Engineering Management
Field Project

The Interactive Knowledge Library: Capturing, Sharing and Synthesizing Tacit Knowledge in Engineering

By

Craig M. Eaton

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_____
Charles Keller
Committee Chairperson

_____
Craig Connell
Committee Member

_____
Tim Wilcoxon
Committee Member

Date accepted:_____

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Executive Summary

The Interactive Knowledge Library is a place to capture, share and synthesize tacit and explicit knowledge. While explicit knowledge (or 'know what') is useful, it is tacit knowledge (or 'know how') that is the quintessence of knowledge, from which there is the most to be gained by sharing. The Interactive Knowledge Library provides a medium through which knowledge is expressed by enabling data and information to be set into context. A Wiki environment (e.g. www.wikipedia.org) is the best information technology solution currently available in order to enable the Interactive Knowledge Library concept. Capturing and sharing knowledge is achieved within the same tool, without any dedicated knowledge management organization. Contributions can be made, knowledge refined, corrections made and issues discussed anytime from any network location. The contributions can be iteratively improved and added to as users gain more knowledge. This collaborative conversational approach to knowledge management has the potential to enable better than linear knowledge growth.

The Interactive Knowledge Library is not intended to replace other knowledge management initiatives but to complement them. The library will provide a major step forward in knowledge management by enabling open exchanges of knowledge to be recorded in an organized framework, allowing any user to easily retrieve this knowledge in the future on an ad-hoc basis, using minimal resources.

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Chapter One

INTRODUCTION

The initial idea for this paper came about as a result of a conversation the author had with the former president of a division of a major engineering company. When asked what would be a good Engineering Management project, his response was simply 'If only we had some way to capture all our knowledge.' Following this conversation got the author thinking about capturing knowledge and the field of knowledge management.

At this time the author was preparing proposals for the latest generation of coal fired power plants. Very few coal fired power plants were built in the United States between the late 1980's through to the early 2000's. While it is true some were designed for the international market, the market resurgence has still revealed a gap in the knowledge of today's engineers especially in the expectations of utilities which are still somewhat set by the plants built in the 1970's and 1980's. The author has found that although the engineers who were around at the time of the previous generation of plants remember the big picture issues, the knowledge behind many of the finer points are lost and are having to be recreated. Even though the project documents for the projects in years gone by still exist, they do not tell you, at least in any easily retrievable form, any of the background as to why the solutions used were selected. Increasingly the author looked at current problems along with past solutions in his daily work and found that while the knowledge was in most cases there to be found, it could take considerable time and require networking with multiple sources to piece it together.

Initial thoughts of solutions were along the lines of discussion boards, however the concept of a Wiki was introduced in a class taught by the project committee chair. While this was not quite a Eureka moment, the authors concept of discussion boards evolved into using Wikis in order to allow collaboration on meaningful texts to transfer knowledge, rather than the fragments of knowledge likely to be exchanged in a discussion board forum. Wikipedia (www.wikipedia.org), the internet's largest Wiki site and 'a Web-based free-content multilingual encyclopedia project (Wikipedia 2006, http://en.wikipedia.org/wiki/Wikipedia)' is after all fundamentally a vast knowledge sharing tool.

In discussion with the staff of the Chief Information Officer's department at the author's company the discussions regarding knowledge management introduced the author to the concept of tacit knowledge, which the author identified as exactly the type of knowledge that is most inadequately recorded by current engineering records and practices. This paper will discuss the concept of tacit knowledge, it's significance to engineering knowledge management and why it is so essential to capture it. The concept of using a Wiki as a tool for both capturing knowledge and sharing it will be examined. The final part of the paper will examine the organization required to successfully develop and maintain an ordered data structure.

Many texts on knowledge management are very theoretical (bordering on crossing into psychology), here the intent is to stay very much with practical concepts. The ultimate aim of this paper is to reveal the potential and demonstrate the feasibility of using a Wiki as a practical engineering knowledge management tool at the corporate level.

Chapter Two

LITERATURE REVIEW

Knowledge Management and Tacit Knowledge

From the Merriam Webster Online dictionary (www.m-w.com accessed 16th Sep 06) knowledge is defined as:

***2 a** (1) **:** the fact or condition of knowing something with familiarity gained through experience or association (2) **:** acquaintance with or understanding of a science, art, or technique*

Knowledge Management makes definitive distinctions between knowledge, information and data. Nonaka and Takeuchi (1995) compare knowledge and information as follows:-

- Knowledge unlike information is about beliefs and commitment, a function of a particular stance, perspective, or intention.
- Knowledge unlike information is about action. It is always knowledge "to some end."
- Knowledge like information is about meaning. It is context-specific and relational.

Data is yet lower in the hierarchy and can be defined as 'Quantities, descriptions, identifiers, words or other representations without context or meaning' (Voeller 2002). In simplistic terms, information is data with context and knowledge is information complete with understanding of its meaning and implications.

The practice of managing knowledge has been going on for centuries or even millennia, although not referred to as knowledge management as such. The skills of hunter gatherers and later farmers were passed from generation to generation. Through the centuries apprentices in a broad spectrum of trades have learned their trade through

verbal or written knowledge transfer and also from observation and practice. As such knowledge management is at the core of what we are as a civilization.

In a retrospective look at the origins of the field of knowledge management Prusak (2001) states the intellectual antecedents as being economics, sociology, philosophy and psychology. In the creation of practical implementation, Prusak goes on to say that much of the content and energy has been influenced by information management, the quality movement and the human factors/human capital movement. Knowledge Management does not appear to have been created in a distinct eureka moment as such but rather to have evolved through the confluence of several fields of study. The identification of Knowledge Management as a distinct field of study can be traced to the first conference dedicated to it in Boston in 1993 (Prusak 2001).

The field of Knowledge Management as we now know it, has evolved through the influences of psychology, management science and information technology (Prusak 2001). Skeptics state that Knowledge Management was born from the waning field of re-engineering (Prusak 2001) by consultants in need of a new product to ply.

The modern economy is undoubtedly increasingly knowledge based. The phrase 'knowledge is power' dates back at least to English philosopher Francis Bacon's '*Meditationes Sacrae'* of 1597 (Wikipedia, http://en.wikipedia.org/wiki/Knowledge_is_power accessed 16th September 2006) but has grown significantly in meaning since those times. This is the topic of Drucker's 'Post Capitalist Society' (1993) in which he argues that the western developed nations have moved away from the capitalist society which dominated through the end of the 19th century, through a period dominated by the industrial worker and charts the rise of the

knowledge worker since World War II. In the modern global economy where increasingly knowledge is the product or at least a product requiring significant knowledge is involved, it seems prudent to actively manage and develop the knowledge asset.

The distinction between tacit knowledge or 'know how' and explicit knowledge or 'know what' was first made by Aristotle (Prusak 2001). Although this distinction seems to have been virtually forgotten in modern times until revived by chemist, economist and philosopher Micheal Polanyi in 'The Tacit Dimension' (1966) and associated works. Polanyi's works like the later works of Drucker were inspired by the impact knowledge has on the economies and societies. The most referenced comment from Polanyi's work is '… *we can know more than we can tell'*. In 'The Knowledge Creating Company' (Nonaka & Takeuchi 1995) the successes of Japanese companies are attributed to a culture of nurturing knowledge. In the process of this examination, Polanyi's concept of tacit and explicit knowledge is revisited and redefined in the context of knowledge management as it was then developing as follows:-

Explicit Knowledge can be expressed in words and numbers, and easily communicated and shared in the form of hard data, scientific formulae, codified procedures, or universal principles.
Tacit knowledge is highly personal and hard to formalize, making it difficult to communicate or share with others.

Nonaka & Takeuchi's view is that western management traditions emphasize explicit knowledge whereas Japanese management views explicit knowledge as only the tip of the iceberg with the majority of knowledge being of the tacit type. Under Polanyi's concept of tacit knowledge it cannot be captured and shared, Nonaka and Takeuchi's concept is

that tacit and explicit knowledge are not separate but mutually complementary entities. They go on to state that their '… *dynamic model of knowledge creation is anchored to a critical assumption that human knowledge is created and expanded through social interaction between tacit knowledge and explicit knowledge*.' The processes of converting knowledge are further defined as socialization (tacit to tacit), externalization (tacit to explicit), combination (explicit to explicit) and internalization (explicit to tacit).

Davenport and Prusak (1998) refer to the process of capturing knowledge as 'codification'. In their model codification is a formal attempt to capture very specific aspects of corporate knowledge of both the tacit and explicit type. They conclude that the best way to capture truly tacit knowledge (or in effect sensemaking) is through telling a story. They include a quote as follows:-

The answer is . . . something that preserves plausibility and coherence, something that is reasonable and memorable, something that embodies past experience and expectations, something that resonates with other people, something that can be constructed retrospectively but also can be used prospectively, something that captures both feeling and thought, something that allows for embellishment to fit current oddities, something that is fun to construct. In short, what is necessary in sensemaking is a good story. (Weick 1995)

The concept of embedded knowledge is added by Davenport and Prusak. Here tacit knowledge is externalized through it's incorporation into a work product. They go on to state that it can be difficult to distinguish between tacit knowledge embedded in a process and that which keeps the process going.

The Circle of Knowledge: A Guide for Bringing Knowledge Management to Your Business (Voeller 2002), pulls together knowledge management concepts and divides knowledge management activities into the following types :-

OnGoing - Current knowledge peers need to coordinate each other's efforts
ReUse - Historical knowledge that can be reused to make subsequent work cheaper, faster or clearer.
Best Practice - A repository of corporate preferred methods of accomplishing certain tasks or functions in a low-risk, high quality manner
Lessons Learned - A repository of ideas and observations about the best method for accomplishing key tasks or handling situations
Expertise Management – An easy method for finding the right person with the right knowledge quickly
External Dependent - Knowledge from authoritative sources such as codes, standards and legal authorities
External Relational - Knowledge from customers and other stakeholders that is current and will guide others on best approaches to build or sustain mutual relations

There are very few texts specifically related to knowledge management in an engineer/architect firm. One which does focus on this are is CoMem (Demain 2004), short for Corporate Memory, building on the ProMem system for projects (Fructer et al. 1998). This is a knowledge management tool specifically aimed at the engineer-architect business and presents a solution for presenting and searching for reuse of designs and the knowledge therein by setting designs and the histories thereof in context. The larger part of the effort required for knowledge management is capturing and documenting the knowledge, CoMem however does offer any new solutions for this knowledge capture.

Wikis and Wikis for Knowledge Management

The first Wiki, WikiWikiWeb was developed by Ward Cunningham in 1994 to assist in software development. The WikiWikiWeb or Portland Pattern Repository was the very first Wiki which is still in operation today (http://www.c2.com/cgi/wiki?WelcomeVisitors). This site is dedicated to :

'People, Projects and Patterns in Software Development. It is home to an informal history of programming ideas as well as a large volume of material recording related discourses and collaboration between its readers.'

The name is derived from the Hawaiian native language:

'Wikiwiki (stative verb). Fast, speedy; to hurry, hasten; quick, fast, swift.' (Leuf & Cunningham 2001)

Ward called it "the simplest online database that could possibly work". In 1994, he wanted a quick way to collaboratively publish software patterns on the Web. Ideas that had developed from his work with the program development and HyperCard stacks went into it, and the first "wiki server" was born. (Leuf & Cunningham 2001)

A Wiki is described as a '*collaborative server technology that enables users to access, browse, and edit hypertext pages in a real-time context*'. (Leuf & Cunningham 2001)

The most popular Wiki is undoubtedly Wikipedia, which as of 10th September 2006 has 1,377,326 articles in the English language version alone (http://en.wikipedia.org/wiki/Special:Statistics?uselang=en). Wikipedia is a Web-based free-content multilingual encyclopedia project (http://en.wikipedia.org/wiki/Wikipedia). The success of this Wiki has even inspired many other Wiki's on the World Wide Web (see http://en.wikipedia.org/wiki/List_of_wikis) including even its own parody Uncyclopedia (www.uncyclopedia.org) the content-free encyclopedia.

Wikipedia went online on 15th January 2001 as a complement to the Nupedia project. The Nupedia project was also a free-content encyclopedia project but unlike Wikipedia articles, were written by experts complete with peer review. Nupedia ran from March 2000 to September 2003, in that time only 24 articles were completed with 74 in

progress at the time of its demise. (http://en.wikipedia.org/wiki/Nupedia accessed 17th Sep 2006). The success and momentum of Wikipedia and the slow progress of Nupedia led to Wikipedia becoming the dominant project.

There is much discussion, positive and negative criticism of Wikipedia and the Wiki model of authoring. The common theme across the reviews appears to be that the open-source and open editorship of style of the Wiki is both Wikipedia's strength and its weakness. Unquestionably edits are made to Wikipedia which are false, unintentionally and on occasion intentionally as a hoax, in jest or to defame someone of stature (just search for 'Wikipedia: hoaxes' to see a sample list, defamatory articles are deleted by Wikipedia's policy however). Most entries are however made with good intent.

The most frequently quoted and most comprehensive study of the actual accuracy of Wikipedia was performed by the journal Nature (http://www.nature.com/nature/journal/v438/n7070/full/438900a.html accessed 9th Jul 06). Nature selected 50 scientific articles from both Wikipedia and Encyclopedia Britannica for review by experts in the field. Of the 50 articles 42 usable responses were used for the article. The article went on to say –

'*Only eight serious errors, such as misinterpretations of important concepts, were detected in the pairs of articles reviewed, four from each encyclopaedia. But reviewers also found many factual errors, omissions or misleading statements: 162 and 123 in Wikipedia and Britannica, respectively.*' (http://www.nature.com/nature/journal/v438/n7070/full/438900a.html accessed 9th July 2006).

The implication from the article is therefore that Wikipedia is not perfect but there again neither are the expensive commercial print encyclopedias. On balance Britannica did perform better than Wikipedia but then you could argue you would expect it to since users are required to pay for using Britannica whether in online or print form.

Unsurprisingly Encyclopedia Britannica objected to the article and published an at length response and attempted to get Nature to retract the article (http://corporate.britannica.com/britannica_nature_response.pdf accessed 9th July 2006). Nature, however stood by it's article (http://www.nature.com/nature/britannica/index.html accessed 9th July 2006).

Wiki's have been billed most frequently as a collaborative tool, however it can be seen that knowledge is captured and shared through the process of collaboration, along with the ideas and communications. An example of a Wiki used for knowledge management is at TakeFive Software, where a Wiki was used to create a knowledge base for the support engineers (Leuf & Cunningham 2001). Even Microsoft now has a Wiki in a similar application on its developers page for sharing of bugs, suggestions and help them improve their documentation (see http://msdnwiki.microsoft.com/en-us/mtpswiki/default.aspx).

Since most Wikis are intended primarily to aid collaboration, most of the literature discusses them in this nature and not in the context of a true knowledge management tool. The strongest case made for a Wiki specifically as a knowledge management tool is presented in the paper Wiki: A Technology for Conversational Knowledge Management and Group Collaboration (Wagner 2004). In this paper Wagner concludes that a Wikis are highly relevant to knowledge work that allows many-to-many type conversational exchanges while leaving behind a knowledge catalog. Fichter (2005a & 2005b) repeats this theme. Judging by the number of papers written Wikis for specifically as a knowledge management tool appear to be popular amongst research

librarians as evidenced by the papers by Stover (2004) and Kille (2005). Drakos et al (2004) also seem to recognize the potential for a Wiki for knowledge management.

Organizing and Maintaining a Wiki

Leuf and Cunningham (2001) provide some guidance as to when to provide 'seeding' of a Wiki. Seeding is to provide an initial set of pages in the Wiki for users to contribute to and branch off from. Seeding can also include establishing template pages. Seeding is a common theme in discussions for implementing Wikis and the subject of the paper by Haake, Lukosch and Schümmer (2005).

Advice for operating and maintaining a Wiki can be found in Leuf & Cunningham (2001) and Burton, Know & Drakos (2004). Fichter (2005b) introduces the concept of a 'gardener' to maintain the Wiki. Wikipedia also contains extensive policies and guidance for editing and ongoing page improvement projects which can be related to the corporate environment.

Chapter Three

Why Capture Tacit Knowledge?

Traditional Engineering Knowledge Management

To determine the need for tacit knowledge management firstly requires examination of the typical experience of dealing with knowledge of an engineer in an architect/engineer setting. The discussion centers on the author's own experience in engineering power plants but is likely to be equally applicable to other fields. A fresh out of university graduate engineer who to a great extent has knowledge of principals but not of practice is usually assigned to a supervisor/mentor with at least several years experience. When the supervisor assigns tasks to the new engineer it is usually accompanied by instructions either specifically telling the engineer how to go about executing the task or referring the engineer to resources to allow them to access enough data, information and knowledge to complete the task. Often the engineer will be in doubt as to how to complete the task and will have to ask the supervisor question in order to gain the knowledge.

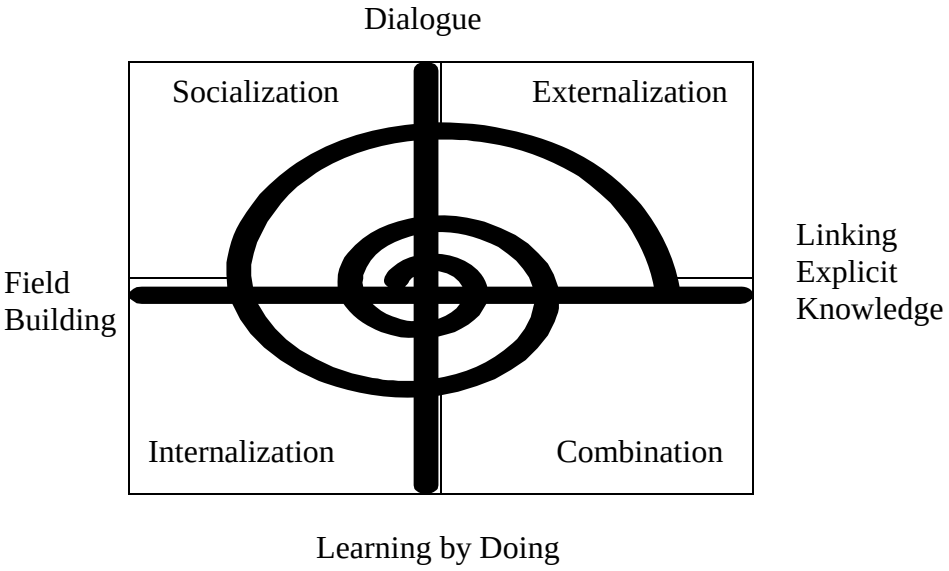
The supervisor or experienced engineer in their own work will largely rely on their own internalized knowledge in solving problems and advising their subordinates. As the engineer becomes more experienced there will come a time when the supervisor does not readily know the answer to a reasonable question the engineer is asking. Then the engineer or the supervisor will likely use the social network within the office amongst peers and superiors. For some topics there may be a corporate expert or someone identified as being knowledgeable about the issue. A chief engineer or his staff may also

be useful in assisting finding the resources needed. Especially for complex issues or ones not frequently encountered it may take talking to multiple individuals to piece together the 'distributed' knowledge to solve the problem. Sometimes for an unfamiliar problem the distributed knowledge fragments obtained are not actually sufficient to solve the problem but may be sufficient that the engineer can come to their own conclusions using other people's thoughts to assist or as a sanity check.

Throughout the above discussion the knowledge transfer can be in multiple forms both tacit and explicit, since it is interactive. Nonaka and Takeuchi's (1995) concept of the knowledge spiral using socialization, externalization, internalization and combination can freely take place, since the medium for knowledge transfer in social interaction can be conversational, written, pictorial, physical demonstration or metaphorical. These concepts are defined as follows:

- Socialization (tacit to tacit) – a process of sharing experiences and thereby creating tacit knowledge such as shared mental models and technical skills.
- Externalization (tacit to explicit) – a process of articulating tacit knowledge into explicit concepts (using metaphors, analogies, concepts, hypotheses, or models as appropriate).
- Combination (explicit to explicit) – a process of systemizing concepts into a knowledge system (i.e. combining different bodies of explicit knowledge).
- Internalization (explicit to tacit) – a process of embodying explicit knowledge into tacit knowledge.

Figure 1: ***The Knowledge Spiral (Nonaka & Takeuchi 1995)***



The Need for Improved Knowledge Management

Conversational knowledge transfer is certainly the most efficient in transferring knowledge directly from one individual to another; it can however be inefficient in that it requires the knowledgeable individual or multiple individuals to be available to take part in the interaction. Also the knowledge transfer is not usually recorded such that the same knowledge may over a period of time need to be transferred from one individual to others on multiple occasions. Retrieving distributed knowledge by social interaction is particularly time consuming. Without any record of the interaction any new knowledge or insights generated may need to be recreated by others in the future. The challenge therefore is to find a tool to enable as many of the knowledge transfer methods available through social interaction and yet store the knowledge where it can be readily accessed.

As well as questioning other engineers there are typically a number of other available resources of information and knowledge within a company. The following is a list of typical documents (not all inclusive), either at a corporate level or from other projects past and present, available to the enquiring engineer in an engineering/architect type firm:

- Arrangement drawings
- Piping and instrument diagrams
- Systems descriptions
- Specifications
- Project Design Manual
- Corporate design standards and procedures
- Industry design standards
- Calculations
- Electrical One-Lines
- Electrical schematics
- Logic diagrams
- Functional description
- Substructure drawings
- Superstructure drawings
- Piping isometrics
- Hanger drawings
- Detail drawings

- Vendor drawings and data
- Equipment specifications
- Bill of quantities
- Equipment, Piping & Device lists
- Circuit Lists
- Operation and Maintenance Manuals
- Plant Instruction Manual
- Project correspondence
- Design studies

Most of these documents contain information and embedded knowledge that may be reused but often very little explicit knowledge and even less tacit knowledge can be ascertained directly from these documents. Even documents which could easily tailored to contain true knowledge such as system descriptions are typically more about 'what' the system is rather than 'why' it is that way. Demian (2004) notes '*Kuffner and Ullman (1990) found that the majority of information requested by mechanical engineers was concerning the operation or purpose of a design object, information that is not typically captured in standard design documents (drawings and specification)'*.

Design studies are probably the best of any of these documents in providing knowledge transfer. Most real projects do not have sufficient time or budget to produce extensive studies beyond looking at the simplest of alternatives and they are by nature very project specific. Industry and corporate standards and guides may sometimes contain knowledge but more often than not they will tell an engineer what must or should

be done and not necessarily why it must or should be done that way. An engineer with sufficient experience and internalized knowledge will in many cases be able to deduce the reasoning behind the information presented and hence to some extent decode the embedded knowledge. In many cases the engineer will be able to determine what was done and even how it works (the explicit knowledge) but only on seldom occasions will the engineer be able to decipher the precise reasoning and knowledge that went into creating that particular solution (the tacit knowledge). Even if an engineer believes they have interpreted the embedded knowledge, this may be incorrect or incomplete so as to cause an error. Often only the engineer that originally performed the work has access to the internalized tacit knowledge behind why things were done the way they were and that engineer may forget. According to O'Dell and Grayson (1998), tacit knowledge can account for up to 80% of an organization's knowledge. It is therefore this tacit knowledge which is both most difficult and most critical to capture. Demian (2004) argues that placing information with embedded knowledge along with the project context and design history allows the engineer to extract the externalized and embedded knowledge for effective reuse.

From this discussion it can be seen that there is a substantial quantity of knowledge created in the engineering process which is rarely documented and essentially lost to all except to those whom have managed to internalize it. As Demian (2004) notes '*… capture and reuse of knowledge is less costly than its recreation.*' Also if a documented knowledge library exists it can be refined and improved upon over time as new experiences are gained and lessons learned. '*The corporate memory must also act as a dynamic knowledge refinery rather than a static knowledge repository*.' (Demian 2004)

A knowledge library containing explicit knowledge in context and hence tacit knowledge, which can be easily updated, has the potential to be an invaluable tool in improving engineering productivity and enabling corporate knowledge growth to provide a competitive advantage.

Knowledge Capture Concepts

Corporate engineering standards and guides are a useful tool in both communicating best practices and providing some level of knowledge transfer. These are 'best practices' in accordance with the Circle of Knowledge (Voeller 2002). Official corporate standards take a significant effort to create and once created must be maintained. The quality assurance system requires that the standards are followed, audited for compliance and deviations obtained if for whatever reason the standard cannot reasonably be followed. To attempt to capture the entire corporate knowledge by creating and maintaining all the knowledge into standards and guides would place an unbearable burden on the engineering staff and in terms of overhead costs. Therefore in order to improve knowledge management and hence the productivity of the engineers, alternative methods must be found to capture and share knowledge outside the scope of that worthy of 'best practice' status.

Some of the existing methods of capturing and refining knowledge are as follows:-

a. Write a book or guide – This requires an extensive effort to attempt to capture everything in a single set of documents. Once created it is hard to maintain and update.

b. Communities of Practice – These are forums for discussing items of common interest. They are most useful when there is a specific problem to solve. They can be by meeting in person (such as ‘roundtable discussions), by conference calls or electronically through discussion boards. Live meetings can produce useful minutes that can be distributed; discussion boards can produce searchable discussion threads. However finding specific knowledge from the resulting records can be problematic.

c. Expert finder – This is a directory of subject experts. This works where you have highly specialized individuals available to provide advice. However for more obscure subjects there may either be no expert or the expert may be found to be lacking the specific expertise sought. The main advantage is that this system is easy to establish and maintain.

d. Lessons learned library – These can be things that were done and worked well and things that were done and did not work well. On occasion when things did not go well there is often a desire to not let it be known too widely as it is potentially embarrassing or worse to the individuals involved and the company, leading to them not being widely publicized.

e. Reuse library placing design information in context – Demian (2004) focused on the concept of a reuse library as a method achieving the following:

- Reduce the time wasted on recreating knowledge.
- Reduce the time wasted on searching for knowledge in obsolete archives.
- Retain knowledge in the corporation even after the retirement or departure of knowledgeable employees.
- Novices can learn and benefit from the expertise of more experienced employees.

- Best practices are captured and reused by employees.

This project aims to go beyond these concepts by outlining the creation of a truly 'Interactive Knowledge Library'. With reference to the concepts of the Circle of Knowledge (Voeller 2002) for capturing and sharing tacit knowledge the library shall incorporate the following features:-

Ongoing –	Enable collaboration for ongoing projects
Reuse –	The explicit and tacit knowledge from previous projects, stored by placing design contexts to reference the design documents.
Best Practices –	While corporate standards are the location for true best practices since they should be incorporated into the quality system, the formation of new proposed best practices can take shape within the knowledge library.
Lessons Learned –	Lessons learned can be posted by all, straight into the knowledge library.
Expertise Management –	The library can identify key contributors and refer to experts to consult for each topic.
External Dependant –	The library can reference the relevant standards and which section thereof for each topic.
External Relational –	Feedback and perspectives from clients can be entered into the library.

A truly interactive knowledge library will allow knowledge to be captured and shared by the same tool. By engaging individuals in interactive discussions the library will facilitate dynamic new knowledge creation. Tacit knowledge can be codified through externalization as individuals contribute to the library. Combination of knowledge fragments by users will create new knowledge. Knowledge will be internalized by users incorporating ideas, concepts and information from the library into their work product. Discussions around the library subjects will facilitate socialization. If all these features can be successfully implemented, then a tool for enabling Nonaka and Takeuchi's knowledge spiral has been achieved. Throughout this process the library provides a medium in which this process is recorded and shared with others arriving at the goal of capturing and sharing tacit knowledge.

Chapter Four

Capturing and Sharing Knowledge in a Wiki-based Web Environment

Wiki as a Knowledge Management solution.

Information Technology Solutions for Knowledge Management

With a concerted effort, vast libraries of knowledge can be built, indexed and with modern software tools made searchable. The engineering business has a tendency to be cyclic in nature and as such when business is quiet there is usually insufficient budget to pursue such efforts. When business is booming, budget may be available for such efforts but most all resources tend to be dedicated to getting deliverables out of the door. Therefore, the need arises for a tool to allow a knowledge library to be built utilizing the minimum possible resources.

In considering solutions for knowledge capture and sharing, the author's initial thoughts were of Communities of Practice centered on discussion boards, since these are capable of capturing knowledge for future retrieval. Discussion boards or forums (originally BBS or Bulletin Board Systems) predate even the World Wide Web and are commonly used to create online communities. By allowing conversational exchanges both explicit and tacit knowledge can be exchanged and refined. However, a brief perusal of any online discussion board reveals that although at the time the discussion takes place everything will make sense, retrieving knowledge later from such conversation strings can be problematic. Discussion boards are a conversational

technology that can be used to refine and even create knowledge. Therefore there is a need for collaborative discussion while creating a lasting, indexable and searchable text to be able to return to in the future to retrieve knowledge on an ad hoc basis.

Wagner (2004) most concisely summarizes the various conversational technologies available as follows:-

Figure 2 – Conversational Technology Overview

Technology	**Communication**	**Knowledge Repository**	**Knowledge Catalog**
E-mail	1-to-1, 1-to-many, person-to-person	Local e-mail archives possible	Local index possible
Static and DataBase backed web pages	1-to-many, approaching many-to-many, "dialog" between web pages through hyperlinks	Local archives	Local index possible, web rings create larger catalog
Discussion forum	Many-to-many in web based forums, repeated 1-to-many in list servers	Central repository if web based, local if list server	Central index if web based
Internet chat	1-to-1, many-to-many	Frequently none, transient communication	None
Video / audio streaming	1-to-many	Central host of decentralized streamers	None, streams not indexed
Video / audio conference	1-to-1, 1-to-many	Local repository if content is recorded	None, content not typically indexed
GDSS (Group Decision Support System)	Many-to-many	Available, but GDSS sessions often treated as one-off.	Typically none but possible
Web Log	1-to-many, can approach many-to-many (similar to web pages)	Local repository within each weblog. "Metablogs" now emerging	Yes, local index, metablog may provide larger catalog
Wiki	Many-to-many	Yes, current knowledge and history ("temporal database")	Yes

Each of the technologies in the table above has their own certain advantages and disadvantages for collaboration and knowledge management. Many of them simply get unwieldy when expanded to the extent required for a knowledge library. For example to try and use e-mail:

'The concept simply doesn't scale well. An e-mail-based collaboration of any size also requires considerable "attention bandwidth" investment by each individual to sort out, manage, and keep up to date on the important developments.' (Leuf & Cunningham 2001).

In Wagner's analysis, a Wiki allows the collaboration of many-to-many while creating a knowledge repository which can be catalogued for retrieval. It is these key features that make a Wiki the best currently available information technology tool for an interactive knowledge library.

What is a Wiki?

A Wiki is essentially like any other Web page except any user can readily modify it. The original Wiki was a Web server designed as a collaboration tool for sharing software patterns. Although more usually identified as a collaborative working tool, since facts, thoughts and ideas are exchanged, this sharing of software patterns is a form of knowledge management application. The most popular Wiki application, Wikipedia the online encyclopedia, is also a form of knowledge sharing, although with it's threshold for inclusion being 'verifiability not truth' (http://en.wikipedia.org/wiki/Wikipedia:Verifiability accessed 24 Sep 06) it is focused on established knowledge rather than encouraging new hypotheses and ideas to create knowledge.

Leuf & Cunningham (2001) summarize from the user's perspective the essence of a Wiki as follows:-

- *A wiki invites all users to edit any page or to create new pages within the wiki Web site, using only a plain-vanilla Web browser without any extra add-ons.*
- *Wiki promotes meaningful topic associations between different pages by making link creation almost intuitively easy and by showing whether a target page exists or not.*

- *A wiki is not a carefully crafted site for casual visitors. Instead, it seeks to involve the visitor in an ongoing process of creation and collaboration that constantly changes the Web site landscape.*

Notably, they go on to say, '*Wiki is also a way to organize and cross-link knowledge ….*'

What are the features of a Wiki, Enabling use as an Interactive Knowledge Library?

Some of the key features of a Wiki which enhance their usability as a knowledge library are as follows:

Adding content - Text can be readily edited or added on a page and any word or group of words can be turned into a hyperlink, a new page or an external hyperlink.

Searching - The search function allows pages to be found by keyword. If there is no specific page for the searched key word they are listed by relevance.

Internal Hyperlinks - Hyperlinks to other Wiki pages are the main way of navigating the Wiki site. If a search does not yield exactly the knowledge required the resultant page may feature a hyperlink to the desired knowledge or may lead the casual browser to an item of interest.

External Hyperlinks - Web pages outside the Wiki, either within the corporate internet or on the World Wide Web can be linked to. These can be used to link to reference material and citations.

Backlinks - These links are to the pages which feature a link to the currently viewed page and allow the user to easily navigate through the Wiki page structure.

Discussion pages – A page attached to the main content page providing a forum where the contents of the page can be discussed without interrupting the continuity of the main text.

Page History - Shows all the edits made to a page, when and by whom, facilitating discussions. By enabling identification of key contributors, enables expertise management.

Reverting to previous versions - If an edit is made to a page which is inappropriate or in error then the whole page can be reverted to a previous version.

Orphans - The software can find pages which for whatever reason no longer have any hyperlinks leading to them. This is a key site maintenance tool. If the knowledge on the orphaned page is no longer relevant it can be deleted, else it can be linked suitably into the rest of the Wiki to enable users to find the knowledge more easily.

In Ward Cunningham's WikiWikiWeb (http://www.c2.com/cgi/wiki) it can be seen that the focus here is on simple text content. Content was and still is largely to be considered more important than presentation. In fact Ward Cunningham states:

'*You're browsing a database with a program called WikiWikiWeb. And the program has an attitude. The program wants everyone to be an author. So, the program slants in favor of authors at some inconvenience to readers.*'

Within WikiWikiWeb simple text edits are very easily performed, however to add hyperlinks, make characters bold, or other such simple formatting, requires using somewhat quirky editing conventions. Wikipedia and many other Wikis still use a markup language, most are simplified versions of HTML (HyperText Markup Language) and most will allow entry in HTML format. While these are not particularly complex, to

the unfamiliar user this is somewhat intimidating. There are now several Wikis available with WYSIWYG (What You See Is What You Get) type capabilities to assist the learning curve for new users and allow at least basic format editing to make content presentable to the casual browser. Many Wikis now also have the capability to cut and paste from other documents including images and to attach files to pages. Being able to attach reference information and knowledge in this way, as well as by providing hyperlinks, adds additional flexibility in how a user can communicate information in context (knowledge).

Knowledge Management with a Wiki

Knowledge Retrieval and Capture

In CoMem, Demian (2004) examines the use of a knowledge reuse library from the perspective of a novice, a mentor and an expert in the field. The same principles apply here to the Interactive Knowledge Library, although the method of finding knowledge for reuse is somewhat different. A novice can explore the library on their own, a mentor can refer the novice to parts of the library or explore it with the novice and an expert can use it to retrieve knowledge they know is there. This concept is taken further with the Interactive Knowledge Library however, by allowing the mentor or even the expert, where confronted with a situation beyond their experience or outside their field, to consult with others within the library to gain the necessary knowledge or at least sanity check their own conclusions.

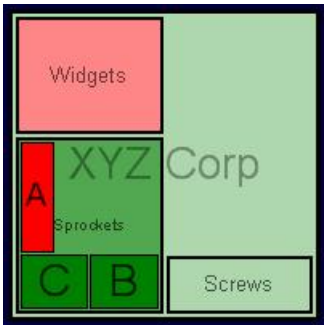
In CoMem, Demian (2004) uses the example of cooling tower frame designs. Here the designs must be placed very specifically and deliberately within the system to allow retrieval for reuse. In the Wiki type Interactive Knowledge Library there could

either be a page all about cooling tower frame designs with links to specific project designs, there could be project pages discussing the specific designs for those projects, or both. In any event, the relevant pages should easily be retrieved either directly from a keyword search, or via hyperlinks and backlinks from pages found in the search. In the event the specific information is not there, the enquirer could find from the page histories of relevant pages who has made any contributions on cooling tower frame design and contact them.

With a Wiki based knowledge library the key advantage versus more rigid knowledge libraries such as CoMem (Demain 2004) is that capture and retrieval occur through the same medium. If the knowledge is not there a user can add it, if it is wrong or needs further explanation a user can correct it, or add an explanation or post a comment to this effect to have the originator correct it. The lack of specific knowledge capture requirements frees the contributor from worrying too much about formal structure and instead focusing on the content of the contribution. Of course this does have the potential to distribute the knowledge too widely but with the Wiki being easily edited, it can be pulled back together and reorganized by any user at any time. Perhaps enabling knowledge capture through a Wiki sacrifices a little in organization in order to more easily capture the knowledge. This should be considered a small sacrifice, since with any knowledge management initiative initially capturing the knowledge is most of the battle. The ease with which the knowledge can be subsequently edited, updated and reorganized means that there is no reason that a disorganized contribution should stay that way for long.

To assist in preventing too wide a dispersion of knowledge, the organization of the Wiki can be directed by seeding, this concept shall be examined in the following chapter. Searching and navigating a Wiki is also relatively easy but it does not incorporate the advanced search features of CoMem, (Demain 2004) where extensive use of treemaps and algorithms to search for entries by relevance are made. Treemaps use spatial location and size to represent the significance and relationships between data elements. An example of a treemap is shown in Figure 3 below :

Figure 3 - An Example of a Treemap



The provision of treemaps and other tools for retrieval and library navigation can be programmed into a Wiki. Treemaps are certainly an interesting concept with some potential but examining their application to a Wiki is outside the scope of this paper.

The Knowledge Spiral and Conversational Knowledge Management in Wikis

In Chapter Three, Nonaka and Takeuchi's (1995) concept of the spiral of knowledge was introduced and how a truly Interactive Knowledge Library can enable the cycle of externalization, combination, internalization and socialization. This can only be achieved by enabling the subject matter to be discussed in context. A Wiki promotes externalization (capturing) of knowledge by allowing contributors to set information in context, either directly on the page, via a hyperlink, a file attached to the page or a

combination of these. The open editing of pages by multiple users easily allows the combination of knowledge, particularly distributed knowledge where different perspectives can refine and grow the knowledge. Users viewing the pages can retrieve the information in context from the pages and put this into practice, hence internalizing the knowledge. Ongoing discussions on the discussion pages regarding the library contents facilitate socialization. Thus a circuit of the knowledge spiral can be repeated; capturing, sharing, and growing the knowledge in the library and held by those who use it.

An alternative description to the form of knowledge management possible with a Wiki is conversational knowledge management. Wikis allow discussion and interaction, hence conversation. Wagner (2004) identifies the following desirable features of conversational knowledge creation:

1. It can be economical and technology undemanding. Many on-line communities are built on little more than a listserv or a (freely available) web-based discussion forum.
2. Conversational knowledge creation is fast, taking potentially only as long as required for one person to post a question and others to post or e-mail a response. Speed makes conversational technologies particularly useful for environments where ad-hoc knowledge creation is required.
3. Conversational knowledge creation is suitable for environments where the knowledge is not centralized, but resides with multiple owners who may be located far apart.

By engaging in such conversations new knowledge may be created by combining and adapting the existing ideas and experience of the participants. With a Wiki the participants can be in any time zone since responses are not required instantaneously. Wagner (2004) states, that conversational technology such as Wikis are most effective at ad-hoc problems, particularly where the knowledge sources are distributed. According to Wagner there is in fact potential for greater than linear knowledge growth using a Wiki.

This argument is logical since as the momentum of collaboration and the Wiki itself grows it will raise many new questions as well as answers. Most importantly answers can be iteratively improved as more knowledge and experience is attained. Individuals can start with even just knowledge fragments for others to add to. Hyperlinks can be left to blank pages for others to fill in, distributing the effort. Joint ownership of the document draws on the knowledge of many who can cross check information and experiences, or as Wagner (2004) refers to the '*Power of N*'.

The concept of conversational knowledge creation is in essence not so different to the knowledge spiral. Conversations are a form of socialization. Also, through the process of conversation knowledge can be externalized, combined and then internalized by the participants, completing the spiral.

Communities of Practice within the Knowledge Library

There are two features of Wikis which in particular, can promote the formation of Communities of Practice. The discussion pages which are attached to the main content pages within many Wiki implementations allow for free flowing conversational type idea sharing without interrupting the main content. E-mail notification allows users to be notified when pages of specific interest to them are made. For example, a steam turbine expert can watch the steam turbine related pages and provide feedback to contributors. Also users may post questions on the comments page, for others to answer and add to the main content page as appropriate. In the event a user needs a quick answer for a subject area where there is not a known expert, they can find a page with related issues on it and look in the page history for the key page contributors and call or e-mail them directly

with the question. The resultant knowledge transfer can then be posted as appropriate to the Library. The formation of Communities of Practice within the library is the ultimate goal since this will demonstrate a true knowledge sharing culture has been developed. How to promote this will be discussed in the following chapter.

The Wiki administrator can restrict who may edit certain pages. While this is largely contrary to the principal of a Wiki and open editing, it may be useful for incorporating corporate standards into the Wiki site or when the content of a page has matured to the point where it is stable and broadly accepted as being high quality content. This feature could also be used to establish a restricted membership community of practice should such a need arise. It may be desirable to lock this content and only allow comments or appending to the page.

Taking the concept of authoring control further, there may be instances where sections of the library may take the form of a Bliki. The word Bliki is derived from Blog (or Weblog) and Wiki. It is in essence simply a Wiki page with a single author like a Blog, where editing by others is not permitted. This is most useful for a Chief Engineer or field expert where they want to publish information or knowledge not to be edited by others. By allowing others to edit the attached discussion page however, the creator can receive feedback with which to improve the pages' contents.

Wiki Software

Different Flavors of Wiki Software.

Wiki software has matured significantly in the last several years. There is, however, no current single universal solution for Wiki software. Wiki type features are

growing rapidly in popularity and are even slowly being incorporated into mainstream software products. Even Microsoft is adding Wiki type features into the forthcoming Sharepoint 2007 (http://download.microsoft.com/download/5/D/C/5DC09195-7D74-4A5D-AFED-62C000648A15/SharePointGuide.doc accessed 9 Oct 06).

A summary of common Wiki software available and comparison of features is available at www.wikimatrix.org. The first Wikis and most current Wikis on the World Wide Web are created and maintained using free and open source software. Common open source Wiki software includes MediaWiki (used by Wikipedia), TWiki, FlexWiki and PHPWiki. The source code language for this software varies widely but Perl and PHP are among the most common. Some are database based (using Oracle or MySQL), others simply use content files stored in HTML or similar format on the server, allowing the potential for pages to be edited externally and uploaded. There are also commercial implementations such as SocialText, JotSpot and Confluence that are available.

Free and Open-Source Software versus Commercial Software

Free and open-source software, apart from being free, also allows the knowledgeable user to modify the software in any way they choose. The disadvantage of the open source route is that significant technical expertise is required to implement the software on the server and while there are on-line communities available for support there is no external entity to assist with any troubleshooting; although there are third party companies that will offer this service. Either the commercial versions can run the Wiki on their server and achieve access through the internet, or they can install the software on a server on the network side of the corporate firewall.

Which Wiki Features are most important for a Practical Interactive Knowledge Library

An examination of www.wikimatrix.org reveals that not all Wiki software is created equal. There is a vast list of features in the comparison matrix revealing the differences between the various Wikis available (69 listed on wikimatrix as of 8 Oct 2006). In selecting software, the following particular features should be considered as being significant to ensure an effective Interactive Knowledge Library. Many of these features are common to most Wikis as discussed above but are repeated here for convenience:

Data Storage –	Preferably a robust database based system to ensure sufficient scalability and backup functions.
Page History -	Knowing what edits have been made, when and by whom is of significant importance in following the evolution of the content and revert to previous versions if necessary.
Page Index -	The creation of an index while not critical aids navigation and management of the library.
E-mail Notification -	Providing a feature to enable users to be notified of page changes will assit greatly in developing Communities of Practice within the Wiki environment.
Comments -	The Wiki must be able to handle comments to enable discussion without cluttering the content page and promote Communities of Practice.

Conflict Handling -	The Wiki must address possible conflicts created when two users attempt to simultaneously edit a page.
Backlinks -	Backlinks greatly aid site navigation.
Math Formulas -	For an engineering Wiki, enabling the easy use of formulae will facilitate knowledge capture
Toolbar -	Having the essential functions on a toolbar will assist novice users on the learning curve.
WYSIWYG -	This will enable novice users to start editing easily straight away.
Auto Signature -	Ensure contributors are easily identified.
Recent Changes -	Useful for site administration and for a user to catch up on the latest contributions.
Wanted Pages -	A useful tool for identifying where contributions are needed.
Orphaned Pages -	Useful for site administration avoiding knowledge from falling by the wayside within the site.
Printer Friendly -	The software should enable the pages to be printed to hard copy in a presentable format.
Auto-TOC -	An auto Table of Contents feature will assist in navigation and administration of the site.
Export -	Some sort of text export whether it is in HTML, XML or other format should be possible to enable users to pull from the library as needed.
File Attachments -	Will enable attachment of useful reference documents such as drawings or calculations.

Determining the best Wiki application for the Interactive Knowledge Library is outside the scope of this report. However a brief examination of the features in WikiMatrix reveals that JSPWiki, MediaWiki, PHPWiki, PMWiki or TWiki would all provide most all of the functions required in an Open Source solution. TWiki has been positioned as an enterprise collaboration platform and has been successfully implemented at Yahoo!, Disney, SAP, Cingular Wireless and Motorola (Gonzalez-Reinhart 2005). Confluence, JotSpot or SocialText are some of the major commercial Wiki software vendors, although according to the WikiMatrix comparison, the Open Source software solutions have more features and flexibility. The output of a comparison from WikiMatrix.org is attached in Appendix A.

Chapter Five

Factors for Successful Implementation of the Interactive Knowledge Library

Management and Organizational Support

To create the conditions for the most effective implementation possible of the Interactive Knowledge Library, management support and encouragement must be provided. Voeller (2002) describes common impediments to knowledge management initiatives as failures to do the following:

- Sharing - Failure to share
- Identification - Mistaking data and information for knowledge
- Organization - Consistently organizing knowledge for retrieval
- Aggregation - Accumulating vast quantities of disorganized knowledge
- Recognition - Not recognizing knowledge contributors
- Incentives - Providing no motivation to contribute knowledge
- Quality Control - Accumulating worthless knowledge
- Technology - Application of inappropriate technology solutions

The concepts in Voeller's barriers somewhat coincide with the concepts from the following list of factors leading to knowledge project success list by Davenport, De Long & Beers (1997):

- Link to economic performance or industry value
- Technical and organizational infrastructure
- Standard, flexible knowledge structures
- A knowledge-friendly culture
- Clarity of purpose and language
- Different motivational practices
- Multiple channels for knowledge transfer
- Senior management appreciation and support

Culture and Management Support

The most fundamental of the barriers to knowledge management is the failure to share, by not creating an environment or culture where sharing knowledge is valued. If knowledge and indeed curiosity are highly valued in the boardroom it has a much greater chance of being truly valued throughout the organization. There must also be a positive outlook on prospects in general. A commonly cited reason for experts not to share their knowledge is due to a belief that their importance is diminished and even their position threatened, if they start freely sharing their knowledge. To overcome these problems, employees need to feel valued more for the knowledge they share, than just for what they know.

The knowledge management project type should fit the existing corporate culture (Davenport, De Long & Beers 1997). The authors' experience suggests that most engineers are inherently conducive to debate (almost to a fault). With the Interactive Knowledge Library the key to overcoming any initial resistance is to demonstrate the potential of the tool and how easily they can record what they know through experience and more importantly openly discuss and debate these issues as a group. The most important feature of culture required for this, is that every viewpoint should be valued and there be no fear of expressing an opinion or stating something in error.

Incentives and Measurements of Value Contribution

A culture which promotes sharing knowledge will go a long way but additional incentives will serve to emphasize the importance of knowledge sharing and provide motivation to contributors. Voeller (2002) suggests incentives can be intellectual,

monetary and cultural. An intellectual incentive is that of being recognized as an expert and mentor. A cultural incentive requires the broader organization to recognize the contribution, or as Voeller (2002) envisages 'knowledge captains' as corporate leaders of a new age. Providing awards for worthy contributions is also a form of intellectual and cultural recognition. Recognition awards can extend to gifts or bonuses. At Buckman Laboratories the best 150 "knowledge sharers" were rewarded with an elaborate company trip to a resort, greatly increasing participation on their new knowledge network (Davenport, De Long & Beers 1997). Voeller (2002) goes further and suggests measuring both use and contributions, and providing a new kind of employee compensation in direct relation to this. 'Tallies' for this compensation are proposed to be accounted for usage, value received (subjective assessments of contributions by users), contributions and references in decisions. Administering such a system fairly is not necessarily straightforward but certainly possible; especially using an intranet based system where forms can easily be filed and hits on pages counted. This tally system can also be extended to give an assessment of the value contribution of the system to the company.

The Interactive Knowledge Library aims to increase engineering productivity, increase the body of corporate knowledge and gain competitive advantage. Although there are many factors influencing productivity, productivity is usually measured in some form. In the long term, if the library is making headway, some measurable increase in productivity should be observed. The increased body of corporate knowledge should be demonstrated by producing designs with improved value, in terms of lower cost, improved constructability or end product performance for the client. Such value would

need to be assessed on a case by case basis of knowledge generated within the library. True competitive advantage will be the ultimate effect but this will take time to truly filter through to the market in terms of reputation, increased capability or reduced cost. Enabling the sales team to have knowledge to hand in selling new projects will certainly enhance the image of the corporation in front of potential clients and the ability to sell.

Organizational Infrastructure

Modern high speed computer networks with inexpensive hard drive storage now enable far more data, information and knowledge to be gathered than can ever possibly be viewed by one individual. Corporate intranets allow rapid access to information, at least when it is organized and stored in a location where it can be easily found. As such IT network infrastructure in most corporate settings is no longer considered a significant limitation on what can be achieved. Software wise, Wiki software is now relatively mature and although still being developed further, the essential tools are now all there. As discussed in the previous chapter either a commercial product will come with technical support, or with open source applications there is an existing large online community to assist with any issues. The main infrastructure problem to be addressed is more organizational.

'*Building an organizational infrastructure for knowledge management means establishing a set of roles and organizational groups whose members have the skills to serve as resources for individual projects. The companies we interviewed often found this difficult to do, in part because it involves spending money on new roles.*' (Davenport, De Long & Beers 1997)

One of the key intents of the Interactive Knowledge Library is that no major organizational infrastructure is required. The knowledge comes directly from the users

such that only monitoring and guidance is required by one or more 'Wiki gardeners' as outlined at the end of this chapter.

To maintain focus the Interactive Knowledge Library should be clearly defined as a 'place to capture, share and synthesize knowledge'. It is not a data and information repository. Any data or information in the library must be placed into context such that it is a complete entry representing true knowledge. Since the library utilizes a Wiki, users may find alternative uses as they experiment with this new medium. Unless it is related to the goals of the library this should be discouraged. Separate Wiki's can be set up outside of the library if necessary to avoid diluting its purpose.

Successful Wiki Implementation

Beyond the challenges to traditional knowledge management initiatives the use of a Wiki brings a few additional unique challenges. The greatest to overcome is probably the management perception of relinquishing control. '*Wikis could be characterized as promoting knowledge management by anarchy.*' (Wagner 2005) It can also be considered to raise issues of corporate governance or retention. Burton, Know & Drakos (2004) state that

'*There is no guidance on how to deal with these issues, and some companies may shut down support for wikis because of them. However that may "throw the baby out with the bath water" because the gains of the collaborative environment are also lost.*'

The Wiki certainly negates the conventional norm of a top-down hierarchical structure to knowledge creation and creates a far more democratic knowledge capture and sharing system. However the fact that multiple users are involved means that the library should be self moderating. This democratization of knowledge enables Nonaka and Takeuchi's

(1995) model of middle-up-down knowledge creation to be implemented since all levels from grass roots to senior management can participate, preferably facilitated by middle management.

To test the claims made by advocates of Wikis, Burton, Knox & Drakos (2004) decided to implement a Wiki site at Gartner. Their paper highlights some key lessons they learned as follows:

Define a content organizational structure that suits your teams collaborative needs. – For the Interactive Knowledge Library this is addressed in the following section on structuring and maintaining Wiki content.

Management must understand the value of the wiki model. – While it is possible for the Wiki to grow and prosper without direct management support, the best results can only be achieved and support for the project maintained, if they are kept informed of progress and actively encourage participation.

Identify and retain wiki technical support – While technical support should not need to be extensive it should be made available to provide assistance as needed. '*Because the adoption and evolution of the wiki is largely by word of mouth, it is helpful to have someone " behind the scenes" who can "clean up" the wiki*.'

Teach users how to deal with editing conflicts and have a conflict resolution policy – When two users attempt to edit a page simultaneously this creates a conflict. Wiki software does assist in handling this conflict but it is not automatic. Therefore users need to be taught how to handle a conflict so as not to lose their contribution.

Logging in is important – Editing is possible without logging in but by logging in correctly the users are clearly identified to promote better collaboration. Ideally on a corporate intranet the users will be logged in automatically if the wiki software can be programmed to support this.

The best way to prevent the wiki from "turning to mush" is to have a community of people – rather than only one person – willing to check, correct and expand contributions. – A true knowledge community will nurture the best content by commenting on, improving on and reorganizing individual contributions.

In order to promote initial use of the system it will be necessary to instruct users on how to use the system and more importantly, why they should use it. Demonstrations can be used along with allowing users to experiment in a 'sandbox' or even with their own personal Wiki installed on their own machine. In fact this personal and smaller

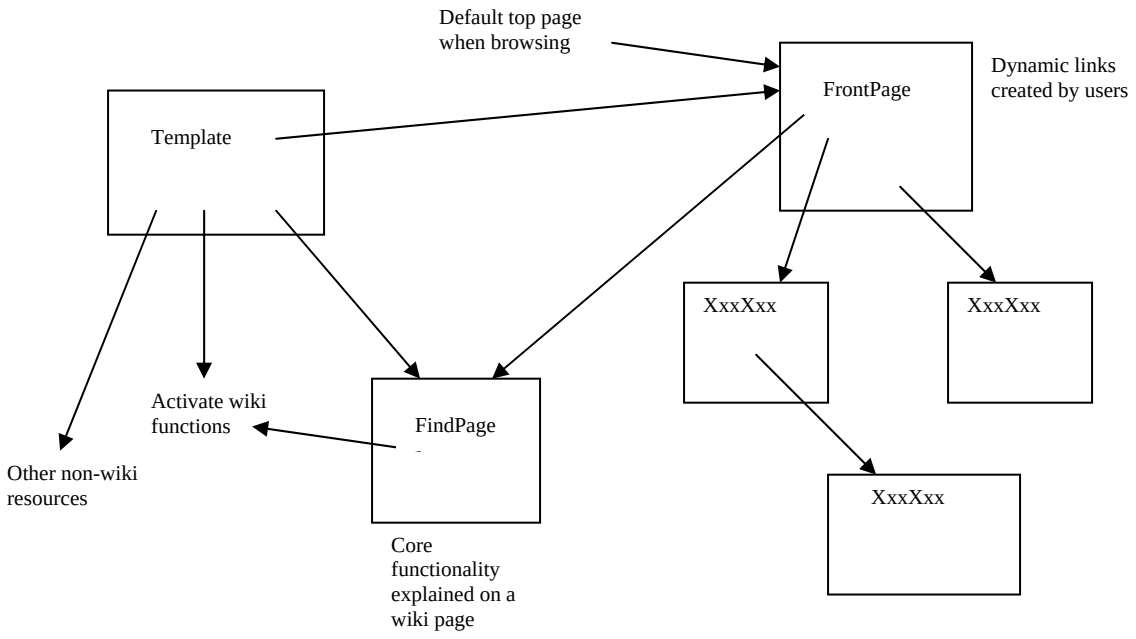
group use of Wiki's has a multitude of possible uses for personal and project knowledge management outside the scope of the Interactive Knowledge Library concept. Instead of compiling documents and e-mails in a hard to search file share system, they can be placed in context within a Wiki. Detailed examination of these possibilities for this type of Wiki use is outside the scope of this paper but by demonstrating the power of this tool for personal use it will encourage users to share their personal knowledge in the library.

Structuring and Maintaining Wiki Content

Wiki Structure

In order to avoid content becoming too fragmented and disorganized some structure must be set up initially and maintained. Aggregations of disorganized knowledge or knowledge "piles" are said by Voeller (2002) to be 'one of the greatest enemies of knowledge efforts'. Within the Interactive Knowledge Library the goal is to organize knowledge such that it clearly falls within the page header of each Wiki page and to creating additional pages as necessary where the discussion strays into territory requiring a new header. Hyperlinks will guide users to the related pages as desired minimizing the use of the search function. Occasionally it will be necessary to reorganize the data to pull it back into a logical form. Pages will become too long and unwieldy, in these cases child pages can be created with a hyperlink from the original parent page. Figure 4 illustrates the different ways Wiki pages can be linked.

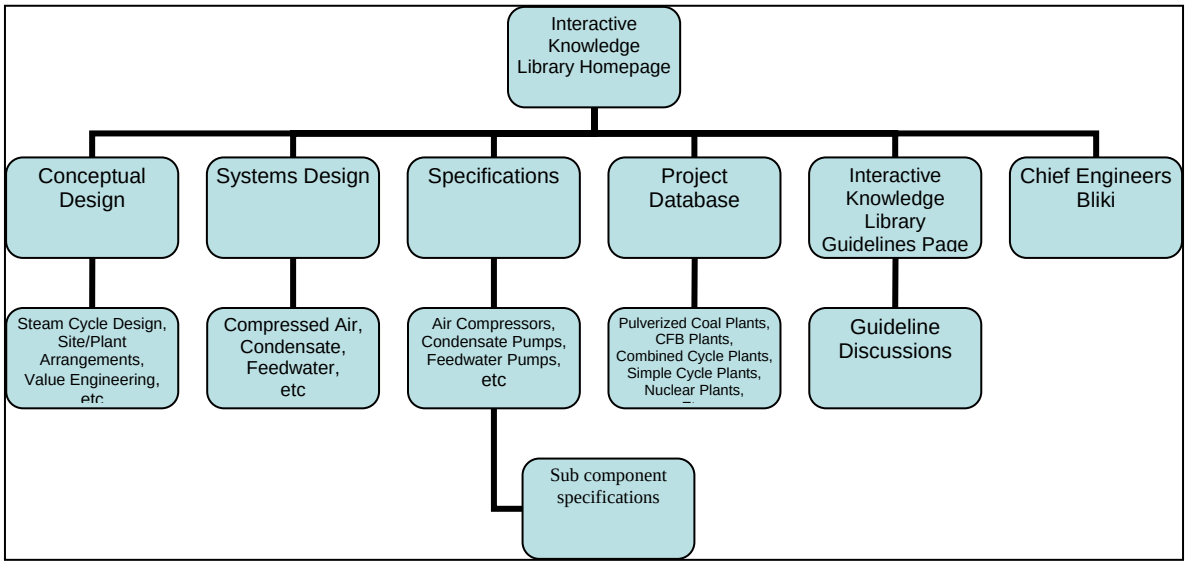
Figure 4 – Generic Wiki Site Structure



Examples of given structures defined by the chosen Wiki model (Leuf & Cunningham 2001)

The site can initially be set up with a tree type top down structure with hyperlinks to crosstie the branches as appropriate. Along with backlinks and the search function this should enable a user to rapidly familiarize them self with the knowledge framework and navigate to the target page. Leuf and Cunningham (2001) refer to the Small Wiki Hypothesis, stating that '*No wiki page is more than a few clicks away*'. Templates can then be used to provide an initial page structure for a given type of page. The process of establishing an outline structure and inserting templates into a Wiki is referred to by Leuf and Cunningham (2001) as 'seeding'. For an engineering company the category structure should follow the manner in which the engineers work. Figure 5 shows the high level organization plan for the library:

Figure 5 – High Level Interactive Knowledge Library Structure



The homepage will greet new users and discuss any pertinent site issues and guide users to any particular knowledge development initiatives of the Chief Knowledge Officer or the Chief Engineer. The Chief Engineers' Bliki allows a forum for the Chief Engineers and their staff to quickly communicate any particularly pertinent issues throughout the corporation. The guidelines page will provide a guide for new users and allow the community to discuss overall library concepts.

The knowledge will be captured and shared within the conceptual design, systems design, specifications and project database sections. Pages under each of these categories should be extensively hyperlinked to freely navigate between sections. For example, the compressed air system page should be hyperlinked to the air compressor specification page. Pages can then also have extensive child pages as needed, for example the air

compressor specification page may have one child page describing screw type compressors and another child page describing centrifugal compressors. To encourage this hyperlinking, there should be specific areas for this incorporated into the page templates. It is not the intent here to define exactly how to seed the Interactive Knowledge Library but to show conceptually how it can be done as a guide to how the site can be built prior to launching it throughout a corporation.

Guidelines and Templates

Probably the most fundamental guideline should be placed on the homepage and state along the lines of the following:

'The Interactive Knowledge Library is not intended to represent any actual or de facto standards. Each engineer must use their judgment in following any guidance herein provided. If further guidance or verification is required consult your supervisor and/or the Chief Engineer's Office as appropriate.'

This statement is required to definitively separate the Interactive Knowledge Library from corporate standards and to make engineers question the contents and not end up in the dangerous scenario of following them blindly.

Many guidelines for editing and adding content can be gathered from the existing Wiki sites out on the World Wide Web (e.g. http://en.wikipedia.org/wiki/Wikipedia:Guidelines and http://www.c2.com/cgi/wiki?WikiEditingCustoms), however these need to be tailored some for the corporate environment. Appendix B contains a list of suggested guidelines for the Interactive Knowledge Library. These guidelines provide a few 'do's and don'ts'

when entering new text or editing existing text. The guidelines in themselves will not however, prevent the site from becoming disorganized. Only by providing an initial structure and template pages can the structure of the library be guided. Ensuring each page has appropriate section headings will encourage users to enter appropriate hyperlinks and content in a consistent manner. The library is intended to complement corporate standards and not in anyway replace them, and as such, it is important that they are referenced. Appendix C includes a suggested template for a system design page. Appendix D includes a suggested template for a specification page. Sections such as a conceptual design section shall by necessity be somewhat more freeform than the system and specification pages, but contain similar initial headings. The project database is intended to contain a project overview and examples for reuse, typically associated with a system or specification.

Site Maintenance

Apart from occasional technical support from IT staff for the server upkeep, the major maintenance effort is to keep the site organized and assist users in producing the best possible content. A prime example of a working Wiki community is Wikipedia. The phrase 'Wikipedians' has even been coined to describe the members of that community. Forming a similar engaged community of users around the Interactive Knowledge Library is the ideal but such a community will not form overnight. There must be at least one, if not more individuals, who will actively champion the goals of the library online by assisting and encouraging editors in making their contributions and maintaining the format and structure of the Wiki. Fichter (2005b) refers to these

moderators as ‘Wiki Gardeners’. Volunteers who have a passion for and belief in the vision of the Interactive Knowledge Library must be found, rather than merely conscripting capable individuals, since the initial effort will require significant dedication and energy (Anderson 2005). The amount of time required of the Wiki gardener will depend on the amount of activity in the Wiki and how developed the larger community becomes. Ultimately, the hope is that the community as a whole will become self-sustaining and governing, with the gardener only intervening very infrequently.

Suggestions for Further Work

- Implementation of the Interactive Knowledge Library on a corporate scale.
- Adding a Treemap visualization of knowledge to the search function of a Wiki environment. Treemaps as used by Demian (2004) in CoMem.
- Developing the concept of Wiki as a data, information and knowledge management tool for smaller project groups and individuals in day to day working.
- Using a Wiki as a file repository, enabling intuitive organization of files for retrival.
- Developing a knowledge management incentive scheme to promote knowledge sharing and use which is fair and does not promote overuse or trivial contributions from users or detract from day to day work functions.
- Developing accurate metrics for measuring the value contribution of the Interactive Knowledge Library to the corporate bottom line.

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APPENDIX A

Wikimatrix Comparison of Popular Wiki Software

Home Choice Wizard Markup Compare Docs Forum Register Login About

Wiki Feature ComparisonShow flagged only

General Features	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
Version	2.2	does not apply	v2.2.33	1.6.3	phpwiki-1.3.12p2	2.2.0	does not apply	TWiki 4.0.5
Last Release	2.2	does not apply	2005-09-07	2006-04-10	2006-03-07	2006-10-06	does not apply	2006-10-24
Author	Atlassian Software Systems	JotSpot	Janne Jalkanen	Magnus Manske, Brion Vibber, Lee Daniel Crocker, Tim Starling, Erik Möller, and others.	Steve Wainstead, Jeff Dairiki, Reini Urban, Carsten Klapp	Patrick R. Michaud	Socialtext	Peter Thoeny, TWiki community
URL	www.atlass	www.jot.co	www.jspwil	www.media	phpwiki.sou	www.pmwi	www.social	twiki.org
Free and Open Source	No	does not apply	Yes	Yes	Yes	Yes	does not apply	Yes
License	Commercia (source included)	does not apply	LGPL	GPL	GPL	GPL2	does not apply	GPL
Programmi Language	Java	does not apply	Java	PHP/OCaml	PHP	PHP	does not apply	Perl
Data Storage	Database	does not apply	Files, DB, RCS	Database	Files, DB, RCS	Files	does not apply	Files, RCS
License Cost/ Fee	from US$1200 (unlimited wikis)	Free for 5 users, then scaled pricing.	0	0	0	0	Free for 5 users; scaled pricing above that. Please see www.socialtex	0
Developme status	Mature	does not apply	Mature	Mature	Mature	Mature	does not apply	Mature
Intended Audience	Commercia	Enterprise or personal use	all	End Users/Desktop Education			Professiona	Medium to large organizations; internet communities
Hosting Features	**Confluence**	**JotSpot**	**JSPWiki**	**MediaWiki**	**PhpWiki**	**PmWiki**	**Socialtext**	**TWiki**
Storage Quota	does not apply	n/a	does not apply	does not apply	does not apply	does not apply	1 GB, $10/GB/mo. above that	does not apply
	does not	n/a	does not	does not	does not	does not	Unlimited	does not

Bandwidth Quota	apply		apply	apply	apply	apply		apply
Other Limits	does not apply		does not apply	does not apply	does not apply	does not apply	Unlimited pages, Unlimited wikis	does not apply
Topic Restrictions	does not apply		does not apply	does not apply	does not apply	does not apply		does not apply
Corporate Branding	does not apply	Yes	does not apply	does not apply	does not apply	does not apply	Yes	does not apply
Own Domain	does not apply	Optional	does not apply	does not apply	does not apply	does not apply	Yes	does not apply
Ads allowed	does not apply	Yes	does not apply	does not apply	does not apply	does not apply	No	does not apply
System Requirements	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
Operating System	Unix, Windows, MacOS X, etc. (Any platform supporting JDK1.4 or higher)	does not apply	any platform supporting JDK 1.4+	UNIX, Windows, MacOS X	UNIX, Windows, MacOS X, probably others	UNIX, Windows, MacOS X, probably others	does not apply	Linux, Windows, OS-X and other
Root Access	No	does not apply	No	No	No	No	does not apply	No
Webserver	included (Apache Tomcat 5.5), or run with the appserver/wel of your choice	does not apply	known installations: Tomcat 4+, Websphere	Apache, probably anything with PHP support	Apache, IIS, anything with PHP support	Apache, IIS, anything with PHP support. Can also be run w/o a webserver.	does not apply	Almost any webserver, typically Apache 1.3/2.0
Other Requirements	JDK 1.4+, J2EE 1.3 compatible appserver (included)	does not apply	Optional JavaMail		none	none	does not apply	RCS (optional), cron/schedule fgrep, egrep; Plugins may have additional dependencies
Datastorage	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
Text Files	No	does not apply	Yes	No	Yes	Yes	does not apply	Yes
MySQL	Yes	does not apply	Plugin	Yes	Yes	Plugin	does not apply	No
PostgreSQL	Yes	does not apply	Plugin	Optional	Yes	No	does not apply	No
Oracle	Yes	does not apply	Plugin	Yes	Yes	No	does not apply	No
SQLite	No	does not apply	Plugin	No	Yes	No	does not apply	No
		does not					does not	

BerkeleyDB	No	apply	Plugin	No	Yes	No	apply	No
RCS	No	does not apply	Plugin	No	Yes	No	does not apply	Yes
Other	HSQL (embedded db), DB2, Microsoft SQL Server, Sybase ASE	does not apply	page provider architecture -> several implementatio	No	gdbm, cvs, MSSQL, ... (ADODB, PearDB)	No	does not apply	RcsLite Perl library for version control without external RCS; backend API for other storage
Security/Anti-Spam	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
Page Permissions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ACL	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Authenticat Backends	Open API - LDAP, Siteminder, CAS and more	does not apply	JAAS	Yes	db, session, pop, imap, ldap, file, webserver	.htpasswd, LDAP, Active Directory, MySQL, (custom available)	does not apply	Internal authentication anything Apache supports such as LDAP, NIS, AD, Kerberos
Host Blocking	No		Optional	Yes	No	Optional	No	Plugin
Mail Encryption	No		Plugin	No	No	Plugin	No	Yes
nofollow	Optional		Optional	Optional	Yes	Yes	No	Plugin
Blacklist	No		Yes	Yes	Yes	Optional	No	Plugin
CAPTCHA	Yes	No	No	Plugin	Yes	No	No	Plugin
Delayed Indexing	No	No	No	No	No	No	No	Plugin
Development/	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
Commercia Support	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Preconfigur Hosting	Yes	does not apply		Yes	No		does not apply	
Code Repository	Source included with commercial license	does not apply	CVS	svn.wikime	sf.net	svn://pmw	does not apply	twiki.org
Issue Tracker	jira.atlassia	feedback.jc	in wiki on jspwiki.org	bugzilla.wik	sf.net	www.pmwi		twiki.org

Mailing List	www.atlass		www.ecyrd	mail.wikipe	sf.net	www.pmich		twiki.org
Support Forum	forums.atla	feedback.jc	www.jspwik	mwusers.co	sf.net	www.pmich	www.social	twiki.org
IRC Channel	Jabber MUC at chat.atlassian.		Freenode: #jspwiki	meta.wikim		#pmwiki on irc.freenode.n		twiki.org
Common Features	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
Preview	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Minor Changes	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Change Summary	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Page History	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Page Revisions	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
Revision Diffs	Between all	Between all	Between all	Between all	Between all	Between all	Between all	Between all
Page Index	Yes	Yes	Plugin	Yes	Yes	Yes	Yes	Yes
Special Features	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
Unicode Support	Yes	Yes	Yes	Yes	Yes	Yes		Yes
Right-to-Left Support	No			Yes	No		No	No
Interface Languages	English	Yes, 1	en	60+	Chinese (Simplified), Dutch, English, French, German, Italian, Japanese, Spanish, Swedish	20+		11
Email notification	Yes	Yes	Plugin	Optional	Yes	Optional	Yes	Yes
Comments	Threaded	Threaded	Flat	Discussion Pages	Plugin	Plugin	Flat	Threaded
Categories	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Namespace	Yes		No	Yes	No	Yes	Yes	Yes

Page Redirection	Plugin	Yes	Yes	Yes	Yes	Yes	No	Yes
Conflict Handling	Conflict Resolution	Page Locking	Page Locking	Conflict Resolution	Conflict Resolution	Conflict Resolution	Conflict Detection	Conflict Resolution
Search	Full Text	Full Text	Full Text	Full Text	Full Text	Full Text	Full Text	Full Text
Links	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
CamelCase	Optional	Yes	Yes	No	Yes	Optional	No	Yes
Freelinks	Yes		No	Yes	Yes	Yes	Yes	Yes
Backlinks	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
InterWiki	Yes	No	Yes	Yes	Yes	Yes	Yes	Plugin
SisterWiki	No	No	No	No	No	No	No	Plugin
Image Links	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Windows Shares	Yes	No		No		Yes	Yes	Yes
Syntax Features	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
HTML Tags	Plugin	All	Optional	Some	Some	Plugin	All	All
Math formulas	No	Yes	Plugin	Yes	Plugin	Plugin	No	Plugin
Tables	simple + complex	simple + complex	simple + complex	simple + complex	simple + complex	simple + complex	simple + complex	simple + complex
CREOLE support								
Markdown Support	No		No	No	No	Plugin	No	No
Textile Support	Yes		No	No	No	No	No	Plugin
BBCode Support	No		No	No	No	No	No	No
Emoticon Images	Yes		Plugin	Optional	No	Plugin	No	Plugin
Syntax Highlighting	Yes	No	Plugin	Plugin	Plugin	Plugin	No	Plugin
Footnotes	Plugin	Yes	Yes	Yes	Yes	Plugin	No	Plugin

Quoting	Yes	Yes	No	No		Plugin	No	Yes
Internal Comments	No	Yes	Plugin	Yes	Yes	Yes	Yes	Yes
Custom styles	Plugin	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FAQ Tags	No	Yes	No	No	No	Yes		Yes
Scripting	Macro plugins / velocity	Javascript, JotScript	TCL plugin, JavaScript	Optional	plugins, templates, PHP	Plugin	Javascript	JavaScript; TWiki variables
Content Includes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Feed Aggregation	Yes	Yes	Plugin	Optional	Yes	Plugin	Yes	Plugin
Usability	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
Section Editing	No	No	Plugin	Yes	No	Yes	No	Plugin
Double-Click Edit	No	Yes	No	Optional	Optional	Plugin	Yes	Plugin
Toolbar	Optional	Yes	Plugin	Yes	Yes	Yes	Yes	Yes
WYSIWYG Editing	Yes	Yes	Plugin	Plugin	Patch	Plugin	Yes	Yes
Access Keys	Yes	Yes		Yes	No	Yes	Yes	Yes
Auto Signature	No	No	No	Yes	Yes	Yes	No	Yes
Statistics	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
Recent Changes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wanted Pages	Yes	No	Yes	Yes	Yes	Optional	No	No
Orphaned Pages	Yes	No	Yes	Yes	Yes	Optional	Yes	Plugin
Most/Least Popular	No	No	No	Yes	Yes	No	No	Yes
Recent Visitors	Plugin	No	No	No		Plugin	No	No

Analysis	Plugin	No	No	Optional	Plugin	Plugin		Yes
Output	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
HTML	HTML 4	XHTML 1.0 Transitional	XHTML 1.0 Transitional	XHTML 1.0 Transitional	XHTML 1.0 Transitional	XHTML 1.0 Transitional	HTML 4	XHTML 1.0 Transitional
CSS Stylesheets	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Printer Friendly	Print View	Print View	Print CSS	Print CSS	Print CSS	Print View	Print View	Print View
Themes & Skins	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
RSS Feeds	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ATOM Feeds	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Abbreviatio	No	Yes	No	No	No	Plugin	Yes	Plugin
Auto-TOC	Yes	No	Plugin	Yes	Yes	Plugin	Yes	Yes
Raw Export	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HTML Export	Yes		Optional	Yes	Yes	Plugin	Yes	Yes
XML export	Yes	Yes	No	Yes	No	Plugin	No	Plugin
PDF Export	Yes	No	Plugin	Optional	Yes	Plugin	No	Plugin
Media and Files	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
File Attachements	Yes	Yes	Yes	Yes	Yes	Optional	Yes	Yes
Media Revisions	Yes	Yes	Yes	Yes	Yes	Optional	Yes	Yes
Embedded Flash	Yes	Yes	No	Plugin	Yes	Plugin	Yes	Plugin
Embedded Video	Yes	Yes	Plugin	No	Yes	Plugin	Yes	Plugin
Image Editing	No	No	No	Optional	No	Plugin	No	Plugin
SVG Editing	Plugin		No	No	No	Plugin	No	Plugin
MindMap Editing	Plugin	No	No	No	No		No	Plugin

Media Search	Contents	Contents	Filenames only	Keywords	No	No	Contents	Contents
Syntax Examples	Confluence	JotSpot	JSPWiki	MediaWiki	PhpWiki	PmWiki	Socialtext	TWiki
Internal Link	[Page Titl [Link Titl [~username [^attachme		[link] [text|link [text|wiki	[[a link]] [[a link|w	WikiWord o [desc | p	[[page nam [[page nam [[link tex	[link]	WikiWord a Otherweb.W [[Wiki wor [[WikiWord
External Link	[http://ww [Link Titl [Shortcut		[http://ww [example|h [text|wiki	[http://ex	http://som [desc | e	http://... [[http://. [[link tex	http://www	http://twi [[http://t
Headlines	h1. Top Le h2. Smalle h6. Smalle		! Level 1 !! Level 2 !!! Level	==Section= ===Subsect ====Sub-su	!!!Headlin !!Headline !Headline3	! Level 1 !! Level 2 !!! Level	^ Headline	---+ Level ---++ Leve ---+++ Lev ---++++ Le ---+++++ L ---++++++
Bold Format	*bold*		__bold__	'''bold'''	*bold* or bo	'''bold'''	*bold*	*bold*
Italics Format	_italics_		''italics'	''italic''	_italics_ or italic	''italic''	_italics_	_italic_
Underline Format	+underline		%%(text-de	<u>underli	<u>underli	{+underlin		<u>underli

Monospace Format	{{monospac		{{monospac	<tt>monosp	<tt>monosp
					<code>code
					<pre>prefo
					<verbatim>
					unparsed t
						@@monospac	.pre
							monospace
							.pre
								=monospace
								<verbatim>
								multi line
								</verbatim

Strikethrou Format	-strikethr		%%(text-de	<s>striket	<strike>st	{-striketh	--striketh	<strike>st
Superscript Format	^superscri		%%(vertica	<sup>super	<sup>above	'^superscr		<sup>super
Subscript Format	~subscript		%%(vertica	<sub>subsc	<sub>below	'_subscrip		<sub>subsc
Images	!attached- !Other Pag !http://ex		[local.jpg [{Image sr [{Image sr	[[Image:wi	[http://f ␣␣externa [Upload:vi ␣␣view up [Upload:vi ␣␣view an	http://foo Attach:foo	http://www	%ATTACHURL http://any

Aligning Text	{html}<div		%%(text-al	Ce	<?plugin R	%center% c %right% ri		| left | or HTML or CSS
Text Indentation			%%(text-in %%(text-in	: indented	;: left in ;;: more l or ␣␣␣paragr ␣␣␣␣␣and	-> indente	> indented	<blockquot multi line </blockquo
Bulleted Lists	* one ** One-two * two * three		* Item 1 ** Item 1. * Item 2	* Item 1 ** Item 1. * Item 2	* list	* Item 1 ** Item 1. * Item 2	* bullet i ** bullett	␣␣␣* Item ␣␣␣␣␣␣␣* 1 ␣␣␣* Item
Numbered Lists	# one ## One-two # two # three		# Item 1 ## Item 1. # Item 2	# Item 1 ## Item 1. # Item 2	# list	# Item 1 ## Item 1. # Item 2	# numbered ## numbere	␣␣␣1. Ite ␣␣␣␣␣␣␣a. ␣␣␣1. Ite
Definition Lists			;term:defi	; term : d	Term:<def>	: term : d	Term > definiti	␣␣␣$ Term
Horizontal Rule			----			----		---
CanvasWiki	remove	remove	remove	remove	remove	remove	remove	remove

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Appendix B

Suggested Editing Guidelines for the Interactive Knowledge Library

General Content –	In general, if it is not suitable content for an e-mail to the whole company it is not suitable content for the knowledge library.
Naming Conventions –	Provide alternate terminology wherever possible as this will aid others in searching for information.
Page Size –	Avoid making a page too long. Create child pages as necessary for lengthy content.
Editing Pages –	Improve pages whenever possible. Try and avoid deleting material unless it is blatantly outdated or incorrect.
Opinions –	If something is only opinion do not state it as fact. Try to be balanced and detail all sides of an issue. Expressing opinion is acceptable and encouraged, as long as it is stated as such.
Respect others opinions –	Engineering is not an exact science. Try and respect the opinion of others.
Build Consensus –	Where disagreement exists, comment and discuss the issue with others within the library rather than deleting their material.
Discussion and Debate –	Wherever possible place comments and discussion in the appropriate area instead of cluttering the main text.
Avoid Criticism –	Focus on knowledge and your learning from experiences. The knowledge library is not intended as a sounding board for criticism of a person or organization.
Provide References –	Wherever possible reference sources of information and knowledge.

Copyrighted Material –	Avoid publishing any copyrighted material from external sources without permission.
Confidential Information –	While the Interactive Knowledge Library is intended for internal use only, placing potentially sensitive information in the library should be avoided.

Appendix C

Suggested Template Headers for System Design Pages

Functional Description	–	A brief description of the purpose and scope of the system. Include alternate terminology to assist search function.
Corporate Design Standards	–	Hyperlinks to any corporate design standards which must be considered in the design of the system
External Standards	–	References to external standards including hyperlinks where available.
Related Equipment	–	Hyperlinks to the specifications relevant to the system
System Design	–	Discussion of system design
Pipe Routing	–	Discussion of any specific pipe routing requirements or recommendations
Instrumentation	–	Discussion of system instrumentation requirements
Controls Philosophy	–	Discussion of requirements for system logics
Project Examples	–	Examples for reuse such as references to piping and instrument diagrams and system calculations. Hyperlinks to project database and drawings to be included as appropriate

Appendix D

Suggested Template Headers for Specification Pages

Function and Scope	–	Brief description of the purpose of the specification and the scope it covers
Corporate Guide Specification	–	Hyperlink to standard specification text
Guide Spec Commentary	–	Discussion of issues relating to the guide specification
Key Interfaces	–	Details of interfaces with systems and other equipment which need to be considered when specifying this equipment.
Potential Scope Issues	–	Discussion of items of note when evaluating and negotiating scope when procuring under this specification
Vendor Details and Experiences	–	Any notable differences in dealing with the various vendors
Typical Lead Times	–	Notes to keep track of the latest lead times for project planning
Related Specifications	–	Hyperlinks to Wiki pages for closely related specifications
Related Systems	–	Hyperlinks to the Wiki pages for system design of the closely related systems
Corporate Standards	–	Hyperlinks to relevant corporate standards
Relevant External Standards	–	References to and hyperlinks where available to relevant industry and governmental standards