Roy Stephen Morum

A MODEL FOR KNOWLEDGE MANAGEMENT
IN AN ARCHITECTURAL ENTERPRISE

km

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ABSTRACT
Knowledge Management deals with the critical processes of transforming the knowledge of individuals into group knowledge, and the knowledge of groups into organisational knowledge. To put knowledge into action, we must understand the processes through which managers can embed knowledge in organisational systems, processes, and values.

This dissertation lays out a comprehensive creative structure for Knowledge Management systems in a hierarchy of levels, orienting each level to work structure in the Architectural profession -- so that a clear picture of integration possibilities is presented.

Cultural barriers, technical implementation, opportunities and examples are explored to illustrate the overall structure. Some processes and techniques used in the Architectural profession are analysed, including the generation, visualisation, capture, and sharing of ideas and information.

This dissertation will explore the attitudes, knowledge and skills essential for effective Knowledge Management (in the Architectural profession in particular). It is proposed that these are contained within the contextual realms of Purpose, People, Resources, Location, Process and Practice. All these elements have aspects that are qualitative and intangible or are subject to more precise definition and measurement. To exploit KM as a strategic asset, an enterprise must excel in all six realms.

Although many of the principles described herein are applicable to general Knowledge Management, this dissertation focuses on general Architectural practice. The Knowledge Base in Architecture is enormous, so, for the purpose of this dissertation, it will be mapped out in broad outline - to the second or third level only.

The authors understanding is that Explicit Knowledge is objective and factual, and encompasses the data which can be catalogued, filed and sorted and this knowledge can be captured and shared by practical and tangible means Tacit Knowledge is encompassed by man's intellect and includes the accumulation of knowledge, experience, observations, discovery and interaction and it is acquired and transferred by experiencing, doing and participating.

To attempt to devise a system that can contain all knowledge present and future, is impossible, so it is necessary to design a process that continues to grow, promotes reuse, improves constantly, and avoids redundancy. To achieve this, the infinite volume of knowledge has to be processed through a filter or formula which is reiterative, not static, and this is the essence of Knowledge Management.

The working model for Architectural KM proposed in this dissertation is a creative approach to the problem and the essential question confronted is how to design and implement an effective KM process for an architectural enterprise. The work end with the initiation stages of the introduction of the model, developed as a result of this research, into a specific architectural practice.
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1. Introduction

Bruce E. Blackmer (FAIA), in the American Institute of Architects Journal of Architecture (Nov. 2004)\(^1\), stated that we live in an era when success is measured more by what we know than by any other means. As knowledge management is applied, understanding reaches higher levels, data transforms from explicit into tacit knowledge and we become more valuable to our firms, our clients and our communities.

Knowledge Management (KM) is more than just another industry buzzword, as it has existed from the day man first used his emerging sentience to educate, develop, utilise, and pass on the fruits of learning, human intelligence and experience. Knowledge has been stored, managed and passed on in many forms throughout history. In the modern ‘Internet Age’, it also includes (but is not dominated by) the sophisticated use of the latest software and electronic tools and the application of the Internet together with the concepts of Groupware, Intranet, Extranet, Business Intelligence, Data Markets, Message Collaboration, E-Commerce, E-Business, Search Engines -- amongst others. The effective use of Knowledge Management assets in an enterprise can empower workers to make correct and speedy decisions to gain competitive advantage.

It is important, that KM is defined within the contextual realms of **Purpose, People, Resources, Location, Process and Practice** using parameters that are qualitative and intangible and also subject to more precise definition and measurement. To exploit KM as a strategic asset, an enterprise must excel in all six realms.

1.1 DEFINITIONS OF KM

The field of Knowledge Management is diverse and has many definitions. In the peer reviewed *Harvard Business Review on Knowledge Management*\(^2\), Peter Drucker states that Information is Data endowed with relevance and purpose. Converting Data into Information thus requires Knowledge. A common (but, in the writer’s opinion, fallacious) definition states “Knowledge management technologies deliver the right information to the right person at the right time.” (Author unknown) This implies that human intelligence and experience can be reduced to technological solutions.

It becomes necessary to differentiate between **Explicit Knowledge**, which is objective and factual, and **Tacit Knowledge**, which is more challenging to capture as it is based on a complex accumulation of knowledge, experience, observations, discovery and interaction. The former can be captured and shared via information technology, in words, diagrams and numbers -- while tacit knowledge is acquired and transferred by experiencing, doing and participating.
Yogesh Malhotra, founder, chairman and CKO of the Brint Institute in Fort Lauderdale, Florida, USA, grouped various interpretations of KM into three paradigms:

- **The Inputs-Driven Paradigm**, which considers Information Technology and KM as synonymous.
- **The Processing-Driven Paradigm** of KM, which has its focus on best practices, training and learning programs, cultural change, collaboration, and virtual organisations.
- **The Outcomes-Driven Paradigm** of KM which has its primary focus on business performance.

Here are examples of KM definitions which fall into these categories:

### RESOURSE OR INPUT DRIVEN KNOWLEDGE MANAGEMENT

- "Knowledge management systems (KMS) refer to a class of information systems applied to managing organizational knowledge. That is, they are IT-based systems developed to support and enhance the organizational processes of knowledge creation, storage/retrieval, transfer, and application." (Alavi and Leidner, 2001)
- "Knowledge management is the generation, representation, storage, transfer, transformation, application, embedding, and protecting of organizational knowledge." (Schultz & Leidner 2002)
- "For the most part, knowledge management efforts have focused on developing new applications of information technology to support the capture, storage, retrieval, and distribution of explicit knowledge." (Grover and Davenport, 2001)
- "Knowledge has the highest value, the most human contribution, the greatest relevance to decisions and actions, and the greatest dependence on a specific situation or context. It is also the most difficult of content types to manage, because it originates and is applied in the minds of human beings." (Grover and Davenport, 2001)
- "Knowledge management uses complex networks of information technology to leverage human capital. The integration of user-friendly electronic formats facilitates inter-employee and customer communication; a central requirement for successful KM programs." (eMarketer 2001)
- "In companies that sell relatively standardized products that fill common needs, knowledge is carefully codified and stored in databases, where it can be accessed and used—over and over again—by anyone in the organization." (Hansen and Nohria, 1999)

### PROCESS DRIVEN KNOWLEDGE MANAGEMENT

- "KM entails helping people share and put knowledge into action by creating access, context, infrastructure, and simultaneously reducing learning cycles." (Massey et al., 2001)
- "Knowledge management is a function of the generation and dissemination of information, developing a shared understanding of the information, filtering shared understandings into degrees of potential value, and storing valuable knowledge within the confines of an accessible organizational mechanism." (CFP for Decision Sciences special issue on Knowledge Management, 2002)
- "In companies that provide highly customized solutions to unique problems, knowledge is shared mainly through person-to-person contact; the chief purpose of computers is to help people communicate." (Hansen and Nohria, 1999)
- Knowledge Management (KM) definition: Knowledge management, or KM, is the process through which organizations generate value from their intellectual property and knowledge-based assets. KM involves the creation, dissemination, and utilization of knowledge.

### PRACTICE OR OUTCOME DRIVEN KNOWLEDGE MANAGEMENT

- "Knowledge Management refers to the critical issues of organizational adaptation, survival and competence against discontinuous environmental change. Essentially it embodies organizational processes that seek synergistic combination of data and information processing capacity of information technologies, and the creative and innovative capacity of human beings." (Malhotra 1998a, 2002)

New competencies and instruments for communication and networking have been made possible by the Digital Age, although some may contend that the major impact of the digital age has been to increase the
quantity and not the quality of data. Carol Hildebrand, in her article “Does KM = IT”\textsuperscript{12} explodes the myths that information technologies can deliver, store and distribute human intelligence and experience. She states that the fact of information in a database doesn't ensure that people will see or use the information and that most of knowledge management technology concentrates on efficiency and consensus – with rational and static data without context. In such systems, there is no accounting for renewal of existing knowledge and creation of new knowledge.

Knowledge Management deals with the processes of transforming the knowledge of individuals into group knowledge, and the knowledge of groups into organisational knowledge. To effectively utilize knowledge, we must understand the processes through which knowledge can be structured, managed, and accessed in organisational systems, processes, and values. KM is a process that promotes a collaborative and integrative approach to the creation, capture, organisation, access, and use of information assets, including the tacit knowledge of people.

The best learning occurs in exchanges between people and is enhanced, but not controlled, by the establishment of databases, methods for measuring intellectual capital, building corporate libraries, building intranets, sharing best practices, installing groupware, leading training programs, leading cultural change, fostering collaboration and creating virtual organizations.

The concept of treating organisational knowledge capital as a valuable asset has been popularised by many modern management and organisation specialists. In order to remain competitive, organisations are advised that they must effectively and efficiently locate, create, capture, and share their organisation's knowledge and have the ability to use that knowledge and expertise to resolve specific problems and develop opportunities. Traditional performance measures are not sufficient to gauge performance and guide organisations in the modern rapidly changing and complex business society. If performance measurement is linked to strategy in an organisation, it must measure performance in ways that promote both positive results and reflect past experience and performance.

With the above in mind, the definition of Knowledge Management developed by the writer for this treatise is as follows:

\textbf{KM is a reiterative business management practice delivering tacit and explicit knowledge to the right person at the right time – using creative conceptual and technological tools and techniques to capture, organise, transfer and maintain a dynamic knowledge base.}
1.2 THE ESSENTIAL RESEARCH QUESTION

This dissertation focuses on how the discipline of Knowledge Management can be utilized to become a creative and dynamic asset for an architectural enterprise. This leads to the following essential question:

*How can an appropriate model, suited to architectural practitioners be developed and how this model can be placed in context?*

This can be broken down into the following elements:

- Definition of requirements for KM in an Architectural Enterprise.
- Analysis of essential tools and skills required for KM in Architecture.
- Methods of implementation of KM in an architectural enterprise.
- Systems that can be adopted to keep the system dynamic and avoid stagnation.

3 Malhotra, Yogesh “Integrating Knowledge Management Technologies in Organizational Business Processes.” Accepted for publication in the Journal of Knowledge Management (Emerald) Special Issue on ‘Knowledge Management and Technology’, Q3, 2004.
7 eMarketer. “Knowledge Management: Executive Brief.”


10 http://www.commerce-database.com/


URL: http://www.brint.org/KMOxymoron.pdf


http://www.cio.com/archive/enterprise/091599_ic.html
2. KM Development

This section deals with a literature review in the form of a study of the development of KM through history up to modern times in an attempt to identify leaders and trends in this field -- from the ancient philosophers to modern times.

2.1 KNOWLEDGE MANAGEMENT THROUGH HISTORY

A key element in knowledge management has been how to deal with the limitations of capacity and the organisation of an infinite knowledge resource. Philosophers and thinkers have, through the ages, pondered on the nature and extent of mankind’s search for knowledge. These thinkers include Aristotle, Plato, Dante, Grotius, Pufendorf, Rousseau, Berkeley, Hume, Hobbes, and John Locke. The following deals with some of the principles espoused by these great men.

♦ THE NATURE OF KNOWLEDGE

Explicit Knowledge is objective and factual, and encompasses the data which can be catalogues, filed and sorted and this knowledge can be captured and shared by practical and tangible means Tacit Knowledge is encompassed by man’s intellect and includes the accumulation of knowledge, experience, observations, discovery and interaction and it is acquired and transferred by experiencing, doing and participating. The rationalists (from Descartes on) had claimed that the foundations of human knowledge are found in Reason - i.e. ideas innate in human nature. John Locke (1690) had questioned this assertion and concluded instead that knowledge was merely the complex combination of ideas that had been acquired through the senses.

In An Enquiry Concerning Human Understanding, David Hume13 (1711-1776) presented the simple query: “What are the limits of human knowledge?” He divided propositions between two types: those which are "relations of ideas" (analytic) and those which are "matters of fact" (synthetic). The first type is acquired without knowledge of anything in the world but solely from reasoning; the second type is acquired only through experience. George Berkeley (1710) refuted the division between qualities: our knowledge is not pictures of reality but pictures, period. They have no necessary connection to reality and merely exist in our head. Thus, Berkeley denied completely Locke’s theory that knowledge was merely the complex combination of ideas that had been acquired through the senses.

Knowledge communities can be defined as “groups of people with a shared passion to create, use, and share new knowledge for tangible business purposes”14. The medical profession was the first of the “knowledge communities” – as far back as the time of Hippocrates, followed by the sciences as they developed through the Renaissance.
The authors J. J. O'Connor and E. F. Robertson\textsuperscript{15} write: - “Aristotle (384 to 322 BC) was not primarily a mathematician but made important contributions by systematising deductive logic. He wrote on physical subjects and some parts of his “Analytica posteriora” show an unusual grasp of the mathematical method. Primarily, however, he is important in the development of all knowledge.” Aristotle promoted the sharing of knowledge, as the author J. Barnes\textsuperscript{16} writes: - “His own researches were carried out in company, and he communicated his thoughts to his friends and pupils, never thinking to retain them as a private treasure-store. He thought, indeed, that a man could not claim to know a subject unless he was capable of transmitting his knowledge to others, and he regarded teaching as the proper manifestation of knowledge.”

Benjamin Jowett, in his translation of Plato's \textit{The Republic}\textsuperscript{17} stated that Plato was perhaps the greatest metaphysical genius whom the world has seen; and in him, more than in any other ancient thinker, the germs of future knowledge are contained. Plato indicates that there is benefit in the sharing of knowledge … “Prithee, friend, do not keep your knowledge to yourself; we are a large party; and any benefit which you confer upon us will be amply rewarded.” Plato speaks of four classes of goods (human activity) and he places Justice and Knowledge in the highest class.

A "guild" (also spelled "gild") was, in medieval times, an association of craftsmen or merchants, formed for mutual aid and protection and to further their own professional interests. The medieval guilds were of two types, the merchant guilds and the craft guilds. Modern professional organizations can be likened to ancient guilds... the keepers and protectors of knowledge. The best known of guilds is that of the Freemasons, which has survived through the ages, and the importance of protecting professional knowledge was well understood in such organisations, although the Freemasons have now lost their direct relationship to the building professions. This secretiveness developed through the need to safeguard the knowledge of craft skills (or knowledge capital) for their own members.

\begin{center}
\textbf{KNOWLEDGE MANAGEMENT METHODOLOGY}
\end{center}

Dante said, “Knowledge doth come of learning well retained, Unfruitful else.”\textsuperscript{18} which reinforces the fact that knowledge is useless unless it can be \textit{structured and stored} for re-use and improvement.

Thomas Hobbes (1588-1679), in \textit{Leviathan}, \textsuperscript{19} writes of the \textit{reiterative} quality of consequences and dependencies of Knowledge Management; “And whereas sense and memory are but knowledge of fact, which is a thing past and irrevocable, science is the knowledge of consequences, and dependence of one fact upon another; by which, out of that we can presently do, we know how to do something else when we will, or the like, another time: because when we see how anything comes about, upon what causes, and by what manner; when the like causes come into our power, we see how to make it produce the like effects.”
THE COMPLEXITY OF KNOWLEDGE SEARCH PATTERNS

It will become evident later in this dissertation how strongly search patterns influence KM and how the concept of knowledge dividing into branches can form the basis of a Knowledge Management methodology. Reiteration takes place when, metaphorically speaking, the outcomes (leaves) become nutrients for the knowledge network (branches/roots). An understanding of this is important when considering the essential question posed by this dissertation.

Jean-Jacques Rousseau\(^2\), (1712-1788) wrote of the intricacy of knowledge search patterns: “When a person has any real taste for the sciences, the first thing he perceives in the pursuit of them is that connection by which they mutually attract, assist, and enlighten each other, and that it is impossible to attain one without the assistance of the rest. Though the human understanding cannot grasp all, and one must ever be regarded as the principal object, yet if the rest are totally neglected, the favourite study is generally obscure. I was convinced that my resolution to improve was good and useful in itself, but that it was necessary I should change my method; I, therefore, had recourse to the encyclopaedia. I began by a distribution of the general mass of human knowledge into its various branches, but soon discovered that I must pursue a contrary course, that I must take each separately, and trace it to that point where it united with the rest; thus I returned to the general synthetical method, but returned thither with a conviction that I was going right.”

2.2 LANDMARKS IN KNOWLEDGE DEVELOPMENT

Here follows a brief tour through history to bring us to the present.

The Dark Ages are generally considered to be a time of technological and intellectual stagnation, but Monasteries remained repositories of knowledge, copying, and preserving knowledge in bound and illuminated books for posterity. Thurow\(^2\) writes that when we hear that term, we are inclined to think of a period in history during which little innovation occurred; during which knowledge remained stagnant, dogmatic, and doctrinaire; and during which ‘barbarians’ destroyed the glory of the Roman Empire and its technological and engineering marvels – yet Thurow considers that no such period ever really existed.

Lacey and Danziger\(^2\) write that knowledge in the year 1000 rarely came from books – only a small minority could read – and they retained data without the help of filing cabinets or mechanical storage systems. They had learned everything by observing and imitating…. and by memorising everything they needed to survive and enrich their lives.

Alfred the Great, who came to the throne of Wessex in 871, commissioned scholars to start the first history of England and the English language, the Anglo-Saxon Chronicle, which recorded events great and small through the centuries up to the year 1154, when the last unfinished (mysteriously terminated) entry was...
This recording of knowledge became one of England's unifying factors. The so-called dark ages were coming to an end and Europe began reaching a period of relative certainty when knowledge could be supported by authenticated fact.

The fifteenth century saw the invention of printing from movable type by Gutenberg. The painstaking hand-copying of books in the Middle Ages gave way to the printing press and a flourishing of literature. The faster spread of knowledge in the Renaissance may never have been possible without Gutenberg's invention and this was as significant to the spread of knowledge as are the digital inventions of modern times.

The era called the Renaissance spanned the 17th and 18th centuries and this period saw significant changes in the way Western man viewed his world. The flowering of knowledge in the Renaissance was aided by the rediscovery of classical knowledge and manifested itself in the arts and sciences -- leading to the restoration of a high view of man and his intellectual capacity. John Adams (1735-18260) wrote: “The preservation of the means of knowledge among the lowest ranks is of more importance to the public than all the property of all the rich men in the country.”

As civilisation moved through the Industrial revolution towards the modern age, a significant landmark in KM was the work of Charles Babbage (1792-1871), British mathematician and inventor, who designed and built mechanical computing machines on principles that anticipated the modern electronic computer.

The digital age had its birth with the development of the computer, from the mechanical “Difference Engine” by Babbage, through a lineage that included the ABC by J.V. Atansoff, ENIAC and the personal computer. This age advanced as Tim Berners-Lee invented the information superhighway known as the Web, which allows anyone with a computer and browser to use the Internet. It was his dream to devise a means to link all the information stored on computers everywhere so that there would be a single global information space. To turn his dream into reality, in 1980 he wrote a program that allowed computers to share information- to link to each other- and in less than ten years this became the World Wide Web – opening up a vast resource for the dissemination of knowledge.

It has become a goal in business practice to devise means of managing and processing this vast resource of knowledge and the term “Knowledge Management’ has begun to be recognised as a specialist discipline.

Section Two will now deal with Current Knowledge Management Practice with reference to current writings and recognised modern leaders in KM.
13 Hume, David.” An Enquiry Concerning Human Understanding” (Public Domain).


15 O'Connor J. J. and Robertson E. F. “Aristotle” -- Article
Internet source: http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Aristotle.html


23 This is based on the document published as The Anglo-Saxon Chronicle (Everyman Press, London,) 1912. (Public Domain in USA). Internet source: http://sunsite.berkeley.edu/OMACL/Anglo/

24 Internet source: http://www.idealfinder.com/history/inventors/babbage.htm


26 Investigation into computer networking technology began in 1969 as a project for the Pentagon’s “Defence Advanced Research Projects Agency” (DARPA).
Section 3 is a literature review of current KM practice, identifying a few current philosophies in organisational strategy and thinking. The focus of this treatise is on the Architectural enterprise, but is necessary to identify general approaches in KM management theory and practice in general terms before narrowing the field.

### 3.1 CURRENT KM THEORIES

Russel Ackoff, along with Emery (1972) characterised human systems as purposeful systems whose members are also purposeful individuals who intentionally and collectively formulate objectives and are parts of larger purposeful systems.

M.I.T.’s Nicholas Negroponte\(^{28}\) describes the difference between physical products and information products in the digital age as the difference between moving atoms around (physical products such as cars and computers) and moving bits around (electronic products such as financial analyses and news broadcasts). Producers of bits can use the Internet to reduce their delivery times to practically zero. Producers of atoms still can’t beam the physical objects through space, but they can use bit speed—digital coordination of all kinds—to bring reaction time down dramatically.

Davenport\(^{29}\) (1997) suggested that the elements of knowledge management should include Culture, Behaviour, Politics, and Technology. Capital value is also an intrinsic part of the KM process and warrants separate mention. It is under the following headings that current practice is now studied -- with reference to writings by a number of professors in the field of Knowledge Management

- **Culture** – Values of and beliefs about KM; benefits and pitfalls that can affect KM.
- **Behaviour and work processes** - How people actually use KM, Skills, and Attitudes.
- **Politics** – Leadership, Communication, Management roles, Relationships
- **Capital Value** – Information Ownership, Security, Knowledge-Based Economy, Knowledge Sharing, and Intellectual Property -- Legalities and Ethics
- **Knowledge Communities** – the value of Communities of Practice
3.2 CULTURAL ASPECTS OF KM

**Cultural Acceptance**

“Knowledge Workers” can be defined as people who work mainly with knowledge intangibles rather than with their hands – to produce value. Frances Horibe, President of ‘VisionArts, Inc.’ in Canada, specialises in assisting organisations with the human and organisational sides of investing in Intellectual Capital. In her book ‘Managing Knowledge Workers’, she states that Organisations that can harness the intellectual capital of knowledge workers will be successful in the information age. The driver of success in “New Economy” is knowledge, with the flood of information coming at light speed.

**REASONS FOR ADOPTING KM**

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<td>Retain expertise of personnel</td>
<td>51.9%</td>
</tr>
<tr>
<td>Increase customer satisfaction</td>
<td>43.7%</td>
</tr>
<tr>
<td>Improve profits, grow revenues</td>
<td>37.5%</td>
</tr>
<tr>
<td>Support e-business initiatives</td>
<td>24.7%</td>
</tr>
<tr>
<td>Shorten product development cycles</td>
<td>23%</td>
</tr>
<tr>
<td>Provide project workspace</td>
<td>11.7%</td>
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3.3 BEHAVIOUR AND WORK PROCESS IN KM

**Implementation Strategies**

Thomas A. Stewart, in his book *The Wealth Of Knowledge*, observed that knowledge work does not necessarily follow the linear path that physical labour often does and here lies much of the difficulty in understanding the reiterative nature of KM. search patterns.

- In *Knowledge Management Strategies*, Jerry Honeycutt provides guidelines for IT decision makers and provides an information foundation for top company management. Digital technology is changing the foundations of how business is conducted today and how it will be conducted tomorrow. Three fundamental elements of all businesses -- the relationships between businesses and their customers, information flow between workers and departments within businesses, and business processes themselves—are undergoing rapid transformation.
Cultural barriers within organisations are important factors to consider in the implementation of any project. Most impediments to KM adoption are "process, culture and behaviour based," says Mark Tucker, senior analyst with The Delphi Group, a research and consulting firm in Boston, Mass. "There's never been a technology invented to make someone do something they're not culturally inclined to do."

In the white paper "Overcoming the 'Cultural Barriers' to Sharing Knowledge," the question addressed is -- What makes a culture that supports knowledge sharing? The answer offered is: Share knowledge to solve practical business problems; execute KM in a way that matches the style of the organisation; build on the core values of the organisation; and many more. Thus, to create a knowledge-sharing culture, one should make a visible connection between sharing knowledge and practical business goals, problems, or results. It is far more important to match the overall style of organisation than to directly copy the practices developed by best-practice organisations.

Without Purpose, KM has no value -- and without proper consideration of People (influenced by culture) KM becomes irrelevant.

In “The Knowing-Doing Gap: How Smart Companies Turn Knowledge into Action,” the authors Pfeffer and Sutton confront the challenge that companies now face in their battle to turn knowledge into productive action. They identify the causes of 'The Knowing-Doing Gap' and explain how to close it. The book is a useful how-to guide for managers looking to make changes. Yet, as Pfeffer and Sutton point out, it takes more than reading their book or discussing their recommendations. It takes action. The authors question why, when market for business knowledge is booming, and companies looking to improve their performance pour billions of dollars into training programs, consultants and executive education, there are so many gaps between what firms know they should do and what they actually do? Why do so many companies fail to implement the experience and insight they’ve worked so hard to acquire? Firms that turn knowledge into action avoid the ‘smart talk trap.’ Companies that act on their knowledge eliminate fear, abolish destructive internal competition, measure what matters, and promote leaders who understand the work people do in their firms. They give many examples of companies that have overcome this knowledge-action gap and they are highlighted in the book. The authors describe the most common obstacles to action---such as fear and inertia---and profile successful companies that overcome them. Other case studies include those companies that tried, but failed, and yet other organisations that managed to avoid the gap from the beginning. Companies which Pfeffer and Sutton say do it right include: General Electric, the Men’s Wearhouse, SAS Institute, Southwest Airlines, Toyota, and British Petroleum.

Chris Argyris and Donald Schön’s 1978 book “Organizational Learning” despite being written 26 years ago, remains relevant in today’s “Digital Age”. They write about the personal transformation that precedes individual learning and enables organisational learning -- and the differences between
knowledge used for understanding, and knowledge used for action. To bridge the gap between organisational learning theory and practice, we need to focus not only on implementable validity but also, as Argyris notes in an interview, on usability. In an interview with Chris Argyris conducted by Mary Crossan, he emphasised the need for both managers and educators (from business schools as well as the corporate world) to focus on the engine of inquiry—the capacity to think. He suggests that what is needed is not only a willingness to engage the ideas, but a capacity to think critically and work through the problems. She states that Argyris is hopeful that information systems, because they can make data available to support productive thinking, may serve as a catalyst for change. She goes on to state that the sceptic might disagree: without critical thinking to drive the analysis and interpretation, information systems will simply reinforce single-loop learning and processes.

Reiterative, as opposed to single loop Processes in KM becomes a strong theme later in this dissertation – the metaphor of an upward infinite spiral as opposed to a closed circle. This reiterative Process is promoted as being a solution to one the core problems facing KM, that of stagnation.

❖ Creativity

- The authors Koulopoulos and Frappaolo (1999) connect knowledge and creativity in suggesting that “creativity is the application of knowledge in completely new ways. Thurow, in Building Wealth (1999) stated that, “Any society that values order above all else will not be creative, but without the right degree of order, creativity disappears as if into a black hole.”

This idea supports one of the core principles promoted in this treatise, Creative Process -- that to be effective, KM must be free of creative restrictions, but it requires order and Process to be effective.

❖ Skills and Attitudes

Francis Horibe (1999) states that as the amount of knowledge available grows by leaps and bounds, workers must gain new skills to master a particular niche. Knowledge capital is only of value if it continues to grow and enterprises need to encourage continuous learning to meet changing needs.

The elements of Resource management, Process and Practice should therefore have built-in renewal or reiterative systems which encourage and reinforce the change/ growth dynamic.

3.4 THE POLITICS OF KM

❖ Leadership in KM
Koulopoulos and Frappaolo (1999) suggest that leadership in the knowledge-based organisation is defined by the roles of chief knowledge officers, related knowledge worker types, and their interactions.

The politics of Creative leadership and Communication (Purpose/ People/ Process/ Practice) are essential, as they can easily degenerate into a bureaucratic data- and procedures-based style of management. This is a pitfall in the Architectural profession, which is subject to a plethora of guidelines, rules and regulations and the essence of the model proposed in this thesis is to keep the ideas fresh and creative despite the constant tension towards stereotype.

♦ COMMUNICATION AND MANAGEMENT ROLES

The politics of communication are well described by Cynthia C. Froggatt (2001) in eight basic work principles: Encouragement of Initiative; the creation of Trust and reduced management control; Joy and job satisfaction; Encouragement of Individuality; shedding the layers of hierarchy and creation of Equality; voiding one-way communication through Dialogue; “Connectivity” – shedding the layers of geographic communication boundaries; offering varied Workplace Options enabled by digital communication.

Internal communications were once centralised, but now they emanate from every department. Corporate intranets have added to the complexity and the quality of information often varies greatly and is relevant only to particular departments resulting in a lack of consistency. Communications often fail to relate back to the company's goals and this results in a need to create a holistic framework for communications that could be used throughout an organisation. The Knowledge Manager can play a major role in this process -- as information architect, designer, and consultant.

John Thackara, Director of the Netherlands Design Institute in Amsterdam, has described KM as "...capturing best practice, harnessing collective intelligence, sharing lessons learned, and harnessing the untapped value that lies among your staff and contacts." He goes on to state that "...We are in a transition to a post-spectacular, post-massified culture. Our cities, from now on, will be judged by their capacity to foster collaboration, encounter, intimacy, and work." 

♦ RELATIONSHIPS

• Ross Dawson, in Developing Knowledge-Based Client Relationships describes how to create profitable and enduring client and customer relationships in the knowledge economy. Dawson examines consulting, investment banking, law and advertising firms as a model for knowledge organisations and shows how they can develop intimate and profitable knowledge-based relationships with their clients.
This book includes over 50 practical studies, including Booz-Allen and Hamilton, DDB Worldwide Communications Group, Ernst and Young, J. P. Morgan’s Riskmetrics Group, and McKinsey and Co., to demonstrate how to create value for clients based on sharing knowledge.

Dawson concludes that KM is not just about an organisation’s internal processes and systems, but about people as the first priority. He analyses the effective knowledge transfer techniques between people and enterprises and the concept of ‘co-creation’ of knowledge, which can add value by facilitating better decision-making by clients and enhancing their capabilities.

### 3.5 THE TECHNOLOGY OF KM

#### Tools

Wendi Williams and Ruth Bukowitz, in *The Knowledge Management Fieldbook*[^44], have produced a guide full of practical advice for managers wishing to implement knowledge management within their organisations. This tactical handbook gives both the ways and means to manage the process that generates useable knowledge assets within an organization.

The authors provide recommendations for the tools and techniques to set up, manage, and exploit a knowledge management system within an organisation. They present a comprehensive and practical approach to knowledge management. The text includes more than 50 interviews with various organisations.

Many enterprises are grappling with how to harness the knowledge economy and most have already felt the impact on their businesses (either positively or negatively). This book contains practical and concrete advice and is a useful guide for those involved in the implementation of Knowledge Management strategy.

In *The Knowledge Management Fieldbook*, the authors have provided tools to enable managers to assess their organisations’ strengths and weaknesses using the Knowledge Management Diagnostic. Using a simple framework for thinking about Knowledge Management, they advocate a strong link between tactics and strategy that will appeal to management at all levels.

In *The Knowledge Management Toolkit: Practical Techniques for Building a Knowledge Management System*[^45], Tiwana delivers hands-on techniques and tools for making KM happen at an enterprise. Amrit Tiwana illustrates how to use KM to make sure that every key decision is made during the construction of an intranet, a data warehouse, and project management structures. The book is presented as a "how-to" guide for building an enterprise knowledge management system and Tiwana offers these recommendations on how to achieve the results by creating a KM ‘Toolkit’, which, in the author’s opinion shows a bias towards a “Process and
Practice” based model for Knowledge Managements and fails to place any emphasis on the cultural and creative aspects.

Performance

Kimball Fisher and Maureen Duncan Fisher⁴⁶ state that for the first time in history, more employees work with their minds than with their muscles. Their value lies in their mental abilities and their knowledge. Collectively, they are the ‘mind’ of the company – a mind spread across many individual brains. The authors call it ‘the distributed mind’, which is a powerful force, for if two heads are better than one, imagine how much better many heads are – if it is possible to manage them all.

They describe how progressive companies are creating teams of ‘knowledge workers’ and coordinating their individual efforts into a web of high performance. Based on interviews conducted with hundreds of knowledge workers, the Fishers have identified trends that are changing the way we work. The Distributed Mind provides insight on how to understand the characteristics of knowledge work teams (and the innovative concept of ‘vertical multi-skilling’).

Techniques described by the authors include: Organising multiple specialists into a cohesive unit; sharing knowledge without creating information overload; Coordinating activities when half the team is dispersed; Understanding the critical role of technology in this new work structure.

♦ THE NETWORKED ECONOMY

• Recently, the Spanish economist Manuel Castells⁴⁷ wrote about the networked economy as the "space of flows" - a metaphor that helps to explain one way in which our world is becoming a hybrid of real and virtual space. In his trilogy Castells traces the effects of three independent processes appearing between the end of the 1960s and the middle of the 1970s and coming together to produce a 'new society': the information technology revolution, the economic crisis of capitalism and statism (communism), and the blooming of new social movements like environmentalism and feminism. According to Castells, the IT-revolution is partly responsible for the collapse of the Soviet Union together with other statisms, and for the rejuvenation of a more effective, flexible and hardened capitalism. Together these three processes are causing a new social structure (a network society), a new economy (a global informational economy), and a new culture (a culture of ‘real virtuality’).

Knowledge ‘Management’ also implies Knowledge ‘Sharing’. Bill Gates stated in his book Business at the Speed of Thought⁴⁸ that the old saying "Knowledge is power" sometimes makes people hoard knowledge. They believe that knowledge hoarding makes them indispensable. Power comes not from knowledge kept but from
knowledge shared. A company's values and reward system should reflect that idea. Gates also stated that the 1980s and 1990s were about quality and re-engineering, but the 2000s are about speed of transaction and information access. These factors will alter the lifestyle of consumers and their expectations of business.

STRATEGY

A variety of technologies, particularly those associated with the Internet, are dramatically affecting the strategies and ways in which companies are managed. Philip Evans and Thomas S. Wurster⁴⁹ (2000), both executives of the Boston Consulting Group, argue that the Internet demands new business strategies because they provide companies tremendous "reach" for customers without sacrificing "richness," or the quality of the information about products and services. In their book, Blown to Bits, they show how some businesses—Microsoft and Intuit in personal finance, Dell Computer in retailing, and the Automotive Network Exchange in manufacturing supply—are thriving amid a rapid expansion of connectivity and the widespread acceptance of new technical standards on the World Wide Web. They argue that the new economics of information allows players to compete on reach, affiliation, and richness using the strategic tools enabled by current technology.

This dissertation seeks to explore how the Architectural profession can move in this networked economy and virtual world, gather the knowledge required for a set of tasks, and emerge with creative concepts and methodology for real world projects. The alternative is to collapse under a heap of process and data overload.

3.6 THE CAPITAL VALUE OF KM

Intellectual Property -- Legalities and Ethics.

The legal and ethical issues related to information ownership could take up volumes and it is not the purpose of this dissertation to explore that avenue. It is, however, a major factor in all decisions and processes related to Knowledge Management. The legalities involved in the definition and protection of Intellectual Property are extremely complex and differ dramatically from region to region and between countries. It is therefore wise to seek expert assistance in developing safeguards, the very least of which is to include a clear statement of policy in all employment contracts and a clearly stated code of practice in the procedures manual of the enterprise. Thurow (1999) stated, “Capitalism requires clear, easy-to-enforce ownership rights”, but the complexities of ownership were recognised by Hugo Grotius⁵⁰ and Samuel von Pufendorf⁵¹ as early as the 17th century.

INFORMATION OWNERSHIP
Thomas A. Stewart, in his book *The Wealth of Knowledge* reveals how today’s companies are applying the concept of intellectual capital to day-to-day operations to dramatically increase their success in the marketplace. The author advocates a four-step process that shows how to put intellectual capital to work. Stewart offers sound advice, in the writer’s opinion, although the bias still leans towards Process and Practice. Architectural and Design enterprises require much more emphasis on Creative Purpose and this is not given much attention in this publication.

One fact reigns supreme in today’s business world -- **Intellectual Capital Premium** is directly connected to an organisation’s **Market Value**. Information ownership is a complex issue – far beyond the old concept of Intellectual Property that could be guarded and kept secure by business practices and the professional Guilds of days gone by. A single “bit” of digital information can now be copied, manipulated and moulded endlessly so that it becomes difficult to establish who the originator of that bit was. In a section on information ownership in his book *Enterprise Knowledge Management: The Data Quality*, David. Loshin looks at the different roles that exist in the context of information production. These roles may represent real people or automated processes within the system:

**Suppliers; Acquirers; Creators; Processors; Packagers; Delivery Agents; Consumer; Middle Managers; Senior Managers; Deciders.**

Each of these actors plays a well-defined role in the data processing operation, and each is responsible at some level for quality assurance within each activity domain. He adds that it is clear, though, that at any stage of processing, it is difficult to specifically assign **ownership** to the information being created or processed.

♦ **SECURITY OF INFORMATION OWNERSHIP**

Loshin states further that information ownership is a management and security issue. Because information is bought, used, created, modified, propagated, and sold throughout an organisation, the enterprise data processing function can be contrasted to a factory where individuals or automated processes play specific roles. Complicating issues make data quality management a difficult task. These issues may include: differing views of the value of data; privacy issues; turf wars; standard bureaucracy.

He states that if stakeholders subscribe to the data ownership policy, a more ordered environment enables better knowledge management overall and data quality management in particular. There are different kinds of data ownership and different ownership rules may apply in different situations.

Francis Horibe (1999) emphasises that a significant factor in retaining security of Knowledge Capital is employee loyalty. This supports the “People” aspect of Knowledge Management – that it is necessary to
foster a healthy culture to effectively implement the building blocks of KM. Such an approach is considerably more effective than a “policing “policy.

❖ Knowledge Based Economy:

The author Lester C. Thurow55 of MIT identified nine rules for Individuals, Companies, and Nations in a Knowledge Based economy, including the observation that “Knowledge-based capitalism isn’t going to work without a new system for determining who owns or controls intellectual property rights. Capitalism requires clear, easy- to-enforce ownership rights”

♦ KNOWLEDGE SHARING

According to Annie Brooking (1998)56, knowledge is a corporate asset which needs to be identified, guarded, and shared. Corporate Memory: Strategies for Knowledge Management shows managers how to explore their company’s intangible assets, identify knowledge assets, and foster knowledge sharing within the organisation.

Seth Shulman57 (1999) refers to the complexities of knowledge ownership involved in the “Human Genome Project”. Scientists hope that the multibillion dollar international effort to will result in a complete map of the human genome. A key issue is the need for open access to this information, but scientists are rushing to patent genes and the battle now centres on what kinds of genetic information can be privately owned. It is for the good of humanity that this kind of information remains in the publicly exploitable domain.

MIT58 have now made an unprecedented move to open up their coursework without restriction to the whole world. MIT OCW is a large-scale, Web-based electronic publishing initiative based on the fundamental principal that “Knowledge shared is knowledge gained.”

❖ Knowledge Communities

In The Harvard Business Review on Organizational Learning, the authors E. C. Wenger and W. M. Snyder offer the following ways which “Communities of Practice” add value to organisations:

- They help drive strategy;
- They start new lines of business;
- They solve problems quickly;
- They transfer “Best Practices”;
- They develop professional skills;
- They help companies recruit and retain talent.
Wenger and Snyder state that “Communities of Practice” are the heart and soul of the World Bank’s management strategy. They have, amongst others, also identified Hewlett Packard, Shell and AMS (American Management Systems) as active proponents of this approach to KM. The participants in these communities learn together by focussing on problems directly related to their work, with the strength being the fact that these groups are self-perpetuating – “As they generate knowledge, they reinforce and renew themselves”\textsuperscript{59}. The Institute of American Architects, amongst other Architectural organisations, offer exceptional facilities for a “Knowledge Community” and this will be explored later, in more detail.

It is this theme of Creative Process that forms part of the fundamental philosophy in this treatise – and this includes the combination of the following elements into a strong Capital Asset for an enterprise:

- Developing a Knowledge-Based Economy
- Promoting Knowledge Sharing
- Building Knowledge Communities

3.7 THE NEED FOR KM IN ARCHITECTURE

Architecture is described as the “Mother of all Arts’,” in classical architectural theory. In practice Architecture requires skills that span across all the Arts, Humanities and Sciences. There is a constant tension between the practical, the functional, and the creative and any solution for KM in Architectures must have a creative base, otherwise there is a danger of losing architecture’s standing in the Arts.

The profession is faced with processing a large amount of random data. Every building designed contains an enormous amount of specified data and creative input – influenced by the requirements of the building brief or program. This dissertation attempts to offer insight into the management of knowledge and data as part of the Architectural work process. In defining a Knowledge Management process, the first step is to devise a creative KM philosophy and flexible framework to contain that knowledge and allow it to develop dynamically.
Collaboration and Communication

John Zeisel\(^60\) offers solutions to integrate research and design, and how to carry out research on people and group -- useful to designers. His work led to a textbook in the field of environment-behaviour research called “Inquiry by Design”, which explores how sociological research and design can be collaborative. He describes "Programming" as the design term for finding out the needs of an organisation and its people before creating the building in which they will operate. Zeisel offers a creative approach to the information gathering element of Knowledge Management and his work will be referred to in more detail in the remainder of this dissertation.

Sabu Francis\(^61\) writes that because of that unique aspect, handling knowledge in architecture is extremely complicated. A building can be looked upon as a complex assembly of information components. The "What" needs to be put together with the "How" and the "Where" -- all of which needs management of knowledge.

Strong Architectural “Knowledge Communities”\(^62\) (in the form of Architectural Institutes) exist and are very powerful in their influence on Architects throughout the world. They are the providers of huge amounts of data, and work process guidelines -- sometimes adding to the input overload. It is up to the individual Architectural Enterprise to develop its own KM philosophy and self-education. Architectural education institutions are often inclined to be creativity-oriented rather than management-oriented. The writer will attempt to meld this approach to Knowledge Management into a creative process – rendering it more appealing to the profession.

Knowledge Management refers to procedures that maximize intellectual and information resources. Employee education, experience, and expertise are examples of intellectual resources. Documents and data are examples of information resources. KM depends on the processes of creation, collection, sharing, recombination, and reuse of these resources, and it becomes difficult to separate intellectual from information resources as the two are absolutely co-dependant.

Towards The Virtual Phase

Architecture is being launched into revolutionary representational and operational strategies by the digital age. This fundamentally challenges the way in which Architects have traditionally conceived and practiced architecture:

\begin{itemize}
  \item A knowledge base limited and dated by (non digital) data available.
  \item Communication limited by available media.
  \item Concept and Design methods limited to static media.
  \item Presentation and Production methods limited to 2 dimensional static media.
  \item Office and Project Management tools limited by static media.
\end{itemize}
The key elements in this revolution are:

*An ‘Infinite’ Knowledge base.*

*Sophisticated Communication media.*

*Advanced tools for Design, Conceptualisation and Visualization.*

*Advanced tools for Presentation and Production.*

*Advanced Management tools.*

Architectural software is evolving rapidly from two-dimensional drafting to a three-dimensional simulation and visualisation. The architect is becoming the creator of the virtual building as well as its caretaker, and consequently his or her role in the building project can continue after the occupancy permit is issued. As a result of this evolution, the architect's ability to construct a "virtual building" on a desktop computer, to simulate the building's behaviour both before it is built and throughout its life cycle, will change the architect's design process, fee structure, and relationship with the client, contractor and the community. In addition to transforming the architect's own practice, his or her ownership of the 3D computer model will carry important competitive advantages in procuring all future work associated with the same building.

In fact, the new set of services surrounding the maintenance of the virtual building will bring to centre stage of society the only professional who is trained as a generalist to conceive geometric solutions to social and economic problems: the architect. To better understand the course of this evolution, we should think of the practice of architecture through the ages in the following phases:

- The *"Master Architect Phase,"* where the architectural profession encompassed all the building professions and used simple tools to document and construct the temples, castles, and cathedrals;

- The *"Contemporary Phase,"* when the building professions split up into specialities and architects represented buildings using complex manual techniques to generate specifications and illustrations for the construction of buildings

- The “Transitional Phase,” which we are now entering, which falls between the “Contemporary Phase” and the “Virtual Phase”. The building professions rely on digital CADD tools to produce “hard copy” documentation for construction.

- The *"Virtual Phase,"* where architects will construct virtual buildings using software instead of hammers, in a simulated environment – for interpretation into the real world by Computer-Aided Design and Manufacturing processes.
The emergence into the “Virtual Phase” can be aided by the use of special conceptual tools and it is the focus of this dissertation to offer tools, uniquely tailored for an architectural enterprise, to pave the pathway to effective Knowledge Management.

**Explicit and Tacit KM Tools**

Tools for Explicit and Tacit Knowledge Management involve the realms of “Purpose, People, Resources, Location, Process and Practice,” and these are dealt with in detail in the body of this dissertation.

**Explicit KM**

The following reflects one interpretation of the **Explicit** knowledge Management process of an enterprise. This dissertation will offer tools and techniques for architects to effectively manage these processes, including Search Engines, Intranets and Extranets, Digital Communications, EDMS (Electronic Data Management Systems), etc.

**Tacit KM**

The tools available for **Tacit** KM have developed to a sophisticated level in the digital age. These tools include Mind-Mapping or Concept Mapping, Virtual Workspace tools, etc and will be discussed hereafter, with emphasis on the metaphors, figurative language and symbolism offered by nature and the world of fractal geometry.

One effective concept mapping tool is the new phenomenon of “Weblogging”. The nature of a “Blog” is to provide an intelligent and constantly evolving digest of commentary and links. Blogs are pithy stories that offer insight into the minds of the authors – presented in the form of an online web page.

It is not deemed possible to manage tacit knowledge, but it is possible to offer tools to influence it. Maish Nichani, Venkat Rajamanickam (May 14, 2001) write that weblogs allow knowledge management to turn information into stories. These stories are already a necessary part of life and are an integral part of the culture of an enterprise. By filtering the information from weblogs, you develop a fair idea of the diversity of opinion and it becomes possible for the Knowledge Manager to effectively use this tacit knowledge.
**Value Added Workplaces**

Dave Pollard⁶⁴ (Oct. 2003) writes: “What, then, is the value proposition for KM, if there is one at all? The answer to this question lies in the Peter Drucker’s assertion that the greatest challenge to business management in the 21st century is, and will be, improving the personal productivity and effectiveness of front-line workers doing increasingly complex and unique jobs. Unlike the work world of the last two centuries, most employees today either come into their jobs knowing more than their boss about how to do it, or quickly acquire such superior knowledge from their peers and from personal experience on-the-job. Every job today, every process, is unique, and therefore the expectation that KM systems could capture ‘best practices’ and ‘success stories’ and ‘lessons learned’ that could be reapplied by others again and again was unrealistic.”

Barbara A. Nadel, in an article in the American journal ‘Architectural Record’⁶⁵ writes that Business leaders have discovered that a high-performance workplace yields superior business results. Face-to-face collaboration occurs in various forms, from casual, spontaneous interaction, to formal, structured work sessions. In shared space and time, people readily adjust their work styles to the environment and project needs. Depending on the setting, tools, and tasks, people collaborate in very different ways. The design of a high-performance, collaborative workplace is a multi-disciplinary undertaking calling for the skills of architects, designers, engineers, anthropologists, workplace experts and communicators. The basic elements involve Purpose, People, Resources, Location, and Process, and incorporate technology and tools while embracing corporate culture and change.

To understand and design value added workplaces Architects must of necessity place themselves in a high performance environment. Using a combination of digital tools and the KM principles proposed in this dissertation, the Knowledge Management process can incorporate growth and change.

Typical work processes used by the Architectural profession are analysed in this dissertation in order to establish a rationale for Knowledge Management. These processes start with the raison d’être for the profession, designing built environment (usually for a client).
As clients create their built environment, they progress through five distinct phases:

**Genesis ►► Focus ►► Design ►► Build ►► Operate**

Architectural practice, in servicing the above, commonly follows this sequence:

<table>
<thead>
<tr>
<th>Inception and Project Initiation</th>
<th>Genesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management and Administration processes</td>
<td>Focus</td>
</tr>
<tr>
<td>Schematic and Conceptual Design processes</td>
<td>Focus►►Design</td>
</tr>
<tr>
<td>Detail Design Process -- Solution evaluation and generation</td>
<td>Design</td>
</tr>
<tr>
<td>Production Processes</td>
<td>Design ►► Build</td>
</tr>
<tr>
<td>Construction and Project Management</td>
<td>Build</td>
</tr>
<tr>
<td>Review /Post-Mortem/ Maintenance</td>
<td>Build►►Operate</td>
</tr>
</tbody>
</table>

These sequential stages in the architectural process coincide with the management, design, production and fee structure traditionally established in the profession in most western countries.

*Section 4 will deal with Knowledge Management principles – and the search for a conceptual ontology and metaphor to define these principles in order to develop the model for implementation in an architectural enterprise.*

28 Nicholas Negroponte is the Wiesner Professor of Media Technology at the Massachusetts Institute of Technology. Internet source: http://web.media.mit.edu/~nicholas/


33 CIO.com White paper-- “Cultural Barriers Challenge KM Implementers; Strategic Directions: Knowledge Management: Collaborating for a Competitive Edge” http://www.cio.com/sponsors/0600_km/061500_km_side10.html

34 White paper “Overcoming the ‘Cultural Barriers’ to Sharing Knowledge” Source: American Productivity & Quality Centre


36 Crossan, Mary. “Chris Argyris and Donald Scho’n’s Organizational Learning: There is no silver bullet.” Academy of Management Executive, 2003, Vol. 17, No. 2.


42 John Thackara, Director of the Netherlands Design Institute in Amsterdam. Internet source: http://www.thackara.com/


50 Internet source: http://cepa.newschool.edu/het/profiles/grotius.htm

51 Internet source: http://cepa.newschool.edu/het/profiles/pufendorf.htm


58 MIT’s Open Courseware  *http://ocw.mit.edu/index.html*


   ASIN: 0521319714

61 Sabu Francis & Associates Portfolio “History of Knowledge Management in Architecture”
   *http://www.archsfa.com/book/view/97*

62 See an example of this at the AIA website:
   http://www.aia.org/knowledgecommunities/

63 Nichani, Maish and Rajamanickam Venkat. “Grassroots KM through blogging.” Weblog (May 14, 2001):

64 Pollard, Dave. “*The Future of Knowledge Management.*” Discussion Paper. October 2003:
   http://blogs.salon.com/0002007/images/TheFutureofKnowledgeManagement.doc

65 Nadel, Barbara A. “Interactive Communication Products: Advancing Knowledge through Collaboration.”
   *Architectural Record* (0nline) http://archrecord.construction.com/resources/conteduc/archives/0311polyvision-1.asp

4. A KM Conceptual Ontology

The process of Knowledge Management resolves itself in a network pattern and follows a spiral path -- controlled by invariants but continuously influenced by variables so that the outcome is never repeated exactly.

Gruber (1992) wrote that in the context of knowledge sharing, the term 'ontology' is used to mean a specification of a conceptualization. Practically, an ontological commitment is an agreement to use a vocabulary (i.e., ask queries and make assertions) in a way that is consistent (but not complete) with respect to the theory specified by an ontology. We build agents that commit to ontologies. We design ontologies so we can share knowledge with and among these agents.

To determine the requirements for KM in an Architectural Enterprise, an appropriate metaphor may be used as an ontology to define KM principles and to assist in the development of a Conceptual Ontology. George Lakoff and Mark Johnson argue that human thought processes are largely metaphorical and that linguistic expressions are possible because there are metaphors in a person’s conceptual system. This leads to the question of how an appropriate ontology model, suited to architectural practitioners, can be developed and how to place this model in context.

4.1 CULTURAL METAPHORS

In the Harvard Business Review on Knowledge Management, in the section "From Metaphor to Model" Ikujiro Nonaka emphasizes the need to draw from the store of figurative language and symbolism in the attempt to convert tacit knowledge into explicit knowledge and to articulate a manager’s intuition and insights. This conceptual ontology is one which will appeal particularly to the Architectural profession, with its roots in the arts and visualization.

Mark Stefik, author of Internet Dreams: Archetypes, Myths and Metaphors, sees at least four archetypal metaphors in the Internet:

- The Digital Library metaphor points to the "Keeper of Knowledge";
- Electronic Mail, points to "Communicator";
- Electronic Marketplace, to "Trader";
- Exploration of Digital Worlds, to "Adventurer."

He is interested in metaphors because they express how we think about things and they point to unconscious archetypes -- the metaphors we use to describe an invention seem to be guiding our imaginations and influencing what we think that invention can become. The Knowledge Management concept combines these metaphors into a new and clearly defined role, with the attitudes, knowledge, and skills essential for effective Knowledge Management contained within the contextual realms of Purpose, People, Resources, Location, Process and Practice.
Architects are trained to use graphic tools for conceptualisation. It is therefore appropriate to find visual metaphors that represent the KM process and transmit the principles espoused in this dissertation. A fundamental rule in architectural design is the use of the ‘Golden Section’ for design proportions and the links to nature have been extensively documented. This base in nature was therefore considered by the author as a starting point for development of this ontology.

Search patterns strongly influence KM and the concept of knowledge dividing into branches can form the basis of a Knowledge Management methodology. Reiteration takes place when, metaphorically speaking, the outcomes (leaves) become nutrients for the knowledge network (branches/roots). An understanding of this is important when considering the essential question posed by this dissertation.

4.2 TOWARDS A CONCEPTUAL ONTOLOGY FOR KM

Knowledge Management Technology enables organisations to define their Knowledge Base, and it networks people, organizations, and documents to solve business problems through, amongst other factors:

- Participation and Interaction
- Content Structuring
- Customisation to enable a User-Friendly interface
- Location of Ability, Skills and Expertise – reduction of staff turnover through greater job satisfaction.
- Establishment of a culture of sharing knowledge.
- Increasing the capacity for change and expansion and the adoption of new technology
- Dynamic Interaction within the Organisation.

In the absence of KM Structure, the results may be:
Too much talk.
Fragmentation of technology solutions.
Too many meetings at too low a level resulting in no action at all
Too much uncoordinated action – the outcome being fragile, fragmented, expensive and systems which are not maintainable.
The belief that knowledge hoarding makes individuals indispensable. Inherent dangers in the establishment of such a culture are loss of intellectual property and skilled staff, who may migrate once they have milked the knowledge base.

Counters to these dangers lie in the following:

- Establishment of secure and efficient employment contracts.
- Security levels built into the knowledge base – with permissions granted only on certain qualifications.
- Efficient knowledge of legalities and good legal resources in case of a breach.
- Incentives to staff to retain loyalty.
- Some acceptance of the fact that, despite security, some Intellectual property will inevitably be lost.
- Some acknowledgement that “Knowledge shared is Knowledge gained”

A company’s values and reward system should reflect the knowledge sharing idea. The following diagram illustrates how value escalates with increased participation in the Knowledge Management process. General usage increases exponentially as soon as the value is seen to be increasing.

4.3 THE NATURE OF KNOWLEDGE

George Berkeley⁵ wrote: “…. to hold the fairest tree of knowledge, whose fruit is excellent, and within the reach of our hand.” The gaining and manipulation of Knowledge can be likened to the roots of an immortal tree – evolving along an infinite network in an eternal quest for nutrients or data -- with the branches or results of this quest growing outwardly in a similar neural network – and the rate of growth being directly proportionate to the quantity and quality of the nutrients. In his book, “Business @ The Speed of Thought” Bill Gates stated that you know you have built an excellent digital nervous system when information flows through your organisation as quickly and naturally as thought in a human being and when you can use technology to marshal and coordinate teams of people as quickly as you can focus an individual on an issue.
Chaos Theory

Thomas A. Stewart, in his book “The Wealth Of Knowledge” observed that knowledge work does not necessarily follow the linear path that physical labour often does and here lies much of the difficulty in understanding the reiterative nature of KM search patterns. Traditional views often limited all work processes to a linear pattern due to the limitations in ability to process data, but the digital age has enabled the manipulation of (apparently) infinite knowledge resources.

Chaos theory is a branch of mathematics that, despite its name, attempts to make order out of seemingly random events and that has found application in the natural sciences. The Chaos Theory refers to apparently unpredictable behaviour arising in a deterministic system because of great sensitivity to initial conditions. Chaos arises in a dynamic system if two or more arbitrarily close starting points diverge exponentially, so that their future behaviour is eventually unpredictable. To the Greeks, chaos signified the infinite formless space which existed before the universe was created.

Manus J. Donahue III writes “Aperiodic behavior never repeats and it continues to manifest the effects of any small perturbation; hence, any prediction of a future state in a given system that is aperiodic is impossible. Assessing the idea of aperiodic behavior to a relevant example, one may look at human history. History is indeed aperiodic since broad patterns in the rise and fall of civilizations may be sketched; however, no events ever repeat exactly.”

Weather is considered chaotic since arbitrarily small variations in initial conditions can result in radically different weather later. This may limit the possibilities of long-term weather forecasting. (The canonical example is the possibility of a butterfly's sneeze affecting the weather enough to cause a hurricane weeks later.)

In past times, until the advent of the computer age, man attempted to contain all knowledge within defined boundaries, for comfort and security. In order to attempt to manage knowledge, there must be an acceptance of its infinite and “chaotic” nature.
Fractals

In *Fractals – The Patterns of Chaos*, John Briggs describes Chaos and Fractals as nonlinear phenomena. The aperiodic nature of Fractals renders them excellent metaphors for Knowledge Management -- representing the fact that, although apparently chaotic, formulas can be applied to harness and manipulate knowledge, while allowing dynamical changes and transformations.

Fractals are geometric patterns that repeat on infinite scales. Many natural objects, like ferns, tree branches, and lung bronchial systems are shaped like fractals. Fractals can also be seen in many of the swirling patterns produced by computer graphics, and have become an important new tool for modelling in biology, geology, and other natural sciences.

One of the fascinating things about the Mandelbrot set fractal is the seeming contradiction in it. It is said to be the most complex object in mathematics, perhaps the most complex object ever seen. But at the same time, it is generated by an almost absurdly simple formula: Multiply Z by itself. Add C. The answer is the new value for Z. Repeat until the absolute value of Z is greater than two, or until our counter expires. If abs (Z) ever exceeds two, then it will very quickly head off towards infinity which means that the point is not in the Mandelbrot set (that's the definition of the Mandelbrot set). These points are typically assigned a colour based on how many iterations were done before abs (Z) exceeded two. If abs (Z) doesn't exceed two after a large number of iterations, then we give up and assume that the initial point is in the Mandelbrot set. These points are typically coloured black. The black, barnacle covered pear is the Mandelbrot set proper - all the bands of colour outside of it are simply curious artefacts that help to expose the detail of the Mandelbrot set itself.
Organic Network Links

The Christian mystic, Pierre Teilhard de Chardin, explored stages of evolutionary development characterised by the emergence or dominance of consciousness, the mind, and interpersonal relationships.

Crucial to the process of human evolution, i.e. to progress is, in Teilhard's view, scientific research. In the past such investigations were isolated, sometimes no more than the hobbies of individuals. "Today we find the reverse: research students are numbered in the hundreds of thousands-soon to be millions-and they are no longer distributed superficially and at random over the globe, but are functionally linked together in a vast organic system that will remain in the future indispensable to the life of the community." (p. 106) One can't but think of today's "Internet," yet this was written forty-six years ago.

The metaphor of “Aperiodic Neural Networks” refers to Fractal systems of channels along which the interactions between Nature, Man, Society and Shells flow along networks. They include streets, the distribution systems for water, gas, electricity; waste disposal systems and all the channels for communication.

“Neural Networks” occur throughout human and environmental systems and reiteration is evident in the endlessly repeated pattern equations, which modify slightly with each reiteration, resulting in a potentially unpredictable outcome.

4.4 “NEURAL NETWORKS” IN ARCHITECTURAL KM

The ‘Academy of Neuroscience for Architecture' in San Francisco supports research that bridges neuroscience with Architecture – linking the way the human nervous system and brain functions with productivity in the workplace and communications networks involving Purpose, People, Resources, Location, Process and Practice.
The Academy offers opportunities for research into Proportion, Harmony and Symmetry in design. The para-hippocampal place area (PPA) in the human brain, coupled with the genetic preference for the proportions of the golden mean may indicate that a historic response to good proportions in building design is innate rather than learned. Fractal geometry has a direct link to the Golden Mean via the ‘Fibonacci Series’.12

A new experimental tool being used by ‘Astorino Architects’13 in Pittsburgh to discern design is the ‘Zaltman Metaphor Elicitation Technique’ (ZMET), a patented interview and interpretation process that draws from a diversity of fields, including sociology, anthroplogy, cognitive science, psychotherapy, linguistics, and marketing strategy. Although ZMET has been used for more than a decade by many Fortune 500 companies to position and market products, the technique has never before been used in an architectural context, the architects and researchers claim.

‘ZMET’ is based on three basic premises:
- Most thought, emotion, and learning occurs without awareness.
- Human thought is visual; the mind thinks in images, not words.
- Metaphoric thinking is the basic mental process and is central to understanding meaning.

Aperiodic Iterations

The acceptable definition of chaos theory states, chaos theory is the qualitative study of unstable aperiodic behaviour in deterministic nonlinear dynamical systems - Manus J. Donahue – (2003).

However, if we do discover a complete theory, it should in time be understandable in broad principle by everyone, not just a few scientists. Then we shall all, philosophers, scientists, and just ordinary people, be able to take part in the discussion of the question of why it is that we and the universe exist. -Stephen Hawking.

Knowledge is aperiodic by nature and exact outcomes cannot be predicted. Data is a series of random facts resulting from the use of knowledge. Knowledge is manipulation of facts and creation of new concepts/data using an underlying philosophy or defined process to obtain an outcome. A critical element in KM is the development of an efficient method for stepped documentation of procedure/records.
Steps

Regardless of the method used to obtain an outcome, this process should be capable of being recorded, refined, repeated, developed, and changed -- with changes being recorded and backed up. Steps in this process are:

<table>
<thead>
<tr>
<th>NEW PROCESS</th>
<th>EXISTING PROCESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Recording of new process</td>
<td>• Retrieval of process</td>
</tr>
<tr>
<td>• Logging of usage (e.g. installation log /</td>
<td>• Reviewing and checking the process</td>
</tr>
<tr>
<td>process log – recorded/written/typed)</td>
<td>• Logging of usage (e.g. installation log /</td>
</tr>
<tr>
<td></td>
<td>process log – recorded/written/typed)</td>
</tr>
<tr>
<td>• Re-use, with changes made according to</td>
<td>• Re-use, with changes made according to</td>
</tr>
<tr>
<td>lessons learned.</td>
<td>lessons learned.</td>
</tr>
<tr>
<td>• Storing of the new generation process.</td>
<td>• Storing of the new generation process as a</td>
</tr>
<tr>
<td></td>
<td>replacement or variation of the original.</td>
</tr>
</tbody>
</table>

Loopbacks

Take an equation, solve it; take the result and fold it back into the equation and then solve it again. Keep carrying out this iteration to infinity. Aperiodic Iteration, as in nature, can be applied to the process of intelligent thought and to principle of Knowledge Management. Skills essential to effective knowledge management are contained within the connection between computer programs and mathematical laws describing natural phenomena. Both have invariants (quantities that do not change during some physical process -- for example energy).

To keep computer programs short, they contain loops where a set of instructions are repeated until a result is obtained. For example to compute the sum of 1000 numbers, instead of writing 1000 times the two instructions:

```
read number ..... 
add number to subtotal ....
........... you define a loop.
```

To each loop in a computer program is connected an invariant. This raises the intriguing possibility that invariants in physical laws are connected to the fact that Nature, like a computer, also executes loops.
Aperiodic Iterations in KM

Far from being a closed loop, the process constantly refines itself, so that the loop becomes a 3-dimensional spiral, another shape reflected in nature, as in the nautilus shell. A governing principle for the process of Knowledge management may now be defined and this process is contained within the following **definitive statement**:

The process of Knowledge Management resolves itself in a network pattern and follows a spiral path -- controlled by invariants but continuously influenced by variables so that the outcome is never repeated exactly.
4.5 THE FRACTAL MODEL IN CONTEXT

Now that the metaphor of Fractal Geometry in KM has been expounded, this dissertation will endeavour to illustrate how this can be practically applied to the overriding philosophy governing Knowledge Management principles in the Architectural Enterprise. Each concept begins with a core idea which proliferates as it is interrogated and analysed, so to continue with the fractal metaphor which has its base in nature, the term “Seed” has been adopted to describe the origins of KM.

❖ The Core Concept or “Seed”

First, the origin, purpose and focus is established:

- *The Core Concept or “Seed” is the starting point for all KM systems.*
- *The seed regenerates and gives birth to new diverse generations.*

❖ Iterations of the Seed

Following this, iterations must be defined to identify and map logical layers and interfaces:

- *A network Pattern of relationships is defined.*
- *Layers and interfaces are analysed.*

❖ Reiteration or Loopback

In order to achieve maximum efficiency in Knowledge Management, it is necessary to analyse the components of this reiterative structure. Starting with the “Seed” or “Core Concept”

- *Loopback to existing pools of content*
- *Loopback to existing and proposed business processes*
- *Loopback to existing technologies with high investment*

❖ Gap Analysis

The next step is to perform gap analysis within and between layers and re-apply the formula

- *Refine with each pass*
Restart if necessary

Restart carries the benefit of experience and history.

It is in this way that a reiterative formula can be created to deal with the complexities of the Knowledge Management process. Dr Jim Botkin\textsuperscript{14} (1999) describes six top attributes relating to knowledge products and services. These further support the reiterative (fractal) process:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEARN</td>
<td>The more you use them, the smarter they get. The more you use them, the smarter you get too.</td>
</tr>
<tr>
<td>IMPROVE WITH USE</td>
<td>Enhanced rather than depleted when used, they grow up instead of being used up.</td>
</tr>
<tr>
<td>ANTICIPATE</td>
<td>Knowing what you want, they recommend what you might want next.</td>
</tr>
<tr>
<td>INTERACTIVE</td>
<td>Two way communication between you and them.</td>
</tr>
<tr>
<td>REMEMBER</td>
<td>Record and recall your past actions to develop a profile.</td>
</tr>
<tr>
<td>CUSTOMIZE</td>
<td>Unique configuration to your individual specifications in real time at no additional cost.</td>
</tr>
</tbody>
</table>

### 4.6 IMPLEMENTATION OF THE FRACTAL MODEL

The fractal process translates visually into complex 3-dimensional patterns which are reflected everywhere in the natural and built environment. Creative perception of KM problems is stimulated by this metaphoric link.

The process should be conceptualised as a 3-dimensional model (think of looking up a spiral staircase). The formula is repeated many times along the path, resulting in new conceptual generations. Knowledge at any one time should be conceived as having a history and a future, with ancestors and descendants who benefit from past experience, growing and improving with each generation evolving along this fractal path. Mark McElroy\textsuperscript{15} refers to the “Complex Adaptive System (CAS) Model” theory which holds that people self-organize and continuously fit themselves individually and collectively to ever-changing conditions in their environment. KM deals with the knowledge generations that evolve as each new “fit” occurs.
The Core Km Concept or “Seed”

The Core Concept or “Seed” of effective Knowledge Management is contained within the contextual realms of Purpose, People, Resources, Location, Process and Practice. The seed continues its evolution along the spiral fractal path, branching out, mutating and developing as the fractal formula is applied in infinite iterations.

It often becomes necessary to freeze generations at a particular step in order to bring a project to fruition. The alternative is to become so involved in constant development, that work cannot be completed. This is, for example, often experienced when making a decision to upgrade software and the introduction of new upgrades becomes a strategic decision based on a clear analysis of current conditions. Each realm resolves into networks which evolve and generate new KM methodologies. The KM core revolves to create new dependencies and dynamics, for example, “Location” when juxtaposed with “People” results in a consideration of how people respond to their environment (see fig 4.11).
Mangement often leans towards standardisation which can quickly turn into obstructive bureaucracy. The reiterative process proposed in this treatise advocates the use of process templates rather than fixed standards, recommended acceptable practices rather than rules and regulations. Frank Lloyd Wright wrote: “So this very useful tendency in the nature of the human mind, to standardize, is something to guard against as thought and feeling are about to take "form,"—something of which to beware,—something to be watched. For, over-night, it may "set" the form past redemption and the creative matter be found dead. Standardization is, then, a mere tool, though indispensable, to be used only to a certain extent in all other than purely commercial matters.”

**Towards a Model for Knowledge Management.**

The task now becomes focused on the creation of a working model for KM in an architectural enterprise. There are many levels of KM, but it is simplistic to try and define a generic model that can be applied to all professions. Because the knowledge base becomes specialised to suit the required outcomes, the method of implementing the management thereof becomes tailored accordingly. An architectural enterprise encompasses the following activities, many of which overlap with other disciplines, but each organisation defines its own unique quality:

- Management.
- Administration.
- Marketing.
- Research.
- Presentation and Promotion.
- Communication.
- Technical documentation.
- Transmission of technical data.
Section 5 explores the nature of the architectural work process, knowledge realms and the application of the Fractal Metaphor to this knowledge base – in order to define a KM model.


4 Stefik, M. Internet Dreams: Archetypes, Myths and Metaphors. (The MIT Press), 1996.

5 Berkeley, George. A Treatise Concerning the Principles of Human Knowledge. (Public Domain)


Donahue Writes:

“The very name "chaos theory" seems to contradict reason; in fact it seems somewhat of an oxymoron. The name "chaos theory" leads the reader to believe that mathematicians have discovered some new and definitive knowledge about utterly random and incomprehensible phenomena; however, this is not entirely the case. The acceptable definition of chaos theory states, chaos theory is the qualitative study of unstable aperiodic behavior in deterministic nonlinear dynamical systems. A dynamical system may be defined to be a simplified model for the time-varying behavior of an actual system, and aperiodic behavior is simply the behavior that occurs when no variable describing the state of the system undergoes a regular repetition of values. Aperiodic behavior never repeats and it continues to manifest the effects of any small perturbation; hence, any prediction of a future state in a given system that is aperiodic is impossible. Assessing the idea of aperiodic behavior to a relevant example, one may look at human history. History is indeed aperiodic since broad patterns in the rise and fall of civilizations may be sketched; however, no events ever repeat exactly. What is so incredible about chaos theory is that unstable aperiodic behavior can be found in mathematically simply systems. These very simple mathematical systems display behavior so complex and unpredictable that it is acceptable to merit their descriptions as random.”

see also An Introduction to Chaos Theory and Fractal Geometry http://www.duke.edu/~mjd/chaos/chaosh.html


12 ‘Fibonacci Series’. (see Glossary)

13 From The American Institute of Architects Newsletter “AIArchitect This Week, 9/15-21/03” article on Astorino Architects [http://www.astorino.com/](http://www.astorino.com/)


5. The Architectural Work Process

It now becomes necessary to explain current work process, in brief, before the proposed fractal model is applied. The fractal metaphor will be applied as an overlay so that the design model can be seen to have relevance. Although many of the principles described from here on are applicable to general Knowledge Management, this dissertation will focus on general Architectural Practice from this point onwards.

Blackmer (2004), describes the dramatic “jump-shift” from the historical model of architectural practice, that of the singular renaissance architect to the comprehensive and integrated architectural teams required to accomplish today’s complex projects. The technological revolution that took the profession from manual drafting to CAD, then to shared 3-D “smart” models.

He states that another jump-shift is the emerging understanding between environmental design and how our brains work.

With the rate of technological development in the digital age, comes the problem of redundancy. The way to avoid this is by the adoption of a dynamic KM system that allows for constant development and rejuvenation. Redundancy occurred when knowledge workers became frozen at one generation of thought and process because it seemed to work well for the work carried out at that time. This problem occurred in the pre-digital age as well, but the interval between generations was so much bigger and there was more time for gradual evolution. As has been previously illustrated, it is necessary to sometimes freeze processes at a certain level in order to finish the work at hand, that should, however, always be done with the knowledge that that generation has a limited lifespan, and should advance towards the next level as soon as is feasible. Architectural practice faces this problem constantly, in all fields, including administration, information technology and software systems (CADD upgrades for example), building documentation and process, etc.
5.1 ENTERPRISE WORK DYNAMICS

The complex inter-relationships of work dynamics in an architectural enterprise are illustrated in the following model, which is a 2-D representation of a 4-dimensional process. All the parts are moving, rotating and evolving, and the relationships become unique with each reiteration.

![Fig. 5.02 A Model of the Work Dynamics of an Architectural Enterprise.](image)

Each element resolves itself in a network pattern and the whole process follows a spiral path of development, looping back to the base of Knowledge Management which encompasses the whole process. Project management coordinates the inner workings within the shell. Office Administration is a link between all parts of the model. The project path has multiple spiral branches, this model only illustrates the path taken by one project and the process may vary between projects.

Jonathan Cohen, in *Communication and Design on the Internet*, describes integration and synthesis as the core skills of the architectural designer. An architect’s skill is in coordinating the work of specialists required to design modern buildings, which are rarely the product of standard construction practices. As building technology advances, the knowledge management required to coordinate these advanced systems becomes more complex.
5.2 PROJECT WORK BREAKDOWN STRUCTURE (WBS)

The Project Managers Body of Knowledge (PIMBOK)\(^3\) refers to “WBS as a results-oriented family tree that captures all the work of a project in an organised way. It is often portrayed graphically as a hierarchical tree, a matrix of "element" categories and tasks or the indented task list that appears in a Gantt chart schedule. Large, complex projects are organised and analysed by breaking them into progressively smaller pieces until they are a collection of defined "work packages" that may include a number of tasks.

ISO 9000\(^4\) standards require that a profession provides a project manual which deals with all the services offered by an enterprise.

Fig. 5.03 Work Breakdown Structure

The first questions to be asked in determining a WBS are:

- **How many tasks should this project have?**
- **How much detail should be included in the project schedule?**

A common mistake both project and knowledge managers make is to lay out too many tasks and it is easy to get caught up in the idea that a project or a KM plan should detail everything everybody is going to do in the project or enterprise. Such plans should not become enormous checklist or step-by-step procedures for doing everything in case we have to do it again. Using “Checklists” can lead to micro-management is generally inappropriate, except when you have a lack of skill and discipline in the organisation. Most competent workers will not thrive under micro-management and this style tends to encourage dependency on the project manager rather than independence where people are held responsible for their results. KM plans are consistently more effective when they hold people accountable for reaching measured achievements rather than completing a list of tasks.

The alternative is a strategic approach where the overall impact is identified in precise terms, then the required elements or contributors required to achieve this outcome are identified and finally the specific actions necessary to achieve the desired outcomes are identified. As no single project is a direct copy of a previous one, templates rather than itemised check-lists are the more effective method.
Using the work breakdown structure (WBS) for cross-functional corporate projects, an assignment and monitoring process can be designed. Activities are broken down into "packets" of achievement for which people and teams are accountable. It is here that the idea of recommended practices, templates or “seeds” comes into play for KM.

The inherent problem in Work Breakdown Structure Diagrams is that they are represented in 2D diagrams. Computer systems and programs enable representation in 4D visualization models. The following table is based on the work structure established by the American Institute of Architects although this may vary in terminology, the pattern is similar to that followed in many countries.

![Project WBS Diagram](image-url)

Fig. 5.04 Project WBS

The WBS of a typical architectural project showing the relations of phases (horizontal) to tasks (vertical...
5.3 KM CONTEXTUAL REALMS

In *A Treatise Concerning The Principles Of Human Knowledge*, George Berkeley spoke of the infinite nature of knowledge, and it is the purpose of this dissertation to show how Knowledge Management can deal with this infinite resource using principles that acknowledge the contextual realms of **Purpose, People, Resources, Location, Process** --aided by (but not subordinate to) the tools of the “Digital Age”. This is the part of the essential question that this dissertation seeks to answer.

In *An Essay Concerning Human Understanding* John Locke states that “Every step the mind takes in its progress towards Knowledge makes some discovery, which is not only new, but the best too, for the time at least.” He promoted the following sound **Knowledge management principles** -- all still relevant today:

1. **Enquiry into origins. (Purpose/ People)**
2. **Self-Knowledge and understanding of what ‘Idea’ stands for. (People)**
3. **Certainty, Evidence, and Extent of knowledge. (People/ Resources)**
4. **Capacity suited to our state or condition. (Resources/ Location)**
5. **Method in which knowledge is pursued. (Process/ Practice)**
6. **Design and Structure of knowledge. (Process/ Practice)**

![Fig. 5.05 Knowledge Management Contextual Realms](image-url)


**Purpose**

The early stages of an architectural project are possibly the most important for continued efficiency throughout the project. It is unfortunate that most management styles are of the responsive “just in time” or “crisis” type. KM systems enable managers to avoid this pitfall as they can draw on the Knowledge Base for historical examples and templates for the setting up of a new project. This is an idealistic view and few projects can be clearly defined at the start, but a good initial dynamic KM structure can ensure the success of a project. Architectural projects can fail because of the lack of a clear vision at the onset.

![Fig. 5.06 An iteration of the ‘Carr 1625’ fractal formula (public domain).](image)

**People & Resources**

An organisation's subtle, "tacit" knowledge is a veritable goldmine for Knowledge Resources, and this is one of the first areas to be mined. The key to entering this mine is found using the people involved and the implements or skills they use. Feedback is important; people need to be asked how they like the communications vehicles; if they understand the company's direction and how they fit in. Based on their responses, the system can be adjusted a system should not just inform employees, it should communicate with them. To effectively utilise the human resources, it is necessary to define the User Levels that may be encountered in an architectural enterprise.
## Multiple Skill user Levels

The system must support users with multiple skill levels: a wide range of domain experience, web experience, and frequency of use. All users of the applications are expected to have some level of exposure to the web, to browsers, and to use of computers.

<table>
<thead>
<tr>
<th>HIGH DOMAIN EXPERTISE/HIGH FREQUENCY USAGE OF APPLICATION - “PROFESSIONAL” USERS</th>
<th>LOW DOMAIN EXPERTISE/LOW USAGE OF APPLICATION - “SELF-SERVICE” USERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>For some applications, a user may be a domain expert, and use the applications daily to perform routine yet complex domain-specific tasks. Users with this profile may be referred to as “professional” users. On the other hand, there are other applications that are targeted for only occasional usage, such as once every 6 months to a year, and the users are expected to have little domain expertise.</td>
<td>Users with this profile may be referred to as “self service” users. Both user profiles and a wide range of profiles in between are supported by the User Interface.</td>
</tr>
</tbody>
</table>

To support the varied needs of these different user types, the User Interface Guidelines provide recommendations, options and/or different choices of UI elements. Chapter 6 outlines high-level recommendations or choices that help to target the appropriate user profile.

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**Location**

Presence, in today’s world, need not be physical. Virtual presence is becoming the norm in many organisations, but this bring with it many new problems related to human communication. Online and Offline Knowledge Communities also contribute to Presence, or Remote Presence & Remote Collaboration.

*Fig. 5.07 An iteration of the Mandelbrot Fractal.*
Time and distance, still dominate how work is carried out, but these remain major obstacles --despite modern technology. The factors that govern these elements are:

- technologies available,
- the manner in which the technologies are used,
- the work environment,
- the work processes employed.

“True collaboration remains elusive for most teams and collaboration across distance is rarer still. There are several pressures being brought to bear on this subject. Increasingly, team members are located in different locations. Travel is becoming more difficult, expensive and dangerous. Issues of life-style are being raised in regards extended time away from home. Productivity demands are rapidly rising. Clearly, now is the time for distance learning and work to work. Today, it does not, and, the rate of betterment is not significant. For there to be significant gain, the four factors mentioned above will have to be dealt with. It is my contention, that if they are, there will be a quantum leap in effectiveness and Remote Presence and Remote Collaboration will be possible.”

**Process and Practice**

Knowledge Management Process involves the establishment of work and behavioural patterns in the work environment. It is an integrated, systematic approach to identifying, managing, and sharing all of an enterprise’s information assets, including databases, documents, policies, and procedures, as well as previously unarticulated expertise and experience held by individuals within the enterprise. In order to organize the KM resources, structured methods of retrieval are necessary, and to design these methods, it is necessary to understand the essential Search Patterns.
## Search Patterns

**Linear Search Pattern**
The Multiple Discrete Steps Checklist (linear) is for an ordered list of tasks. This option is recommended when the user must perform tasks with multiple, discrete steps in a specific order. It does not allow users to jump forward from task to task. Rather, the user must complete the first task in order to proceed to the next one on the list.

**Nonlinear Search Pattern**
The Multiple Discrete Steps Checklist (nonlinear) is for an unordered list of tasks. This option is recommended when the user can perform tasks in any order. It does allow users to skip to different tasks (i.e., jumping forward and backwards) from task to task.

**Hierarchical (Linear) Search Pattern**
The Hierarchical Checklist (linear) is for an ordered list of grouped tasks. This option is recommended when the many tasks can be clearly organised into high-level groups, and that the user must perform the groups of tasks in a specific order. The hierarchical version of the checklist is represented via an HGrid.

**Hierarchical (Nonlinear) Search Pattern**
The Hierarchical Checklist (nonlinear) is for an unordered list of grouped tasks. This option is recommended when the many tasks can be clearly organised into high-level groups, and that the user can perform any group of tasks in any order. It does allow users to skip to different tasks (i.e., jumping forward and backwards) from group to group. The hierarchical version of the checklist is represented via a Hierarchy Grid or Tree Table.

**Reiterative (Fractal) Search Pattern**
This process encompasses all of the above and it relies on the ability to return to the start when an “end” or limit is reached – with reiteration occurring at a higher plane, or next generation -- using the benefit of past experience. It invokes a loopback spiral action on all the search patterns.

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*Section 6 will illustrate a KM Model for and Architectural Enterprise, focussing on to specific areas and methods for KM.*


5 Berkeley, George. “Treatise Concerning The Principles Of Human Knowledge” (Public Domain) Berkeley writes as follows:

“Some there are of great note who, not content with holding that finite lines may be divided into an infinite number of parts, do yet farther maintain that each of those infinitesimals is itself sub divisible into infinity of other parts or infinitesimals of a second order, and so on ad infinitum. These, I say, assert there are infinitesimals of infinitesimals of infinitesimals, and., without ever coming to an end; so that according to them an inch does not barely contain an infinite number of parts, but an infinity of an infinity of an infinity ad infinitum of parts.”

6. A Knowledge Management Model

In *The Harvard review on Knowledge Management*, David Garvin describes a learning organisation as “an organisation skilled at creating, acquiring, and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insights.”

New ideas are essential to any organisation and to be successful, these ideas need to be translated into new ways of behaving.

To comprehend the purpose of the model proposed here, the elements of Knowledge Management need to be analysed, and these are put forward as follows:

- **The acquisition of Knowledge** (ongoing research and education).
- **Creation of Knowledge** (Mining).
- **Manipulation of Knowledge** (modelling)
- **The Exchange/sharing of knowledge** (Intra/Extra-nets, virtual communities and blogging).
- **Transfer of knowledge** (Benchmarking/Experience)
- **Using knowledge** (Techniques/decision Making)
- **Exploit/Implement knowledge** (Entrepreneurship)
- **Knowledge Communities** (Organisational behaviour and cognition)
- **Culture** (create a knowledge oriented culture - learning organisation)
- **Search knowledge** (Search Methodology)

The model proposed here deals with one element of the whole concept of Knowledge Management, that of the **manipulation of knowledge**. Each of the elements described above are subjects for further study and research and will be only briefly dealt with. The model assumes that the desired level of computer skills exist and that training, that will enable the users to access the model, has already taken place in the enterprise. The skills necessary are briefly outlined in the next section.

In *The Knowledge Management Fieldbook*, the authors have provided tools to enable managers to assess their organisations strengths and weaknesses using the **Knowledge Management Diagnostic**. Using a simple framework for
thinking about Knowledge Management, they advocate a strong link between tactics and strategy that will appeal to management at all levels.

In order to understand how Architectural Knowledge can be managed, architectural work strategy can be reduced to iterative parts which form a sequence of actions defined in the Work Breakdown Structure. This can be used as an outline model structure for the manipulation of knowledge in an Architectural Enterprise. These processes require a complex database of dynamic actions, data, concepts, precedents, codes, etc. No single item can be used again in exactly the same manner – if it was a simple process of re-assembling standard data, the result would be stagnation and the potential repetition of past errors or poor judgment. This is the fundamental difference between Data Management, which is simply a filing activity, and Knowledge Management, which is a reiterative and dynamic process.
6.1 ARCHITECTURAL WBS DATABASE FIELDS

Knowledge mined from the various sources has to be catalogued for retrieval and re-use. Typical Work Processes used by the Architectural profession can be defined as ‘fields’ in data-base terms and these are now analysed, using the WBS already defined in Section 5, to establish a rationale for the Knowledge Management receptacles to receive the mined information. The following fields have been designed by the author for use in this model, allowing for multiple user levels for customisation by individual knowledge managers.

Fig. 6.02 The KM Hierarchical database structure

- **FIELD 1:** (26 iterations) The discipline field allows this model to be developed for other professions -- in a multi-disciplinary practice, the data could be tailored for engineers, surveyors etc by changing the prefix.
- **FIELD 2:** (9 iterations) This field defines Extended Elements of Building Practice.
- **FIELD 3:** (09 iterations) This field defines the functional elements of Architectural Practice.
- **FIELD 4:** (0099 iterations) This field defines Required Tasks in Architectural Practice.
- **FIELD 5:** (0000-99 iterations) User Defined fields for Catalogued Templates and Recommended Practices.
- **FIELD 6:** (0000-00-26 iterations) User Defined field.
- **FIELD 7:** (0000-00-00-26 iterations) User Defined field (further levels may be added if required).

When the database design is converted to a matrix, it translates as follows. The icons are used for easy recognition of the elements and these are repeated in the file structures developed from this model:

Fig. 6.03 The Architectural Work Structure Matrix
<table>
<thead>
<tr>
<th>PHASE</th>
<th>TASK</th>
<th>PHASE</th>
<th>TASK</th>
<th>PHASE</th>
<th>TASK</th>
<th>PHASE</th>
<th>TASK</th>
<th>PHASE</th>
<th>TASK</th>
<th>PHASE</th>
<th>TASK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>10</strong></td>
<td>PROJECT MANAGEMENT</td>
<td>PM Tasks: set contract form and fee structure. Establish Communication Procedures</td>
<td><strong>20</strong></td>
<td>DOCUMENTATION</td>
<td>Project Info: Space Study Org Diagram Site Plan</td>
<td><strong>30</strong></td>
<td>AGENCY REVIEWS</td>
<td>Entitlements Code check Agency survey</td>
<td><strong>40</strong></td>
<td>DESIGN/SPECS</td>
<td>Architectural Programming Client surveys</td>
</tr>
<tr>
<td>A0110</td>
<td>A0120</td>
<td>A0210</td>
<td>A0220</td>
<td>A0310</td>
<td>A0320</td>
<td>A0410</td>
<td>A0420</td>
<td>A0510</td>
<td>A0520</td>
<td>A0610</td>
<td>A0710</td>
</tr>
<tr>
<td>PM Tasks.</td>
<td>Preliminary Designs CADD Model Concept</td>
<td>PM Tasks: set team parameters for project completion CADD Model Presentation</td>
<td>Development Phase Drawings</td>
<td>30/60/100 Dwg Color Boards CADD Model Data Files</td>
<td>Bid Evaluation and Negotiation Tasks</td>
<td>Addenda</td>
<td>Bulletins Field Reports Drawing Markup</td>
<td>PM Tasks: set construction observation times</td>
<td>Record Dwgs. Incorporated into CADD for owner use</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>60</strong></td>
<td>MEETINGS</td>
<td>Client consultation, Facility review &amp; site walk</td>
<td><strong>70</strong></td>
<td>CONSULTANT/ CONTRACT COORDINATION</td>
<td>System analysis &amp; Needs assessment</td>
<td><strong>80</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A0160</td>
<td>A0170</td>
<td>A0260</td>
<td>A0270</td>
<td>A0360</td>
<td>A0370</td>
<td>A0460</td>
<td>A0470</td>
<td>A0560</td>
<td>A0570</td>
<td>A0670</td>
<td>A0770</td>
</tr>
<tr>
<td>Client meetings, minutes</td>
<td>System analysis &amp; Needs assessment</td>
<td>Client meetings, minutes</td>
<td>Schematic Diagrams</td>
<td>Client meetings, minutes Dwg signoffs.</td>
<td>System coordination</td>
<td>Checking at 30% 60% 100%</td>
<td>Coordinate addenda &amp; Review</td>
<td>Site meetings, minutes</td>
<td>Field Observation Coordinate shop drawing checking</td>
<td>Special systems design and integration</td>
<td></td>
</tr>
<tr>
<td><strong>90</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>100</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHASE</td>
<td>TASK</td>
<td>A0100 PROGRAM</td>
<td>A0200 SCHEMATIC DESIGN</td>
<td>A0300 DESIGN DEVELOPMENT</td>
<td>A0400 DOCUMENTATION</td>
<td>A0500 CONTRACT</td>
<td>A0600 CONTRACT ADMINISTRATION</td>
<td>A0700 POST CONSTR.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>----------------</td>
<td>------------------------</td>
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<td>----------------</td>
<td>-------------------------------</td>
<td>-------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>ADMIN - CLERICAL</td>
<td>A0180 Clerical, filing and digital management</td>
<td>A0280 Clerical, filing and digital management</td>
<td>A0380 Clerical, filing and digital management</td>
<td>A0480 Clerical, filing and digital management</td>
<td>A0580 Clerical, filing and digital management</td>
<td>A0680 Clerical, filing and digital management</td>
<td>A0780 Special project online hosting and database setups.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(up to 0099 iterations)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(up to 0990 iterations)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1000</td>
<td>SPECIAL SERVICES &amp; STUDIES</td>
<td>A1100 Site surveys &amp; Photographic Documentation</td>
<td>A1200 Study models, renderings, CADD modelling studies</td>
<td>A1300 Detail cost breakdowns Finish models</td>
<td>A1400 Permit expediting Code studies Mathematical modelling studies</td>
<td>A1500 Separate &amp; Alternate bidding strategies</td>
<td>A1600 Additional submittals, reviews &amp; alternates</td>
<td>A1700 PM Tasks: set fees for additional project reqn'ts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3000</td>
<td>RESEARCH</td>
<td>A3100 Establish scope, goals, client issues</td>
<td>A3200 Research</td>
<td>A3300 Writing Graph/Mapping</td>
<td>A3400 Visual &amp; Digital models and exhibits</td>
<td>A3500 Presentation &amp; review with owner</td>
<td>A3600 Final Report</td>
<td>A3700 Post-publication dissemination &amp; outreach</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4000</td>
<td>CUSTOM INTERIORS</td>
<td>A4100 Image studies Develop budget</td>
<td>A4200 Alternative systems &amp; furnishings</td>
<td>A5300 Colors, materials, refine budget Plan layouts</td>
<td>A5400 Specs, color boards, custom documents</td>
<td>A5500 Bid &amp; subcontractor selection</td>
<td>A5600 Field observation Shop Drawing review, samples</td>
<td>A5700 Special coordination with construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5000</td>
<td>GRAPHICS &amp; ARTWORK</td>
<td>A5100 Image studies Develop budget</td>
<td>A5200 Signage concepts, graphics</td>
<td>A5300 Process, Selection &amp; refinement of sign program</td>
<td>A5400 Specs, color boards, custom documents</td>
<td>A5500 Bid &amp; subcontractor selection</td>
<td>A5600 Field observation Shop Drawing review, samples</td>
<td>A5700 Installation coordination</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Division
01000 to 16000
CSI Construction Index

'CSI' is a Component based indexing system used in the USA. Architectural Process Based input is contained by adding a 'DOCUMENTATION' subset in each division, e.g. 01000_GENERAL-DOC/ 02000_SITEWORK-DOC/ 04000_MASONRY-DOC etc.

The above data base structure has been applied to the KM manual, which has been included in this dissertation as Addendum-1. The hierarchical data base can be managed by any data base computer program and recommendations are included in the last section, dealing with the Tools and Skills required for KM. The method of delivering the structure to the enterprise is via the structured Intranet, designed to be accessible from each workstation internally and externally to remote authorised locations.

Colours & Symbology

Colours and Iconic symbols have been used to represent the different elements, in order to provide ease of recognition and to facilitate usage of the knowledge base.

[Colours and symbols image]
6.2 KNOWLEDGE BASE STRUCTURE & DELIVERY

Using the WBS matrix illustrated in sub-section 6.1, the database hierarchy is translated into a file structure. It is here that the Fractal GUI (Graphic User Interface) comes into play. The GUI chosen for this application design is ‘Fractal PC Version 2™’ – chosen because of the match with the KM ontology of this work. This structure forms the basis of the digital ‘dashboard’ of the Enterprise Intranet.

---

**Fig. 6.04 The Digital Dashboard – a fractal Representation of the structure (constructed with ‘Fractal PC’ and adapted)**

This interactive interface is developed for use in the ‘Graphic User Interface (GUI)’ for the Enterprise Intranet. The fractal iterations respond at each level to a “mouse over” action on the computer screen.

**Fig. 6.05 Tree representation of the Data Base File Structure.**

The WBS proposed here is formatted to precede the standard Construction Specifications Institute hierarchy indexing (CSI) currently used in the USA for referencing construction specification data. Although the USA system is used, the same principle can be applied to the protocols used in other countries (e.g. CiSFb in Europe, ‘Common arrangement of work sections for building works’ (CAWS) in the UK and ‘Co-ordinated Building Information’ (CBI) in New Zealand). The fields defined provide receptacles for the file structure for the knowledge base.
6.3 KM MODEL TEMPLATES/ SEEDS

In this section, the tools are applied to the architectural work stages defined above. These stages also provide Action Templates or “Seeds” for KM implementation. As each level is subject matter enough for a separated thesis, only examples and general principle are illustrated here in order to keep the ontology of the KM process intact. Knowledge Management requires tools to make the strategy operative and the recommended tools and skills required to carry out the strategies are dealt with in Section 7. All documents are coded within the hierarchical database.

It is important that ownership of the various Knowledge Domains is encouraged and knowledge owners are identified so that the different parts of this structure remain dynamic. The basic formula needs to be applied to each bit of information drawn from the knowledge base. Blind use of information quickly transforms to bureaucracy and redundancy and each user needs to fully understand content and to be aware of the consequence of use.

<table>
<thead>
<tr>
<th>NEW PROCESS</th>
<th>EXISTING PROCESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Recording of new process</td>
<td>• Retrieval of process</td>
</tr>
<tr>
<td>• Logging of usage (e.g. installation log /</td>
<td>• Adapt to new usage</td>
</tr>
<tr>
<td>process log – recorded/written/typed)</td>
<td>• Reviewing and checking the process</td>
</tr>
<tr>
<td>• Re-use, with changes made according to</td>
<td>• Logging of usage (e.g. installation log /</td>
</tr>
<tr>
<td>lessons learned.</td>
<td>process log – recorded/written/typed)</td>
</tr>
<tr>
<td>• Storing of the new generation process.</td>
<td>• Re-use, with changes made according to lessons learned.</td>
</tr>
<tr>
<td></td>
<td>• Storing of the new generation process as a replacement or</td>
</tr>
<tr>
<td></td>
<td>variation of the original.</td>
</tr>
</tbody>
</table>

The fractal approach promoted in this dissertation defines the following formula to be applied to the above:

read number ..... add number to subtotal .......

...... you define a loop.

Or

read iteration ..... enable evolution of the iteration ......

.. apply new generation refinement

...... you define a loop.

The following levels illustrate the content of the Knowledge Base, with the starting point being the construction and introduction of the receptacles, or database structure to contain this knowledge base. Many of the ‘Receptacles’ start out empty, with content added as the knowledge base develops. These levels include formats for Meetings, Communications, Correspondence, etc. -- please refer to the Addendum 1 'Index to the Enterprise Procedural Manual' for a list of these elements. The various content types are illustrated under the hierarchical headings.
The Administration stage precedes all others and this is where the company has its founding, where operation procedures are established, staff matters and finances dealt with and the core principles of the enterprise are defined.

The database allows access to templates in various formats, such as all “Microsoft Office” documents, CADD drawings, Graphics files etc.

A specific document (an ‘Excel’ spreadsheet in this case) can be retrieved using the KM database which is hyperlinked to the specific document.

**LEVELS UNDER THIS SECTION ARE AS follows:***

Confidential levels have restricted database access.

- A0010 Procedural Manual
- A0020 Marketing And Corporate Information
- A0030 Information Technology
- A0040 Employment & Staff Matters (Confidential)
- A0050 Office Management
- A0060 Records
- A0070 Purchase Of Materials & Services
- A0080 Financial Matters (Confidential)
- A0090 Insurance, Provident & Fidelity Funds (Confidential)
Each of the hierarchical levels can include a brief Statement of Purpose. The “ownership” of the information – one or more of the Enterprise Knowledge Managers -- is also noted where applicable. Examples of such documents are as follows:

**A0110 PROJECT INCEPTION**

<table>
<thead>
<tr>
<th>Project Inception – Statement of Purpose</th>
<th>A0111-03a</th>
</tr>
</thead>
<tbody>
<tr>
<td>At this level of the architectural project the embryonic <strong>Project Title, Category and the Project Action Statement</strong> are defined in order to achieve an understanding of strategies and methodologies within the project team. The early stages of appraisal and definition are critical to the overall continuity of philosophy that will start at this point and run throughout the project. If the sense of place and environmental goals are clearly defined at this early stage, the project stands a good chance of fulfilling these goals. The label attached to the project at this stage is likely to influence the vocabulary utilized throughout the project. This should be kept simple, evoking a pattern statement through the use of descriptions like “Energy Efficient Building Project”, “Landscaped Office Park”, “High Density Housing”. This description encapsulates the whole marketing concept and should be carefully chosen. Social and environmental aspects should be carefully considered at this early stage and should be reflected in the title</td>
<td></td>
</tr>
</tbody>
</table>

**A0112 PROJECT INCEPTION - COMMUNICATION**

**A0112-01 PROJECT EXTRANET (Example)**

*The use of a project Extranet can enhance communication dramatically, providing a delivery medium for concepts, graphics, minutes, events, meetings and minutes, etc. which can reach the client body quickly and efficiently. The following example is the front page of a working project site created as a knowledge sharing medium for a project. Two examples, created by the author, have been attached as part of Addendum 2:*
This website, created by the author, provides an immediate medium for project communication and knowledge sharing at all levels within the project team.

### Environmental Impact Studies - Building Materials – Statement of Purpose.

It becomes the responsibility of the design manager to guide the design team along the path that has the least impact on the environment. The complexity of this is compounded by financial restraints and the manager may often be faced with the dilemma of making an ethical choice between maintaining his clients favor and what is environmentally sound. The ultimate test of ethics would be advising a client not to proceed with a project when it is, in the belief of the design manager ecologically unsound even though it complies with regulation. If the KM tools used include fields which allow for a continuous audit of environmental factors, this task could be facilitated.

All building materials have some impact on the environment, to a greater or lesser extent and Architects are ethically committed to choose materials and processes that have a minimal impact. Each “bit” of knowledge carries with it a quantifiable element of responsibility in the way in which it is used and this can be included in the fields defined in the Knowledge Base. The following table illustrates the nature of this impact.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Buildings’ Share of Problem</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of Virgin Minerals</td>
<td>40% of raw stone, gravel, and sand; comparable share of other processed minerals such as steel</td>
<td>Landscape destruction, toxic runoff from mines and tailings, deforestation, air and water pollution from processing</td>
</tr>
<tr>
<td>Use of Virgin Wood</td>
<td>25% for construction</td>
<td>Deforestation, flooding, siltation, biological and cultural diversity loss</td>
</tr>
<tr>
<td>Use of Energy Resources</td>
<td>40% of total energy use</td>
<td>Local air pollution, acid rain, damming of rivers, nuclear waste, risk of global warming</td>
</tr>
<tr>
<td>Use of Water</td>
<td>16% of total water withdrawals</td>
<td>Water pollution; competes with agriculture and ecosystems for water</td>
</tr>
<tr>
<td>Production of Waste</td>
<td>Comparable in industrial countries to all other solid waste generation</td>
<td>Landfill problems, such as leaching of heavy metals and water pollution</td>
</tr>
<tr>
<td>Unhealthy Indoor Air</td>
<td>Poor air quality in 30% of new and renovated buildings</td>
<td>Higher incidence of sickness—lost productivity in tens of billions annually</td>
</tr>
</tbody>
</table>

Source: Worldwatch Institute
LEVELS UNDER THIS SECTION ARE AS FOLLOWS:

- A0110 Project Inception
- A0120 Project Information
- A0130 Program Review
- A0140 Program Documentation
- A0150 Program Costing
- A0160 Program Meetings
- A0170 Program Consultant
- A0180 Program Administration

A0200 to A0299 SCHEMATIC DESIGN TEMPLATES

Design guidelines and philosophies which are concurrent with those of the enterprise may be incorporated as a template or KM seed, as illustrated by the following example:

A0220 SCHEMATIC DESIGN PRELIMINARIES

In his book entitled Enquiry by Design, Zeisel \(^1\) (1981) identifies design characteristics which interact together to create a ‘design development spiral’ (refer fig. 6.09). Three elementary activities combine to create a cycle of imaging (conceptualisation or envisaging something beyond the initial information), presenting (presentation of ideas in a format that renders them understandable to the designer and others) and testing (reviewing and critically assessing the product). This cycle is supported by three types of information. Information which acts as a catalyst for imaging, information that offers formats for the presentation of ideas, and information which is a body of knowledge for testing. These types of information can create conceptual changes which modify the designer’s ideas and lead to new cycles of imaging, presenting and testing.

Ownership: PT
Tools for decision making can also be included:

<table>
<thead>
<tr>
<th>BUILDING PHASE</th>
<th>DESIGN ELEMENT</th>
<th>CHARACTERISTICS</th>
<th>ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0000 Administration. A0100 Programming &amp; Pre-Design. A0200 Schematic Design</td>
<td>01000-16000 CSI Categories (as used in the USA)</td>
<td>Size</td>
<td>Habitat</td>
</tr>
<tr>
<td></td>
<td>Building Groups &amp; Sites</td>
<td>Shape</td>
<td>Ecosystem</td>
</tr>
<tr>
<td></td>
<td>• Transportation (Streets, Parking, Public Transit Bikeways, Walks)</td>
<td>Enclosure</td>
<td>Health</td>
</tr>
<tr>
<td></td>
<td>• Buildings (Type)</td>
<td>Orientation</td>
<td>Species</td>
</tr>
<tr>
<td></td>
<td>• Open Space (Plazas, Parks &amp; Recreation, Habitat &amp; conservation)</td>
<td>Increment</td>
<td>Diversity</td>
</tr>
<tr>
<td></td>
<td>• Landform (Topography)</td>
<td>Location</td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td>Buildings &amp; Gardens</td>
<td>Edges</td>
<td>Supply</td>
</tr>
<tr>
<td></td>
<td>• Massing (volume)</td>
<td>Organization</td>
<td>Use</td>
</tr>
<tr>
<td></td>
<td>• Rooms</td>
<td>Thin</td>
<td>Treatment</td>
</tr>
<tr>
<td></td>
<td>• Outdoor Rooms (courtyards, gardens, porches)</td>
<td>Thick</td>
<td>Site Hydrology</td>
</tr>
<tr>
<td></td>
<td>• Circulation (paths, lobbies, indoor streets, corridors, stairs)</td>
<td>Zoned</td>
<td>Food</td>
</tr>
<tr>
<td></td>
<td>• Transitional Space (in-between space, entrances, arcades)</td>
<td>Elongated</td>
<td>Community Gardens</td>
</tr>
<tr>
<td></td>
<td>• Subspaces (alcoves)</td>
<td>Networked</td>
<td>Urban Agriculture</td>
</tr>
<tr>
<td></td>
<td>• Cores</td>
<td>Nodal</td>
<td>Energy</td>
</tr>
<tr>
<td></td>
<td>Building Parts &amp; Organisms</td>
<td>Compact</td>
<td>Embodied</td>
</tr>
<tr>
<td></td>
<td>• Foundations/Base</td>
<td>Clustered</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>• Floors</td>
<td>Dispersed</td>
<td>Metabolism</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hierarchical</td>
<td>Demolition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interwoven</td>
<td>Resources</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Modular</td>
<td>Reducing Non-renewable consumption</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stacked</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Staggered</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Specific design audit strategies focused on the formal implications of ecological issues. Each strategy (when complete) will establish a set of relationships between architectural elements, give a tool for determining the magnitude of this relationship (or some other design procedure) and show relevant examples of how the strategy has been used well by other designers.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Preliminary Detailing</td>
<td>• Preparation of Work Packages</td>
<td>• Site Prep &amp; Excavation</td>
<td>• Changing Uses</td>
</tr>
<tr>
<td>• Coordinating Systems</td>
<td>• Contractual issues</td>
<td>• Building Foundations</td>
<td>• Disassembly</td>
</tr>
<tr>
<td>• Advanced Materials Selection</td>
<td>• Advertising of Bids</td>
<td>• Framing</td>
<td>• Recycling</td>
</tr>
<tr>
<td>• Advanced Detailing</td>
<td>• Answering of Queries</td>
<td>• Closing-In</td>
<td>• Building Transformation</td>
</tr>
<tr>
<td>• Coordinating Systems</td>
<td>• Issuance of Addenda</td>
<td>• Finishing</td>
<td>• Biodegradation</td>
</tr>
<tr>
<td>A0400 Documentation.</td>
<td>• Bid receipt &amp; Analysis</td>
<td>• Landscaping</td>
<td>Ownership: RSM  -- Adapted from the Washington University School of Architecture Ecological Design Strategies</td>
</tr>
<tr>
<td>A0500 Contractual</td>
<td>• Recommendations to Client</td>
<td>A0070 Post Construction.</td>
<td>Levels Under This Section Are As Follows:</td>
</tr>
<tr>
<td>A1000 Special Services.</td>
<td></td>
<td>A0070 Post Construction.</td>
<td>○ A0220 Schematic Design Preliminaries</td>
</tr>
<tr>
<td>• Windows &amp; Doors</td>
<td></td>
<td>A0070 Post Construction.</td>
<td>○ A0230 Schematic Design Reviews</td>
</tr>
<tr>
<td>• Walls (including partitions)</td>
<td></td>
<td>A0070 Post Construction.</td>
<td>○ A0240 Schematic Design Specifications</td>
</tr>
<tr>
<td>• Roofs</td>
<td></td>
<td>A0070 Post Construction.</td>
<td>○ A0250 Schematic Design Building Costs</td>
</tr>
<tr>
<td>• Trees</td>
<td></td>
<td>A0070 Post Construction.</td>
<td>○ A0260 Schematic Design Meetings</td>
</tr>
<tr>
<td>• Vines</td>
<td></td>
<td>A0070 Post Construction.</td>
<td>○ A0270 Schematic Design Consultant Coordination</td>
</tr>
<tr>
<td>• Ground cover</td>
<td></td>
<td>A0070 Post Construction.</td>
<td>○ A0280 Schematic Design Administration</td>
</tr>
<tr>
<td>• Machines</td>
<td></td>
<td>A0070 Post Construction.</td>
<td></td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td><strong>Utilities &amp; Services</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Principles</td>
<td>• Water Supply</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Exterior</td>
<td>• Sanitary Drainage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Interior</td>
<td>• Stormwater Drainage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Structural</td>
<td>• Heating Ventilation &amp; Cooling</td>
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<tr>
<td></td>
<td>• Photovoltaics</td>
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<td></td>
<td>• Power, Gas &amp; Electricity</td>
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<td></td>
<td>• Fire-fighting Services</td>
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<td></td>
<td>• Security Systems</td>
<td></td>
<td></td>
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<tr>
<td><strong>Shared Growth</strong></td>
<td><strong>Pollution</strong></td>
<td></td>
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<tr>
<td><strong>Re-inhabitation</strong></td>
<td><strong>Air</strong></td>
<td></td>
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<tr>
<td><strong>Flexibility</strong></td>
<td><strong>Water</strong></td>
<td></td>
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<tr>
<td><strong>Use/Occupancy</strong></td>
<td><strong>Soil</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Linkages</strong></td>
<td><strong>Human Health</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Layers</strong></td>
<td><strong>Community</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Connections</strong></td>
<td><strong>Place</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type</strong></td>
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<tr>
<td><strong>Color</strong></td>
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<td></td>
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</tr>
<tr>
<td><strong>Texture</strong></td>
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<td></td>
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<tr>
<td><strong>Material</strong></td>
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<td></td>
<td></td>
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<tr>
<td><strong>Switching Cycles Tasks</strong></td>
<td></td>
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<tr>
<td><strong>Wastes</strong></td>
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</tr>
<tr>
<td><strong>Pollution</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Air</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Water</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Soil</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Human Health</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Community</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Place</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Levels Under This Section Are As Follows:**

- A0210 Schematic Design Programming
- A0220 Schematic Design Preliminaries
- A0230 Schematic Design Reviews
- A0240 Schematic Design Specifications
- A0250 Schematic Design Building Costs
- A0260 Schematic Design Meetings
- A0270 Schematic Design Consultant Coordination
- A0280 Schematic Design Administration
This is the section that connects the pattern or idea of the Concept Design to a strategy to actually make decisions, set the magnitude or size of elements or their relationships, or make basic choices about formal configuration. Such templates also assist in helping Clients, Project Managers and Consultants make qualitative decisions. The development of this type of template comes directly from the tacit knowledge and experience of the knowledge workers.

The following is a sample document, of this type, retrieved from the database:

**A0310 DESIGN PARAMETERS**

<table>
<thead>
<tr>
<th>DESIGN DEVELOPMENT TOOLS</th>
<th>A0310-01a</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOOLS TO HELP MAKE DECISIONS</strong></td>
<td></td>
</tr>
<tr>
<td>Some design strategies will not be directly about form decisions, such as form or color. They may instead involve sifting through a large amount of information in order to come to some decision, such as where to locate a building on a site or what material to choose. The tool should help the designer understand the options available, the pros and cons of each choice, the variables and issues involved. But beyond this, it should offer either a clear set of recommendations or a clear method for making the decision. The tools utilized may include or combine mystical, emotive and practical techniques.</td>
<td></td>
</tr>
<tr>
<td><strong>TOOLS FOR FORMAL OPTIONS</strong></td>
<td></td>
</tr>
<tr>
<td>Often, there are many ways to create form that will have the same positive environmental effect. This kind of tool can be generative, because it offers the designer a set of options that may not have been considered. It shows that the strategy can be transformed in many ways. For instance, earth may be used as a building material in several ways: as a flooring material of compacted soil and cement, as adobe, as compressed blocks, as rammed earth in wall forms, as earth berms, as a sod roofing material, and as spray-on shotcrete. Each of these has various formal implications and aesthetic opportunities. In other strategies, a particular element may take on many forms. One might, for instance create a series of diagrams showing different roof organisations, looking at variations for collecting in several different ways, such as at the four corners, at one point from a central valley, or along a line at one eave.</td>
<td></td>
</tr>
<tr>
<td><strong>TOOLS FOR SIZING</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Whenever possible, a sizing tool is most helpful. Ultimately, everything that is drawn or built has a size and must be quantified. This tool should answer the designer's questions:
How much? How big or small? In what relationship? In what proportion?

In many cases there are simple physical processes at work that are predictable. For instance, the size of a roof in a particular climate can be related to the amount of water collected by the roof on a monthly basis, which will determine the size of gutters needed. The amount of rainwater supply and the seasonal characteristics of rainfall, in relation to the demand for water in the building, will determine the size of the cistern to store the water, and the amount and quality of discharge will determine the size of the treatment facility needed. In general, if this tool takes a graphic form, rather than a mathematical one, it will be easier to use and will appeal more directly to the visually oriented designer.

TOOLS FOR PLACEMENT

Here the design tools or related disciplines may be freely utilized. These tools have an inspirational and creative value to them and would provide guidance for the following decisions:

Where should you enter? How should you orientate? How should you place? What relevance does the environment have? What relevance do the immediate surroundings have? What authoritative (Code) influences can be defined? What social influences can be defined?

Ownership: RSM

FURTHER LEVELS UNDER THIS SECTION ARE AS FOLLOWS:

- A0310 Design Parameters
- A0320 Design Development Phase
- A0330 Design Reviews
- A0340 Design Specifications
- A0350 Design Costing
- A0360 Design Meetings
- A0370 Design Consultants
- A0380 Design Admin
This is the stage where final decisions should (ideally) be reached. Revisions beyond this point are likely to cost extra. This section also includes all the implementation tools for project documentation, including the CADD manual of standards, checklists, etc.

Content example is as follows:

**A0410 DOCUMENTATION STANDARDS**

<table>
<thead>
<tr>
<th>PART OF THE INDEX TO THE ENTERPRISE CADD MANUAL (SEE ADDENDUM 1)</th>
<th>A0410-01a</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction - CADD Management considerations</strong></td>
<td></td>
</tr>
<tr>
<td>Creation/ modification of budget</td>
<td></td>
</tr>
<tr>
<td>Creation/ delivery of a training program</td>
<td></td>
</tr>
<tr>
<td>Staff development and evaluation</td>
<td></td>
</tr>
<tr>
<td>File/ data management concerns</td>
<td></td>
</tr>
<tr>
<td>Evaluation and deployment of software upgrades</td>
<td></td>
</tr>
<tr>
<td>Upkeep/ modernisation of CAD-related hardware</td>
<td></td>
</tr>
<tr>
<td>Normal technical and production-related support tasks</td>
<td></td>
</tr>
<tr>
<td>Minimising or eliminating last-minute crises through planning</td>
<td></td>
</tr>
<tr>
<td>Ownership: RSM</td>
<td></td>
</tr>
</tbody>
</table>

**A0410 CADD Manual Table of Contents**

- A0410-01 Table of Contents
- A0410-02 Acknowledgements
- A0410-03 Glossary of Terms (01451-02 Building Glossary)
- A0410-04 Abbreviations (01451-03 Arch Abbreviation)
LEVELS UNDER THIS SECTION ARE AS FOLLOWS:

- A0410 Documentation Standards
- A0420 CADD Data
- A0430 Documentation Reviews
- A0440 Documentation Specifications
- A0450 Documentation Costing
- A0460 Documentation Meetings
- A0470 Documentation Consultants
- A0480 Documentation Administration
LEVELS UNDER THIS SECTION ARE AS FOLLOWS:

- A0510 Contractual Procedures
- A0520 Contractual Documentation
- A0530 Contractual Reviews
- A0540 Contractual Adjustments
- A0550 Contractual Costs
- A0560 Contractual Meetings
- A0570 Contractual Consultants
- A0580 Contractual Clerical
As a project proceeds, the types and extent of the information used by the various organisations involved will change. A listing of the most important information sets would include:

- Cash flow and procurement accounts for each organisation,
- Intermediate analysis results during planning and design,
- Design documents, including drawings and specifications,
- Construction schedules and cost estimates,
- Quality control and assurance records,
- Chronological files of project correspondence and memorandum,
- Construction field activity and inspection logs,
- Legal contracts and regulatory documents

LEVELS UNDER THIS SECTION ARE AS FOLLOWS:

- A0610 Contract Administration Inception
- A0620 Contract Field Observation
- A0630 Contract Admin Reviews
- A0640 Contract Admin Documentation
- A0650 Contract Admin Cost Control
- A0660 Contract Admin Meetings
- A0670 Contract Observation
- A0680 Contract Admin Clerical
LEVELS UNDER THIS SECTION ARE AS FOLLOWS:

- A0710 Post Construction Project Management
- A0720 Post Construction Documentation
- A0730 Post Construction Reviews
- A0740 Post Construction Design-Spec
- A0750 Post Construction Costing
- A0760 Post Construction Meetings
- A0770 Post Construction Cons Coordination
- A0880 Post Construction Administration

A1000 to A9000 SPECIAL SERVICES

This level is represented by the following headings. These activities are complex and are the subject of further research by the author.

- A1000 SPECIAL SERVICES & STUDIES
- A2000 MASTER PLANNING.
- A3000 RESEARCH.
- A4000 CUSTOM INTERIORS.
- A5000 GRAPHICS & ARTWORK.
In this example, Images required for inclusion in an architectural rendering are accessed from the element based CSI data base levels. Apart from the intuitive search path, search engines may be used to interrogate the data base and retrieve the desired image. Refer to sub-section 6.2 for a description of the CSI levels.

*Content example is as follows:* This is the result of search of the database for graphic elements required for an architectural rendering.

**01000 GENERAL DOCUMENTATION**

![Fractal GUI representation of the CSI level](image-url)

*Fig. 6.17 The Fractal GUI representation of the CSI level*

*Sections 7 will deal with the skills and tools necessary for effective knowledge management.*


3 ‘Fractal PC©’ version 2.0 by ‘Fractal Edge’ http://www.fractaledge.com/

4 Construction Specifications Institute (CSI) http://www.csinet.org/s_csi/index.asp


7. Knowledge Management Tools

According to the Harvard Business Review on Organisational Learning, Seely Brown and Duguid\textsuperscript{97} (June, 2000) describe reengineering and knowledge management as two profoundly different processes. Reengineering is about the structured coordination of people and information (a top-down process), while knowledge management is a bottom-up process, assuming that managers can foster knowledge by responding to the improvisational way in which people actually get things done. Despite this opinion, proper Knowledge Management can only take place if the two concepts are combined, i.e. KM and reengineering are seen to be part of the same process.

As illustrated in the previous chapter, an Architectural Practice could be defined as a ‘Matrix Organisation’\textsuperscript{98}, with multiple managers, multiple priorities, multiple projects and multiple role identities. Such an organisation requires the coordination and interaction of tasks, processes and input from different functional specialties. The Architectural process framework comprises stages ranging through Inception to Project Closeout – involving: Marketing and Public relations; Ongoing education; Design for analysis principles; Structured planning; Design for Component and Assembly methods; Quality function deployment; Project Management. The model presented can only be successfully implemented with the proper preparation, skill-sets and training and KM structuring provides a set of reiterative components that can be installed into existing systems.

7.1 THE KNOWLEDGE BASE SEED

The core concept or “Seed”, of the Knowledge base is resolved in a radial pattern of influences. This diagram can be conceptualised as having moving parts, with the circle spinning to create varying relationships (similar to a colour wheel).

Fig. 7.01 The defining factors in determining the Knowledge Base “Seed”.
KM Business Concepts in the Digital Age

*Key concepts in today's methods of doing business in the digital world are:*

♦ **PROCEED WHILE “UNDER CONSTRUCTION”**

Many of the experiments we see on the Web today are labeled "under construction." That's the accepted mode of work in the digital environment. You don't wait until everything is complete – but you rather get on-line quickly, sample customer response, and keep changing and improving based on demand and feedback. Knowledge Management relies on this type of interaction as the initial “spark” to generate innovation.

♦ **RAPID CHANGE**

In the Internet age we have seen not just rapid change, but a rapidly changing frame of reference, with major innovations in technology and also in how people use that technology.

♦ **SPEED**

Knowledge management in the Internet Age supplies the intelligence for improved decisions, enables rapid actions, reactions and responses, enables effective collaboration/intelligence gathering and provides the ability for companies and individuals to compete at speeds heretofore unknown.

♦ **ACCESS**

The internet provides a single point of access to all project information, whether document-based or system-based, across multiple groups.

♦ **GENERATION, FEEDBACK AND RENEWAL**

As organisations generate knowledge, they reinforce and renew themselves.

♦ **PROJECT COMMUNICATION**

Using the extended enterprise to effectively deliver programs ahead of schedule has introduced new collaboration and communication challenges. Organisations can no longer rely on casual conversations or impromptu meetings to discuss ideas and resolve issues. Bringing the extended team
together by traditional means is too slow and costly to meet the demands of today's competitive marketplace.
7.2 TOOLS OF EFFECTIVE KNOWLEDGE MANAGEMENT

The following factors form the essential tools of effective Knowledge Management and these identify the elements and skills that require development and consolidation within and enterprise. In order to introduce KM practice, this maps a strategic starting point for the creation of an action plan. (This list has been adapted from a paper by David Skyrme Associates.99)

**Culture/Structure**

Culture stands out as the key factor that determines success or otherwise with knowledge management. “How can you get people to share knowledge?” is a common complaint.

**Processes**

Knowledge processes need to be examined for their effectiveness at all stages of the knowledge life cycle - from creation through to use and exploitation.

**Explicit Knowledge**

Explicit knowledge is best managed by applying the core principles of information resources management (IRM). A commonly used model is that developed by Nick Willard:

- **Identification** - What information is there? How is it identified and coded?
- **Ownership** - Who is responsible for different information entities and co-ordination?
- **Cost and Value** - A basis for making judgements on purchase and use
- **Development** - Increasing its value or stimulating demand
- **Exploitation** - Proactive maximisation of value for money.

**Tacit Knowledge**

Tacit knowledge, by its very nature, is difficult to access, since by definition it is in people’s heads. There are two general approaches to managing tacit knowledge: 1) converting some of it into a more explicit form, through elicitation and articulation and 2) creating mechanisms such that informal knowledge exchange can occur when needed. Hence one of the management tasks is that of motivating and managing knowledge workers, so that they are innovative and readily share their knowledge.
Knowledge Hubs and Centers
Many organisations create knowledge centers as hubs of knowledge. A center aggregates knowledge that would otherwise be dispersed and lack critical mass. They act as a focal point for collection, structuring and disseminating knowledge. Often evolving from a department or corporate library, their responsibilities are much wider.

Market Leverage
Although many knowledge initiatives are focused on achieving organisational benefits (e.g. reducing duplication, improving processes) significant additional benefits can be achieved by seeking ways of exploiting knowledge externally. This can be in the form of improved products and services or knowledge-based products and services in their own right.

Measures
The identification of the different components that constitute intellectual capital, such as human capital, structural capital, and customer capital.

People/Skills
These questions assess the organisation's soft infrastructure. The human resources function has a key role to play in addressing this, for example through reward policies.

Technology Infrastructure
Information and communications technologies can significantly enhance knowledge activities. Paramount is the overall information and communications network that provides connectivity of people to information and other people. Collaboration software, such as that of document management systems, groupware, the intranet and now knowledge management suites are the most commonly found components of such an infrastructure.

7.3 DIGITAL TOOLS FOR KNOWLEDGE MANAGEMENT
Knowledge Management is a philosophy and a set of principles, rather than specific types of software. The various programs are merely used as tools and can be taken on or discarded as the need arises, after the necessary detailed analysis of requirements. The Knowledge Base can incorporate growth and change using a combination of digital tools and KM principles and an efficient data-base framework will contribute towards dynamic growth. Architecture is being launched into revolutionary representational and operational strategies by the computer age and the key elements in this revolution are: An 'Infinite' Knowledge base; New methodologies for Design, Conceptualization and Visualization; Changes in Presentation Techniques; New philosophies for Management and Documentation. Wenger and Snyder100 (2001) describe communities of practice as the “new frontier” in business and these communities are the heart and soul of knowledge management strategy, consisting of informal networks of people within an organisation and, on the larger scale within the profession. These communities require certain tools to assist the KM process.
Digital Tools to assist and enable the KM Process may be defined as follows:

<table>
<thead>
<tr>
<th>Tools for setting short term and long term Goals and Objectives.</th>
<th>Project Management Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced tools to study and Mine Data.</td>
<td>Search Engines</td>
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<td></td>
<td>Text Retrieval</td>
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<tr>
<td></td>
<td>Data Warehousing</td>
</tr>
<tr>
<td>Digital Communication Tools.</td>
<td>Extranets / Intranets / E-Mail</td>
</tr>
<tr>
<td></td>
<td>Groupware</td>
</tr>
<tr>
<td>Software for determining and establishing Flowcharts, Programs, Schedules, Checkpoints and Time restraints</td>
<td>Project Management Software</td>
</tr>
<tr>
<td>Tools for Assignment of Tasks and direction of Resources and Teams.</td>
<td>Project Management Software</td>
</tr>
<tr>
<td>Tools for Documentation of the project.</td>
<td>Computer Aided Design</td>
</tr>
<tr>
<td></td>
<td>Document Management Software</td>
</tr>
<tr>
<td>Management tools to automate Repetitive Tasks.</td>
<td>Groupware</td>
</tr>
<tr>
<td>Communication tools to reinforce Team Commitment, Collaboration and Work Management</td>
<td>Organisational Learning</td>
</tr>
<tr>
<td></td>
<td>Knowledge Organisations</td>
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<tr>
<td></td>
<td>Workflow Management</td>
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</tbody>
</table>

Information overload is a common problem in today's world, yet important information is acquired regularly and needs to be made available to those who can use it. Knowledge Management addresses this problem. Knowledge needs to be continually freshened for best practices to evolve. Knowledge acquired through knowledge management needs not only to be made available to individuals, but it needs to be integrated into software as knowledge support as well. These are some of the major themes in knowledge management software, some of which may interrelate and cross categories.

There are many software packages available for KM in an enterprise and these require analysis. A useful method of carrying out this analysis for decision making is as follows:
| Function | ACORDX | ADOBE | BROOKSON | BRAPP | CHILDS | DOMINO | EXPBASEDBS | ICAM | ICETEAMWORKER | INGITE | JAVABE | JSP | ORACLE | ODIGO | OUTLOOK | PLUMTREE | RAVEN | RETRIEVAL | SEMIO | THIRD VOICE | VERITY | VERITAS | WEBLOGY |
|----------|--------|-------|-----------|-------|--------|--------|------------|------|--------------|--------|--------|----|--------|-------|---------|---------|-------|------------|-------|-----------|-------|----------|--------|---------|
| Cataloging |        |       |           |       |        |        |            |      |              |        |        |    |        |       |         |         |      |            |       |           |       |          |        |         |
| Classification |        |       |           |       |        |        |            |      |              |        |        |    |        |       |         |         |      |            |       |           |       |          |        |         |
| Association |        |       |           |       |        |        |            |      |              |        |        |    |        |       |         |         |      |            |       |           |       |          |        |         |
| Content Storage |        |       |           |       |        |        |            |      |              |        |        |    |        |       |         |         |      |            |       |           |       |          |        |         |
| Presentation |        |       |           |       |        |        |            |      |              |        |        |    |        |       |         |         |      |            |       |           |       |          |        |         |
| Publication |        |       |           |       |        |        |            |      |              |        |        |    |        |       |         |         |      |            |       |           |       |          |        |         |
| Retrieval |        |       |           |       |        |        |            |      |              |        |        |    |        |       |         |         |      |            |       |           |       |          |        |         |

The matrix above represents the technological resources available for Knowledge Management (KM) functions. Each cell indicates the presence or absence of a technology for a specific function.
7.4 INFORMATION COLLECTION, STORAGE & ACCESS

Extranet

An extranet is a private network that uses the Internet protocol and the public telecommunication system to securely share part of a business's information or operations with suppliers, vendors, partners, customers, or other businesses. An extranet can be viewed as part of a company's intranet that is extended to users outside the company.

Data Collection

Data collection involves the following essential elements:
- Mining and Data Input
- Cataloguing
- Classification
- Abstraction and Association
- Presentation
- Publication
- Retrieval
- Reiterative “Loop-Back Spiral” for constant refinement.
- Content Storage
KM TOOLS - CHAPTER SEVEN

Fig. 7.04. The Content Management Seed

♦ Content and Storage Management

Multiple Axes and Information

“Receptacles” enable Knowledge Management. The Structural Content and Classification Components include the following:

Direct (Archival) Data Management.
Indirect (Catalogue) Data Management.
Reference Data and Relationships for unique structured tags (Taxonomy)
Loopback spirals defining relationships.
Automated Storage and Regeneration of data.
Security of Data
Backup Processes

♦ Data and Resource Classification

♦ ORGANISING INFORMATION IN DATABASES

Hendrickson101 (1998) writes that given the bulk of information associated with construction projects, formal organisation of the information is essential so as to avoid chaos. Database managers enable formal, computerised databases for even small organisations and projects. A database is a collection of stored operational information used by the management and application systems of some particular enterprise. This stored information has explicit associations or relationships depending upon the content and definition of the stored data, and these associations may themselves be considered to be part of the database, as illustrated in the following diagram.
A manager need not be concerned with the details of data storage since this internal representation and manipulation is regulated by the Database Manager Program (DBM). The DBM is the software program that directs the storage, maintenance, manipulation and retrieval of data.
7.5 IMPLEMENTATION OF THE MODEL

The following is an effective strategy for the introduction of a Knowledge Management system into an Architectural Enterprise. For an alternative view of an architectural KM work process, see M. G. Taylor’s “10-Step Knowledge Management”.

Fig. 7.07 The Phoenix Fractal and the 7-step process

### Seven Step KM Implementation

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Research</td>
</tr>
<tr>
<td></td>
<td>Research historical processes in order to enable a qualitative evaluation.</td>
</tr>
<tr>
<td></td>
<td>Research the culture, nature, and environment of the organization.</td>
</tr>
<tr>
<td></td>
<td>Summarise the mission statement or statements of the organization.</td>
</tr>
<tr>
<td>2.</td>
<td>Evaluate</td>
</tr>
<tr>
<td></td>
<td>Evaluate the research results.</td>
</tr>
<tr>
<td></td>
<td>Diagram and catalog the business processes in the firm, both manual and automated.</td>
</tr>
<tr>
<td></td>
<td>Inventory the existing automation facilities and practices.</td>
</tr>
<tr>
<td>3.</td>
<td>Visualize</td>
</tr>
<tr>
<td></td>
<td>Visualize the automated organisation and its processes.</td>
</tr>
<tr>
<td></td>
<td>Map out stages for achieving goals.</td>
</tr>
<tr>
<td></td>
<td>Visit more progressive firms who might serve as models; invite their people to speak to the staff.</td>
</tr>
<tr>
<td>4.</td>
<td>Enlighten</td>
</tr>
<tr>
<td></td>
<td>Interview individuals to assess personal opinions.</td>
</tr>
<tr>
<td></td>
<td>Openly discuss the unspoken issues of personal fears.</td>
</tr>
<tr>
<td></td>
<td>Brainstorm approaches for avoiding the effects that frighten people.</td>
</tr>
<tr>
<td></td>
<td>Reinforce the concept that a digital knowledge base is the wave of the future, and one which will enable them to build their expertise.</td>
</tr>
<tr>
<td></td>
<td>It is important that the staff has an opportunity to “buy into” the proposals – ownership of the process is essential.</td>
</tr>
<tr>
<td></td>
<td>Establish the concept of collaborative teams, reinforced by information flow.</td>
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<tr>
<td>5.</td>
<td>Educate</td>
</tr>
<tr>
<td></td>
<td>Isolate and “plug” knowledge gaps for staff.</td>
</tr>
<tr>
<td></td>
<td>Plan and implement education and training courses.</td>
</tr>
<tr>
<td></td>
<td>Shift knowledge workers into high-level thinking -- to turn passive data into active information - a new level of information analysis that enables knowledge workers.</td>
</tr>
</tbody>
</table>
6. Implement

Evaluate available systems.

Look beyond cost -- to the future in choosing a system -- try to determine future trends.

Choose systems that allow regular and constant upgrading -- the older approach of only upgrading every few years has many pitfalls in today's culture of rapid development.

Choose and implement appropriate processes and systems.

Establish Web sites, Intranets, and facilities for bringing everyone up to date.

Convert old processes to paperless digital processes.

Build time based controls into every process to achieve just-in-time delivery.

7. Review & Reengineer

Create a method for a reiterative feedback loop, with in-built re-evaluation processes.

Reengineer processes constantly, even if one has to return to the start.

7.6 KM STRUCTURE AND ACCESS

Structure, Assignment of Ownership and Responsibility

The first principle encouraging of ownership is to recognise all workers as knowledge workers within the system and identify the 'owner/s' of critical information; Encourage communication and 'communities of interest' among employees; Provide an effective means of sharing information; and provide Support.

In a centralised ownership model, there is a single person or Workgroup responsible for all data ownership for the entire enterprise, whereas a de-centralised model will require one coordinating group to maintain common standards and quality control.

The most effective way of sharing knowledge is via an Intranet structure and the enterprise's operational structure can establish a hierarchy of access permissions for information according to the sensitivity thereof.

- An organised Intranet structure will save significant time in locating and accessing information.
- Individual directories for all workgroups should be contained within the Intranet at the appropriate level.
- Each workgroup should maintain an index/file or ‘HomePage’ on the Intranet and the maintenance thereof is the responsibility of that group.
- The author/owner’s contact details (e-mail or homepage link) should be clearly notes on each document. This information can be contained in the “Properties” field of each document.
- Sharing of information is made possible via hyperlinks.
Access to Information

Using the various tools previously described, all Staff can have access to all relevant information at their desktop, with all changes being immediately accessible as soon as they are made. All information can be cross-referenced to related information and continuous improvement should be part of the reiterative loopback process, as follows:

- *Access document.*
- *Re-check data contained in document.*
- *Refine (and combine) document and apply to new situation – combining actions if possible.*
- *Save under a new version number – if the original is to be kept.*
- *Add notes regarding performance feedback- to use to improve the next iteration of the document.*

Format, Standards, Quality and Rules Management

It is necessary to create an 'environment' that acknowledges and embraces change and improvement. The reiterative process includes rules for upward re-cycling and improvement of the data. A document becomes outdated almost immediately after its first use. Because the source file (electronic or “soft” copy) can be amended, if only to change grammar, punctuation, format or the addition/deletion of content, it should always be considered the most current version. The electronic version retains the highest level of validity as it can be amended, re-formatted, added to, and adapted to suit the latest circumstances. A hierarchical process for version control can be implemented.

When information is shared, agreement is required as to the format for that data and that format is defined as a data standard. The owner is also responsible for making sure that all relevant data sets conform to their standard form, as well as negotiating standards on behalf of the users. The Standards adopted must also include a quality component to ensure the integrity of the data. All data processes incorporate rules for application and these include checking and validity procedures.

Database Backup and Security

Architects today transmit and record information in both paper and digital forms. Besides CAD files, digital data includes e-mail correspondence, project spreadsheets, and construction administration documents. And though we are still far from a paperless process, the role of paper is now significantly different. It is often no longer the "original" but now only a temporary medium that represents just another "copy". All
architectural data can be reduced to an electronic medium and this should include all communication media, including e-mail correspondence, telephone calls, and fax transmissions. Non-digital media can be scanned or photographed and include in the electronic archive.

Enterprises today require Security, Backup and Recovery solutions that offer maximum reliability while also supporting full productivity and efficiency. But to achieve both of these goals companies must address an age-old dilemma - preventing data loss during backup due to open files.

The principle of backing up is critical to security. Backing applies to all KM activities, not only electronic and it is a fundamental principle which is often neglected with disastrous consequences. Where a single “bit” of hard-earned knowledge is reduced to a single copy, whether electronic or otherwise, the system becomes vulnerable. For this reason, “Backup” becomes an essential part of the Reiterative Fractal Formula.

♦ STORING AN ARCHIVE

An architectural enterprise requires at the very least a two-stage archiving plan. The first stage would encompass all the documents needed to fulfil legal obligations. State law in the United States usually includes a "Statute of Repose" that limits the length of time after project completion during which most construction professionals can be sued. Most statutes specify a range from six to ten years, which is a good one to set for the first-stage, comprehensive documentation. At the end of this time, documents can be archived into a final historical archive used for reference only.

A second archival process can be via various digital media, including the many affordable options available for online storage at various Internet sites. The most important caveat with that option is to find a reputable site that has a chance of still being in business in 10 or 20 years. It is important that at least one of the backup copies is securely kept off-site.
7.7 CASE STUDY

E.T. Boggess Architects, Inc.
101 Rockledge Ave • Princeton, WV • 24701
Phone: (304)425-4491
http://etbarchitects.com/

The author is currently employed at ETB and on learning of the direction of the author's dissertation study, a mandate was given by the principles of this company to introduce the model proposed in this dissertation.

Time does not allow a full case study of the results of implementation of the KM model, but this will be the subject of ongoing study.

E. T. Boggess, Architect, Inc., is a full-service architectural firm whose full range of services includes:

- Architectural Planning and Design
- Site Evaluation and Master Planning
- Interior Design and Space Planning
- Feasibility Studies
- Computer Visualisation and Imaging
- Construction Observation
- ADA Compliance Evaluation

Structure

Mr. Ted Boggess is Chairman of the Board and is responsible for business development, marketing activities, and design document review.

Todd Boggess is President and is responsible for design development, project management, supervising the office staff, and the overall management of the corporation.

The staff of 10 consists of project architects, project managers and technical staff in architecture, mechanical engineering and structural engineering. Leadership in the projects varies depending on the skills required, but all are directly responsible to the president.
**History**

E. T. BOGGESS ARCHITECT, INC., was established by E. T. "Ted" Boggess in January, 1966, in Princeton, West Virginia. ETB has accomplished commissions for many different types of buildings in locations throughout 12 states and 1 foreign country.

**Projects**

The company has carried out a variety of projects including:

- Commercial
- Governmental
- Recreational
- Educational
- Religious
- Residential - Single and Multifamily
- Senior Housing - Retirement and Assisted Living
- Historical Renovations and Recreations

**Mission Statement**

- Dedicated to knowledge sharing and collaboration
- The company’s policy is to remain the forefront of the industry, utilising computer aided design and 3D visualisation programs, photorealistic imagery, computer modelling, and digital photography.

**Processes already in place**

The practice already utilises many innovative processes and is particularly oriented towards new and innovative systems to improve efficiency and ROI. There is a high level of ethical awareness of the value of quality, community and environmental responsibilities and the range of projects already completed attests to this.

Certain elements of the ‘Work Matrix’, such as the Computer Aided Design manual and certain documentation protocols have already been introduce in an embryonic format. Work process, templates and ‘Project Extranets’ have been used for over a year and much feedback (mainly positive) has been received from client, consultants and participants.
Interviews

See Addendum 2 for the interviews carried out.

A number of interviews, both formal and informal, were held in order to introduce the concept of this model and to get feedback before the full installation of the model into ETB work practices. The participants in these interviews were all connected to ETB Architects, either members of the enterprise, consultants, or clients. Due to the fact that aspects of the KM model proposed in this thesis have already been partially introduced, some informal feedback has already been obtained, both positive and negative and some of these informal responses are listed in the table below.

<table>
<thead>
<tr>
<th>Positive feedback</th>
<th>Negative feedback</th>
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</thead>
<tbody>
<tr>
<td>Interest in being able to tap into the “Knowledge Vault” and increase efficiency and the learning rate.</td>
<td>Fear of loss of Intellectual property.</td>
</tr>
<tr>
<td>The new system represents many the latest philosophies of modern practice – the opportunity was welcomed to “stay ahead of the game.”</td>
<td>Resentment of the introduction of a new system as opposed to “how we have always done it.”</td>
</tr>
<tr>
<td>Understanding of the reiterative process, with templates and recommended practices helped cushion the negative “book of rules” fear.</td>
<td>Reservation about the restrictions of a “Book of Rules” – seen as a loss of freedom.</td>
</tr>
</tbody>
</table>

Implementation

The proposed model is now being introduced in accordance with the “Seven Step KM Implementation” process proposed in this chapter. Results of this implementation will be subject to ongoing analysis and, hopefully, proof of success reflected by constantly improving profitability, efficiency, and staff satisfaction.

7.8 CONCLUSION

By now, most Architectural professionals realize the inevitability of the change that the information age has imposed onto traditional processes. The management and sharing of tacit and explicit knowledge promotes the search for excellence and by fostering the development of Knowledge Communities at a local, national and international level, the profession can only benefit.

According to the American Institute of Architects\textsuperscript{106}, Knowledge communities are groups of people who share common challenges, opportunities or a passion for a given topic, and who collaborate to deepen their
understanding of that topic through ongoing learning and knowledge sharing. The AIA, as do the architectural institutes in other countries, offer guidelines for “best practices” and these are usually offered through digital extranets for use by members and the public.

Quality Management

The case for Knowledge Management and the adoption of a model such as the one proposed in this thesis, is supported by the expansion of many enterprises into the international market and the need for international certification, such as ‘ISO 9000’ to facilitate this expansion. Knowledge Management forms an essential part of Quality Management certification.

ISO 9000 Certification

The purpose of ISO 9000\textsuperscript{107} is to ensure that an enterprise meets with certain Quality, Ethical and Customer requirements, and continue to improve these standards. In order to achieve ISO 9000 certification, an enterprise is required control the quality of certain aspects of the business, including.

- Customer focus
- Leadership
- Provision of appropriate resources (infrastructure, personnel, equipment, etc)
- Involvement of people, Staff training etc.
- The planning of the Processes required to carry out the service
- System approach to management
- Continual improvement
- Factual approach to decision making
- Mutually beneficial supplier relationships, purchasing and procurement activities.

In order to achieve this international standard, the organisation is required to keep records of certain activities such as design and production processes, Process Manuals (e.g. a CADD manual) reviews of Customer relationships, records of staff training, etc. A written (printed or in electronic format) set of procedures which describes how an activity is conducted (such as Control of documents, Internal Quality Auditing, etc) becomes evidence of these measures and will facilitate ISO 9000 certification, enabling an architectural enterprise to begin seeking work internationally – bearing in mind that local regulations and codes will also have to be complied with.

Future Development of KM in Architecture

Verna Allee\textsuperscript{108} (2003) writes that the better we comprehend our organisations with a whole-system perspective, the more likely we will be to create workplaces that are good for business, people and the planet.
She writes “We come together in purposeful organisations to manifest our dreams. An endless cycle turns as we dream, create, experiment, and then dream again.”

In the Digital Age, it is necessary to implement a KM process to deal with constant change and adaptation and this can be achieved by means of continuous renewal or reiterative process -- one that acknowledges the inexorable rate of technological progress. The implementation of an effective plan for Knowledge Management releases the power of the digital age and enables a company to maintain its edge in ever-increasing competition. By adopting a model such as the proposal in this dissertation, architectural enterprises can achieve this goal with out fear of redundancy caused by outdated practices.

8 Addenda

- Addendum 1: Content of the Enterprise Procedural Manual
- Addendum 2: Project Websites
- Addendum 3: Interviews


102 Project Management Publication -
http://www.ce.cmu.edu/pmbook/14_Organization_and_Use_of_Project_Information.html

103 Project Management Publication -
http://www.ce.cmu.edu/pmbook/14_Organization_and_Use_of_Project_Information.html

http://www.mgtaylor.com/mgtaylor/glasbead/tenstep.htm


107 ISO 9000 International Organization for Standardization (ISO) http://www.iso.org