

constitute a multiplicity of spheres of activity. We define engineering asset management in this paper as the total management of physical, as opposed to financial, assets. However, engineering assets have a financial dimension that reflects their economic value and the management of this value is an important part of overall engineering asset management. We also define more specifically what we mean by an "engineering asset" and what the management of such an asset entails. Our approach takes as its starting point the conceptualisation of asset management that posits it as an interdisciplinary field of endeavour and we include notions from commerce and business as well as engineering. The framework is also broad, emphasising the life-cycle of the asset. The paper provides a basis for analysing the general problem of physical asset management, relating engineering capability to economic cost and value in a highly integrated way.

Keywords Engineering asset management, Definitions, Frameworks, Challenges

1 Introduction

Shaping an emergent field of endeavour requires understanding the boundaries of the specific activities contained within that field. However, acknowledging the associated activities and functions from closely related fields may also provide new insights and analytic tools. As such it may also involve learning from other related fields. In developing a definition of engineering asset management (EAM), we have drawn from the general field of asset management, but also from associated asset management sectors.

Since the 1990s however, it has been argued that the field of asset management requires an interdisciplinary approach in order to ensure that an appropriate mix of skills can be brought to bear on resolving the vexed issue of asset management. The new orientation has been on developing a range of strategic responses to safeguard the large public and private investments in assets. In this context, however, definitions of what is asset management, engineering or otherwise, tend to be broad in scope. In this paper, we propose to define EAM as the management of physical, as opposed to financial, assets. Moreover, it is contended that while the management and maintenance of the asset is a critical task, engineering assets also have a financial dimension that reflects their economic value. The management of this value is an important part of overall EAM.

Following from this previous research, our approach is interdisciplinary and we include notions from commerce and business as well as engineering. The framework also draws on a broader set of considerations, emphasising the life-cycle of the asset rather than just focusing on the maintenance aspects. The paper starts by briefly and selectively reviewing what the literature considers asset management to be and outlining the various conceptualisations of asset management, examining the appropriateness of these. The next section of the paper develops a detailed characterisation of the basic concepts of EAM that is needed to support a broader understanding of EAM. Lastly, the paper draws out the implications of the characterisation of EAM to highlight the most commonly cited problem confronting asset management, that is, data quality.

2 Viewpoints in the Literature About Engineering Asset Management

Until quite recently, definitions of EAM focussed on two distinct but important aspects of the management of assets. The first concentrated on the information and communication technology required in the management of data relating to assets. The second focused on the way in which EAM systems can be integrated and managed to inform decision-making about those assets. However, in the last five years or so, there has been an increasing emphasis on the overall dimensions of what constitutes EAM. The arena of the constitution of the *total* asset management is suggested as an important consideration for advancing the field of EAM.

Investigations relating asset management to issues of data capture and information technology focus on the ways in which the condition of assets can be monitored more effectively to prevent premature deterioration of an asset. Madu (2000) suggests maintenance, reliability and cross-organization analysis are key issues in managing equipment asset use, arguing that 'asset management' is facilitated by IT software. Madu refers to asset management as being dependent upon on enterprise resource systems (ERS) that collect data and contends that firm competitive advantage can be gained through the effective use of these.

Asset management has also been defined in a range of different contexts including transport (US Federal Highways Authority, 1999; McElroy, 1999), construction (Vanier, 2001), electricity (Morton, 1999) chemical engineering (Chopey and Fisher-Rosemount, 1999) and irrigation (Malano *et al.*, 1999). A US study in transport by the Federal Highways Authority (FHA, 1999) was an early and systematic attempt to understand the critical elements of asset management. The FHA developed an asset management primer to guide thinking and activities in this area.

McElroy (1999) in outlining the approach of the US Department of Transport to asset management, defines asset management as a 'systematic process of maintaining, operating and upgrading physical assets cost-effectively'. The focus on effective asset management is argued to require an asset decision making framework that incorporates organizational structures and information technology aligned with financial and budgetary considerations.

Malano *et al.* (1999) elucidate general principles and functions of asset management from their research interest in irrigation and drainage infrastructure. They contend that key principles of asset management comprise a set of pre-asset acquisition strategies for planning and initiating assets, asset operation and maintenance, performance monitoring, together with allied asset accounting and economics, and audit and renewal analysis.

Vanier (2001) lists among the challenges for asset management, seamless data integration, a standardisation framework and life cycle analysis. The attention to asset life cycles, especially in infrastructure research and practice flags a growing interest in generalising asset management away from the traditional areas of asset maintenance. An upsurge of publishing activity around 2000 focused on the design and formulation of asset management systems. By the early 2000s, a broader conceptualisation emerged recognising more than the ICT and systems approaches to asset management. In the area of maintenance management, Tsang (2002) adds human dimensions as a key issue for the successful management of engineering assets. Complex interactions of skills and resources, physical asset specificity and the way these assets are managed are discussed in Reed *et al.* (1990).

In the context of the built environment, Amadi-Echendu (2006) relates a number of themes including the application of a scientific approach to whole of life asset management ("terotechnology"), the importance of considering the asset as being part of a "value chain" and the need to take a holistic approach to asset management by analyzing problems across the traditional boundaries of the business, information technology and engineering disciplines. He notes a number of key developments in asset management. First, there is a demand for the development of improved financial metrics to inform asset managers about the performance of their assets. Second, the value of assets has to be considered in the light of capital funding and expenditure options. Third, the value of assets have to be assessed as part of a larger program of projects and not just in isolation. Fourth, asset management takes place in an organizational setting that is becoming more fluid, so that greater flexibility in management scenarios (*e.g.* outsourcing) is becoming more important. Fifth, innovation in engineering and communication technologies is rapidly changing the opportunity set facing the asset manager. Sixth, regulation and increasing quality standards are making it essential that asset managers are professionally trained and adopt increasingly sophisticated best practices. Finally, seventh, for all of the above reasons the approach of the asset manager requires to change to accommodate a broader style of thinking about the elements of and approaches to their profession.

The main theme of the Amadi-Echendu paper, that asset management is much broader and has many more dimensions than asset maintenance, traditionally conceived, is echoed in Woodhouse's (2001) conception of asset management. Woodhouse sees the asset manager as a translator of ideas, an interface between business objectives and engineering reality, effecting economic outcomes from physical assets in a complex environment of changing technologies and ideas, numerous regulations and differing social values. Woodhouse also sees the same threats to good asset management as does Amadi-Echendu: a silo mentality based upon adherence to traditional paradigms and a myopic, disciplinary focus; short termism concentrating on immediate profit at the expense of asset longevity and engineers and accountants who do not speak to each other. He also identifies some other key areas of concern where practice has not kept pace with theory: dysfunctional incentive systems, reliable and objective risk quantification, a fire fighting mentality and poor data quality. Woodhouse sees the greatest danger, however, in the shortfall of human capital educated to adapt to the more sophisticated needs of modern asset management. In a sense, he believes the techniques and know-how already exist, and only need to be adapted to produce the systems needed for effective asset management. It is the human factor that is the weak link in the chain.

Mathew (2005) gives an account of how the Centre for Integrated Engineering Asset Management (CIEAM), an Australian collaborative research centre funded by the Australian federal government, is addressing the issues highlighted by Amadi-Echendu and Woodhouse, including the problem of training a new generation of assets managers with what would traditionally be seen as multi-disciplinary skills. The focus of CIEAM is on integrating the human dimensions and decision modelling aspects of EAM with technology (advanced sensors and intelligent diagnostics) through systems integration.

These holistic views of asset management reflect the general movement in engineering circles to emphasize the importance of asset management rather than just asset maintenance, to focus on the bigger picture of life cycle asset assessment, including strategy, risk measurement, safety and environment, and human factors. These themes are common to Townsend (1998), Mitchell (2006), Schuman and Brent (2005) and sources such as the Organization for Economic Cooperation and Development's (OECD's) definition of asset management (OECD, 2001). In the UK a Publicly Available Specification has been released by the British Standards Institution (PAS 55 1&2, 2004) embodying the same principles of life cycle analysis, systematic risk assessment and sustainability.

The tendency to generalise and broaden the conceptualization of asset management is clear and presently seems to form an unwritten consensus among practitioners and academics alike. The commonalities are focusing on the life-cycle of an asset as a whole, paying attention to economic as well as physical performance and risk measures, appreciating the broader strategic and human dimensions of the asset management environment, with the objective of improving both efficiency and effectiveness of resources. In the next section we develop these characteristics in a discussion of the basic concepts of EAM.

3 Basic Concepts in Engineering Asset Management

In this section we discuss, much more precisely than is usually done, what are the key concepts that must underpin the broader frameworks for EAM that have been proposed in the literature. Our aim is to characterise the subject matter of EAM more specifically and clearly. We want our characterisation to be as general as possible so as not to exclude useful and interesting work in this area. For this reason the definition should be flexible, to accommodate new areas as they become relevant. However, we also want the definition to provide focus to our research.

Any characterisation of EAM in the broadly conceived form must have two main parts: (i) an object, *i.e.* the 'engineering asset' and (ii) a process of managing that asset. We will discuss these parts of the definition separately, then combine them together.

3.1 What Is an 'Engineering' Asset?

The definition of an asset given in the Oxford English Dictionary (OED) is:

> *"All the property of a person or company which may be made liable for his or their debts." (OED, 2007)*

The importance of considering this ordinary meaning of the word 'asset' is that we want our concept of an engineering asset to be consistent with basic, everyday ideas. The main points to note about the dictionary definition are that there is (a) an object ('property') to which (b) a legal entity ('person or company') attributes (c) a value ('debt'). Thus an asset is more than just a physical thing. It is part of a relationship between an object and an entity and a value is attached to the object by the entity. We consider these three aspects of an asset in turn.

a. Engineering Asset Objects. First we need to differentiate 'engineering' asset objects from 'financial' asset objects. All asset objects fall into one of these two categories of objects. Financial objects, such as securities traded on stock exchanges, patent rights and derivative securities of various sorts exist *only* as contracts between legal entities. Legal rights, either in engineering objects or in other financial objects are transferred between legal entities by contracts. Engineering objects, the things that are managed by engineering asset managers, such as inventories, equipment, land and buildings, in contrast, exist independently of any contract, although rights in them can be included in contracts creating financial assets (*e.g.* commodity futures). Financial assets exist and have value only as derivatives of engineering assets.

Engineering asset objects can therefore be likened to the base of a pyramid structure on which all other asset objects rest, as visualized in Figure 1. Above the base of the pyramid are various levels of financial asset objects that can, in principle, be created at will. Everything above the base of the pyramid is a financial asset object that we exclude from the definition of an engineering asset. Only the objects at the base of the pyramid (the 'real' assets) are the subject matter of EAM.

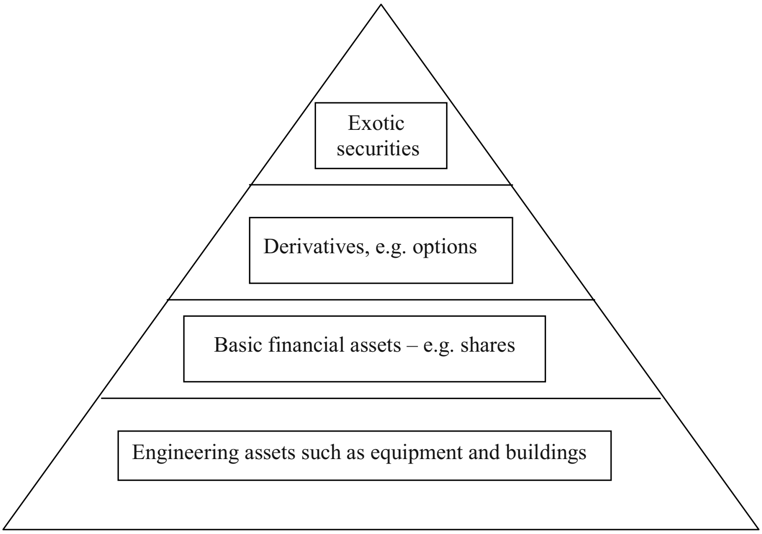

Figure 1 The fundamental nature of engineering assets

b. Legal entities. Legal entities are natural individuals or other entities such as companies created by a legal agreement. An object becomes an asset when a legal entity has legal rights in the object. Consequently the notion of an asset is defined as being an object with respect to a legal entity or some collection of legal entities. The reference to 'collections of legal entities' allows us to logically refer to the assets of, say, a Mining Corp's group of companies (which are not legal entities as such). Assets, therefore, do not exist as objects in limbo, without specifying the entity to which they relate, whether they are engineering or financial assets. Consequently, EAM must always have an organizational context in mind, such as managing the earthmoving equipment owned or leased by a Mining Corp or the naval vessels of the government.

The basic organizational concept that underpins the notion of an asset, the relationship between the asset object and a set of legal entities, is summarized in Figure 2.

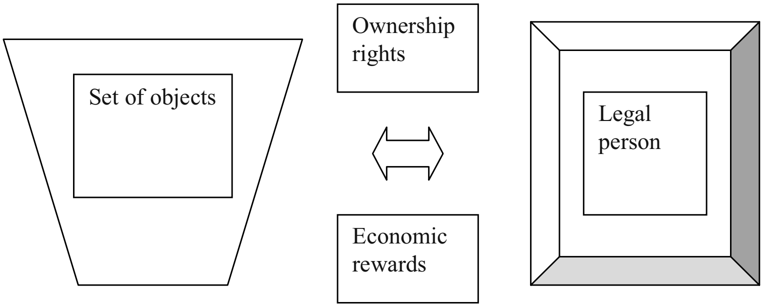

Figure 2 The basic components of an asset

c. Value. Engineering assets can have two basic types of value: *capability* value and *financial* value. Both types of value have the common feature that they depend upon the purpose for which the asset is being used. Capability value is the value traditionally of interest to engineers and is mainly of relevance to engineering assets rather than financial assets. It is measured on a physical, not a financial, scale. The capability of naval vessels, for instance, depending upon purpose, might be measured by the probability of the vessels requiring maintenance during an operation. The capability of a machine might be measured by the number of products that it can process per second, *etc.* Physical measures are heterogenous, measured by many different scales, such as units, length, weight, *etc.*

Financial value can also take many forms, depending upon the purpose for which the asset is used. The original cost of an asset is appropriate, for example, if the aim of the valuation is to identify how funds have been expended. If 'valuation in use' for the purpose of determining if an asset should be retained or replaced is the aim of the measurement, present values of estimated future cash flows and the expected value from disposing of the asset are relevant to the decision. Financial value is measured on a monetary scale. In single currency this means that all assets can be compared in one measurement dimension, which can sometimes be useful in decision making. Different measurement scales exist because the financial scale can be measured in different currencies. At any point in time the different currency units can be converted by a linear transformation. However the currency conversion rate can change significantly and quickly, which can cause difficulties in using financial measures for international comparisons.

Capability value and financial value of engineering assets are related in some manner, otherwise we could not know, for example, how much it costs to own and

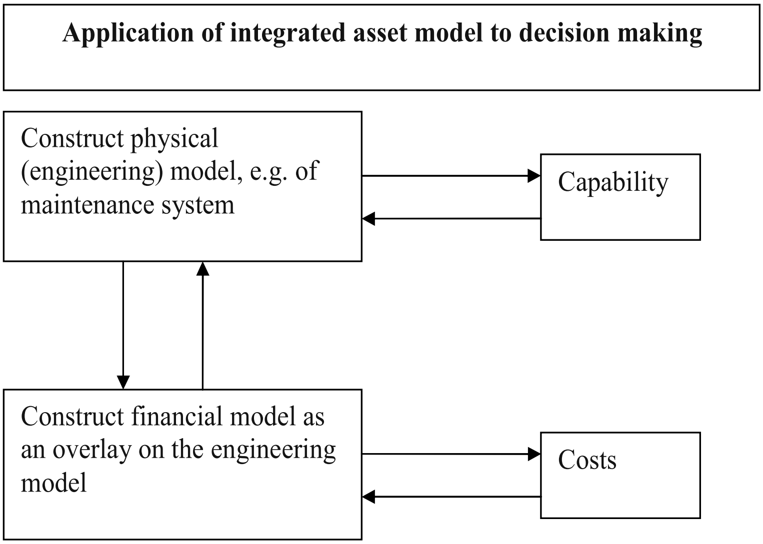

Figure 3 The relationship between capability and financial values of engineering assets

use an asset or how much more expenditure is needed to raise the capability of the asset to satisfy a change in service delivery requirements. This fact is important in any analysis of an engineering asset. The nature of the relationship between capability value and financial value is shown in Figure 3.

This Figure provides a basis for understanding the problems faced by engineering asset managers in pursuing the main function of asset management, *i.e.* the optimisation of performance against a profile of value requirements.

3.2 Engineering Asset Management

Management is defined in the OED as follows:

> *"Organization, supervision, or direction; the application of skill or care in the manipulation, use, treatment, or control (of a thing or person), or in the conduct of something." (OED, 2007)*

The OED more specifically defines asset management, perhaps significantly citing quotation from quite recent US sources, as:

> *"... the active management of the financial and other assets of a company, etc., esp. in order to optimize the return on investment." (OED, 2007)*

Management is goal-directed towards some purpose. In the case of EAM, purpose takes many forms which can be thought as differing views of the basic questions implied by Figure 3, *i.e.* how can an intervention in the processes relating capability and financial values be effective in achieving a particular goal, such as increasing the level of capability or reducing costs?

Management takes place at different levels of an organization and this also affects the views of service delivery capability and value profile that concern asset managers. An engineer engaged in condition monitoring very close to the basic engineering process may look at a specific point in a complex process, which might impact on the values connected as in Figure 3 in only a small part. An information manager may be concerned with providing the data that supports measurements of the relationships. An accountant might be interested in how the costs are caused by operating the assets and a human resource manager might be concerned with the safety and health issues arising from the process. Senior management may be concerned with overall profitability, longer term, life-cycle strategies for the asset and its relationship to organizational policy. The differing views of the capability-value profile management, relating to different levels of the organization are thus governed by the fundamental decision categories in respective strategic, tactical and operational contexts.

The recent tendency has been to define EAM in an all-encompassing manner, embracing the various dimensions of asset management implied in Amadi-Echendu

(2006), Mathew (2005) and Woodhouse (2001). The characterisation of EAM in this section is consistent with that tendency and provides a structure within which the different concerns expressed about asset management can be related together. The major challenges facing EAM are discussed in this context in the next section.

4 Requirements and Challenges for Broad Based EAM

The literature and our characterisation of EAM highlight a number of key requirements of the broader consensus interpretation that has recently begun to emerge:

1. Spatial generality: EAM extends across all types of physical asset, including human resources, in any industry.
2. Time generality: EAM extends over time to include short term (*e.g.* utilisation) and long term (*e.g.* lifecycle) aspects of physical assets.
3. Measurement generality: Real and financial measurement dimensions: measurement data includes measurements of the economic value the (financial dimension), social as well as the physical (the capability dimension) attributes of assets.
4. Statistical generality: Risk and other higher moment estimates of measures are important in EAM as well as the basic, first moment return measure of asset performance.
5. Organizational generality: EAM takes place at all levels of the organization, from direct contact with the asset to the strategic interactions that take place in the boardroom.

These five requirements of EAM generality have at least three implications. First, EAM is multi-disciplinary since it requires input of skills from virtually any discipline source, such as traditional engineering areas, information technology, economics and management. Second, decisions in EAM extend from operational and tactical aspects of asset management to strategic aspects, such as life-cycle modelling. Third, the human dimension of EAM requires the use of qualitative modes of analysis as well as the more traditional quantitative modes typically considered to be central to EAM.

Broadly based EAM consequently demands an information system that captures data supporting decision making across the areas suggested by the requirements and implications just described. Ideally an information system is needed that provides continuous data on the physical and financial conditions and changes in condition of a set of assets that is being managed for some purpose. The purpose for which the asset set is managed is defined by reference to the organization that controls the assets. This may be maximizing profits in a private company or providing satisfactory safety and environmental outcomes in a government agency, for example. It is evident, however, that in the vast majority of organizations, the opinion of many engineers is that poor data quality is probably the most significant single factor impeding improvements in EAM (*e.g.* Woodhouse, 2001).

Amadi-Echendu (2006) discusses an accounting system as the basis of an EAM information system in this context. Figure 4 reproduces the structure discussed in that paper. An advantage of using an accounting system as a starting point for an information system that would support the kind of comprehensive style of EAM envisaged in this paper and elsewhere is the generality of its coverage of organizational assets and its use in organizational decision making, especially at high levels. All of what we have defined in this paper as the engineering assets of an organization are recorded in an accounting system. Further, the accounting systems and assets of organizations are defined in such a way that those of one organization can be aggregated to provide asset analyses of arbitrarily defined organizations of any size (by a process of what accountants call ‘consolidation’).

The engineering asset manager focuses on what accountants and economists refer to as the ‘real assets’, *i.e.* everything except the trade marks, licenses and patents shown in Figure 4. The main strength of accounting systems in terms of the measurements they provide for decision making lie in the financial dimension referred to earlier and in the fact that they are routinely used for decision making at the most senior level of organizations and for reporting to stakeholders. The information accounting systems produce therefore has significant real world impact.

However, accounting systems as such are often deficient in relating financial measures to physical measures used for traditional engineering decisions. Engineers tend to rely on plant maintenance and inventory systems for such data. These engineering focused systems, although easily capable of integration with financial

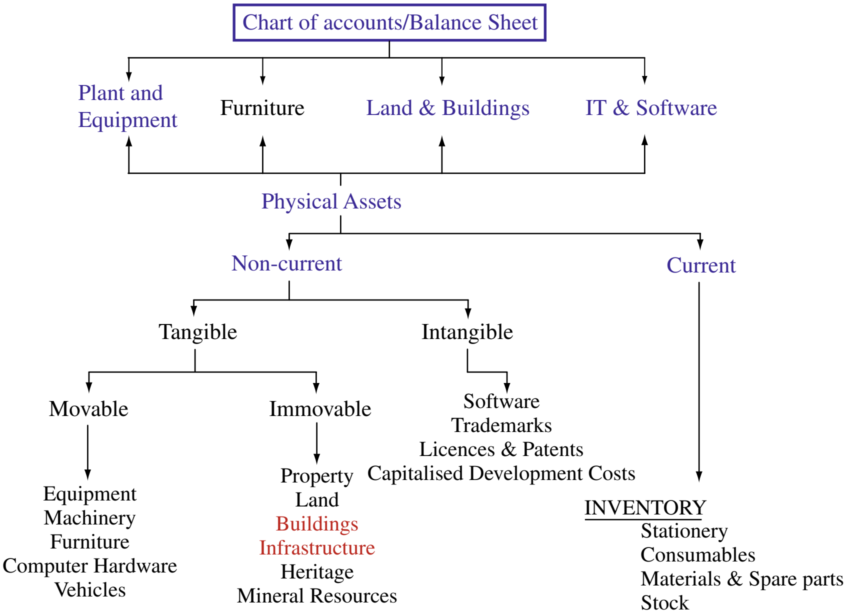

Figure 4 Asset structures in accounting systems