UNIVERSITY OF STRATHCLYDE, GLASGOW

Department of Design, Manufacturing and Engineering Management

Knowledge Management: Identification and Realisation of Requirements and Best Practices

Fraser Macintyre

A thesis presented in the fulfilment of the requirement for the degree of MPhil

2013

Acknowledgments

Thanks first of all to the following people from the Department of Design, Manufacturing and Engineering Management at the University of Strathclyde, Glasgow for their assistance, guidance and motivation.

Avril Thomson
Andrew Wodehouse

Additionally, thanks must go to everybody at Hulley & Kirkwood Ltd for their support and accommodation during the project, in particular.

Bill Kilpatrick
Simmy Telfer
Derek Graham
Michael Brown

Abstract

This thesis focusses on the development of a Knowledge Management system for a multi-office engineering design consultancy. It describes the identification and realisation of user and business requirements in a new Knowledge Management system together with approaches for the implementation and evaluation of a Knowledge Management system. Transferable lessons in the form of Best Practice guidelines are then identified.

The thesis begins with a review of the current and recent literature relating to the field of Knowledge Management and Knowledge Management systems. It also explores literature relating to communication, design, implementation and evaluation. Following the literature review the methodology chapter outlines the seven stages of the project and desired outcome from each stage. A mixture of data collection methods including questionnaires, semi-structured interviews and informal discussion were employed to gain an understanding of the current Knowledge Management practices and procedures in the engineering design consultancy. A process for the capture and understanding of Knowledge Management requirements is also identified. Chapter 5 then addresses how these requirements can be translated into specifications for a Knowledge Management system. Specifications and matrixes were employed to select an appropriate software platform for the development of the Knowledge Management system which is introduced in Chapter 7.

Following the development of the Knowledge Management its implementation and evaluation across the organisation is described. Finally recommendations and lessons learned for the design, development, implementation, embedding and evaluation of a

Knowledge Management system are provided. These are presented in the form of best practice guidelines which may be transferable to other organisations including SME's.

Contents

List of Figures

List of Tables

1. Introduction and Background

1.1 Introduction

This research describes an industry based study aimed at developing a Knowledge and Information Management System 'HKnowledge' within a UK-based engineering design consultancy, Hulley and Kirkwood Consultancy Engineers Ltd (H&K). The study commenced in April 2009. The objective of 'HKnowledge' is to best support communication throughout H&K's design process through the capture, validation, and sharing of key design knowledge and information. Identifying and understanding the knowledge and information requirements throughout the company's design process is the foundation to providing appropriate and effective support. Figure 1 illustrates the project stages of the Knowledge Management project and the academic outcomes that could be gained at each stage.

Project Road Map

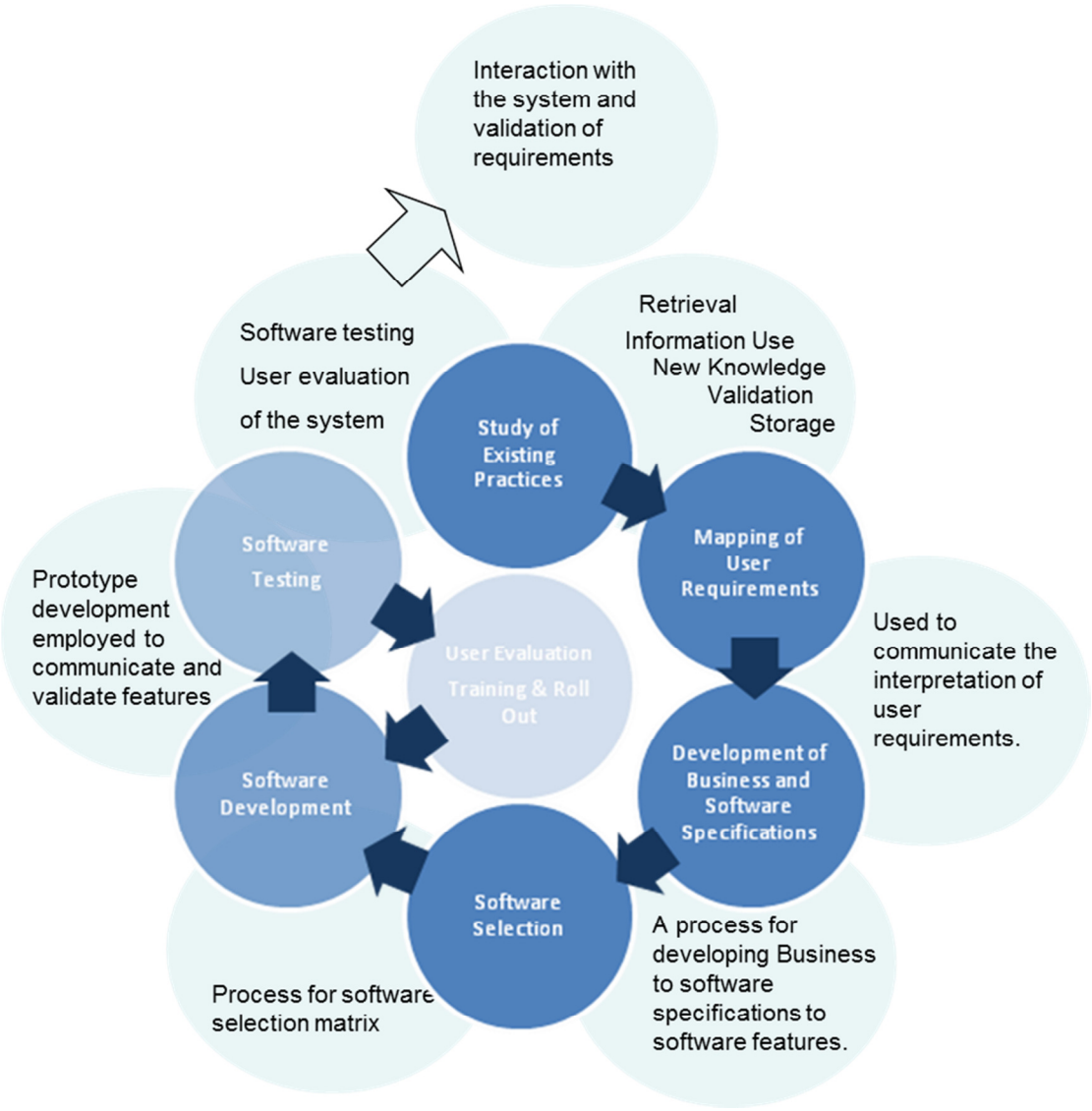
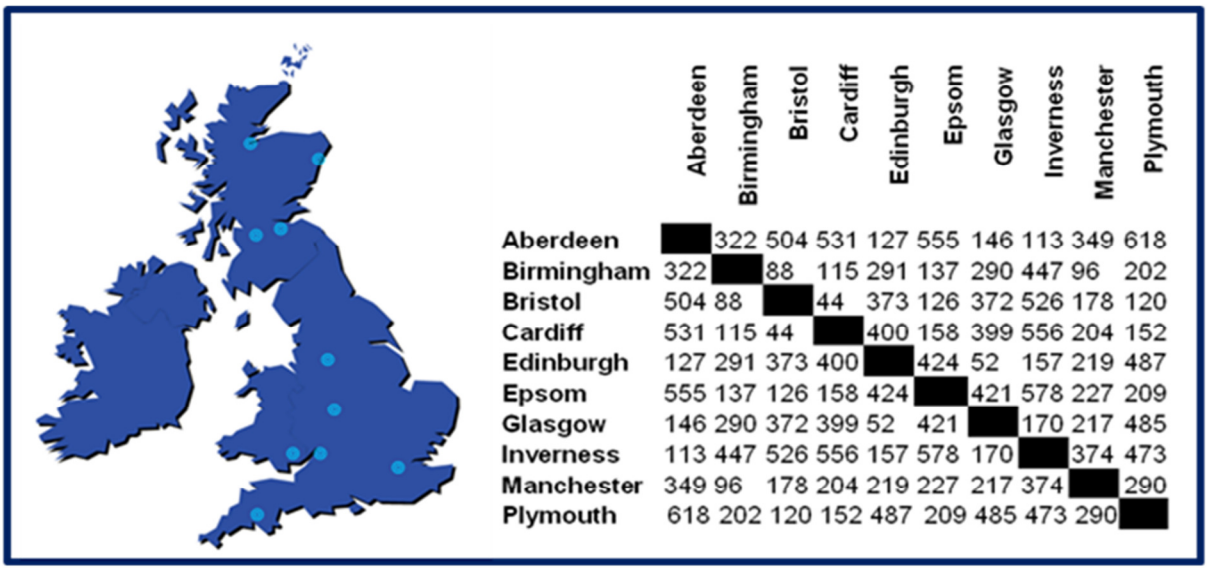


Figure 1 Project Road Map

1.2. Company Introduction

Established in Glasgow in 1953, H&K is a leading mechanical and electrical building services design consultancy, and has over 180 staff in 10 locations distributed across the UK. Glasgow remains the head office hosting just over 30% of the total staff, with regional offices in Inverness, Aberdeen, Edinburgh, Manchester, Birmingham,

Bristol, Cardiff, Plymouth and Epsom. Figure 2 illustrates the distribution of H&K offices throughout the UK. This distribution allows H&K to respond effectively to projects based in any UK location.



	Aberdeen	Birmingham	Bristol	Cardiff	Edinburgh	Epsom	Glasgow	Inverness	Manchester	Plymouth
Aberdeen		322	504	531	127	555	146	113	349	618
Birmingham	322		88	115	291	137	290	447	96	202
Bristol	504	88		44	373	126	372	526	178	120
Cardiff	531	115	44		400	158	399	556	204	152
Edinburgh	127	291	373	400		424	52	157	219	487
Epsom	555	137	126	158	424		421	578	227	209
Glasgow	146	290	372	399	52	421		170	217	485
Inverness	113	447	526	556	157	578	170		374	473
Manchester	349	96	178	204	219	227	217	374		290
Plymouth	618	202	120	152	487	209	485	473	290	

Figure 2 H&K offices (Distances in Miles)

To fully exploit this competitive advantage H&K leverage skills and resources through the adoption of distributed design across regional offices on a project-to-project basis. The approach H&K adopts involves each project being managed from a 'Lead Office' located closest geographically to the actual 'Project Site'. The lead offices communicates with the external design team members and relays information back to designers in a 'Support Office' who have more time or appropriate skills and knowledge to complete all the elements of the design work. Figure 3 illustrates H&K's distributed design approach. Whilst working in a distributed manner offers H&K competitive advantage, it requires effective and efficient communication of knowledge and information throughout the design process. There are numerous barriers to distributed design including technical expertise, management, cultural, trust, lack of time etc. SME's (Small and Medium sized Enterprises) like H&K can

find it particularly difficult to overcome these barriers to distributed design. To combat this H&K employed a 'collaborative design' working environment as demonstrated in figure 3. (Ion & Neilson, 1998)

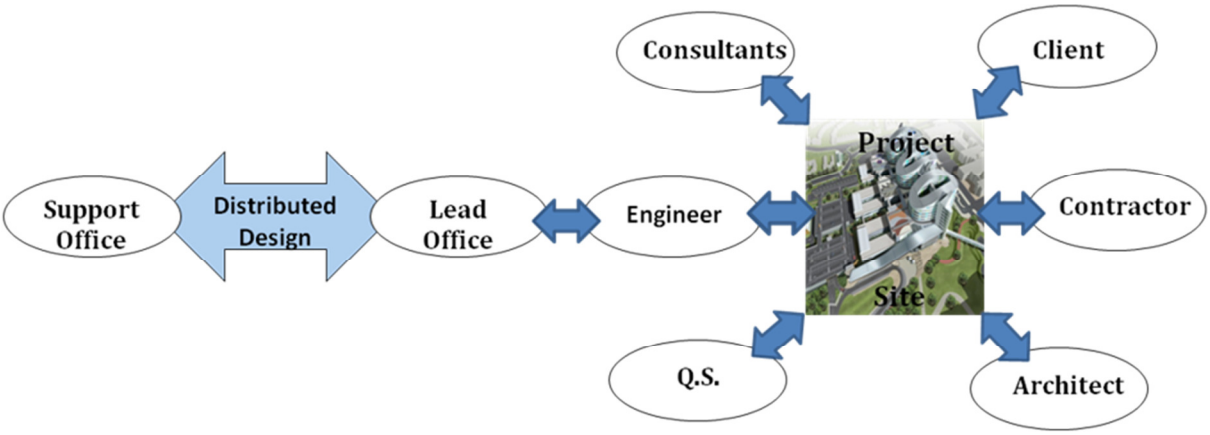


Figure 3 H&K Distributed Working Approach

Accordingly, H&K have invested in an IT infrastructure for efficient multi-site communication and in standardisation of processes and tools across their organisation (Thomson et al, 2007). Whilst the company have reaped many benefits from these developments they have identified several issues with their existing practice for improvement. These include:

- delays caused by too much 'starting from scratch' on new projects when existing project knowledge and information could facilitate streamlining of initial design stages
- experienced design engineers with significant knowledge and information resource but no effective method for capturing, validating, storing, and communicating this knowledge and information for reuse
- lack of expertise in knowledge and information management approaches

A consistent finding from existing studies is that 'personalised' capture and codification of knowledge and information is necessary for different organisations (McMahon, C et al 2004). This work focuses on the process of understanding the knowledge and information requirements within H&K's design process and providing support for these requirements through their translation into system features.

1.3 Motivation

H&K have 180 engineers located across 9 sites throughout the UK. The organisation is growing with increasing turnover, locations and staff. Target turnover by June 2011 is £15million. However the organisation was affected by the UK recession with turnover decreasing and redundancies taking place across the organisation. The organisations distribution of expertise presents exceptional challenges in the efficient and effective management of information and knowledge across the organisation. H&K want to establish a clear and consistent company identity by ensuring they sell and deliver the same product across their 9 sites, providing them with the ability to "resell" similar product where and when required. The ability to capture, validate, re-access, re-use knowledge and information will help achieve this.

1.4 Aims and Objectives

The Aim of this research is to develop a process that will assist in the identification of Knowledge Management requirements within an organisation, and provide a guide of best practices for Knowledge Management development, realisation and evaluation.

To achieve this aim, the following key objectives were addressed;

O1. Review and develop an understanding of literature in the field of Knowledge Management.

O2. Understand the current Knowledge Management practices and procedures within and engineering design consultancy.

O3. Develop a process for the capture and understanding of all Knowledge Management requirements, and how they can be communicated.

O4. Identify how requirements can be translated into software features.

O5. Understand how requirements that have been translated into software features, can be communicated and validated with the user.

O6. Realisation of System features and identification of methods for their communication and validation with potential users.

O7. Evaluate and assess the impact of the Knowledge Management system.

O8. Produce guidelines of best practice for the development and implementation process for a Knowledge Management system

1.5 Structure of Thesis

Chapter	Title	Objectives	Research Method
1.	Introduction	-	
2.	Literature Review	O1	Critical appraisal
3.	Methodology	-	
4.	Understanding Information and Knowledge Requirements	O2,O3	Questionnaires, Interviews, and Informal discussion
5.	Communicating User Requirements and Building a Specification	O3,O4, O5	Mapping, Diagrams and Communication Resources
6.	Software Selection	O6	Matrix of Requirements
7.	System Overview	O6	
8.	Implementation and Evaluation	O7,O8	Statistics and Informal discussion and Feedback
9.	Impact Recommendations and conclusions	O8	

Figure 4 Structure of Thesis

Chapter 1 provides an introduction to the thesis, describing the background, motivation, aims and objectives of the research.

In **Chapter 2** a review of current and recent literature relevant to the research domain is presented, defining the field of Knowledge Management, reviewing the state of the art literature on Knowledge Management and the organisational behaviours that require to be considered.

The overall research methodology is described in **Chapter 3.**

Chapter 4 addresses how the user's information and Knowledge Management requirements can be interpreted and understood.

Chapter 5 demonstrates how user requirements can be communicated and validated with the user and employed to build specifications.

Chapter 6 describes the process employed to select the software platform for development.

Chapter 7 provides an overview of the Knowledge Management system and its key functions based on the user requirements.

Chapter 8 addresses the implementation of the system and evaluates the system generating user feedback, this is employed to create conclusions, best practices, limitations and recommendations for future work.

The final **Chapter 9** provides a recommendations and lessons learned in the form of best practice guidelines for the development and implementation of the Knowledge Management system, summarising the realisation of the thesis objectives.

2. Literature Review

2.1 Introduction

This chapter will demonstrate a review and understanding of literature in the field of Knowledge Management. The image in figure 5 demonstrates the key areas that the literature review will cover; this chapter will address the first of the objectives.

O1. Review and develop an understanding of literature in the field of Knowledge Management.

Figure 5 Knowledge Management Literature Review and Related Terms

Mark Easterby-Smith comments that in 2003 the idea of Knowledge Management has arrived only very recently, this is reinforced by Davenport and Prusak (2000) comment that it was still in its infancy in 1998, (Davenport & Prusak, 1998/2000) Mark Eastaby Smith furthers this argument that it is only post 2000 that Knowledge Management has gainned legitimacy the driving force being ‘major consultancy

companies seeking to capitilize on the enormous potential of information and technology in a period following disenchantment with the methods and prescriptions of re-engineering (Hammer & Champy, 1993).

2.2 Defining Knowledge and Information

The oxford dictionary defines knowledge as; 'facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject.' (Oxford University Press, 2011) But can this definition be applied to a corporate setting when we discuss knowledge almost like a currency; authors have argued that there are knowledge markets, with knowledge buyers, sellers and brokers in organisations, who seek a personal gain in knowledge transactions (Davenport & Pruska, 1998; Holsapple, Johnson, & Waldron, 1996).

Before reviewing the area of Knowledge Management, it is necessary to define what we mean by knowledge, and make a clear distinction between Knowledge and Information. This has been outlined in a number of different ways, from the classical philosophical perspective as 'justified true belief' (Petersen & Poulfelt, 2002) to a more pragmatic view as 'for action' (Davenport & Prusak, 1998) At the same time, knowledge has become an umbrella for many different words – including data, information, wisdom, codified, personal, proprietary, common, organisational, diffused, migratory, embedded, embodied, encultured, embrainned, tacit, explicit, sticky and so forth cf. (Boisot, 1998; Badaracco, 1991; Blackler, 1995; Petersen & Poulfelt, 2002; Nonakak & Takeuchi, 1995; Saint-Onge, 1996; Hippel, 1994).

In addition to defining knowledge, it is also important to understand its broader context. Much of the academic literature on information use that has emerged in recent years is acknowledged to have derived from Ackoff's (1989) exploration of the relationships between data, information, knowledge, intelligence and wisdom – now commonly referred to as the 'DIKW hierarchy'. Several authors (Rowley, 2007; Zins, 2007) have attempted to summarise the variations and similarities across the field:

- *Data:* observable properties of objects, events and their environment.
- *Information:* inferred from data, containing descriptions of how data can be used.
- *Knowledge:* the abstraction, generalisation and application of information.
- *Wisdom:* judgment and the ability to review the other levels critically.

In his attempt to adapt the DIKW hierarchy for the purposes of interaction design, Shedroff (1999) identifies location (in global, local and personal terms) and context (the type of cognitive activities undertaken) as important factors in transformation across the hierarchy. In a similar vein, figure 6 depicts the DIKW hierarchy adapted for the engineering design domain. Broadly speaking, data is available to all in the form of catalogues, mechanisms, material samples and so on. These are sourced and structured by engineers for use in the particular design context, becoming information. The application of this information in the synthesis of new design concepts is regarded as forming knowledge items. Both information and knowledge are shared by the design team working on the particular design problem. Wisdom sits somewhat apart from the other levels in that it is the reflection and absorption of knowledge by individuals that allows them to critically apply any of these information types in the future. For the purposes of this research, then, information sourced by the team as relevant to the design problem, and the effect this has on the subsequent development of new knowledge items are critical.

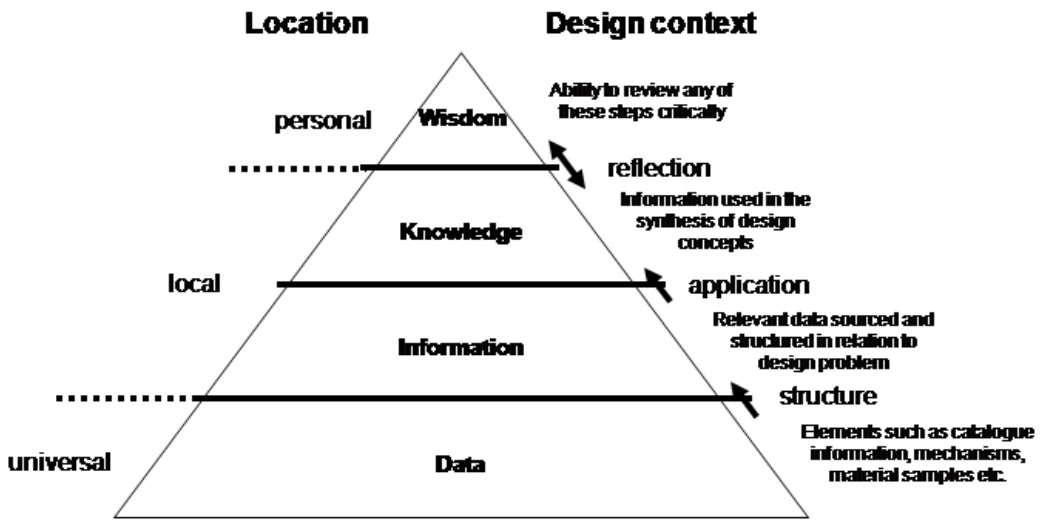


Figure 6 Information in the Design Team Context (after Shedroff, 1999)

Given the industrial focus of the research described in this paper, we adopt a pragmatic view of knowledge similar to that of Davenport & Prusak and consider knowledge to be the abstraction, generalisation and application of information for a specific purpose (Rowley, 2007).

2.3 Communicating Information

The information sourced and generated must be shared effectively for the design team to be successful. To achieve this, it is necessary to have clear methods of organisation and communication, as individuals can build complex mental maps of information resources that may be understandable to them but confusing to others. An example of this is the messy office desk that may look confused to casual onlookers but makes perfect sense to its occupier. In the development of the desktop metaphor for computing systems, the development of 'files and piles' metaphors were of considerable importance. Piles of papers were found to be informal information stores which in addition to negating the need for classification, performed important roles as

reminders for tasks to be undertaken (Malone, 1983; Mander, Salomon, & Wong, 1992). Thus, messy office spaces which can seem disordered to the onlooker may nevertheless have a systematic way of organising all the information resources contained in it and be able to work extremely effectively. Indeed, such individuals are often able to find a particular document immediately when required to do so: the personalisation of information allows individuals to tailor these mental maps to their own requirements. For the organisational context, however, the challenge is that collective models are required to allow everyone to understand where and how resources are located to encourage their utilisation. To achieve this, it is necessary to move beyond the 'files and piles' metaphor to more specific knowledge models that facilitate clear communication. When teams are distributed, these communication issues become even more critical and difficult to solve, as many of these channels are restricted. The nuances of language and gesture used to fully express meaning, for example, are often lost across lower resolution webcam and videoconference technology. It is therefore necessary to effectively capture the requirements for the design context.

2.4 Knowledge Management Systems Defined

Not all Knowledge Management initiatives call for or involve the implementation of IT (Information Technology), however many Knowledge Management initiatives rely on IT as an important enabler. The importance of IT in Knowledge Management can be at the expense of the social and cultural facets that are essential in successful Knowledge Management System implementation.

Daniel Tkach of IBM worldwide describes Knowledge Management as;

> *"a discipline used to systematically leverage expertise and information to improve organisational efficiency, responsiveness, competency and innovation. Systematically means that the discipline does not rely in just water cooler conversations, but one planned processes technology and behaviours. Knowledge Management leverages all the key resources that a company had already and that can be out to use in a more effective way."*

For Knowledge Management to be a planned activity it must align with business strategy, Knowledge drives strategy and strategy drives knowledge management. There must be a clear link between Knowledge Management and business strategy. In the context of a Knowledge Management system, business strategy is usually at a high level. In contrast, system design is always at a low level – rise Knowledge Management system design to a level of business strategy and pull strategy down to a level of system design. In the context of the H&K project, this can be referenced in the interviews and the sample as we had a high level in the project with the input from the MD's.

So how are we defining a system, the system is the toolkit that will assist us in our Knowledge Management strategy. However this also must take into account and be integral with business strategy. Information and Communication Technologies (ICTs) have a prominent role in many Knowledge Management activities. ICTs can be

defined as “technologies which allow/facilitate the management and/or sharing of knowledge and information. Thus the term covers an enormous diversity of heterogeneous technologies including computer, telephones, e-mail, databases, data-mining system, search engines, the internet and video conferencing equipment” (Donald, 2009). Therefore a Knowledge Management system in the context of this project can be defined as a planned activity that will encapsulate ICTs that will facilitate the management and sharing of knowledge and information.

2.5 Taxonomy and Metadata Tags

Taxonomies can be defined as a basic classification tables that enable us to describe concepts and their dependencies – typically in a hierarchical fashion (Dalkir, 2005). A taxonomy involves the identfication, defining and grouping of elements. Taxonomies can also be explained in the context of everyday life by Pellini and Hones:

> *“Taxonomies are part of our daily life and this is particularly apparent today. The explosion in the volume of information and knowledge available through information technology and through the internet today has made it more urgent than ever to adopt systems, processes, and technology to orginisation this information.”* (Pellini & Jones, 2011)

Using this interpretation of taxonomies within the concept of Knowledge Management taxonomies can be viewed as a hierarchal structure that shapes a body of

knowledge. Taxonomies in Knowledge Management can be used for the identification, defining and grouping of knowledge within a Knowledge Management system.

Metadata is described by most at its most basic definition as "data about data" (Yariez, 2009). The term metadata alludes to data that facilitates the description, discovery and retrieval of networked electronic resources. (Hudgins, Angew, & Brown, 1999) This quote is also be interpreted to describe the use of metadata in a Knowledge Management system that metadata facilitates the discovery and retrieval of knowledge within a Knowledge Management system. Tiwan indicates that in Knowledge Management automatic metadata tagging is not always appropriate and that it is more appropriate for the user to generate metadata (Tiwan, 2000). This would give the knowledge greater description and facilitate knowledge discovery within the system.

2.6 Knowledge Management System Requirements and Design

A requirement can be defined as "an objective that must be met" (Kanner, 1999). The process for requirements capturing and how they are communicated between users and development team is critical to the success of any Knowledge Management project, in order to derive the software features from user requirements. Requirements can be segregated into two categories: functional and design requirements. Functional requirements describe what the software must accomplish from the users view point. The design requirements describe how the software meets the requirements, with acceptable level of user performance and satisfaction (Clements, 1999). It is the

functional requirements that are difficult to capture and communicate between user and project team: there are several techniques available such to communicate these such as the Delphi Technique that employs a group of experts and a facilitator and mathematically based approaches (PMBOK, 2008). Despite this, many organizations spend huge amounts on fixing poorly specified software but seem unwilling to invest a much smaller amount to get the requirements right in the first place (Robertson & Robertson, 2006). It appears to be the phase-to-phase communication between the user and the project team that provides the misinterpretation of the requirements (Robertson & Robertson , 2006), hence the importance of the communication and understanding of requirements throughout the design process.

It is fundamental that requirements are communicated and understood by the users and the project team, and are incorporated into the system design. During the system design, there are several methods that can be employed to reinforce that the requirements have been communicated and understood.

- *Use Cases:* a scenario used to describe a requirement or set of requirements to communicate how the system will interact with the end users and that the requirement had been understood (Cockburn, 2001).
- *Prototype:* a mock-up of an application. Allows the end user to visualize the system before construction. Prototypes increase the communication between users and project teams (Crinnion, 1991).
- *Application Simulation Tools:* allows users to build lightweight models of the application, this allows the user and project team to quickly communicate and validate requirements (Cockburn, 2001).

Each one of these methods for understanding and validating requirements during the design process also provides a route for communication between the user and project team. Employing these tools during the design of a Knowledge Management system ensures that requirements are understood and not misinterpreted during the design and development of a system.

2.7 Implementation and Evaluation

Implementation of a system involves creating the right environment in which the system can be used and evaluated (Bocij, Chaffey, Greasley, & Hickie, 2006). A period of changeover is traditionally employed which describes the period of migration from the existing system to the new system. Because the Knowledge Management system is a new system and dose not replace any existing systems within the organisation phased implementation can be employed which will deliver parts of the system at different times (Bocij, Chaffey, Greasley, & Hickie, 2006). The advantage of this with a new system is that is allows staff to learn about the new system gradually and any problems encountered addressed. This also highlights one of the disadvantages of phased implementation or development. The fact that it encourages overlapping activities this encourages queues with interdependencies between phases delays can be found when phases are not approved due to development issues which will then affect the timing of the next phase. (Smith & Reinersten, 2004) So when employing phased implementation of a new system, it is important to ensure issues generated in a phase are tackled in a timely manner to ensure a review can take place and the next phase of implementation can begin.

It is inevitable that there will be resistance to implementation and the changes that the new system will create. With a Knowledge Management system resistance can be viewed in two ways, barriers to the new system itself and the concept of Knowledge Management itself. Resistance to the new system can be explained because of the change to the way work is performed and the fact that user's job functions will be changed (Bocij, Chaffey, Greasley, & Hickie, 2006). In order to achieve; buy- in to the concept of Knowledge Management, Tiwan (2000) highlights a user's attitude to Knowledge Management "Users of a Knowledge Management system will contribute only if they feel they are gaining something *valued by them* in reciprocation." (Tiwan, 2000) The fact that users will buy into Knowledge Management and participate in activities if there is a percived benefit for themselves. This concept reinfources the use of phased implementation in that the system can be implemented across the orginisation in phases that seek to deliver specfic bennefits to the users. Delivering specfic benefits to users during the implementation of the system will seek to sway resitance to Knowledge Management as a concept.

During the implementation of a new system it is essential that on-going evaluation takes place against set criteria performance measurement can be employed to evaluate a Knowledge Management system. Performance measurement is a standard of good management practice for many years, therefore can performance measures be employed to evaluate a measure the value of Knowledge Management systems? Hanley and Malafsky (2004) argue that using performance measures in relation to Knowledge Management require special rules; "Performance measurement is generally best suited for tangibles, and much of Knowledge Management deals with intangibles, such as intellectual capital and organisation memory" (Hanley &

Malafsky, 2004). They suggest that measures should focus on the factors that affect the ability to achieve strategic objectives. Metrics can be used to develop specific measures that are considered to be the most relevant and useful that will measure the performance of the Knowledge Management system against its strategic objectives (Tipping, Zeffren, & Fusfield, 2004).

2.8 Literature Review Summary

This summary of the literature review demonstrates the understanding of the literature in the field of Knowledge Management and the context of this project. For the purpose of this project, the following interpretations can be made;

- Davenport & Prusak (2000) definition of knowledge is adopted that considers knowledge to be the abstraction, generalisation and application of information for a specific purpose.
- A Knowledge Management system in the context of this project can be defined as a planned activity that will encapsulate ICTs that will facilitate the management and sharing of knowledge and information.
- Taxonomies in Knowledge Management can be used for the identification, defining and grouping of knowledge within a Knowledge Management system.
- Metadata can be utilised in Knowledge Management systems to give the knowledge greater description and facilitate knowledge discovery within the system.

- Design tools such as use cases, prototypes and application simulation tools can be employed to ensure requirements are fully understood when developing a Knowledge Management system.
- Resistance to the implementation of a new system can be expected. Delivering perceived benefits to users can be employed to contest barriers to implementation.
- Performance measures and metrics can be used to evaluate a Knowledge Management system against strategic objectives.

3. Methodology

3.1 Introduction

The project consists of seven main stages as illustrated on the vertical axis of figure 7 each stage is explored briefly. The horizontal axis of figure 7 describes the 'requirement', 'metric', 'method' and 'output' for each project stage. The requirement describes the desired outcome from each stage, the metric describes what is being measured at each project stage, the method column describes the process that was

employed, and the final column output gives a brief description of the outputs achieved or expected.

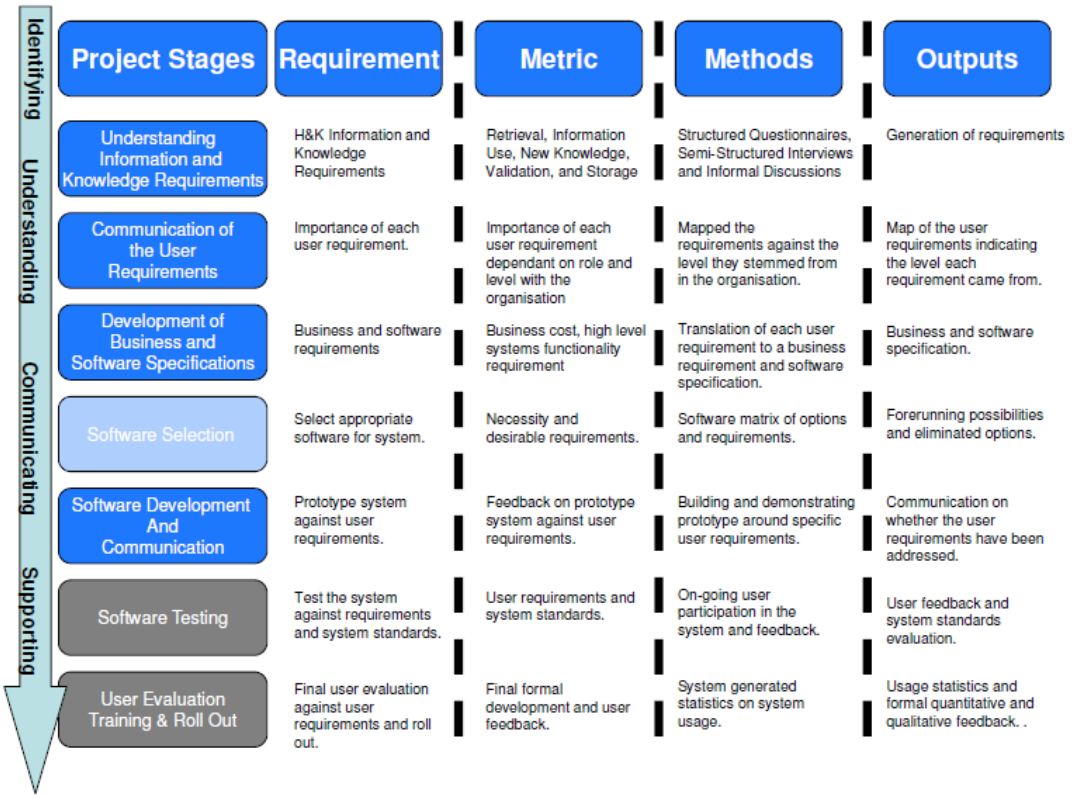


Figure 7 Overall Project Methodology Diagram

Understanding Knowledge and Information Requirements

The 'Understanding Knowledge and Information Requirements' stage is concerned with identifying and understanding the knowledge and information management requirements. The requirement was to identify the organisation's knowledge and information requirements. The metrics explored was the organisation's approach to retrieval, information use, new knowledge, validation and storage of knowledge and information. The methods employed to explore these metrics were structured questionnaires, semi-structured interviews and informal discussion. The output from this stage was the generation of requirements for the Knowledge Management system.

Communication of the User Requirements

The requirement for the 'Communication of the User Requirements' was to identify the importance of each of the user requirements dependant on that users role and level within the organisation. The method employed was to develop a map of the user requirements identifying their importance based on the area and level of the organisation that the requirement stemmed from. The output from this stage was a map of the user requirements that could be employed to communicate, validate and refine them with users in the future.

Development of Business and Software Specifications

The requirement from the third stage was the development of business and software specifications. The metrics explored were to generate the business cost or impact of each requirement and the high level systems functionality required. The output from this stage was the business and software specifications. Methods employed to develop these specifications was the process that translated each user requirement to a business and software requirement and finally software feature.

Software Selection

The appropriate software was selected for carrying out the project in order to ensure correct selection. Requirements had to be evaluated against the various software options and requirements were deemed necessary or desirable, this was the metric from this stage of the project. The method employed was the production of a metric of software options. The final output from this stage was the software options that could be eliminated and forerunning options.

Software Development

The requirement for the 'Software Development' stage of the project was the development of a prototype system against the users requirements. The metric for this stage was feedback on the prototype system against the users requirements and the methods employed where building and developing prototypes around specific user requirements. The final output for this stage was communication and validation on whether the user requirements had been addressed in the prototype development.

Software Testing

The requirement for this stage was to test the system against specific requirements and system standards. The methods undertaken were on-going user participation in system usage and feedback. Outputs from this stage included user feedback and the evaluation of the system against specific standards.

User Evaluation Training and Roll Out

This final stage was the user evaluation against the requirements during the training and roll out of the system. The metric for this stage was final formal feedback from the users on the system. Methods employed were the generation of system statistic and informal discussion with users. Outputs from this stage included statistics on the system use and qualitative feedback from users across the organisation.

3.2 Conducting the Research

The research was carried out as part of a Knowledge Transfer Partnership project between the university and the organisation H&K. The aim of the project was to develop a Knowledge Management system for the organisation. The university has worked with H&K previously on other projects so a working relationship existed between the two. While previous projects had been aimed at engaging with the entire organisation it was found that participation was limited to the Glasgow head office. It was essential for the Knowledge Management project that engagement came from all the regional offices. The researcher would be based in the Glasgow offices. However a working relationship was established with the director and staff of each regional office to ensure their engagement in the project at an early stage.

3.3 Data Collection

Quantitative and qualitative data was captured during the project. The employee interviews qualitative research Denzen (2003) describes qualitative research as 'an emphasis on the qualities of entries and on process and meanings that are not experimentally examined or easured in terms of quality, amount, intensity or frequency' (Denzen & Lincoln, 2003). In contrast Denzin (2003) describes the quantitative research as a 'the measurement and analysis of causal relationships between variables, not process.' (Denzen & Lincoln, 2003) This project use both quantitative and qualitative research methods. The interviews are qualitative; the aim was to derive interpretations, not facts or laws, from the respondent talk. (Warren, 2001; Warren 2002) discuss the way in which qualitative interviews are framed and identifies two techniques researchers that frame the qualitative interview as a 'speech event' (Mishler, 1986), where they seek to analyse the conversation, this looks at the interview from a more ethnomethodology perspective as the interviewer seeks to

understand the way in which people make sense of their worlds (Baker , 2002). While Warren (2002) frames it "more substantively and internationally, aiming to understand the meaning of respondents experiences and life worlds" (Warren, 2001). This project will adopt the Warren's (2002) frame as the interviewer seeks to gain more of an interaction with the participant and meaningful responses to build up a picture of knowledge management in the organisation.

Both quantitative and qualitative methods employed the term given to this is 'mixed methods'. This is the general term when both quantitative and qualitative data collection techniques and analysis procedures are used in research design (Saunders, Thornhill, & Lewis, 2006).

The qualitative research employs interviews with participants at different stages in the project. The quantitative research also takes place at different stages in the project. This is in the form of a structured questionnaire that accompanies the interviews, Quantitative research is also evident in the analysis of the statistical outputs from the system in the final evaluations. The structured questionnaire allows us to collect quantitative data which can be analysed and inferential statistics (Trochim, 2006). The researcher has a clear view of what information is required to be captured before the questionnaire is adminstrated. This clarity must be refelcted in the way the questionaire is constructed (Nesbary, 2000). It is desirable to collect as much relevant

information as possible, the more data we look for the more time consuming the questionaire will be. It is therefore important to strike a balance. To this end, close-ended questions were selected for the survey which took the forum of mutiple choice questions to produce uniformed and concise responses. The criticism of this is that they may be poorly conecived and produce invalid answers (Nesbary, 2000). In order to combat this, the survey would be piloted to ensure it would be understood by the participants, and any issues of clarification could be resolved.

3.11 Interviews and Questionnaires

Interviews and questionnaires were used with H&K employees during the project. Because interviews with employees were being asked for, this would take time away from paid work. Smith et al (2003) suggest that your request for access is more likely to be accepted if the amounts of time and resource you asked for are kept to a minimum. A judgement was made on this and maximum of 60 minutes per interview was requested. A document explaining the interview process and objectives for the Knowledge Management system, in general, was produced and passed to those being interviewed. All requests for interviews were accepted. This can be attributed to the early relationship that was built up with the organisation and the fact that the research question was strategically important for the organisation. A structured questionnaire was also created that would be issued and completed by the candidate prior to the semi-structured interviews. This generated quantitative outputs which allowed statistics to be produced.

4. Understanding Information and Knowledge Requirements

4.1 Introduction

This chapter will address objective two and part of objective three. It will demonstrate an understanding of the current Information and Knowledge Management practices and procedures in an engineering design consultancy. Also developing a process for the capture and understanding of Knowledge Management requirements. The process for communicating requirements are dealt with in chapter five.

O2. Understand the current Knowledge Management practices and procedures within an engineering design consultancy.

O3. Develop a process for the capture and understanding of all Knowledge Management requirements, and how they can be communicated.

An investigation of existing knowledge and information practices within H&K was undertaken in order to facilitate the identification and understanding of the company's knowledge and information requirements. Four main approaches were adopted:

- mapping of typical information in H&K's design process
- questionnaire
- semi-structured interview
- informal discussion

The following sections provide details on how each of these were conducted together with the main findings.

4.2 Mapping of typical information in H&K's design process

The first step was to map the main stages in H&K's design process and to gain an understanding of the information sourced, generated and shared at each stage. The findings are illustrated in table: Table 1 is based on an adaptation from Ulrich and Eppinger (1995) to reflect H&K's design process and information practices. It illustrates the seven main stages in H&K's design process together with the types of information that are typically sourced, shared and generated at each stage. The contents were derived using a combination of standard company documentation in the form of H&K's 'Design Guide' together with understanding of company practices gained from the researcher being based within the company over a three year period.

Design Stage	**Examples of information sourced**	**Examples of information shared and generated**
Pre-Project	qualification based selection	establishment of fees and duties, meeting notes & general communications, preliminarily proposals
Pre-	previous design schemes	brainstorming notes/sketches, sketches,

Construction		drawings, rough calculations, meeting notes & general communications
Scheme Design Stage	consultant/client expectations	sketches, drawings, rough mock-ups and physical models, cost evaluation calculations, meeting notes & general communications
Detail Design	standards, catalogues, suppliers data	detailed drawings and design calculations, final costing calculations, 3D solid models, mathematical and numerical models, meeting notes & general communications
Tender	standards, databases	drawings and specifications, notes on the capability of contractors.
Construction	customer feedback, snagging lists	site queries, project quality plan, coordination drawing, commissioning records, operating instructions for all equipment, maintenance schedules for all equipment
Post-Construction	load monitoring information, energy consumption, installations costs, running costs, maintenance cost	key performance indicator surveys, client feedback, client satisfaction, contractor satisfaction

Table 1 Information and the Design Process Adapted from Ulrich and Eppinger (1995)

4.3 Questionnaires, Semi-structured Interviews and Informal Discussions

Questionnaires, semi-structured interviews and informal discussions were carried out with a cross section of the company's staff across the regional offices. Each of these approaches were used to investigate existing practices for retrieving, using, creating, validating and storing knowledge and information. The questionnaire focussed on producing quantitative data relating to which sources of knowledge and information were being used the most and which were considered the best in terms of breadth, quality, and richness. The semi-structured interview allowed qualitative aspects of existing practices and requirements to be explored. Informal staff discussions were carried out following the questionnaire and semi-structured interview to further elaborate and validate findings. At this stage all participants were given the opportunity to provide any further information they felt appropriate. A representative

cross-section of staff throughout the company participated in the questionnaire, semi-structured interview and informal discussion. In total, 42 members of staff were interviewed from six offices. The aim was to gain a 30% representatives of staff from each office with a representative spread across each of the roles (i.e. mechanical, electrical etc) and levels (i.e. Director, Senior Engineers, Graduate Engineers etc). Four offices Inverness, Aberdeen, Cardiff and Plymouth did not participate as their total staff numbers were too small to best represent a spread of roles and levels as desired.

Office (total staff)	**Role**			**Level**					
	Mech	Elec	Other	Dir.	Senior Eng.	Grad Eng/ Eng.	Other	Total Participants	% staff total
Birmingham (20)	3	3	0	1	4	1	0	6	30
Bristol (17)	2	3	0	1	2	2	0	5	30
Edinburgh (20)	3	3	0	2	2	2	0	6	30
Epsom (13)	2	1	1	0	0	3	1	4	30
Glasgow (50)	3	4	8	3	5	1	6	15	30
Manchester (20)	2	4	0	1	3	2	0	6	30
∑(140)	15	18	9	8	16	11	7	42	30
%age of role/level	36	43	21	19	38	26	17		

Table 2 Breakdown of Questionnaire, Structured Interview and Informal Discussion Participants

Table 2 shows the breakdown of H&K staff participating in the questionnaire, structured interview and informal discussion. The last column clearly demonstrates that the total number of participants in each office why 30% of the overall staff. The total percentage of role and level shown in the bottom row is also representative of the H&K staff profile across all offices. Findings from the questionnaire, structured interview and informal discussion are presented in the following sections:

4.3.1 Questionnaire

The questionnaire consisted of four questions aimed at gaining a quantitative understanding of which sources of knowledge and information are used most and which provide the best information in terms of breadth, depth, quality, and richness. Each question asked participants to rate different sources of information against specific criteria. Table 3 illustrates the criteria assessed and the sources ranked by each question.

	Question	Criteria Assessed	Sources Ranked
Internal	1	used most	Peer Discussion; Company Systems; Shared Company Computer Drives; Personal Computer Desktop; Books (inc. Journals, Professional magazines etc)
	2	best (breadth, quality, richness)	Peer Discussion (communicating with others); Company Systems; Shared Company Computer Drives; Personal Computer Desktop; Books
Internal& External	3	used most	External Sources (i.e. internet); Peer Discussion; Company Systems; Shared Company Computer Drives; Personal Computer Desktop; Books
	4	best (breadth, quality, richness)	External Sources (i.e. internet); Peer Discussion; Company Systems; Shared Company Computer Drives; Personal Computer Desktop; Books

Table 3 Questionnaire Content

As illustrated in table 3, questions 1 and 2 focus on information sources internal to the company, whilst questions 3 and 4 allow a comparison to be made with external sources.

Figures 5 (a) and (b) highlight and compare the findings of Q1 and Q3, respectively.

Q1. Which internal sources of knowledge and information do you use the most (rank 1-5, 1 being most often)?

Q3. Which internal or external sources of knowledge and information you use the most (rank 1-5, 1 being most often)?

The pie charts in figure 5 show the percentages that each source ranked top. It is clear that peer discussion i.e. communicating with others ranks top on both occasions scoring 47% and 53% respectively. Interestingly, when given the option of using external sources of knowledge and information such as the internet only 17.5% select this as their top choice and in fact, peer discussion increases in popularity by 6% to 53%. Books score 0% in both questions.

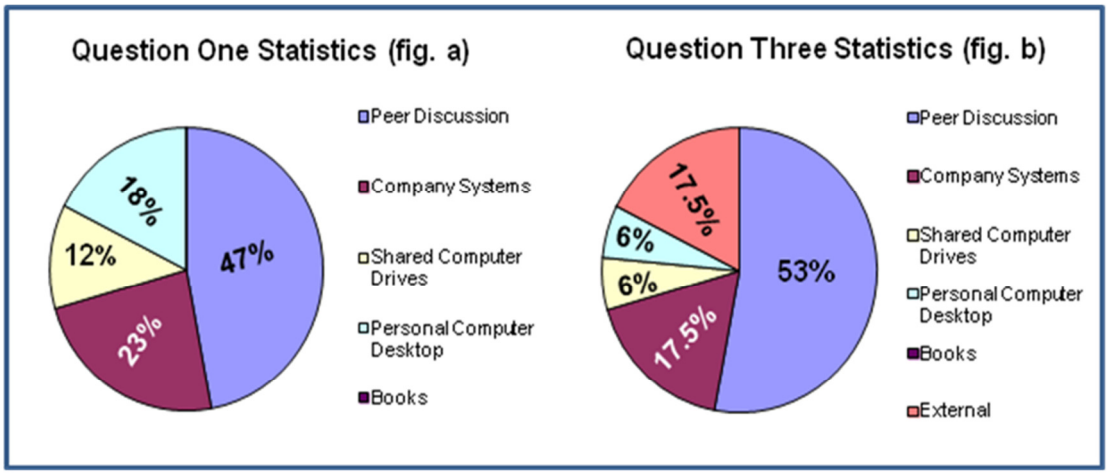


Figure 8 (a) & (b). Results from Structured Questions One and Three Respectively

Figures 6 (a) & (b) highlight and compare the findings of Q2 and Q4, respectively.

Q2. Which internal sources of knowledge and information do you consider to be best (i.e. breadth, quality, richness) (rank 1-5, 1 being best)?

Q4. Which internal and external sources of knowledge and information do you consider to be best (i.e. breadth, quality, richness) (rank 1-5, 1 being best)?

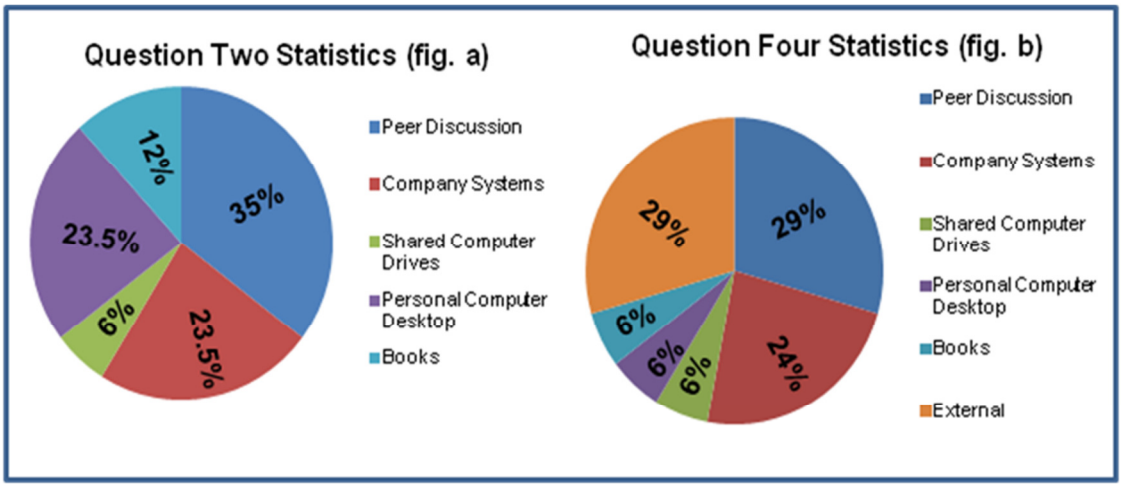


Figure 9 (a) & (b). Results from Structured Questions Two and Four Respectively

When considering internal sources only peer discussion ranks top with 35% considering it to be the best information source. Interestingly, when external sources are considered peer discussion ranks joint top with external sources, both scoring 29%. Staff consider company systems to be equally 'best' in both instances. However, the popularity of information stored on personal computer desktops drops by 17.5% when external sources are considered.

4.3.2 Semi-structured Interviews

The main aim of the interview stage was to identify and capture the requirements of the Knowledge Management system from the H&K users. (An example of interview questions and transcribed answers can be seen in appendix 1) This was from all areas of the business. In addition to unearthing those requirements the interviews also identify how the other offices work; what practices and procedures they do differently and how this could make them work more or less effectively. The semi-structured

interview is aimed at identifying current Information and Knowledge Management practice at H&K. It has been developed to identify good practice, core information and Knowledge Management requirements, together with people and change management issues.

Because of the nature of the work that H&K carry out, they are a project based organisation. This impacted upon the format of the interview. The interviewee selected a particular topic which will be important to the individual or office that the interview was taking place. The discussion focused on retrieving, using, creating, validating and storing knowledge and information.

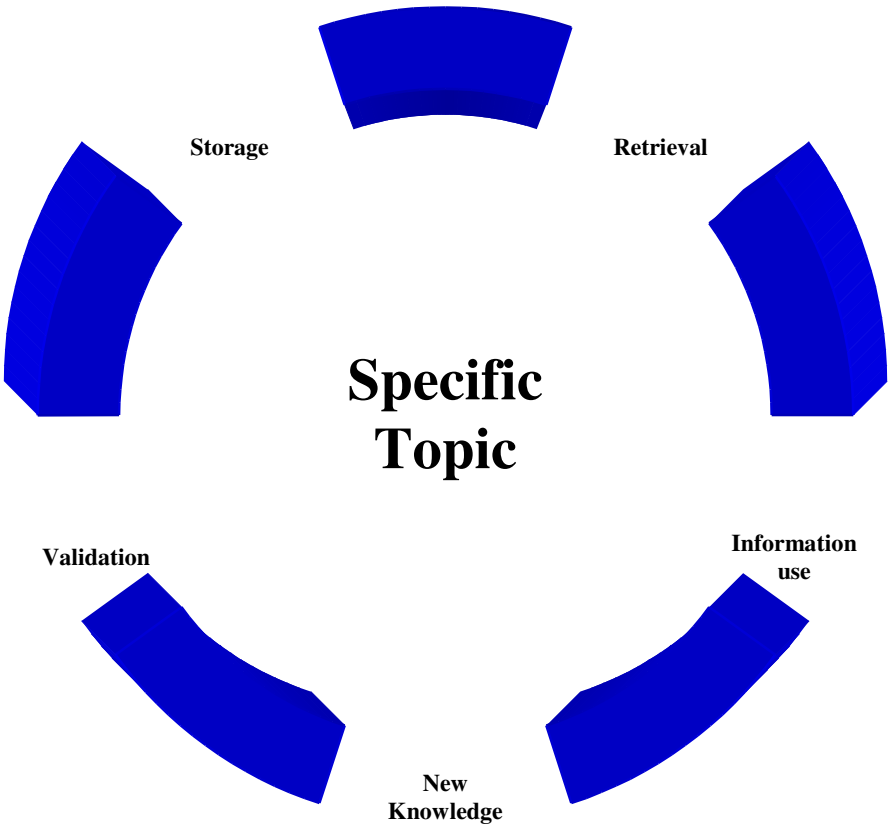


Figure 10 Interview Topic Map

The second stage of the interviews focused on a different topic selected by the individual, posing the same questions in order to identify the similarities and differences in the process. It is important to note that the interview was informal and the overall aim was to gain a rich overview of current Knowledge Management practices at H&K which was ascertained with insight from all its employees.

Retrieval – This section of the interviews aimed at addressing how the employees currently retrieved any information/knowledge on the particular topic being discussed. It looked at typically where the employee would find this information and if there was a specific individual in the organisation that the employee would look to speak to about this topic. This section of the interview also took into account how satisfied the employee was with the current route to this information/knowledge and how accessible they felt that the format was. Finally they were asked about topics in which this route for retrieval of information differed.

The quotes from the structured interviews below are representative of typical responses regarding standard practice for retrieving knowledge and information:

> *Retrieving knowledge and information:* 'I don't have a specific process for retrieving information, but I would always start off by speaking to a senior engineer if they have not dealt with the subject

> themselves then they are usually best placed to point me in the right direction. I would not have any problems about approaching anyone in this office for information. However, I would not feel comfortable contacting anyone in any of the other offices. Think the current systems are quite good once you get to know them. I find asking people first the easiest route because nine times out of ten it is already there within someone's head.'

To summarise the responses for retrieval of information it was found that employees felt comfortable speaking to colleagues within their own office for advice and prompts to look in certain areas for information and knowledge but this communication broke down out with that office and it was recorded that employees would be apprehensive about contacting colleagues in other offices for help and advice. They would look to similar past projects and review correspondence for hints. There was also a number of standards and guidelines that would be checked via subscription websites. Final they would contact external sources, in the case of new technology these external sources would be the likes of manufacturers, suppliers, and installers.

Information Use – This section address how the employees use the information and knowledge that they retrieve, where in the traditional project design process they are using this knowledge and information. One of the main questions that this section of the interview set to address was the extent to which project specific information/knowledge is transferable across sectors. Finally like the retrieval sections it was posed if this process was typical for other topics as well.

The quote from the structured interviews below is representative of typical responses regarding standard practice for use of knowledge and information:

> *Knowledge and information use:* 'Primarily the information is used for guiding the design and pushing the design forward. There was a lot of information required for each area, so you had to streamline the information before you actually started the design, and integrate all the elements into one.'

To summarise the responses from 'Knowledge and Information use' it was found that primary objective for information is guiding the design and pushing the design forward. It was important for the engineer to retrieve information for reuse at the earliest possible opportunity in the decision making process. Employees look to gain feedback on any information/knowledge that they employ and feed this back into the loop.

Creation of New Knowledge and Information – This third section of the interview looked at how the employees recognised when they had created a piece of new knowledge. It looked at determining if the new knowledge was added to the existing body of knowledge on that particular topic.

The quote from the structured interview below is representative of typical responses regarding standard practice for the creation of new knowledge and information section of the interview.

> *Creation of new knowledge and information:* 'Realistically I should create a new document but when you are busy it is very easy not to put this information down.' (Response from Senior Engineer)

There is realisation amongst the employees about what the best practice is for recognition when a new piece of knowledge or information has been created. However, there is a general realisation that this best practice is not always carried out. It was also found that most attempted to explain rational and inserted notes and comments where possible especially when using external sources of knowledge but like the previous best practice this was not always carried out. It was found that when new knowledge and information was identified and saved it was saved in a place that was inaccessible to all except its creator so it was not being shared.

Validation of New Knowledge – It was extremely important that we identified the route for validation of new knowledge and information that the employees came into contact with. This section looked at how the employee validated the new knowledge and information that they created, was this using a internal source or could a external source be employed to validate this new knowledge. If an internal or external source was used then the interview focused on how the employee came into contact with this source or individual and how they communicated with them.

The quote from the structured interviews below is representative of typical responses regarding standard practice for the validation of new knowledge and information section of the interview.

> *Validation:* 'I would start by validating new knowledge and information against a benchmark so I had an idea if there were any problems with it. I would then validate the knowledge through peer review. Some information could also be validated through the client or manufacturer reps.' (Response from Associate Engineer)

As part of the H&K QA policy everything that is being issued externally by employee should be validated by a senior engineer or above. Employees recognised that information/knowledge should be validated by themselves as well against standards, benchmarks, and rules of thumb. Some information/knowledge can be validated through knowledge provided by clients, manufacturers or marketing representatives from suppliers. Employees recognised that rules of thumb are built from experience, so when the information/knowledge is on a new topic then this level of experience that creates rules of thumb would not exist and there would therefore be a gap in the knowledge base. The validation process also depends on the source of the information/knowledge; will dictate how much scrutiny it requires. When discussing inter office validation of new knowledge it was evident that this only takes place at a high level within the organisation. So it would be common for directors to seek assistance from other directors in regional offices for validation of certain topics but not employees below this level.

Storage of Information and Knowledge – This section of the interview aimed at identifying how the employees stored new knowledge that they created, and more specifically if this new knowledge was stored in such a way that it is accessible for

others to retrieve it. If it was found that the new knowledge was stored in such a way that it was not readily accessible to others, then the interview addressed the factors that stopped this from happening.

The quote from the structured interviews below is representative of typical responses regarding standard practice for the storage of information and new knowledge section of the interview.

> *Storage of knowledge and information*: 'Usually any information that I gather I would put on files on my desktop. There is only a small percentage that I have felt a need to put on to the system. This is because I'm unsure if the information is already on the system and I don't have time to check. Therefore it is not stored in a place that makes it easily accessible for others; the biggest reason that stops me from publicising this information is the worry that it is not relevant.' (Response from Regional Director)

It was evident from the interviews that when new knowledge was stored, it was not being stored in a manner in which it was accessible for others. The above quote identifies one of the reasons that stops employees from storing new knowledge in an area that is accessible by others because of a fear that the information may not be relevant. This was just one of the concerns that was identified as a reason behind employees not storing new knowledge in an accessible area, other factors that stopped employees storing new knowledge in an accessible environment where; fears over data protection, fears over validation, a belief that it was too much work, or an

unwillingness to share knowledge. The interview also posed the question on where the employee would like to see the knowledge being stored from a retrieval and storage perspective. The overwhelming answer was that they would like to be unrestrictive in viewing information others created in other offices and would like to see knowledge store in an environment that is accessible by all.

4.3.3 Informal Discussion

The main finding from informal discussions was that whilst peer discussion was the most popular, employees would not usually engage with individuals in other regional offices to seek information unless they were explicitly told to do so. This emphasizes that there is a general reluctance to approach other regional offices for knowledge and information or to give or share information with other regional offices. Interestingly, respondents felt that using peer discussion to source knowledge and information encourages team working and collaboration. Discussion under informal discussion also focused on the lack of standard procedures for carrying out work and the implications that this had on the understanding of projects, new staff understandings, and how it could hinder work being transferred between offices. In reflection, this could also impact upon the introduction of a Knowledge Management system as this would require staff to use the system in a standard manner and upload information to it in a standard manner as well.

4.3.4 Requirements Capture Summary

One of the most interesting factors to emerge from the structured questionnaires section of the surveys was the split over opinion on the internal systems. Half of those participating believed it was a source of rich knowledge while the other half did not. This theme was repetitive throughout the rest of the semi-structured interviews with some participants viewing it as a source that they would go to as a first in order to retrieve information, while others only used the internal system when they were prompted to do so. This indicated that the use of the internal systems was dependant on the participants experience within the company. So if they had been with the company for a long time they would have experience with the internal systems and would find it easy to navigate them. This would also explain why less experienced participants require a prompt from experienced engineers guiding them to information in the internal systems. This would also explain why the less experienced participants require a prompt from experienced engineers guiding them to information in the internal systems. It was also found that there was no general practice for retrieving information, validation and storage, as the current practices for these seemed to differ between offices and participants. The current process for knowledge management's strengths and weaknesses were identified which allowed us to begin to capture the requirements for a new system. One of the major weaknesses of the current systems that were identified was the fact that information was not easily transferred between offices and a lot of rationale and understanding was lost. This is something that can be built into the requirements of a new system. The peer network (face-to-face) within the offices was also identified as a major tool for current Knowledge Management.

The following key points can be summarised from the questionnaire, structured interviews and informal discussions:

- Normally knowledge and information is sought verbally from other engineers i.e. peer discussion;
- Engineers are reluctant to seek knowledge and information from staff outside their own specific office;
- It is easier to ask someone than become familiarised with existing systems;
- Knowledge and information generally requires processing before it is useful;
- Engineers are generally too busy to document and detail new knowledge and information they have created;
- New knowledge and information is generally validated by peers;
- New knowledge and information is generally not shared amongst the community but stored on individual desktops;
- Time restriction plays a major role in the practices adopted for retrieving, using, creating, validating and storing knowledge and information.

The main output from this stage of the project was the generation of almost one hundred user requirements. Chapter 5 demonstrates the process that can be employed for communicating, validating and refining user requirements in addition to how they can be used to build specifications.

5. Communicating User Requirements and Building a Specification

5.1 Introduction

The previous chapter dealt with how the user requirements for a Knowledge Management system could be captured. This chapter identifies how captured user requirements can be communicated to designers validated and further refined. It also deals with how requirements once identified can be translated into a specification. This chapter addresses the second half of objectives three and objectives four and five.

O3. Develop a process for the capture and understanding of all Knowledge Management requirements, and how they can be communicated.

O4. Identify how requirements can be translated into software features.

O5. Understand how requirements that have been translated into software features, and can be communicated and validated with the user.

In developing a Knowledge Management system it was found that there were two broad stages to building the specification for H&K's Knowledge Management system:

- Communication, validation, refinement and further capture of Knowledge Management requirements.
- Development of the business and software specification.

It was important to present an understanding of all requirements that had been generated for the Knowledge Management system prior to embarking on the procedure for developing formal business and software specification. Section 5.2 focuses on the communication, validation and refinement of the Knowledge Management requirements that had been captured. Section 5.3 identifies how specifications were developed from the capture of Knowledge Management requirements that define the criteria for the software solution.

5.2 Communication, Validation and Refinement of Requirements

In order to fully demonstrate to the user that their requirements where fully understood and would be met in the development it was important to communicate an understanding of these requirements back to the user in some manner. The use of a prototype was selected in order to communicate an understanding of all system requirements. Two mediums were employed to communicate the prototype, a paper based prototype and an electronic prototype.

5.5.1 Paper Based Approach

The initial prototype was a paper based model of the Knowledge Management system that demonstrated an understanding of the requirements. Figure 11 demonstrates the paper based prototype which shows the flow of information and knowledge and views of information and knowledge that will be available to the users based on their requirements. This initial prototype of the system was used for communication, validation and the refinement of captured Knowledge Management requirements. This would be used as a basis for developing the electronic prototype and for mapping the user requirements.

The paper based prototype was presented initially to the senior management group at H&K. At a high level it identifies the various areas from the captured requirements that the user would like to be able to view knowledge and information. The initial prototype was also presented to potential key users from across the regional offices. It was important that each time the initial prototype was presented, feedback was collected that would allow for the validation of requirements and to refine the next stage of the prototype. The next stage of the prototype creation was to create an electronic prototype that would allow for further communication of an understanding of Knowledge Management requirements and a validation and refinement of these requirements with a bigger audience.

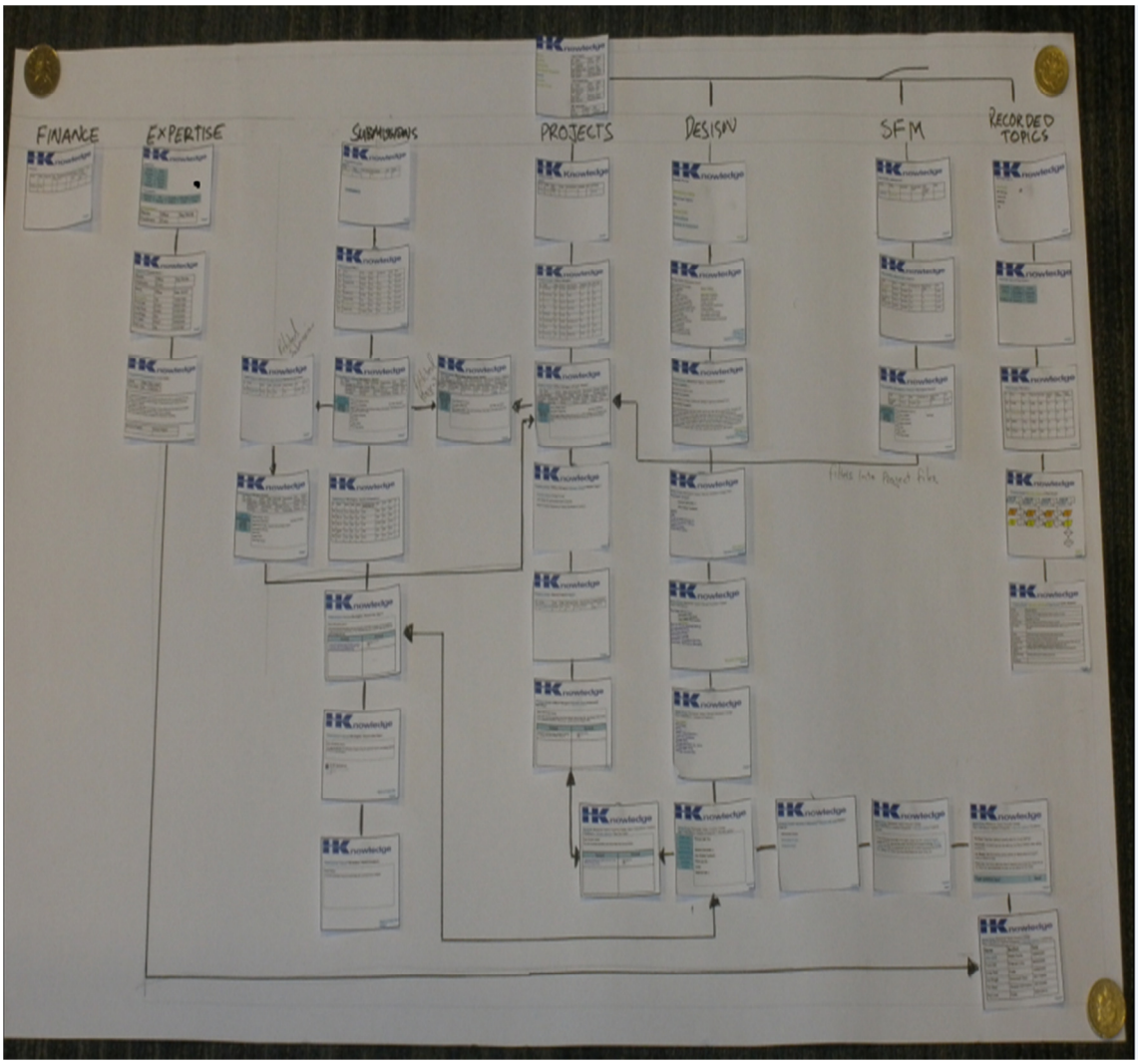


Figure 11 Initial Paper Based Prototype Knowledge Management System Flow

5.2.2 Electronic Based Approach

The next stage in the prototype process was to create an electronic prototype. This was used as a feedback tool with the users in order to further demonstrate to them the interpretation of the user requirements to validate and further refine the desired system features. The audience for the electronic prototype was much larger than the paper passed prototype. Because of the nature of the medium used for the electronic prototype it was able to be placed on the organisations shared drives. This allowed the

electronic prototype to be viewed by a cross section of potential users across the regional offices.

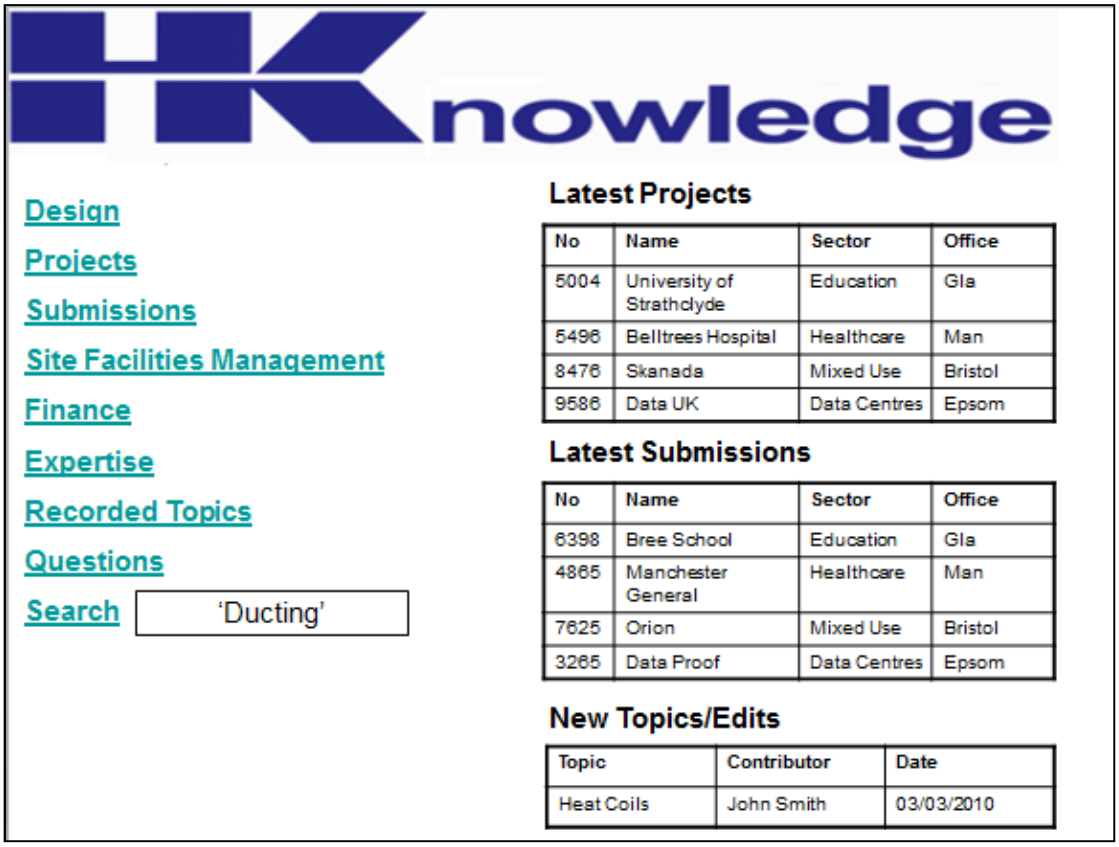


Figure 12 Electronic Prototype

Figure 12 is a screen shot from the electronic prototype that was created; appendix 2 contains further examples of screen shots from the electronic prototype. The users were able to access the prototype and select the various areas for knowledge that had been created based on the captured requirements. Each of the areas contained an example of the type of knowledge that the user could expect to see in that area. In addition a presentation accompanied the electronic prototype that identified themes for feedback and discussion that would provide validation and refinement of interpretation of the captured requirements. Once the captured requirements had been validated and refined through the prototype process the next stage was to map the

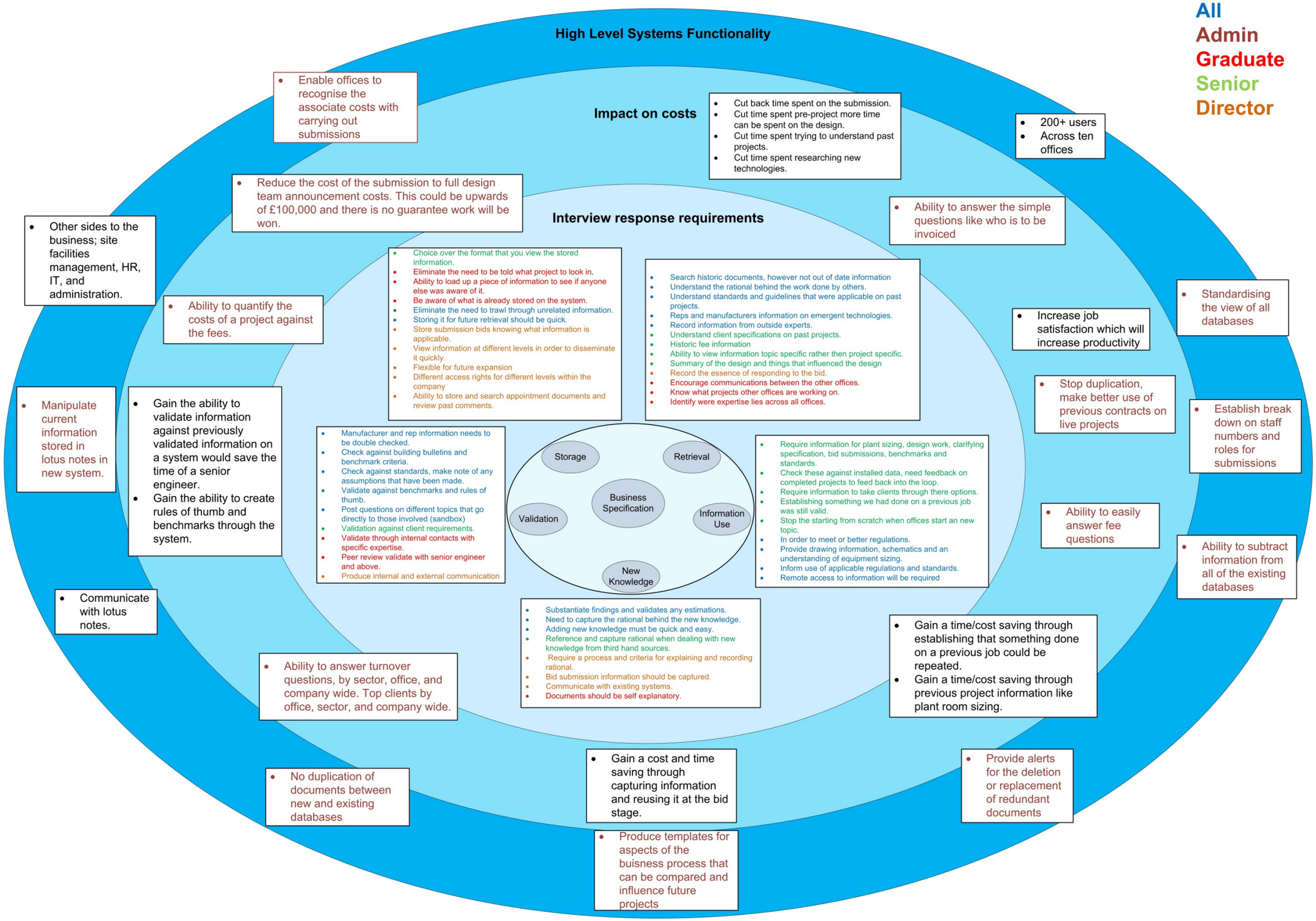
requirements in order to provide an overview of the requirements, the user group the requirement was established in, and the systems functionality that will deal with the requirement.

5.2.3 Requirements Mapping

In order to understand and fully support the knowledge and information requirements, a requirements map was produced. The aim of the requirements map is to provide a high level communications tool that allows the senior management team to identify the captured user requirements and the user group that the requirement came from. Figure 13 shows the requirements map containing a reduced number of example requirements. It was important to understand where in the business the requirements stemmed from at what level and which role. The second circle in figure 13 'Understanding Requirements' illustrates using colour coding how requirements are associated with particular levels within the company. The third circle 'Communicating Requirements' identifies the business benefits from each of the user requirements. Finally the outer circle 'Supporting User Requirements' identifies the high level systems functionality necessary for meeting each user requirement. There were two main benefits to mapping the requirements in this manner. It acted as a useful tool for communicating the requirements between the user, project team and senior management. Secondly the requirements map acted as a foundation for generating business and software specifications for Knowledge Management system. It was important that these documents were understood by all and that it was identifiable for the users to understand the interpretation of their user requirements in the business and software specification. The requirements map was a useful tool that

could be quickly employed to demonstrate where in the organisation specific requirements originated and how these requirements would be interpreted in specifications.

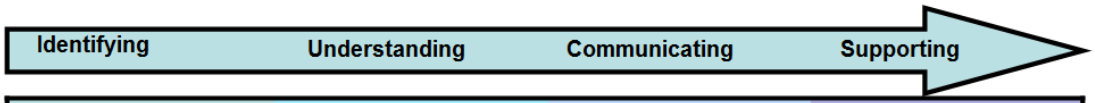
The following page contains Figure 13 User Requirements Map


All
Admin
Graduate
Senior
Director
High Level Systems Functionality
Impact on costs
Interview response requirements
Enable offices to recognise the associate costs with carrying out submissions
Cut back time spent on the submission.
Cut time spent pre-project more time can be spent on the design.
Cut time spent trying to understand past projects.
Cut time spent researching new technologies.
200+ users
Across ten offices
Reduce the cost of the submission to full design team announcement costs. This could be upwards of £100,000 and there is no guarantee work will be won.
Ability to answer the simple questions like who is to be invoiced
Other sides to the business; site facilities management, HR, IT, and administration.
Ability to quantify the costs of a project against the fees.
Choice over the format that you view the stored information.
Eliminate the need to be told what project to look in.
Ability to load up a piece of information to see if anyone else was aware of it.
Be aware of what is already stored on the system.
Eliminate the need to trawl through unrelated information.
Storing it for future retrieval should be quick.
Store submission bids knowing what information is applicable.
View information at different levels in order to disseminate it quickly.
Flexible for future expansion
Different access rights for different levels within the company
Ability to store and search appointment documents and review past comments.
Search historic documents, however not out of date information
Understand the rational behind the work done by others.
Understand standards and guidelines that were applicable on past projects.
Reps and manufacturers information on emergent technologies.
Record information from outside experts.
Understand client specifications on past projects.
Historic fee information
Ability to view information topic specific rather then project specific.
Summary of the design and things that influenced the design
Record the essence of responding to the bid.
Encourage communications between the other offices.
Know what projects other offices are working on.
Identify were expertise lies across all offices.
Increase job satisfaction which will increase productivity
Standardising the view of all databases
Stop duplication, make better use of previous contracts on live projects
Establish break down on staff numbers and roles for submissions
Manipulate current information stored in lotus notes in new system.
Gain the ability to validate information against previously validated information on a system would save the time of a senior engineer.
Gain the ability to create rules of thumb and benchmarks through the system.
Manufacturer and rep information needs to be double checked.
Check against building bulletins and benchmark criteria.
Check against standards, make note of any assumptions that have been made.
Validate against benchmarks and rules of thumb.
Post questions on different topics that go directly to those involved (sandbox)
Validation against client requirements.
Validate through internal contacts with specific expertise.
Peer review validate with senior engineer and above.
Produce internal and external communication
Storage
Retrieval
Business Specification
Validation
Information Use
New Knowledge
Require information for plant sizing, design work, clarifying specification, bid submissions, benchmarks and standards.
Check these against installed data, need feedback on completed projects to feed back into the loop.
Require information to take clients through there options.
Establishing something we had done on a previous job was still valid.
Stop the starting from scratch when offices start an new topic.
In order to meet or better regulations.
Provide drawing information, schematics and an understanding of equipment sizing.
Inform use of applicable regulations and standards.
Remote access to information will be required
Ability to easily answer fee questions
Ability to subtract information from all of the existing databases
Communicate with lotus notes.
Substantiate findings and validates any estimations.
Need to capture the rational behind the new knowledge.
Adding new knowledge must be quick and easy.
Reference and capture rational when dealing with new knowledge from third hand sources.
Require a process and criteria for explaining and recording rational.
Bid submission information should be captured.
Communicate with existing systems.
Documents should be self explanatory.
Gain a time/cost saving through establishing that something done on a previous job could be repeated.
Gain a time/cost saving through previous project information like plant room sizing.
Ability to answer turnover questions, by sector, office, and company wide. Top clients by office, sector, and company wide.
No duplication of documents between new and existing databases
Gain a cost and time saving through capturing information and reusing it at the bid stage.
Provide alerts for the deletion or replacement of redundant documents
Produce templates for aspects of the buisness process that can be compared and influence future projects

5.3 Development of Business and Software Specification

The development of the specifications was delineated according to business and software specifications. The business specification document addresses the requirements for the system in three ways: user requirements, high-level systems functionality and financial implications. Many of the business requirements were derived from the requirements map figure 13. This included specific requirements that derived from different levels of organisational hierarchy such as directors, associates, graduates, administration and financial users.

The software specification defined at a functional level the software requirements specification for the Knowledge Management system. These were derived from the business specification previously identified. In addition to tackling technical issues including user interface and metadata taxonomy, the software specification also addressed broader usage issues such as performance requirements. The business and software specifications were rigorous documents consisting of approximately 300 requirements. An extract from the software specification is contained in appendix 3. One of the most interesting aspects of the specifications was the translation of requirements from user requirements to business and then software requirements and finally software features.



User Requirements	Business Requirements	Software Specification	Software Features
1. Access to knowledge built up in other offices	Identify where expertise lies across all offices, encourage communication between offices, and understand what projects other offices are working on	Access to the system across all offices. Easy to add information and knowledge to the system from any location.	System has the ability to present information and knowledge to the user from a different source that has links with what the user is currently viewing.
2. Ability for the user to place metadata tags on the with knowledge in the system	Record information and knowledge with metadata tags. Will ensure reuse of valuable information and knowledge.	Structured taxonomy and process for tagging information and knowledge to the system.	Ability to place multiple metadata tags on documents and entries using the taxonomy.
3. Ability for knowledge to be validated by experts from anywhere in the company.	All displayed information must be validated against standards and guidelines or peer review.	Structured validation process. Ability for all documents and entries to pass through a validation process.	Implemented validation process. Interactive process that allows users to send information to be validated and approved for the system.
4. Display information that may have originated with an outside expert, but has been employed and commented upon.	Identify information and knowledge that has been created by and outside expert but has been employed and is useful.	Ability to tag information and knowledge in the current databases.	Links between the existing database and KM system that allows the user to tag information between systems.
5. Employ information and knowledge that has already been created in current systems, but is not accessible for all. .	Pots of information and knowledge are within the organisation but at current are difficult to find and unavailable, access could provide potential savings.	Ability to produce and view links to information and knowledge that has been created in other areas of the organisation.	KM system should break down barriers between the regional offices so information and knowledge flows between them.

Table 4 Translation of User Requirements to Software Features

Table 4 demonstrates the process that a user requirement goes through to become a software feature, and how it is represented in the business and software specification. This allows both the project team and the users to validate the software feature and guarantees that it meets the user requirement. Laying this information out in this manner ensures that both parties fully understand the user requirements. The requirements map also informed the software selection process. It was used to develop the criteria for the software selection matrix that was produced and is discussed in the next chapter.

6. Software Selection

6.1 Introduction

Chapter five identified how the captured system requirements were communicated to ensure they were validated and refined, it also dealt with the creation of system specifications and requirements mapping. This informed the criteria for the software selection. Chapter six software selection focusses on objective six;

O6. Realisation of System features and identification of methods for their communication and validation with potential users.

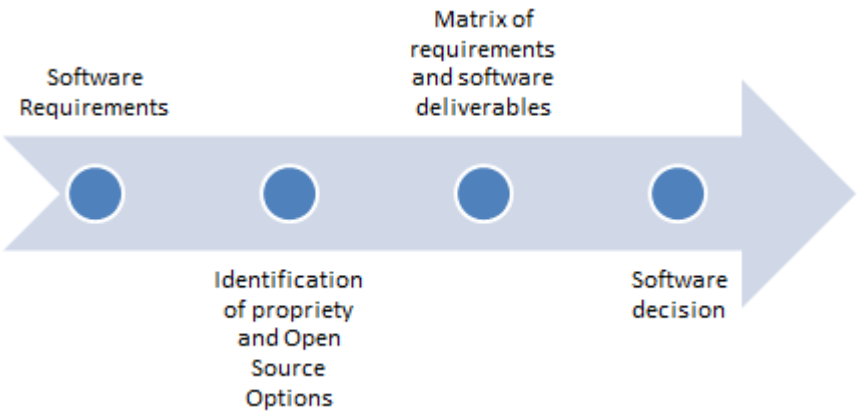


Figure 14 Software Selection Process

When selecting the software for the Knowledge Management system it was critical that the appropriate platform was selected to insure that the system features could be realised. In order to make a decision on an appropriate platform for Knowledge Management system investigation into possible software options was carried out. This

investigation looked at 15 proprietary and open source software solutions. A matrix for the software requirements was produced in order to benchmark the various software options. The software requirements were divided into essential requirements and desirable. Developing a software options matrix allowed the project team to quickly identify the options that would be closely considered for development and those options that could be eliminated as they did not meet mandatory requirements. The options could then be divided into 'forerunning options' and 'eliminated options'. An extract from this software options matrix is displayed in appendix 4.

H&K had databases and systems in place from previous IT projects, much of this centred around Lotus Notes development, the lotus notes databases that H&K had in place were very document centric and contained a wealth of information and knowledge that would be useful to H&K in a Knowledge Management system. Therefore, one of the key requirements of whichever software was selected was that it would be compatible with Lotus Notes, and that it would have the ability to extract information from the current Lotus Notes system that could be used in the new Knowledge Management system. There were also more fundamental requirements like the fact that the software had to be able to support 200 users across ten regional locations. An extract from the software specification is displayed in appendix 3. It highlights the captured software requirements that were translated in Table 4 in the previous chapter.

6.2 Eliminated Options

An eliminated option is a software option that was being considered for implementation but has been eliminated from the software selection procedure because it did not meet one or more of the mandatory software requirements.

6.2.1 Tikiwiki

An open source software that has been used by the Design Manufacturing Engineering and Management department at Strathclyde (DMEM) in the past for their on-line learning environment. However it has be eliminated for use in this project because of a number of factors. The main reason being that the open source community support for it is disappearing, Tikiwiki has also been spiked and used for many different projects. This has left the original code very diluted and would mean that for a project like 'HKnowledge' it would run a lot of unnecessary functions which combined with our high number of users would slow down the H&K servers.

6.2.2 Joomla 1.5.15

Joomla is another open source software that has been eliminated and like Tikiwiki it is a piece of software that has been employed by the DMEM department. Unlike Tikiwiki, Joomla has a very large community support, so lack of support is not an issue. The reason that it was eliminated is that we were advised by experts that Joomla would be unable to deliver the complexity and functionality that we would expect.

Joomla is a useful for creating small websites and simple content management systems. However the 'HKnowledge' project goes far beyond the limits of Joomla and Joomla would not deliver the level of complexity necessary.

6.2.3 Novell GroupWise

Novell Group Wise a propriety software that was eliminated from the selection process. Novell GroupWise is a collaborative work environment; it is very similar to the Lotus Notes product that H&K currently use, it also would not offer any more functionality than is provided currently by the Lotus Notes product. This is part of the reason why it would be eliminated as it would involve a migration away from Lotus Notes to a similar product that does not offer any additional functionality. Novell GroupWise like Lotus Notes is a very document centric platform which would encourage more of an information management solution than a Knowledge Management one.

6.2.4 Central Desktop

This was another propriety software that was eliminated from the selection, Central Desktop is a cloud based collaborative working environment. The fact that it was a web based solution ruled the system out from a data protection and security point of view. As H&K were not prepared to risk sensitive information on the internet. It was also found that Central Desktop was not compatible with H&K's legacy Lotus Notes system.

6.2.5 Other Open Source Software

A number of other open source software solutions were also eliminated such as; Zimbra, Knowledge Tree, eGroupWare, Open Xchange, and Open KM. These options could largely be eliminated due to the fact that they lacked a large community support. We had also found an open source software called 'Drupal' that presented itself as a very strong candidate and was elected for further analysis. Other proprietary software that were eliminated included Jive SBS and Oracle Beehive as it was found that the functionality they delivered was not in line with requirements and a number of issues in relation to cost and migration.

6.3 Forerunning Options

These options were selected as forerunning options as they met with the mandatory requirements that has been established in the software specification, they were then selected based on the software's ability to meet with desirable or 'nice to have' software requirements. Ultimately cost and implementation issues would also be employed to select the final software option for implementation.

6.3.2 Lotus Notes

One of the forerunning options was identified as an expansion to the current Lotus Notes system. This would involve pulling information from the current Lotus notes database into a Notes web Portal. The biggest advantage to 'HKnowledge' being

developed in a in Lotus Notes environment is that it would eliminate any concerns over pulling information from the existing Lotus Notes databases. The system would also benefit from the experience of in-house IT support. The major drawbacks with the Lotus Notes based system would be that H&K are further tying themselves to Lotus Notes based products and could be potentially missing out on further functionality that an Open Source solution could offer in the future.

6.3.3 Sharepoint

This is another propriety software that presented itself as a forerunner. Sharepoint provides a vast amount of out of the box functionality but this all comes with a cost. One of Sharepoint's biggest advantages compared to other propriety software's is the amount of functionality that can be used out of the box. Although implementation is required Sharepoint can be manipulated by novices. Because of the cost involved in implementing Sharepoint is so great it, would involve a complete migration to Microsoft products, as it would be uneconomical to continue to run a legacy Lotus Notes system in addition to Sharepoint. This would have turned the project into a migration project rather than a standalone knowledge management project.

6.3.4 Drupal

This was an open source solution that was identified as a forerunning option for 'HKnowledge'. Unlike many of the other Open Source solutions that were investigated, Drupal enjoys a large amount of community support. Drupal is a modular based software. This is a software design technique that increase the extent to

which a software is composed of separate parts called module. The goal of this is to have as few dependencies as possible; this makes software successfully built on a modular basis, far more reusable than a traditional monolithic design.

In addition to this, Drupal has had high profile users for example; Cap Gemini and the World Bank both use it for their internal Knowledge Management system, and it is also used by the Whiteoffice.gov. However, there were two major drawback/concerns to implementing Drupal. Firstly there are some concerns over the timescale for pulling information from the current Lotus Notes System. This is because the Lotus Notes system is bespoke to the organisation and has been heavily developed over a number of years. 'HKnowledge' is required to pull some data from the existing legacy Lotus Notes system; there was some dubiety over whether this would be able to be done in Drupal.

Because Drupal is an open source product there is no direct support for it, this can be a problem when developing new uses for software like Drupal. Essentially Drupal is a content management system and for this project Drupal would be developed for another use. This would mean that the organisation would not have access to updates and fixes for Drupal at a later date as our code would be different form the main Drupal development.

6.4 Software Decision

After consideration of the forerunning products and numerous meetings and discussions, Lotus Notes was selected as the software option that would be employed for the development of the Knowledge Management system. Sharepoint was eliminated due to the cost implications and that it would ultimately mean a migration away from Lotus Notes. There was a lot of interest in employing the Open Source option Drupal but also concerns over its integration with the current Lotus Notes system, attempts were made to resolve these concerns with meetings with IBM and Drupal experts. However with these questions still un-answered, the decision was made to employ Lotus Notes to undertake the development of the Knowledge Management system.

7. System Overview

7.1 Introduction

This chapter introduces the Knowledge Management system that was developed for Hulley & Kirkwood Ltd 'HKnowledge'. It provides a detailed overview of the system Figure 14 identifies the areas that this chapter will focus on;

- System Home Page
- Design Section
- Project Section
- Global Search Facility
- System Taxonomy
- Approvals Process

This chapter address the system realisation objective.

O6. Realisation of System features and identification of methods for their communication and validation with potential users.

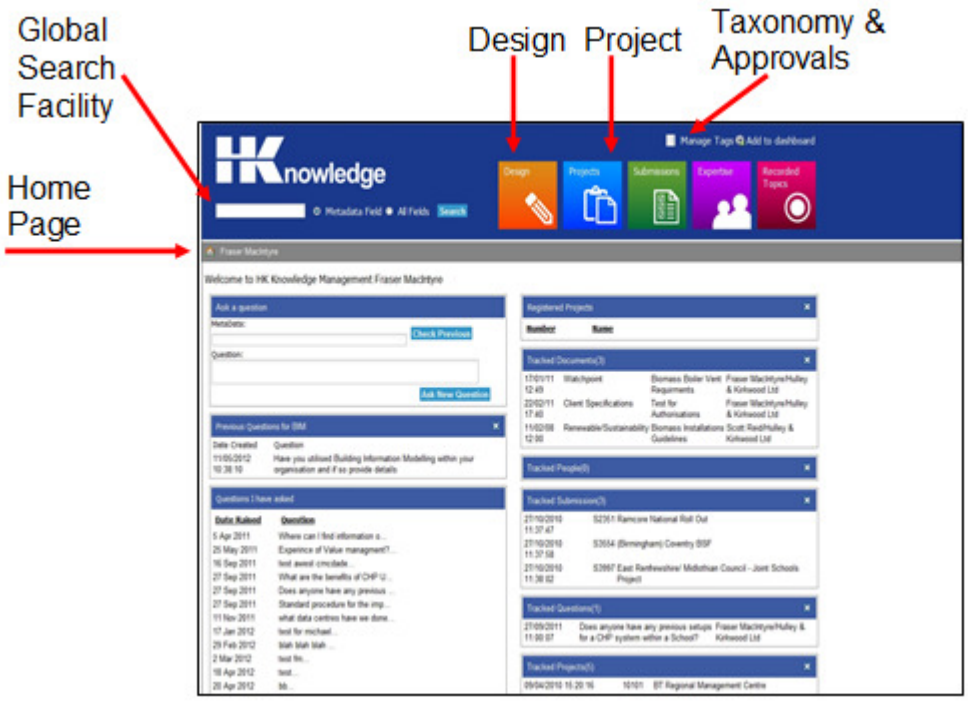


Figure 14 System Overview

7.2 Home Page

Below figure 15 gives an overview of an example of a typical user's home page in the 'HKnowledge' system. This is based on some of the generic user requirements that were established in the 'Understanding Information and Knowledge Management Requirements' stage of the project. Figure 15 displays a typical user's home page in the system, each home page is unique to that user and gives them the ability to track specific; documents, projects, topics, or submission in the system. This allows the user to elect to follow specific topics and areas of the system that they have an interest in. The system will then update them via their home page when the information in that specific area is updated or new information and knowledge is added. This helps to drive new information and knowledge to the user rather than that user having to go and search for it. This software feature realises the first requirement that was identified and translated in table four of chapter 5, i.e. the requirement for users to

view knowledge that was built up in other offices based on the topics they were interested in.

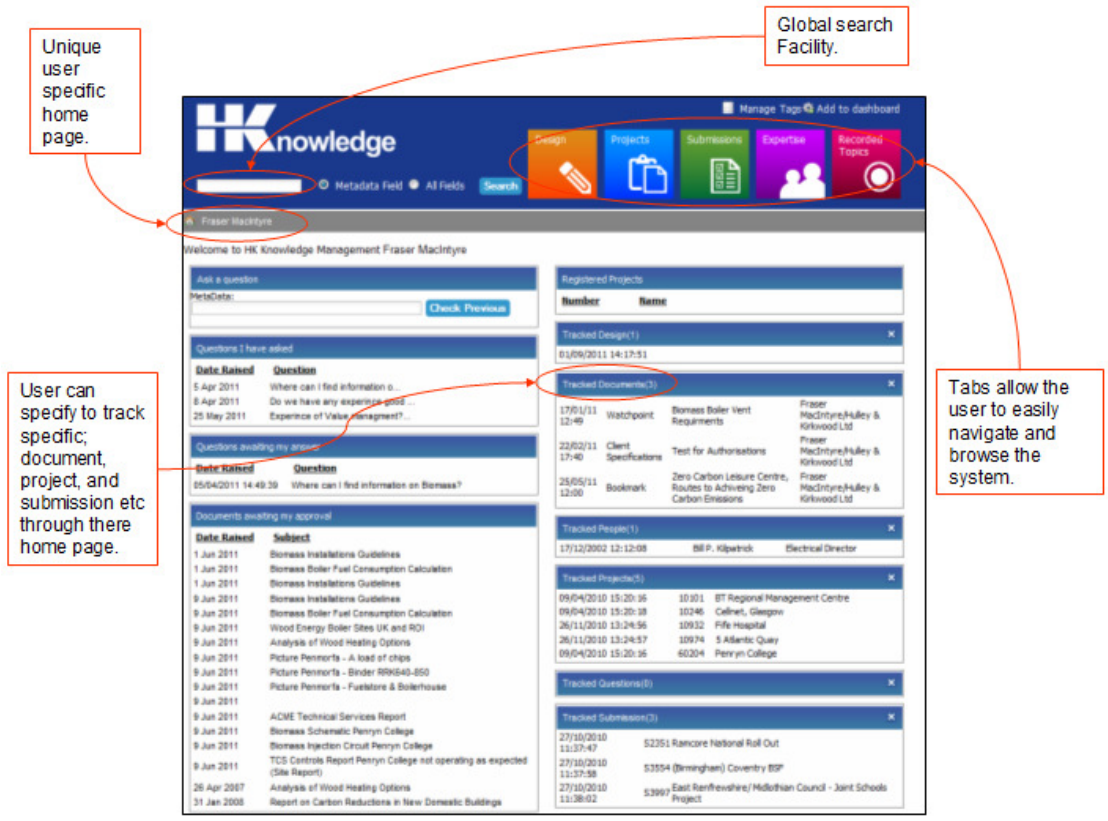


Figure 15 Users Home Page

The home page gives the users two main options which then can employ to navigate the system. The system contains a global search facility that allows the user to perform searches on the systems content. In addition to this the system has five tabs Design, Projects, Submissions, Expertise and Recorded Topics. Within these tabs, all of the information and knowledge in the system is stored. This accommodates for different user preferences, those that are comfortable performing searches across all of the knowledge and information and those that would prefer to browse through specific areas in order to find the information and knowledge that they require.

It was also essential that the home page provided a good introduction to the user interface that would assist in the users learning and understanding of the system and how it operates. Within figure 15 the five main areas of the Knowledge Managment system; design, projects, submissions, expertise and recorded topics are highlighted. Each of the five areas has a unique colour and icon representing that area that colour and icon become more identifiable when the user access one of the five area, this insures that the user has a clear understanding of what area of the system they are in and the type of information they are viewing at any one time.

.

7.3 Design and Projects Sections with Metadata Tags

The five tabs that can be displayed in the banner of the front page are links to the design, projects, submissions, expertise and recorded topics sections of the Knowledge Management system. Figure 16 below displays the links to these five main areas, each of the area was similar in terms of structure for the purpose of this research project we will focus on the description of the Design and Projects section of the system.

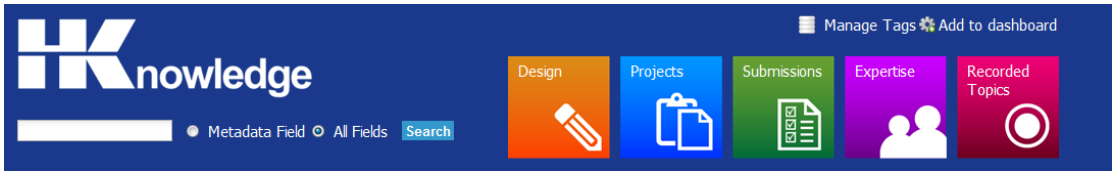


Figure 16 Knowledge Management Banner with Five Main Areas

The user can access any of the five areas by simple clicking anywhere in the icon box. Figure 17 demonstrates the view the user would be presented with when accessing the Design section of the Knowledge Management system.

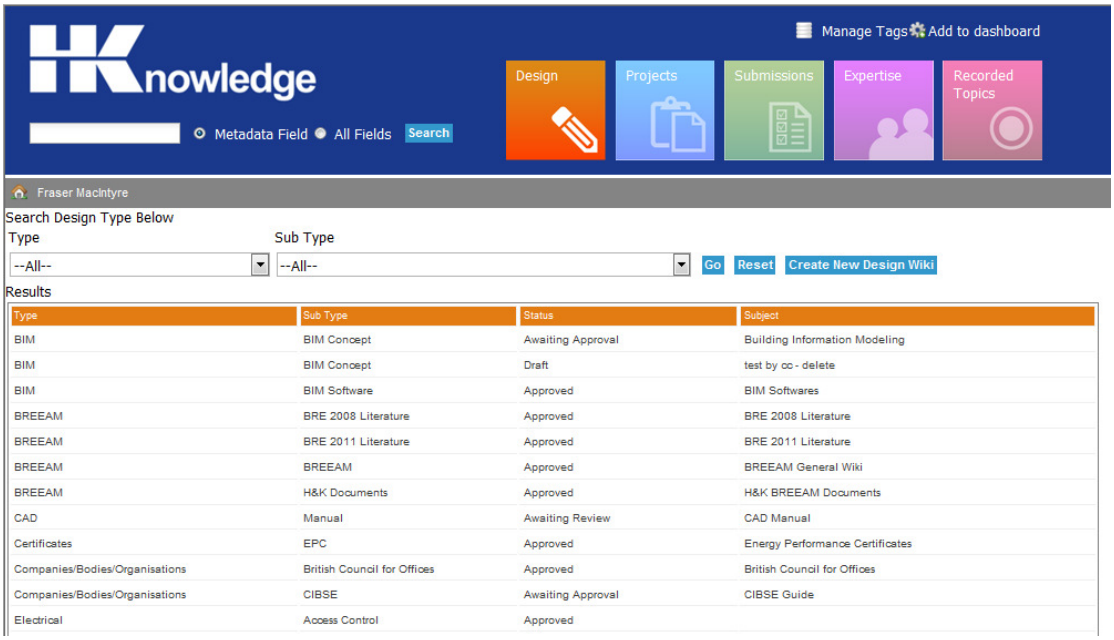


Figure 17 Design Section

Within the Design section there are two filter boxes called ‘type’ and ‘sub type’ all design information and knowledge that would is added to the system can be categories by type and sub type. Sixteen types of information and knowledge were identified that would be added to the system and within each of these types several sub-type topics were identified. For example a type of information and knowledge that would be added was ‘mechanical’ or ‘electrical’ knowledge. For each of these topics there are several sub-type topics associated with them. In total there were 148 topics or areas in which H&K users could add information and knowledge identified within the design section of the Knowledge Management systems. This is not a static

number and there was the facility to add new topics. Figure 18 displays the typical design file page for a type and sub-type topics.

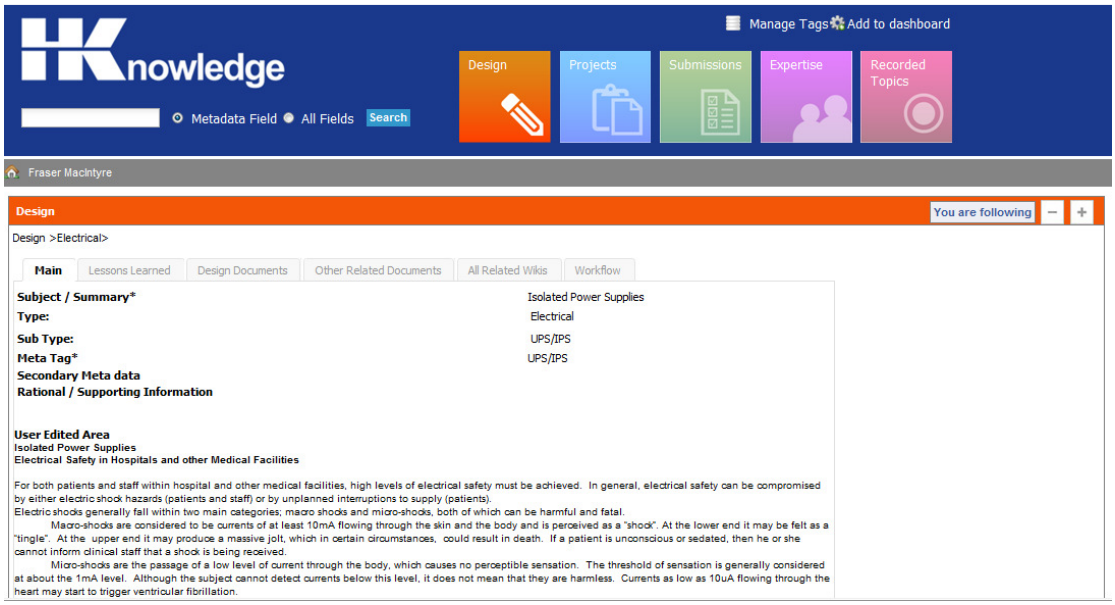


Figure 18 Typical Design File Page UPS/IPS

The design file page displayed in figure 18 is for the Uninterrupted Power Supply and Interrupted Power Supply (UPS/IPS) section of the Knowledge Management system, this topic falls within the 'Electrical' type of topics and sub-type UPS/IPS. The main page that is displayed is a user editable wiki for each topic, the wiki allows all users to input and share tacit knowledge about that topic. The information and knowledge stored in the wiki section would be in the form of lessons learned and experience on that topic that can be employed to determine how another user could tackle that topic in the future. The users can add information and knowledge in relation it experiences they have had with particular products, suppliers or contractors. They could provide links to external sources of information about that topic. The other main area within each design file is a design documents section. The design documents section for UPS/IPS is shown in figure 19.

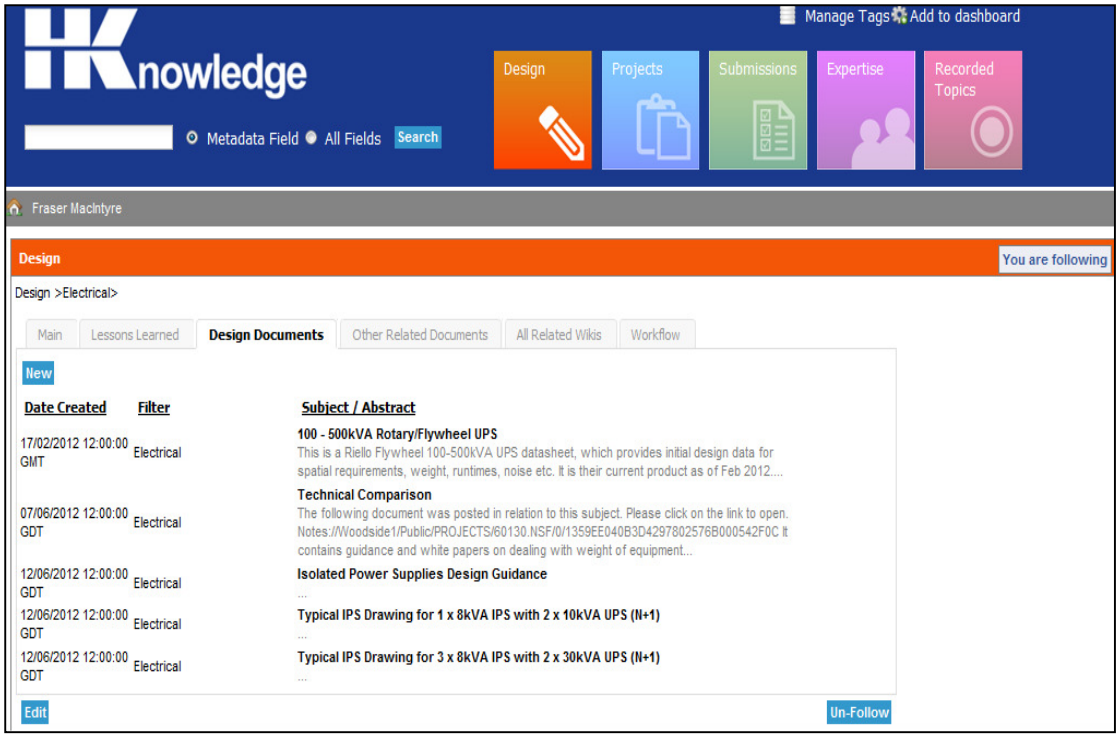


Figure 19 Design Documents UPS/IPS

The Design documents section of a design file provides the users with an area in which they add documents specifically about that topic; this would be documents that contain specific knowledge about that topic. Regardless of whether they have been created internally or are from an external third party. Any documents that are added to this section can be searched and found using the global search facility.

Figure 20 below demonstrates a typical Project page and how each entry in the system requires metadata tags. It displays a typical Project page where the unique metadata tags for that project have been entered at the top. This then allows the 'related documents' section to be populated. The 'related documents' section uses the metadata that the project has been tagged with in order to display to the users documents and knowledge that have been created in other projects a design topics. This is across the company so the user will be pushed information that has been built

up in other office. This again demonstrates the realisation of the first user requirement of table four in chapter five that users are pushed knowledge that is built up in other areas and locations.

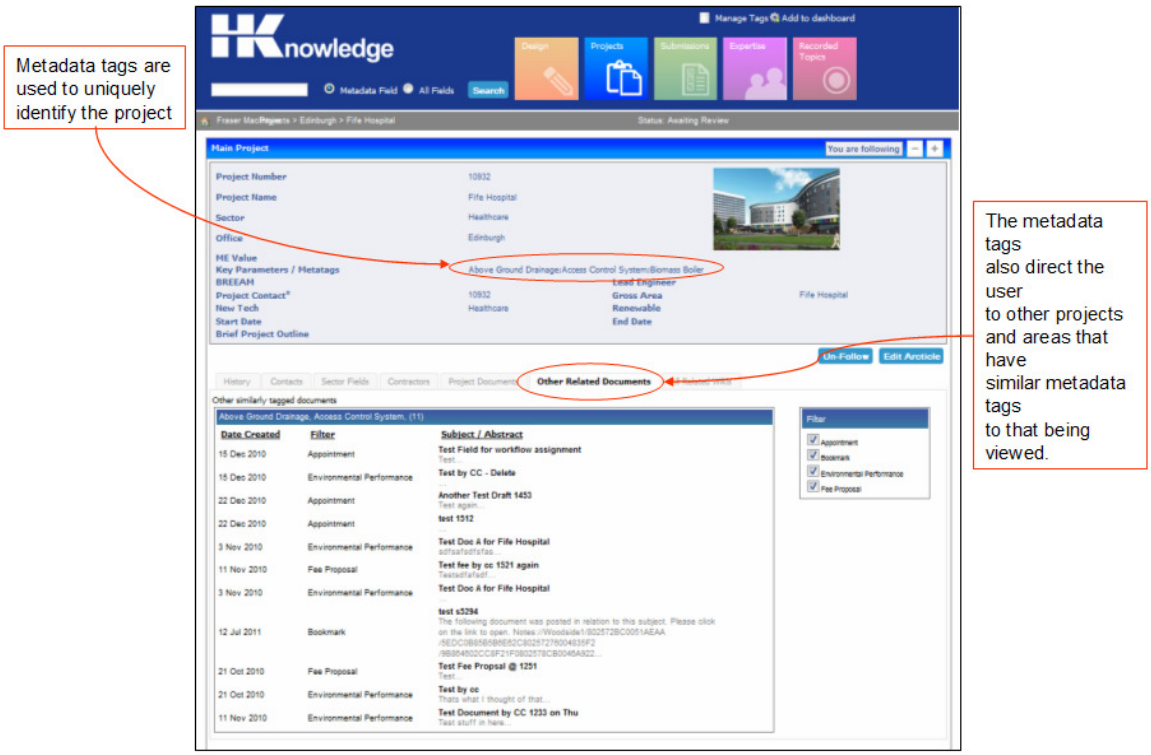


Figure 20 Typical Projects Page

Figure 20 also addresses points two and three in table 4 of chapter five. The image shows how a user can place multiple metadata tags selecting them from a structured taxonomy. Figure 21 below demonstrates the lookup facility in metadata field that allows the user to select suitable tags to uniquely identify the knowledge that they are inputting. This allows for them to be searched and easily found in future for re-use.

Secondly figure 20 addresses the third requirement in table 4, for 'knowledge and information to be validated by experts from anywhere within the company. Figure 21 shows the view that a validator will have, they can view all the necessary high level information that has been placed on that document along with any metadata tags and rationale, they can also view the document directly and then select to 'approve' or 'reject' that document. This ensures that the user requirement for validators to be able to validate information and knowledge from anywhere within the company is satisfied.

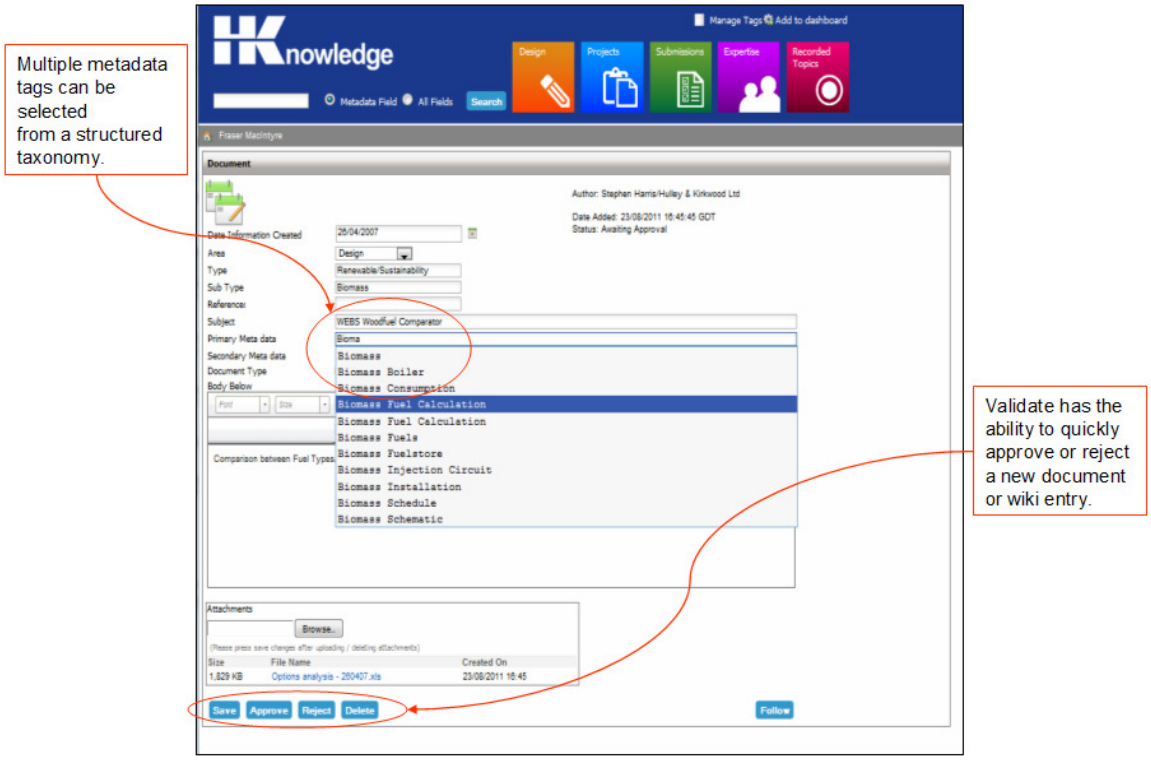


Figure 21 Tagging and Validation

The support for user requirements four and five from table 4 are displayed in figure 22.

> *4. Display information that may have originated with an outside expert, but has been employed and commented upon.*
>
> *5. Employ information and knowledge that has already been created in current systems, but is not accessible for all.*

Figure 22 displays the process that allows a user to send a piece of knowledge that may have been generated externally and stored in an internal database to be sent to the Knowledge Management system. A user can send information from any of the other H&K databases using a simple right click function. When the user selects to do this, they are required to enter the metadata and a subject for that document within the specific database before it is sent to the Knowledge Management system. This allows the user to send information that may have been created externally but employed in some way by H&K to be found and used again where previously it may not have been discovered again. Also, prior to the Knowledge Management system these documents would only have been available in the office that they were created. As demonstrated in the prototype the Knowledge Management system breaks down this barrier and allows the transfer of knowledge between offices.

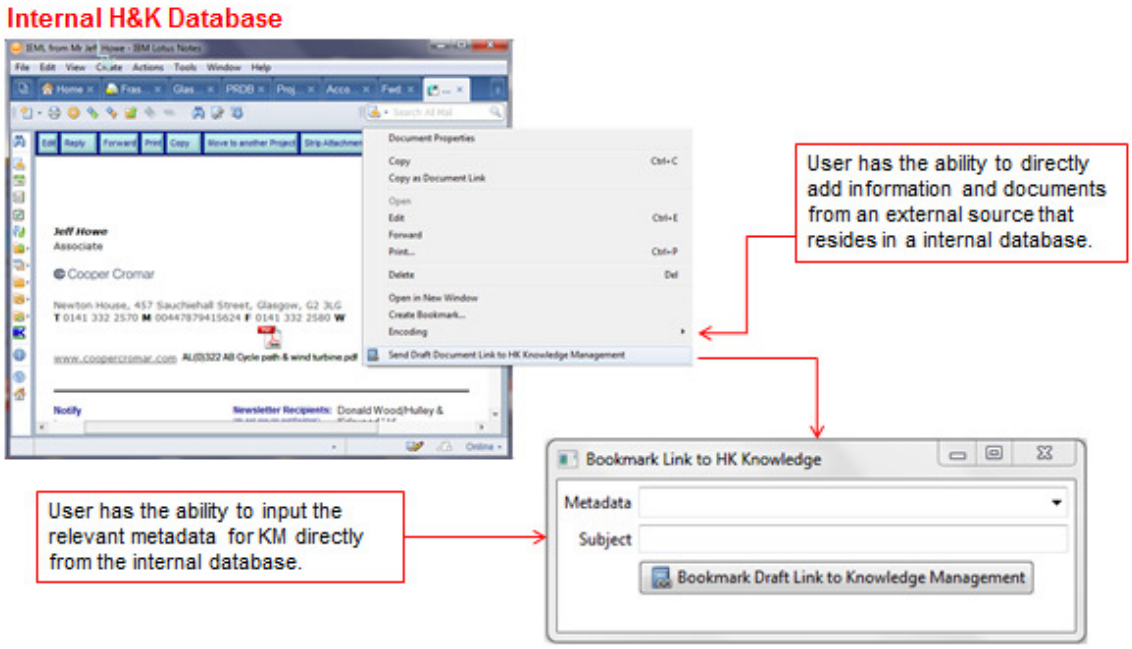


Figure 22 Adding External Knowledge

7.4 Global Search Facility

The global search facility allows the user to search for knowledge across the entire system. Figure 23 below demonstrates typical search being carried out in the system and the expected results page. Highlighted in this figure, the user has the option to perform an all fields or metadata search of the system. An all fields search will locate the users key words in any text or knowledge that is placed on the system. While the metadata search allows the user to search for key words selected form the taxonomy this will deliver less results than the all fields search that will assist the user in finding the knowledge they are trying to locate faster. On the right hand side of figure 23 a filter is displayed which is to allow the user to filter out the type of search results that the user does not wish to see. This could be used if for example the user only wished to view design related knowledge in their search results.

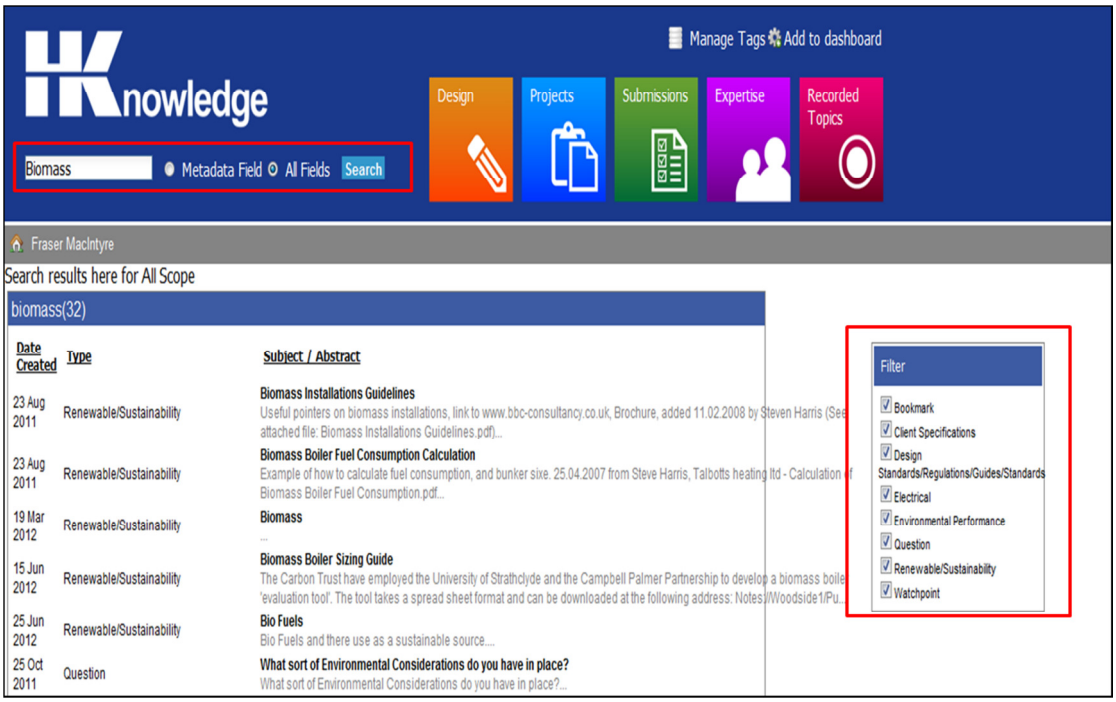


Figure 23 Search Results

7.5 System Realisation Summary

The development of the system using prototypes allowed the users to review how their user requirements had been interpreted and translated into system features. The realisation of the system features in the development acted as a communications tool between the users and the project team. Giving the users the ability to communicate back to the project team on how their requirements has been interpreted and translated into system features. In chapter 5 the process that was employed to translate user requirements into software features was discussed. Chapter 7 demonstrated how the system features identified in table 4 of Chapter 5 have now been realized within the Knowledge Management system. This further reinforces the software selection

decision of Lotus Notes that it has provided the ability for the user requirements to be realized in the system development.

8. Implementation and Evaluation

This chapter addresses the implementation and evaluation of the 'HKnowledge'. It will address objectives 7 and 8 to evaluate and access the impact of the Knowledge Management system. Chapter 8 will also begin to produce guidelines for best practice for the development and implementation of a Knowledge Management system.

O7. Evaluate and assess the impact of the Knowledge Management system.

O8. Produce guidelines of best practice for the development and implementation process for a Knowledge Management system.

Introduction

As previously stated H&K have offices distributed across the UK with the project being led from the Glasgow office. However, it was important that all of H&K sites had the same training and understanding of the system in order to support organisational buy in. The regional offices had been involved in system development from the outset of the project through participation in the initial interviews and questionnaires. During the development of the system they were kept informed of progress by regular progress presentations. This facilitated all potential users developing the same understanding of the system.

In conjunction with the successful integration/implementation of the system, it was fundamental to assess and evaluate the impact of the system on the organisation

during the implementation stage of the system and in the future. The evaluation of the Knowledge Management system will be dealt with in the second section of this chapter.

8.1 Implementation Approach

The implementation of the Knowledge Management system was carried out over a four month period with three different user groups that where identified within Hulley and Kirkwood (H&K). 170 users would be given access to the system over the five month period; figure 24 depicts the three different user groups.

Authorisers – The authorisers or validators group contained 52 users that had previously been identified. The authorisers were the first users to receive access to the Knowledge Management system. Authorisers were spread across each of the regional offices and had the remit of validating information and knowledge that would be added to the system.

Topic Based Group – The topic based group is the largest group of the three different user groups. Topic based group users were made up of 70 users across all the regional locations. Users were identified as those that could add specific knowledge and information to the system based on topics that they were working on.

Wider User Group – The wider user group was the final user group that the system would be rolled out to. It was made up of 48 users across the regional locations. This user group was made up of users that had previously not interacted with the system

but would have the support of the authorisers and topic based group in their locations during the implementation process.

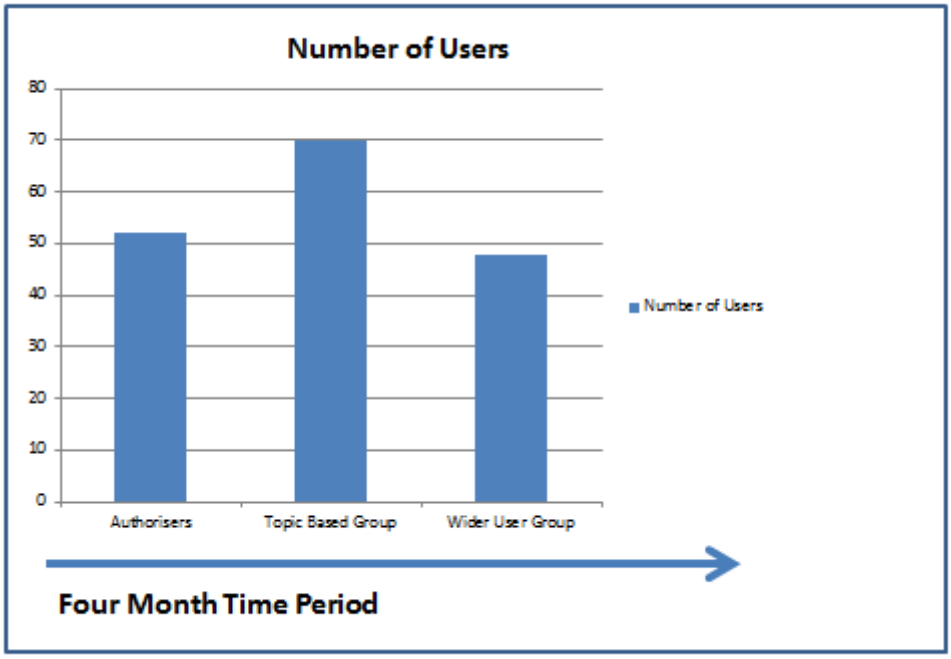


Figure 24 Implementation Period

It is recognised that individuals responded to different types of training materials. In response four mediums were adopted to introduce and train individuals in system usage. The mediums adopted for introduction and training were videos, group presentations, one to one training and training documents.

Video Training Materials

A series of videos were developed for introduction to the Knowledge Management system and training in its various functions. These videos were designed to first of all introduce the concept of Knowledge Management, what it means to H&K and the

goal of the Knowledge Management System. The following videos then took the user through the process for;

- Adding knowledge and information
- Searching the system
- Approving knowledge and information
- Explaining to the user various areas of the system
- Demonstrating system specific tools

Each video was limited to two minutes in duration in order to hold the users full attention. The videos were stored in a central location in order for them to be used as a future reference tool for the users if they wanted clarification in specific functions of the system. Figure 25 depicts a screen shot from the initial video that sought to identify what Knowledge Management meant to H&K. This ensured that every user has the same understanding of Knowledge Management and most importantly an understanding of what it meant to H&K. (Some examples of the video materials are contained on CD in appendix 5)

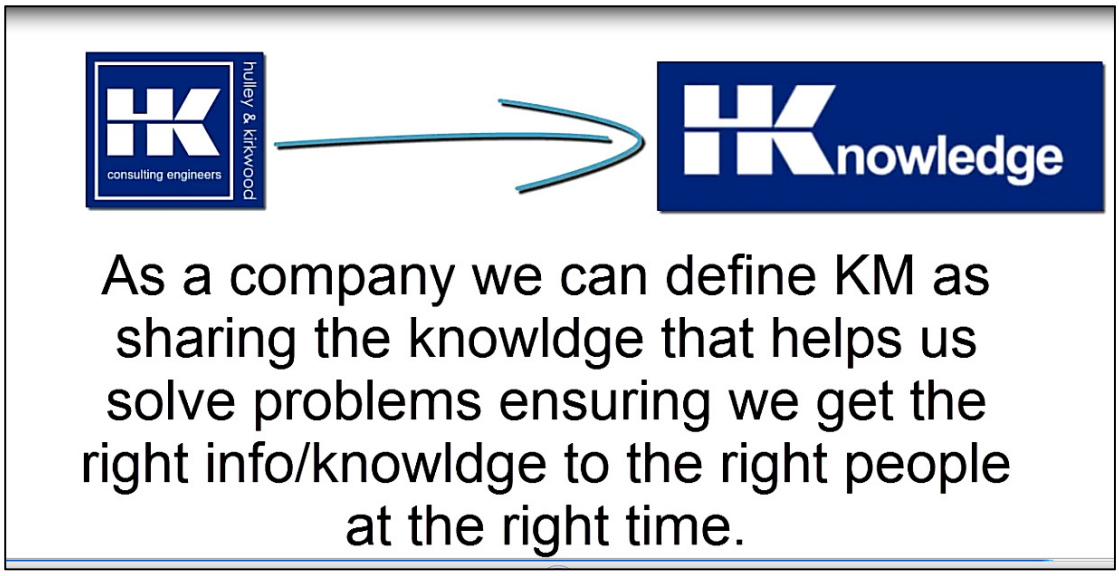


Figure 25 What is Knowledge Management Video Introduction?

Group Presentations

Prior to the system release presentations based on the Knowledge Management system were delivered at each of the regional offices. These presentations aimed at generating interest in anticipation of the system release. Like the videos, they explained the purpose and concepts behind the Knowledge Management system delivering limited training on some of the high level elements of the system. Group presentations present an opportunity to demonstrate the videos and some of the other resources that had been created and alert the users to how they could be used.

One to One Training

One to one training on how the system could be used was also made available across the organisation. This could be delivered in two ways, in person or via the organisation's video conferencing tool which enabled training and assistance in solving problems and issues users encountered with the system to be solved remotely.

Training Documents

A number of training documents were also created that could be used as a reference tool and to complement the other training materials. These training documents explained in detail the various functions of the system and how these functions could be employed by the user. These documents were also designed to be used in training new users in the system in the future.

Summary

All of the training and introduction materials regardless of their medium were designed with longevity in mind to ensure that they could be used to train current and future H&K employees that would use the Knowledge Management system. The structure of the materials also ensured that the user could find out specific information about a particular function of the system and each training material would complement the users understanding of this function.

.

8.2 Evaluation Approach and Themes for Evaluation

Approaches employed for the evaluation of the Knowledge Management system were statistical information, reports on the system usage and informal feedback from users. Findings from these approaches were combined to develop a full understanding and evaluation on how the system was being used across the organisation. Furthermore, the functions or methods that would be employed to evaluate the system, nine themes that the evaluation of the Knowledge Management system would focus on was identified. The names of these themes and a brief description of them is listed below.

1. Activity in the system – One of the most basic evaluations of the impact is the amount of activity that is taking place within the system. Part of the first questionnaire looked at which sources of information in the current systems the employees used the most. The Knowledge Management system itself was designed with the ability to create statistical information about activity levels in the system.

2. Critical Mass – This theme aimed at identifying if a correlation could be established between the amounts knowledge and information users are downloading from a file compared to the amount of knowledge and information they are uploading to the same file. Could this then establish that the file had reached a 'critical mass' in terms of the amount of knowledge, that the users are now able to learn from that file instead of constantly uploading to it. Statistical information from the system can identify cases in which this may occur which can be reinforced through user feedback.

3. Change in Methods for Gathering Information – From the results of the first questionnaire described in Chapter 4 we can map the users information gathering behaviour. System statistics, usage statistics and user feedback can be employed to determine if there has been a change in the methods for gathering information in light of the introduction of Knowledge Management system.

4. Download/uploads – The system has the ability to produce statistics that inform the user the number of downloads and uploads in certain areas and by certain individuals, offices and levels. This allows us to view the difference in the number of downloads and uploads across the different offices and levels within the regional offices. In the original questionnaire we looked at where they would store documents that have been downloaded from an external source. The system statistics address if the practices for storing knowledge and information has changed as a result of the Knowledge Management system.

5. Logins - This theme will look at how many times on average the users are logging into the system on a daily basis. In the first questionnaire, data was collected about

where the user's first port of call would be for knowledge sharing. This allowed statistics and testimonials to be generated on how much they used these areas. This can then be contrasted with statistics in light of the introduction of the Knowledge Management system. The output of this theme would be the extent to which the number of logins and use of the Knowledge Management system represents a deviation from the previous identified working practices.

6. Expertise – In the initial interviews we found that the social network within the organisation was not as well used as it could be. Statistics gained in the first questionnaire and interviews demonstrate that employees are apprehensive about approaching others directly for information and knowledge, in particular, those from other offices. This will be revisited to identify the extent to which the Knowledge Management system has assisted in breaking barriers that stop employees approaching others for information and knowledge.

7. Richness Source of Information – The peer network or social network (face-to face communication) was identified as a rich source of information and knowledge in the original interviews. The Knowledge Management system is an explicit version of the peer network. Feedback from users will seek to address the extent that the Knowledge Management system is viewed as a rich source of information and knowledge in comparison with the peer network.

8. Search for Knowledge Process – In the original interviews H&K employees' route to searching and finding knowledge and information was mapped. This route to

knowledge and information will be re-investigated in order to identify the changes that can be identified as a result of the Knowledge Management system.

9. New Knowledge – In the initial questionnaires and interviews, H&K employees were asked how they identified when they created new knowledge. How they recognised this, where they saved it, and how it could be found if required in the future. This will be re-investigated in light of the Knowledge Management system to identify the extent that this process has changed.

The themes identified for evaluation employ both the quantitative statistical information that the system can provide on the usage and the qualitative information from informal feedbacks to provide a rounded evaluation of the system. It is important for the evaluation of the system to begin as it was being rolled out as this would provide feedback on the implementation techniques allowing the development of best practices guidelines for the introduction and implementation of a Knowledge Management system. These best practices guidelines could be employed directly when introducing the system with new user groups across the regional offices.

8.3 Roll Out

The roll out of the Knowledge Management system took place during a four month period where the system was rolled out and implemented across all of H&K's regional locations. During this four month period different users would gain access to the system at different points. Three levels of roll out took place during these four months with the aim of fully embedding the system within H&K. The first level was

the approver roll out, followed by a topic based roll out and finally the wider user group was introduced and trained in the usage of the system.

8.3.1 Knowledge Management Approvers roll out

As previously stated, the business specification identified that it was fundamental that all information and knowledge added to the system underwent a strict approval process. One of the first stages of this approval process was to identify those individuals within the organisation that would be suitable candidates to approve topics within the system. This involved an expertise search across the organisation to identify those with the specific expertise in the different areas that the system would require approvers. Some of the outputs from the semi-structured interviews were employed in order to assist in the identification of these experts. In the first instance a list of the various topics that authorisers were required for was published. Employees were invited to sign up for topics they believed they could validate. A four week time period was given for employees to sign up for these specific topics. By the end of this process the majority of topics had an authoriser, some with some topics gaining more than one volunteer to authorise that area. Where there was more than one volunteer to validate a specific topic a decision had to be reached on who the most appropriate validator for that topic would be. This decision was undertaken by the Knowledge Management steering group made up of members of the H&K senior management team.

A steering group for the Knowledge Management system made up of the senior management team and representatives from the regional locations met to reach a

decision on the authoriser for each topic selects from the volunteers and identifying authorisers for topics where there had been no volunteers. During the roll out of the system this steering group would also act as Knowledge Management champions in each of the regional locations in order to assist and encourage usage of the system. Appendix 6 lists the authorisers selected and the topic areas that they were given responsibility for. Where an authoriser had been given more than one or several topics to authorise it has been ensured that the topics they have been given are areas where there is not an expectation of regular changes to that body of knowledge. For example, compared to traditional topics, there was expectation that Renewable Related topics in the system will receive regular changes and updates. It was therefore ensured that where an authoriser has been given several topics these topics are of the more traditional type where there is not an expectation of regular changes and updates.

Creating the approver group also created the first group for the roll out of the system across all of the regional locations. The approvers would be the first to access and use the Knowledge Management system across the organisation. Their remit in this first instance was to build up the knowledge base in their pre-defined topic areas. This would insure that when others came to access the system these areas would be tested and have a population of knowledge and information that would give the new user an image of how the system should operate.

The first group of user to use the system, the ‘approver group’, contained 52 users made up of volunteers from across the regional offices. Each of the users that would be part of the ‘approver group’ attended a group presentation which delivered training

on how the system was used and what was expected of them in terms of participation. These users were also given access to video resources that assisted in training and explaining how the system can be used. In addition to this, they were given a bank of training documents that explained how specific tasks and functions could be carried out.

8.3.2 Approver Usage

The 'approver group' gained access to the system on the 1st of February 2012 and for the preceding six weeks they would be the only user group using the Knowledge Management system. For the purpose of evaluation 3 of the 9 themes for evaluation could be looked at during this six week period. The first theme 'Activity in the system', 'download/uploads' and the fifth theme 'Logins'.

Activity in the system

Activity in the system is one of the most basic forms of evaluation that can be undertaken on system. Figure 27 below demonstrates the activity in the during the six week from the 1st of February 2012 to the 8th of March 2012 where the system was rolled out to the 'Approver Group'. During this time they were the sole user of the system. The X axis on the graph in figure 27 indicates the date on which the system was accessed and the Y axis indicates the user hits on that date. The system records user hits as the number of different areas and files within the system that was accessed. The graph demonstrates that as the period of the approval roll out

progressed the activity in the system heightened showing that at the end of this period the levels of activity had doubled on what they were at the start.

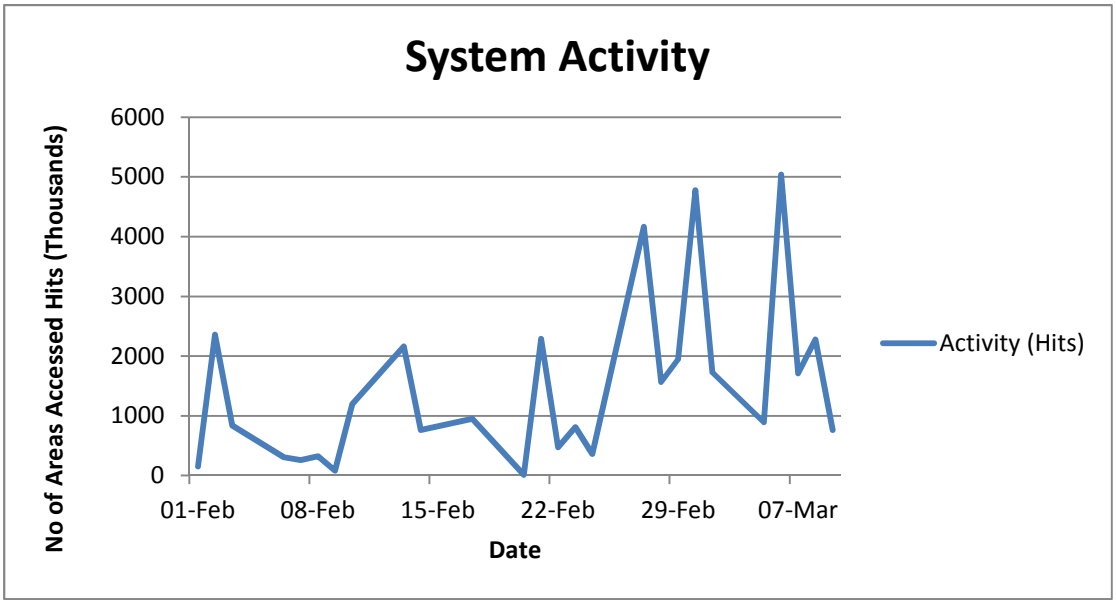


Figure 26 Activity in the system during 'approver roll out'

Logins

The login theme in the evaluation of the system looked at the average number of times on a daily basis the users were logging in and using the system. It also addressed the amount of time each user was spending in the system. The graph in figure 28 shows the average time being spent in the system by users, at the beginning of the roll out period for approvers in the system it was found that the average user was spending between 5-10 minutes within the system on each occasion they accessed it. It was also found that a user rarely accessed the system on more than one occasion in the average day. However, at the end of the approval roll out period it was found that the average user was spending between 15-20 minutes accessing the system on each occasion that they logged in, and that user would now visit the system multiple times in the average day.

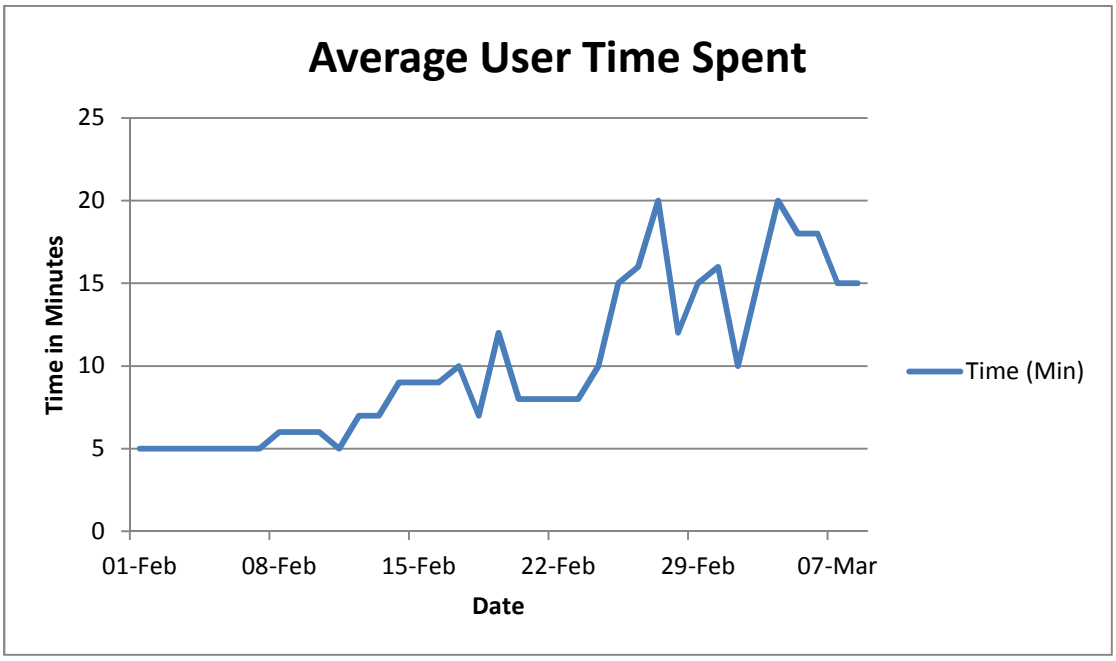


Figure 27 Average Time Spent in the System by User

Downloads/uploads

The fourth theme 'downloads and uploads' utilises the system's ability to record the addition of documents to the system during the 'approver' roll out period. During the 'approver' roll out period, it was found that there were 40 documents added to the system during this time. Downloads were not recorded as there was so little knowledge and documents within the system, the expectation was that the activity would be focussed on the addition of documents. This was poor as each of the approvers had been given the remit of adding knowledge and documents to the areas of the system they were responsible for validating. This meant that by the end of the 'approver' roll out period, the majority of approvers had not yet added knowledge and documents to areas they were responsible for. The downloads/uploads theme also looks at the regional locations, that the knowledge and documents are being added from and the level within the organisation that these additions came from. It was found that when the regional variation was looked at although the 'approver' group

had a spread of users across all regional locations the majority of additions to the system were taking place in the Glasgow and Manchester offices. It was also found that the user were senior engineers or associates although the 'approver' group was made up for the majority of these levels. It was found that additions were not being made by the director and regional director groups that also made up the majority of the 'approvers' group.

Summary

It was found that during the roll out and implementation of the Knowledge Management system across the 'approvers' group that the usage and activity in the system increased towards the end of the six week period. The average length of time that a user spent logged in to the system also increased from 5-10 minutes to 15-25. At the start of the period users would only use the system once in anyone day and by the end of the period there was evidence of the user using the system multiple times in a day. The evaluation statistics with regards to the upload of documents evidence demonstrated that additions were being made predominantly from two of the regional offices. Furthermore, it was found that the addition of documents was taking place predominantly by two levels of user within the organisation i.e. senior engineers and associates. This identified that the system was not being utilised by the director and regional director users within the 'approver' group and action would be required to increase their buy in and usage of the system. In general, the evaluation of the 'approvers' group usage of the system identify that there was activity taking place within the system and the amount of time user were spending in the system was increasing. However, this was not being converted into the addition of knowledge and documents to the system.

8.3.3 Topic Based User Group Usage

The next stage in the roll out process concentrate on rolling the system out to additional users across the organisation based on the topics that were being undertaken in those regional locations. This strategy took a different route from other strategies that based roll out on user groups within a particular level within organisation or that carried out a particular function. Instead, we concentrated on the topics that we wanted to establish a body of knowledge and identified individuals across the organisation that were generating information and knowledge on these topics. These individuals were introduced to the Knowledge Management system and encouraged to add information and knowledge to these areas that they were generating information and knowledge in.

The 'topic based' user group would be the second user group to gain access to the Knowledge Management system and contained 70 users across the regional locations. The strategy for roll out and implementation of the system with this user group was similar to what had taken place with the 'approvers' group. The 'topic based' group received group presentations across the regional offices that provided training in the system. The new user group were given access to the video and training documents. Further videos and training documents were created to support this new user group in the implementation and use of the system. Each of the users in the topic based group were given a remit to add specific knowledge to the system based on topics that were arising in project they were working on. For example, the Bristol office were working on a new college project that involved wind turbine technology. Specific individuals

from the topic based group were given the remit of adding this knowledge and information. This insured that when a user accessed the system they had specific task that they could carry out that would familiarise themselves with the system.

As the 'approvers' group had previously been given access to the system and were more proficient in its use approvers in each of the regional offices could act as a support mechanism for the new users that were accessing the system in their office. Due to the evaluation that had been carried out on the system while the approvers group being rolled out the system it was found that interaction in the system at a director and regional director level had been limited and that activity in the system was not being converted into the addition of documents and knowledge. Mechanisms were put in place to improve the usage in the system with the approvers group during the roll out of the system to the topic based group. This resulted in one to one training sessions being delivered to approver group users in order to increase their activity and usage in the system this also resulted in further training documentation that detailed how to perform specific functions and tasks.

8.3.4 Topic Based Group Usage

Users from the topic based user group gained access to the system on the 9th of March 2012 the roll out period for the topic based user group lasted until the 30th of April during this period the topic based user group would use the system alongside the approvers group. Evaluation on the system took place during this period the activity in the system, downloads/uploads, logins and the search for knowledge process themes were employed to evaluate the usage in the system.

Activity in the system

The graph in figure 29 demonstrates the activity in the system from the 9th of March until the 29th of April during the time when the system was rolled out to the topic based user group. At this point there was now 122 users with access to the system across all of the regional offices. Compared with the previous roll out period with the approvers group the activity in the system was lower. This can be contributed partly to the Easter vacation and many users taking holidays during the months of March and April. However, what can be seen from this graph is the spikes where activity in the system heightens which is more frequent than in the previous roll out period. An interesting aspect about these spikes of activity in the system is that they fall on a Friday which will be explored in the downloads/uploads theme.

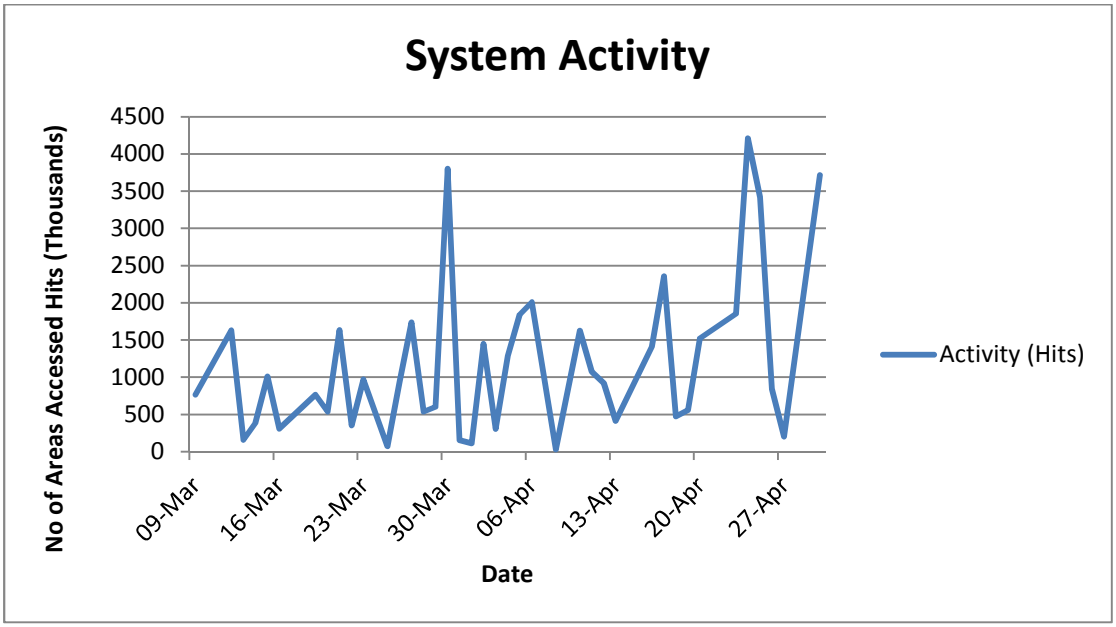


Figure 28 Topic Based Group Usage

Downloads/Uploads

The number of uploads or additions of knowledge and documents increased during the topic based roll out of the system. There is also evidence of the usage of documents and knowledge that had been added to the system. Informal discussions with engineers highlighted the usage of BREEAM related knowledge that had been added to the system. The diversity in the users that were adding knowledge to the system increased as additions of knowledge came from the graduate and design engineer groups within the system. However, it was still found that additions from the director and regional director level limited. As previously identified, spikes of activity were taking place on a Friday. This was found to be linked with the addition of documents. The system gives the user the ability to save a document as a draft so that it can be edited or changed prior to submission for validation. It was found that users were saving documents as drafts Monday to Thursday prior to spending time editing and then submitting them for approval on a Friday. However, the number of additions to the system did not meet the expectations of the Knowledge Management steering group and the amount of activity that was taking place in the system. It could be viewed that the user were accessing the system and browsing without issue but this was not being translated into the addition of documents and knowledge.

Logins

The evaluation of the login information during the time period where the system was rolled out to the topic based user group demonstrated that initially at the start of this period the system was now being used by a wider user group for shorter periods of time. Figure 30 demonstrates the time being spent in the system during the topic group roll out. The average time spent in the system at the beginning of the roll out of

the system to the topic based user group was 10 minutes. This saw a reduction in the time compared to the time being spent in the system at the end of the approver's group usage, however the system is now being used by 122 users rather than 52. The new users could be seen to be logging on to the system and spending short periods of time browsing through the system and returning at a later date to repeat this process. The login information also highlighted that the Glasgow and Manchester offices were still the regional locations where the most amount of Knowledge Management activity was taking place. However, there was a growing usage of the system in the Epsom and Edinburgh offices. This also identified the Birmingham, Bristol, Cardiff and Plymouth offices as the regional locations where there was limited activity taking place.

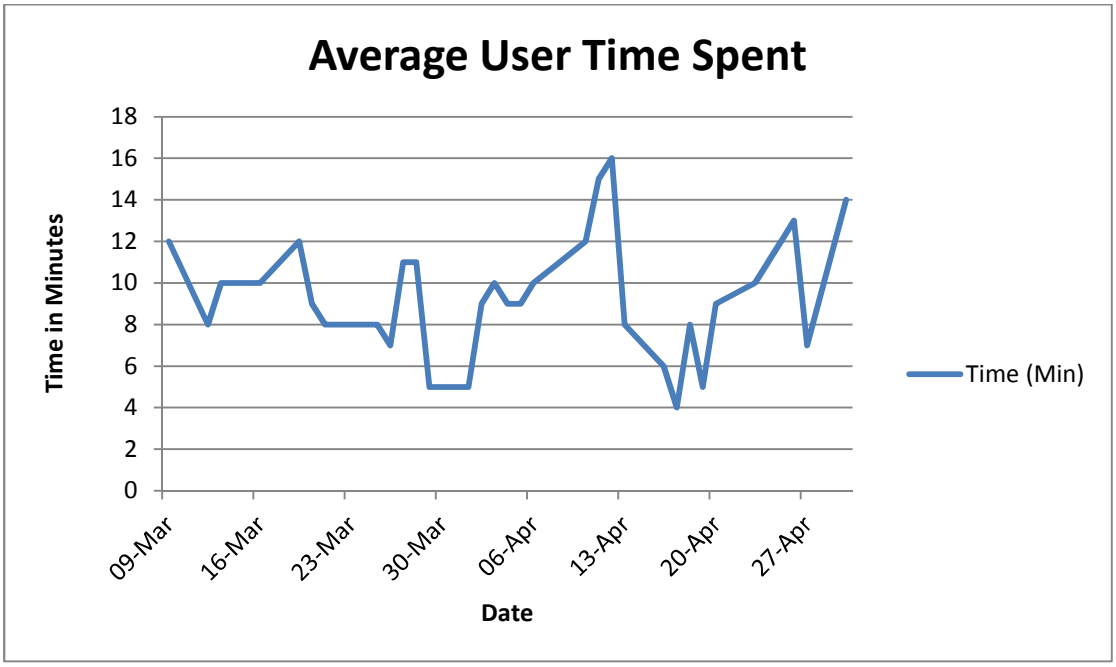


Figure 29 User Time Spent in the System During the Topic Group Roll Out

Search for Knowledge Process

In the original interviews H&K employee's route to searching and finding knowledge and information was mapped. Through the evaluation of the Knowledge Management system this route can be re-mapped. The evidence from the activity in the system statistics and the logins suggests that the majority of users spend short periods of time browsing through the different areas of the system in order to find information and knowledge. One of the other functions of the system that was seen to be employed more as the number of users and information and knowledge in the system increases is the search function. The graph in figure 31 shows the increase in searches being carried out in the system over the three months when the approver and topic based group were given access to the system. During the month of February, the number of searches being carried out in the system was limited to only 52 searches which indicates that not all users were using the search facility. However the figures for March and April show's a dramatic increase in the number of searches taking place in the system. In March, the number of searches rose to 188 more than three times the number that had been carried out in February. In April this number rose again to 255. This increase in the use of the search facility demonstrates a growing use of the Knowledge Management system as a resource for the search and acquisition of knowledge and information.

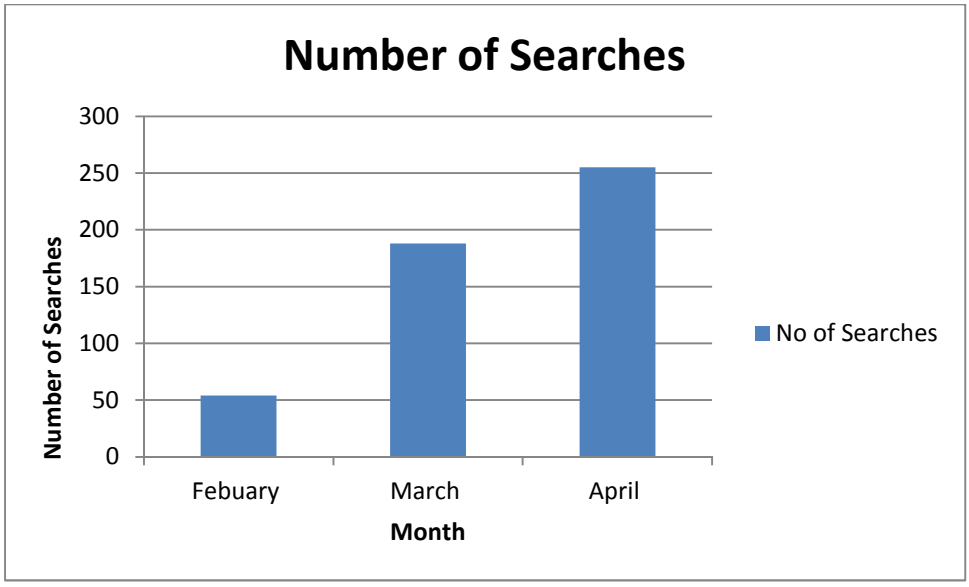


Figure 30 System Searches

Summary

The addition of the second user group, if the topic based user group, generated an increase in the number of documents being added to the system. It was also noted that additions of documents was mainly taking place on a Friday which could be capitalised on in the future. The average length of time that a user was spending in the system once logged in reduced with the introduction of the topic based user group. It was found that with the increase in users there was more activity in the system. However, users were logging in and browsing the system for short periods of time. Linked with this was the increase in the number of searches being carried out on the system, which increased quite dramatically from February to April. This information and the increase in activity demonstrate, that the Knowledge Management system was becoming a route that the users would employ for the acquisition of knowledge and information. In general, by the end of the of the topic group roll out of the system the amount of activity that was taking place in the system was positive and the fact that there was evidence of the search function being employed by users demonstrated that

the Knowledge Management system was becoming a route for the acquisition of knowledge and information. However, positive signs of the systems usage were not contributing to the addition of knowledge and documents. Regional variations in the use of the system was also identified with Birmingham, Bristol, Cardiff and Plymouth offices being identified as locations where there was limited amounts of usage of the system.

8.3.4 Wider User Group

The wider user group was made up of those that had not yet be involved with the system at either of the two previous roll out stages. This group was largely made up of those that provided administration functions within the organisation and were therefore not involved in the previous roll out stages; there were 48 new users in the wider user group. Introduction and training in the system was tackled in the same manner at each of the roll out stages using the four mediums identified to introduce and train users in the system. Additional videos and training documents were delivered to this group along with group presentations and one to one training in the system.

The final roll out stage was also used as an opportunity to improve the usage in the authoriser and topic group that had previously been given system access. The system allows us to identify the regional sites and individuals that are adding information and knowledge to the system and those sites and individuals where the uptake and usage of the system is weaker. The final roll out stage of the system began on the 1st of May 2012 until the 29th of June 2012. During the final roll out stage of the system, one to

one training in the system was delivered to not only the new 48 users within the wider user group but a refresher training was delivered to all users across the groups that the system had previously been rolled out across. This training focused on the addition of knowledge and documents to the system in an attempt to stimulate the addition or uploads to the system.

Those users involved in the wider user group also had the benefit of users within their regional location that had been using the system for several months. Knowledge Management champions were identified across the regional locations, these users were those that had demonstrated good practice in the use of the system in the previous months. The Knowledge Management champions formed a support structure for those new users within their location and those that had previously been demonstrating limited use of the system. Knowledge Management champions were given the remit of encouraging and supporting these users in order to create an improved usage of the system. Additional support was given to Knowledge Management champions in the Birmingham, Bristol, Cardiff and Plymouth offices where the usage of the system had been limited.

In Glasgow, Manchester, Epsom and Edinburgh offices where the usage of the system had been positive, a strategy of usage improvement was introduced in order to further improve the systems usage. It was identified that the high number of additions and activity in these offices could be attributed to a select group of users. These users were identified and contacted. Each of these users was tasked with the training of another user within their location whose usage was weaker. They were asked to take

that user through their processes and practices for using the system and explain to the user the benefits that they could see from using the system.

As previously identified within the topic based group roll out of the system, the number of searches being carried out on the system was increasing dramatically. After some evaluation it was found that the searches were not always producing results for the users. This was attributed to the addition of knowledge and documents to the system and while users were accessing and using the system this was not translating to the addition or upload of knowledge and documents. The system has the ability to record the search terms that are being used, the frequency of these searches and the number of results that is returned. Figure 32 below shows the top twelve search results for the month of May and the percentage that they were used. Based on the search queries a strategy was devised to attempt to increase the number of additions to the system. The operations director for H&K agreed to produce a communication to the organisation on a weekly basis highlighting the searches that had been carried out on the system identifying those that had produced zero or limited results. This was designed to encourage those that were in the possession of knowledge in these areas to add this to the system.

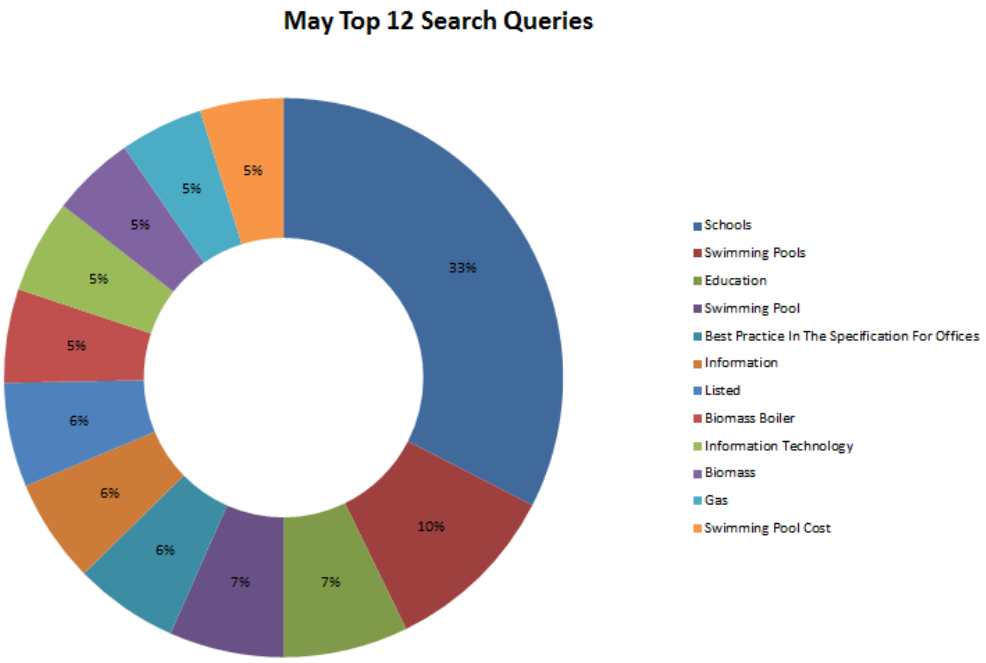


Figure 31 May Search Queries

Figure 32 demonstrates part of the communications that were produced on a weekly basis by the H&K operations director. The aim of this communication strategy was to demonstrate to staff across all regional locations the searches and frequency of these searches that were being carried out within the system. The donut graph in Figure 32 shows the top 12 searches that were carried out that week as a percentage of their frequency. The communication also included information on the results of these searches in order to encourage users to add information and knowledge to the areas that were appearing in searches but producing poor or limited results.

Activity in the System

Figure 33 demonstrates the activity in the system during the wider user group roll out of the system between the beginning of May and end of June 2012. At this point there were now 170 users across the organisation with access and using the system. Compared with the previous activity in the system during the topic group roll out the spike of activity in the middle of July nearly reached 6000 user hits the highest recorded. We can also see that spikes in activity are now becoming closer together which indicates that high levels of activity are taking place in the system more often. Figure 34 also demonstrates system activity. This graph compares the activity taking place during the topic based and wider user group roll out of the system. As can be seen in figure 34, during both roll out phases the spikes in activity in the system are becoming closer together, this indicates that the system is being used more frequently by more users. The comparison of the two roll out periods also demonstrates that the spikes of high levels of activity in the wider user group roll out period were far higher than what was evident during the topic based roll out. As previously discussed communications were produced during the wider user group roll out period by the operations director in order to highlight the searches that were taking place in the system and encourage activity and the addition of new knowledge and information. A result of these communications was that a correlation could identified between the release of a communication and a spike in activity during the wider user group roll out period. The rise in the amount of activity in the system that can be seen in figure 33 on the 15th and 29th of May and the 5th, 12th, 19th and 26th of June were the results of communications from the operations director.

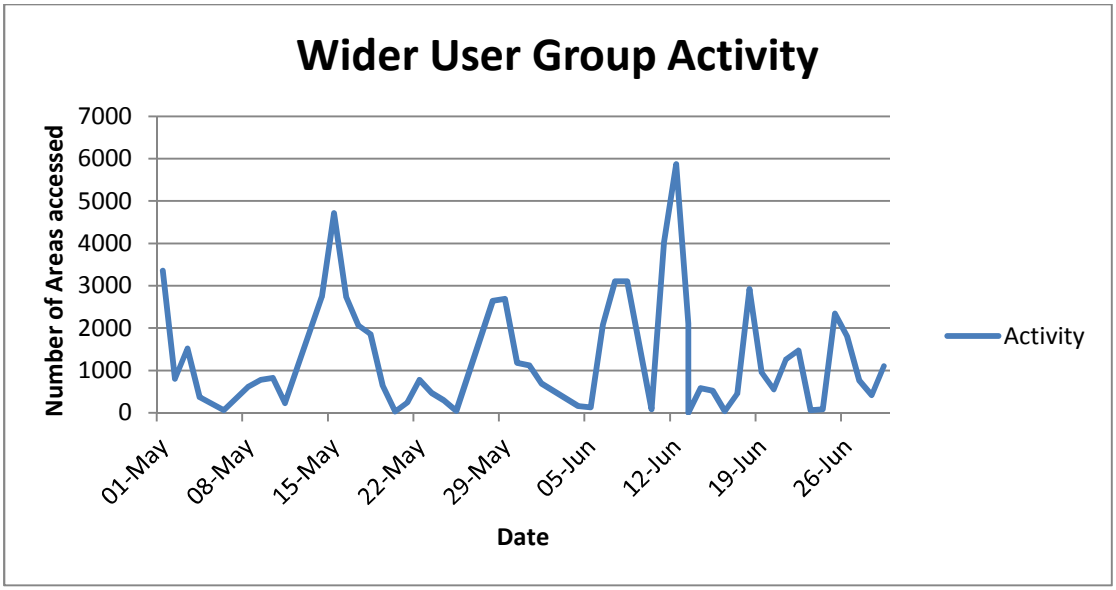


Figure 32 System Activity Wider User Group

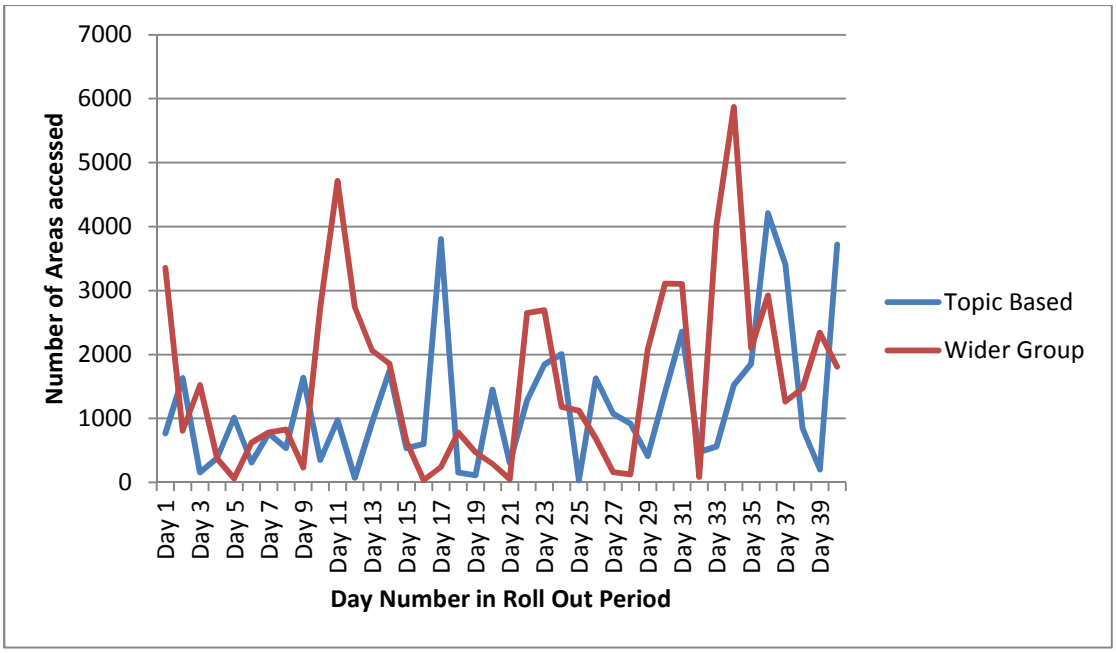


Figure 33 May and June Usage Comparison

Downloads/Uploads

It had been identified that in the two previous roll out stages of the Knowledge Management system that uploads or addition of documents to the system were not as high as anticipated. In order to increase the number of additions, a communication was devised in order to encourage the addition of documents to topics users were searching for. In addition to this the wider user group had the benefit from users from previous roll out groups that had experience in the usage of the Knowledge Management system. Knowledge Management champions were identified to assist with the usage of the system across all user groups. Finally during the wider user group stage a further initiative was employed to encourage and improve usage of the system. This initiative was for experienced users to mentor and support new or user with limited usage of the system to improve their usage and increase the addition of knowledge and information to the system. Figure 35 is a bar graph that demonstrates the growth in the number of additions to the system during the three user group stages. As viewed in figure 35 it can be seen that the number of additions to the system was similar in the roll out periods for the authorisers and topic based groups. However during the roll out of the system to the wider user group the number of additions of knowledge and information to the system can be seen to have grown four fold from 53 and 69 respectively to 199. This demonstrates that the strategies and initiatives put in place during the final roll out stage of the system contributed to the growing number of additions of information and knowledge to the system.

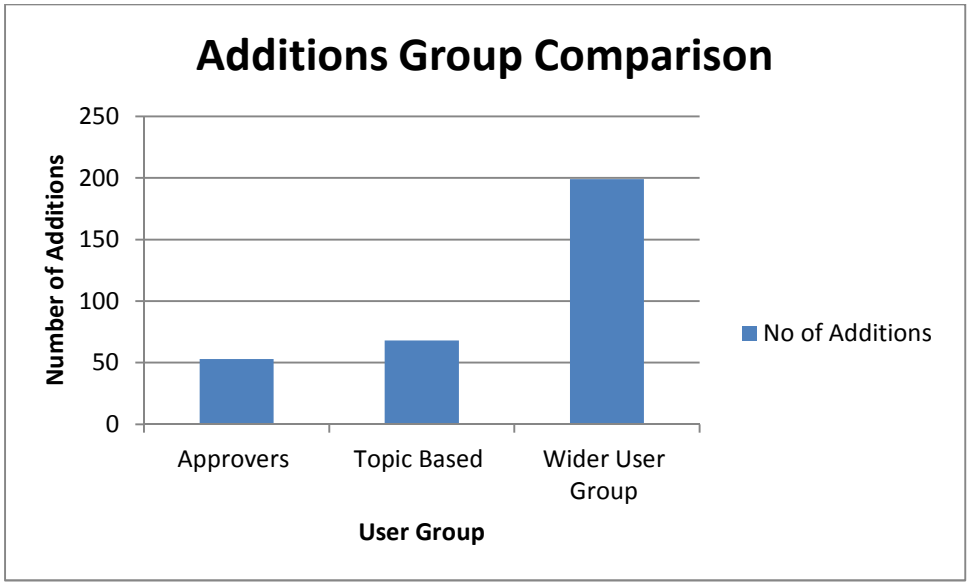


Figure 34 Additions Group Comparison

Logins

The introduction and implementation of the system with the wider user group saw the number of system user jump to 170 the entire H&K work force. This introduction of new users and improvement in the usage patterns by other users saw the time being spent in the system grow dramatically. The average users time in the system increased to 15-20 minutes per visit which was similar to the time being spent in the system at the end of the roll out to the authorisers group. However this 15-20 minute period of usage in the system could now be seen to be happening multiple times in a day by the same user. This usage pattern had not been evident in any of the other roll out periods. It could now be summarised that the average user was only using the system for 15-20 minutes at a time but this was taking place on average several times a day. By the end of the wider user group roll out period of the system it could also be seen that some users were spending periods of up to an hour of active usage of the system. This portrays the Knowledge Management system as becoming a regular knowledge and information gathering activity for the H&K employees.

Search for Knowledge Process

Previous evaluation during the authoriser and topic group roll out of the system demonstrated that users were browsing through the system for knowledge and information. However, statistics suggested that the search functionality of the system was being employed regularly. Figure 36 demonstrates the growth in the number of searches being carried out in the system over the roll out period. We can see that during the wider group roll out of the system the number of searches increased to 342 in May and then nearly doubled to 600 in June. The dramatic increase in the number of searches can be attributed to the communications strategy that was introduced during the wider roll out stage that publicised the searches that were taking place in the system. The rise in the number of searches being carried out in the system indicates the extent to which the Knowledge Management system has been established as a route to knowledge and information.

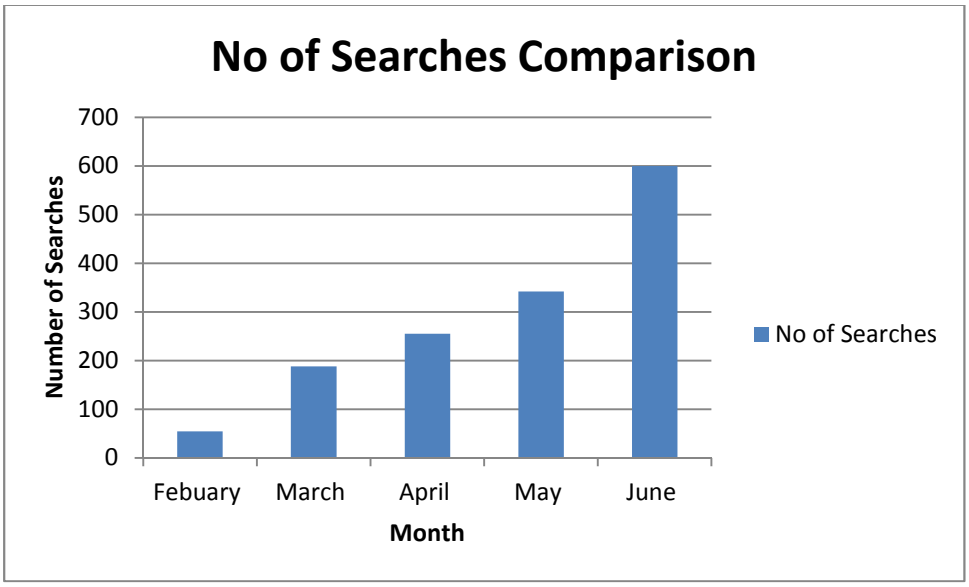


Figure 35 Number of Searches Comparison During Roll Out Period

Summary

The third and final roll out stage of the system saw the increase in system activity increase. The spikes in the levels of activity displayed in figure 33 were also becoming closer together which indicates that high levels of activity was taking place more often in the system. Increases in activity can also be correlated with the communications of search activity that was produced by the operations director. This demonstrates that this strategy was successful in increasing activity in the system. In addition is the communications strategy, there were two other strategies that aimed at increasing the number of uploads or additions to the system, Knowledge Management champions and experienced users mentoring new or users with limited use of the system. Figure 35 demonstrates that these strategies that were employed have been successful in increasing the number of additions of information and knowledge to the system. The wider roll out stage saw the number of users in the system increase to 170, the entire H&K workforce. This had an effect on the amount of time users were spending in the system. Prior in the topic based roll out the average amount of time users were spending in the system decreased with the increase in users. However during the wider group roll out of the system the amount of time users, spent in the system, increase back to 15-20 minutes. In addition to this, users were accessing the system for this length of time on multiple occasions on an average day with some users recording periods of activity of up to an hour. This reinforces the fact that the Knowledge Management system was becoming a regular knowledge and information gathering activity of tool for the H&K employees. In addition to this were the results for the search for knowledge process. The number of searches in the system nearly doubled during the wider group roll out of the system. This further reinforces the fact

that the Knowledge Management system had become a route for searching and finding information and knowledge.

8.4 Further Evaluation

During the discussion of the roll out of the Knowledge Management system across the authoriser group, topic group and wider user group four of the nine evaluation themes were addressed; activity in the system, downloads/uploads, logins, and the search for knowledge process. The remaining five themes can be addressed now that the system is fully rolled out across all groups within the organisation. These themes can be evaluated employing both the quantitative statistical information form the system and the qualitative data generated from interviews and informal discussion.

Critical Mass

The critical mass theme aimed at identifying a correlation between the number of downloads from a topic and uploads and if this could be used to identify when a topic has reached critical mass in terms of its size of knowledge in that the user can now learn and use knowledge from this topic rather than constantly uploading to it. Figure 37 shows the Uninterrupted Power Supply/Interrupted Power Supply (UPS/IPS) design file in which there had been a great deal of knowledge and documents added to this file by 10th of June 2012 after which date additions were less frequent and it was observed that the number of downloads of knowledge and information from this area had overtaken the uploads. This indicated that this area could have reached a critical mass. Informal discussion with Knowledge Management champions across the regional offices agreed that the level of knowledge and information within the

'UPS/IPS' topic was at a level where it would be used as source of knowledge and information and the number of downloads from this section would be greater than the number of additions in the future. Discussions with Knowledge Management champions also indicated that there would not be the ability to reach this level of critical mass for all topics across the system. The 'UPS/IPS' topic is an example of a topic in the knowledge and information stays static in that there is not as many frequent changes to the depth of knowledge we know about this topic. Other topic areas especially those that fall into the renewables and sustainability categories have been identified as topic's where the organisations body of knowledge will change on a frequent basis. Therefore, the evaluation of a topic's critical mass within the organisations is able, with informal feedback to identify a level when specific topic's deliver knowledge and information.

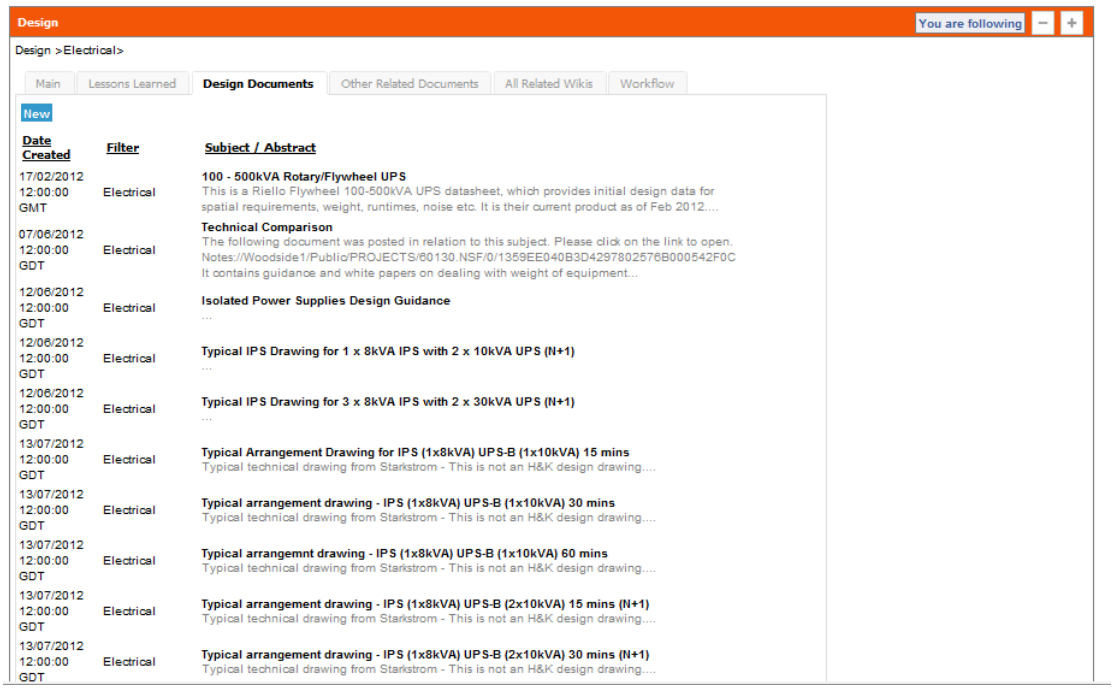


Figure 36 Critical Mass UPS/IPS

Change in Methods for Gathering Information

During the 'Understanding Information and Knowledge Management Requirements' phase of the Knowledge Management project structured interviews, questionnaires and informal discussions were employed to map the process and methods employed by the users to gather information and knowledge. Key points from the current process for gathering information and knowledge can be summarised from this stage;

- Engineers are reluctant to seek knowledge and information from staff outside their own specific office;
- It is easier to ask someone than become familiarised with existing systems;
- Knowledge and information generally requires processing before it is useful;
- Engineers are generally too busy to document and detail new knowledge and information they have created;
- New knowledge and information is generally not shared amongst the community but stored on individual desktops;
- Time restriction plays a major role in the practices adopted for retrieving, using, creating, validating and storing knowledge and information

Prior to the introduction of the Knowledge Management system, it was also found that the peer network or face-to-face communication was a popular tool for gathering information and knowledge. However this only took place within regional offices and communication with staff in other offices outside their own specific office did not regularly take place. It was also found that the use of existing systems within H&K does not take place in favour of the peer network due to a lack of familiarisation with the systems.

The information and statistics gathered during the roll out of the Knowledge Management system points to a change in the information gathering practices of H&K employees. It was demonstrated during previous discussion on system activity during the five month roll out period for the system that the amount of activity in the system along with the amount of uploads or additions of information and searches being carried out in the system increased dramatically. This indicated that the use of the systems was growing among H&K employees. Informal discussions with many users across the regional offices reinforced these indications. Users made statements such as the fact that the Knowledge Management system was now their 'first port of call' for gathering information and knowledge. Other users noted that they would always try to search the Knowledge Management system in the first instance prior to using other tools for gathering information and knowledge. Prior to the implementation of the Knowledge Management system it can be seen that the use of internal systems for the gathering of knowledge and information was limited and that they would rarely share knowledge or harness it from a offices outside their own. Since introducing the system the statistics and informal discussion with employees have demonstrated that there has been a change in information and knowledge gathering practices, i.e. that the Knowledge Management system, an internal system, has become a popular first port of call for and information gathering. With uploads or additions of information taking place across the organisation, it demonstrates a willingness to share knowledge and information and that the information gathering practices had firmly changed across all staff.

Expertise

In carrying out the initial 'Understanding Information and Knowledge Management Requirements' stage it was found that face to face communication or the peer network provided H&K employees with the richest source of knowledge and information. However employees were apprehensive about approaching those out with their immediate environment or regional office. The Knowledge Management system can be viewed as a tool that will assist in breaking down the barriers that stop employees approaching others for information and knowledge. The statistics from the final wider user group during the implementation phase of the Knowledge Management system indicate that high levels of activity and uploads or additions of knowledge and information were being made to the system. During the final wider user group roll out of the system nearly 200 additions were made to the system. This was four times the number from any of the previous roll out phases. It can also be noted that this high number of additions came from a cross section of users across the organisation. This demonstrates a willingness from users around the organisation's regional locations to share their expertise on specific topics.

Using informal discussions with groups of users across the organisation, it has been found that the high number of documents that was added in the wider user group roll out allowed users to identify experts on topics outside their regional location. It has been found that many users during this period were able to identify users with specific expertise that they could leverage in the future that they would previously have been unaware of. For example, users in Glasgow were unaware that the Plymouth and Bristol offices had experience of wind turbine technology and would attempt to harness this knowledge on a project that required this expertise. This demonstrates

that the Knowledge Management system has been successful in assisting users to fully realise the expertise that can be gained from breaking down barriers and approaching peers outside of their regional location for knowledge and information.

Richness of Source Information

It was found in the 'Understanding Information and Knowledge Management Requirements Phase' that the H&K employees identified the peer network or face to face communication as the richest source of knowledge and information. It has been previously identified in the expertise heading (page 116) that users were now adding information and knowledge from various regional locations and this was breaking down barriers and allowing users to access the knowledge and information of others outside their immediate peer group. The Knowledge Management system aimed at becoming an explicit version of the knowledge and information that is shared between individuals and capture the tacit knowledge and rationale. The statistics that has been gathered on the amount of activity, additions and searches that are taking place in the system had established that the Knowledge Management system has become a popular tool for knowledge and information gathering among employees. This statement is also reinforced by informal discussions that took place with employees. It is difficult to assess how rich a source of knowledge and information this system has become. However, examples of where tacit information or information that would normally be communicated face to face can be found in the system.

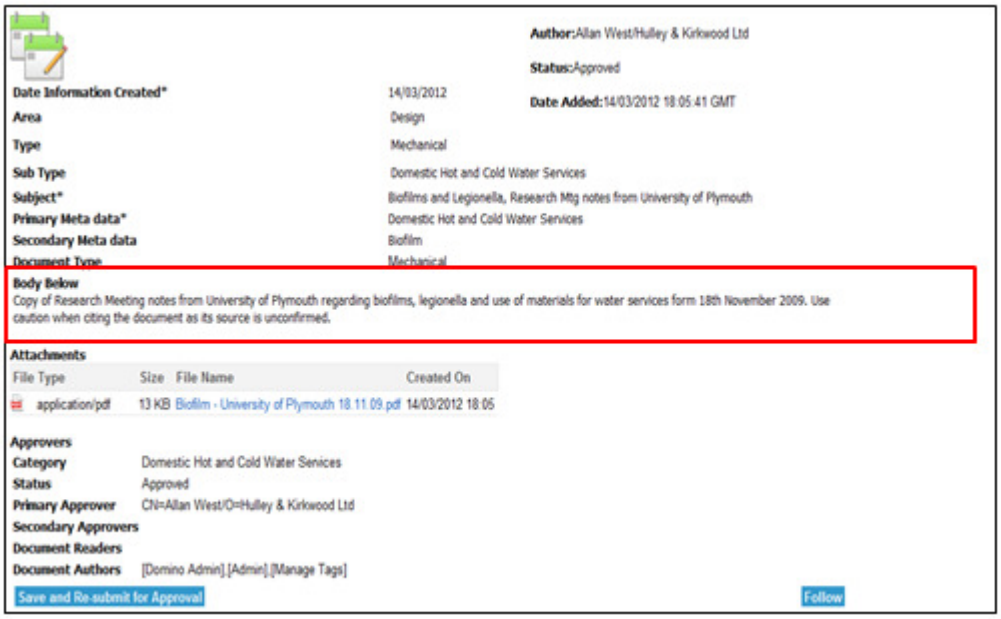


Figure 37 Knowledge and Information Rationale Example

Figure 38 displays a typical upload of knowledge and information to the Knowledge Management system. Highlighted in red is the free text area that the user can add further information and rational about the piece of knowledge or information they are adding to the system. As shown in figure 38 the user has provided further information to future users on the content and source of the information, they have also given a health warning for the use of the information and knowledge in the future. During informal discussion with the users it was found that this additional information and rationale input provides users a guide to the knowledge and information presented to them. The rationale contains the typical information and knowledge that would be transferred in a face to face meeting and increased the source in terms of richness of content. While there has not been the ability to measure the Knowledge Management system as a rich source of information and knowledge compared with face to face communication, it has been established that elements of the Knowledge Management system provide qualities of face to face communication that was judged to be the richest source of information and knowledge.

New Knowledge

During the 'Understanding Information and Knowledge Management Requirements' phase of the Knowledge Management system development, it was found that new knowledge and information is generally not shared amongst the community but stored on individual desktops. So knowledge and information was not stored in an environment where it was easily accessible and shared with others. The statistics in relation to uploads or additions to the Knowledge Management system in figure 35 demonstrate that by the end of the roll out period there was a high number of users adding knowledge and information to the system. This indicated that there had been a change in the practices of users in relation to where user would store new knowledge and information that they had found or created. Informal discussion was undertaken with a cross section of user across the regional locations in order identify if there was a change in practices by users and if new knowledge was now being stored in an environment that was easily accessible and shared with others.

The informal discussion was held during presentations with cross sections of staff within regional offices, on the Knowledge Management activities that were taking place across the organisation. Discussions were held on how users now react to new knowledge and information that they create or find. It was found that users recognised the benefits of storing new knowledge in the Knowledge Management system as it was an environment in which the knowledge could be shared and used by other users across the organisation. While that statistics generated demonstrated that some knowledge and information was now being stored in this way, users during the informal discussion identified those barriers they were encountering when attempting

to store new knowledge in this way. It was identified that having the time to add new knowledge was the most significant barrier to this taking place. Many user testified to the fact that they recognised the Knowledge Management system as being the most appropriate area for new knowledge to be stored as it places it in an environment that was easily accessible and could be shared with others. Users stated that they attempted to store new knowledge that they created or found in this manner but due to time constraints this was not always possible. This demonstrates a change in practices for identifying and sharing new knowledge among H&K employees in that there was as recognition that storing new knowledge in the Knowledge Management system was the most appropriate method for ensuring that new knowledge was accessible by others. The statistics demonstrate that there was an effort across the organisation to employ the Knowledge Management system in this manner but due to time constraints placed on users there was not the capacity for all new knowledge to be stored in this manner.

8.4 Further Evaluation Summary

It was found during further evaluation of the Knowledge Management system that it was not possible to identify a uniform level at which areas within the system can be said to have reached critical mass in terms of the number of downloads compared to uploads. This was due to the fact that these levels would not be the same for every topic. It was found that there is evidence of a change in the processes for gathering information and knowledge across the organisation. It was found that there is evidence of a change in the processes for gathering information and knowledge across the organisation. This was evident due to the amount of system use that was taking

place in comparison with the use of internal systems prior to the Knowledge Management system. It was also found that the system contributed to the change in attitude to expertise across the organisation with employees communicating and sharing knowledge and information with those outside their regional location. A direct comparison with the richness of knowledge in the system compared with face to face communication could not be achieved. However, it was found that the Knowledge Management system provided qualities that were evident in the face to face transfer of knowledge. Finally, it was found that the Knowledge Management system impacted in the process for storing and sharing new knowledge. The system provided an environment in which knowledge and information could be stored in a way that it was easily accessible for others. This demonstrated a significant change in the process for storing and sharing new knowledge that had been established prior to the system. It was found that not all new knowledge was being stored in this way. However, statistics demonstrated that there was a considerable effort across the organisation for new knowledge to be stored within the system.

9. Impact Recommendations and Conclusions

Introduction

This final chapter will provide recommendations and lessons learned for the design, development, implementation, and embedding of a Knowledge Management. This will be detailed in the form of best practice guidelines for the creation of a Knowledge Management system. This is summarised in a table 5. In addition, this chapter will provide a summary of the realisation of the objectives in addition to recommendations for future work. This chapter specifically addresses objective 8 through the development of recommendation and lessons learned in the form of best practice guidelines for the development and implantation of a Knowledge Management system.

O8. Produce guidelines of best practice for the development and implementation process for a Knowledge Management system.

9.1 Project Stages Recommendations and Best Practice Guidelines

This section aims to provide recommendations and best practice guidelines for each of the main project stages identified in developing a Knowledge Management system. The best practice guidelines are summarised in table 5 in the second section of Chapter 9.

Understanding Knowledge and Information Requirements

It is essential to understand the knowledge and information requirements of the organisation prior to embarking upon a Knowledge Management system development project. It has been demonstrated that methods such as questionnaires and semi-structured interviews along with informal discussion can be employed to develop an understanding of an organisation's Knowledge and Information requirements. Employing a mapping approach created a visualisation for the current process that was taking place within the organisation for retrieval, information use, new knowledge, validation and storage this provides validation and refinement of requirements. It also allowed a solid understanding and development of the knowledge and information requirements. It can be recommended that methods such as questionnaires and semi-structured interviews along with informal discussion and mapping approaches can be employed to provide and understanding of current knowledge and information requirements within and organisation.

Development of Business and Software Specifications

It is essential that a full understanding of requirements is generated between both the development team and the end users. This ensures that all requirements are validated with the end user and refined where necessary. It can be recommended that prototypes can be employed both paper based and electronic as a feedback tool. Requirements maps from the 'Understanding Knowledge and Information Requirements' stage can be employed again to facilitate the understanding of requirements between the development team and end users. It is also recommended that the process of translation of user requirements to software features is documented to allow each feature to be validated and refined. Best practice guidelines from this stage are the

ability to employ user requirement maps as a visual aid to ensure the full understanding of requirements and their validation against prototypes.

Software Selection

The software selection was critical in the project to ensure a platform was selected that the software could be successfully delivered on. The refining of the user requirements during the 'Development of the Business and Software Specifications' stage allowed a matrix of essential and desirable requirements and deliverables to be identified. This could then be employed as a tool to inform the final software selection decision. It can be recommended that during any Knowledge Management system development or software development project that matrix's are employed to assist in identifying forerunning options and element unsuitable options and explore validated requirements in conjunction with possible software options.

User Evaluation Training and Roll Out

It was critical for the system's success that it was fully implemented and embedded across the organisation's regional offices. To successfully roll out a Knowledge Management system it is recommended that the roll out takes place in stages. It can be recommended based on lessons learned from this project that the roll out takes place with key user groups during these stages. Assigning user groups specific tasks to carry out within the system generates a purpose for their usage of the system and assist in the user group familiarising with the system functions. Four mediums for training material can be identified as materials that will successfully assist with the roll out process; videos, group presentations, one to one training sessions and training documentation. A best practice guideline from this stage is for the system roll out to

take place in stage with key user groups and the necessity to communicate the goal or shared vision of the system and the purpose for using it.

In order to carry out evaluation on a Knowledge Management system it can be recommended that themes for evaluation on the system are identified in order to identify a full understanding of how the system is being used across the organisation. It is also fundamental to identify the statistical information that can be generated from the system itself. Some of the key themes for evaluation identified were; identifying when an area had reached critical mass, changes in the methods for users gathering information and knowledge and the process for storing and sharing new knowledge. It can be recommended that mapping approaches can be employed to identify changes in the process for gathering information and process around new knowledge when compared with previously mapped existing practices. A best practice guideline from the evaluation process of the Knowledge Management system is the extent to which statistics generated form the system itself can be employed to build profiles of how the system is being used.

Improving System Usage

From carrying out evaluation on the system during the roll out period it was identified that there was evidence of good and poor usage from users across the organisation. Strategies were produced in order to increase the number of users demonstrating good usage patterns of the system. It can be recommended that using multiple mediums of training materials is successful in implementing a system with a wide and diverse group of users. In order to improve usage these support materials have to be improved and increased in order to create a support culture to fully embed a new Knowledge

Management system. Best practice guidelines for improving usage of the Knowledge Management system focused on three areas; the identification of champions, peer training and regular communications. Champions identified across the regional offices provided a direct contact for that office for Knowledge Management related activities and to lead incentives to improve usage. It can be recommended that placing support mechanisms to allow peer training to take place on a new system across an organisation can improve usage as users learn from colleagues and peers. Regular communication of activities taking place within a Knowledge Management system can be recommended as it increases the awareness of the system and the activities it can be employed for. In the H&K example communication was produced regularly to highlight the searches that were being carried out on the system. The information that was available for these searches had an effect on the increase of usage of the search facility and an increase in the addition of information and knowledge relating to these searches. These activities can be recommended as best practice guidelines that will assist in the improvement of the system usage.

9.2 Summary of the Best Practice Guidelines

Project Stage	Best Practice Guidelines
Understanding Knowledge and Information Requirements	• Questionnaires, interviews, informal discussion and mapping approaches provide an understanding of the current knowledge and information requirements within an organisation. • Mapping approaches create a visualisation for the current process taking place within an organisation for retrieval, information use, new knowledge, validation and storage.
Development of Business and Software Specifications	• Prototypes of a system can act as a communications tool between users and development team to provide understanding and validation of user and business requirements. • Employ a process for the translation of user and business requirements assist in the further validation and refinement of requirements.
Software Selection	• Explore software options based on refined and validated requirements. • Validated requirements can be used to identify essential and desirable software features. • Matrix's assist in the identification of forerunning software options and eliminate unsuitable options to facilitate the selection of a suitable software platform for a Knowledge Management system.
User Evaluation Training and Roll Out	• System roll out should take place with key user groups across an organisation. • Assigning user groups specific tasks to be carried out in the system assist with user familiarisation of system functions. • Multiple mediums of training materials are successful in implementing a system with a wide and diverse group of users. • Themes for evaluation provide an understanding of how the system is being used across an organisation. • Statistics generated from the system can be employed to build profiles of how the Knowledge Management system is being used across an organisation. • Comparing results from previously mapped processes identify changes for gathering information and knowledge in light of the introduction of a Knowledge Management system.

Improving System Usage	• Support materials and mechanisms of support across an organisation are required to be improved and increased in order to create a support culture to fully embed a new Knowledge Management system. • Knowledge Management Champions provided a direct contact for each office for Knowledge Management related activities and to lead incentives to improve usage. • Support mechanisms to allow peer training to take place on a new system across an organisation can improve usage as users learn from colleagues and peers. • Regular communication of activities taking place within a Knowledge Management system can be recommended as it increases the awareness of the system and the activities it can be employed for.

Table 5 Summary of Best Practice Guidelines

9.3 Realisation of Objectives

This section revisits each of the original objectives as presented in Chapter 1 and summarises how each of them have been met.

O1. Review and develop an understanding of literature in the field of Knowledge Management.

Objective 1 was realised in chapter 2. The chapter demonstrated a literature review and understanding of literature in the field of Knowledge Management.

O2. Understand the current Knowledge Management practices and procedures within and engineering design consultancy.

Chapter 4 addressed objective two and part of objective three. It demonstrated an understanding of the current Information and Knowledge Management practices and procedures in an engineering design consultancy. Also developing a process for the capture and understanding of Knowledge Management requirements, process for communicating requirements were dealt with in chapter five.

O3. Develop a process for the capture and understanding of all Knowledge Management requirements, and how they can be communicated.

O4. Identify how requirements can be translated into software features.

O5. Understand how requirements that have been translated into software features, and can be communicated and validated with the user.

Chapter 5 identified how captured user requirements can be communicated to designers to be validated and further capture and refinement. It also deals with how these requirements once identified can be translated into a specification. This realises the second half of objectives three, four and five.

O6. Realisation of System features and identification of methods for their communication and validation with potential users.

Chapters 6 and 7 dealt with objective 6 the realisation of system features. Through the development of the Knowledge Management system and the process for prototyping and validating and refining systems features.

O7. Evaluate and assess the impact of the Knowledge Management system.

O8. Produce guidelines of best practice for the development and implementation process for a Knowledge Management system

Objectives 7 and 8 were realised in the final Chapters 8 and 9 through the evaluation and roll out of the Knowledge Management system. Evaluation was carried out on the Knowledge Management system in Chapter 8. Furthermore, an assessment of its impact and recommendations and best practice guidelines were produced for the development and implementation of a Knowledge Management system in Chapter 9.

9.4 Future work

Within the scope of this MPhil, considering constraints on time, resources and accessibility, it was possible to develop guidelines of best practice and for the development and implementation of a Knowledge Management system with one organisation. This presents a limitation in the work since there is no guarantee that whatever works within one organisation will necessary work within another. The first key recommendation for future research in this field therefore, would be to test the transferable best practice guidelines within other types of organisations. The Knowledge Management system may be addressing a different domain, but the method for development and implementation of the system should be similar and prove just as effective.

Secondly, during the development and implementation of the Knowledge Management system it was found that time constraints placed on the user can be identified as one of the barriers to them adding information and knowledge to the system. Future work could consider the development of strategies and processes that specifically address the impact of time constraints on user participation and engagement with a Knowledge Management system.

References

(n.d.).

Ackoff, R. L. (1989). From Data to Wisdom. *Journal of Applied Systems Analysis*(16), 3-9.

Badaracco, J. L. (1991). *The knowledge link.* Boston: Harvard Business School.

Baker , C. (2002). Ethnomethodological Analyses of Interviews. In J. Gubrium, & J. Holstein, *Handbook of Interview Reaserch: Contect and Method* (pp. 777-795). Thousand Oaks, CA: SAGE.

Blackler, F. (1995). Knowledge, knowledge work and orginisations: An overview and interpretation. *Organisation Studies, 16*(6), 1021-1046.

Bocij, P., Chaffey, D., Greasley, A., & Hickie, S. (2006). *Business Information System 3rd Edition.* Prentice Hall.

Boisot, M. H. (1998). *Knowledge assets: Securing Competitive advantage in the information economy.* Oxford: Oxford University Press.

Clements, P. C. (1999). *Constructing Superior Software (Software Quality Institute Series)* (1st edition ed.). Sams.

Cockburn, A. (2000). *Writing Effective Use Cases* (1st Edition ed.). Addison Wesley.

Cockburn, A. (2001). Agile Software Develoment. Addison-Wesley Professional.

Crinnion, J. (1991). *Evolutionary Systems Development, a practical guide to the use of prototyping within a structured methodology.* New York: Plenum Press.

Dalkir, K. (2005). *Knowledge Managment in Theory and Practice.* Oxford: Elsevier Butterworth-Heinemann.

Davenport , T. H., & Prusak, L. (1998). *Working Knowledge - How organisations manage what they know.* Cambridge, MA: Harvard Business School Press.

Deal , T., & Kennedy, A. (1982). *Corporate Culture: The Rites and Rituals of Corporate Life.* London: Basic Books.

Denzen, N. K., & Lincoln, Y. S. (2003). *The SAGE Handbook of Qualitative Research.* Sage Publications, Inc.

Donald, H. (2009). *Knowledge Management in Orginizations.* Oxford: Oxford University Press.

Easterby-Smith, M., & Lyles, M. A. (2003). *The Blackwell Handbook of Organizational Learning and Knowledge Management.* Wiley-Blackwell.

Hammer, M., & Champy, J. (1993). *Reeengineering the Corporation.* London: Nicholas Brealey.

Hanley, S., & Malafsky, G. (2004). A Guide for Measuring the Value of KM Investments. In C. W. Holsapple, *Handbook on Knowledge Management* (pp. 369-390). Berlin : Springer.

Hippel, E. V. (1994). Sticky Information and the Locus of Problem Solving: Implications for Innovation. *MIT Sloan School of Management Working Paper, Published in Management Science, 40*(4), 429-439.

Hofstede, G. (1991). *Cultures and Orginisations: Software of the Mind.* London: McGraw-Hill UK.

Hofstede, G. (2001). *Culture Consequencies: International Differencies in Work Related Values.* London: Sage.

Holsapple , C., Johnson, L., & Waldron, V. (1996). A Formal Model for the Study of Communication Support Systems. *Human Communication Research (International Communication Research), 22*(3), 422-47.

Hudgins, J., Angew, G., & Brown, E. (1999). *Getting mileage out of metadata: applications for the library.* American Library Association.

Ion, W. J., & Neilson, A. I. (1998). The Implementation of Shared Workspace Systems in Design - Common Barriers and Success Factors. *Proceedings of the National Confrence in Manufacturing Research, University of Derby.* Derby .

Jones, S., Till, D., & Wrightson, A. M. (1998). Formal methods and requirements engineering: Challenges and synergies. *Journall of Systems and Software, 40*(3), 263-273.

Kanner, C. (1999). *Testing Computer Software* (2nd Edition ed.). Wiley.

Malone, T. W. (1983). How Do People Organise Their Desk? Implications for the Design of Office Information Systems. *ACM Transactions on Information Systems, 1*(1), 99-112.

Mander, R., Salomon, G., & Wong, Y. Y. (1992). A "pile" metaphor for supporting casual organisation of information. *SIGCHI conference on human factors in computer systems.* Monterry, CA.

Martin, J. (2002). *Orginizational Culture: Mapping the Terrain* . Thousand Oaks, CA: Sage .

McMahon, C., Culley, S., & Lowe, A. (2004). Knowledge management in engineering design personalization and codification. *Journal of Engineering Design, 15*(4), 307-325.

Mishler, E. (1986). *Research Interviewing: Context and Narrative.* Cambridge, MA: Harvard University Press.

Nesbary, D. (2000). *Survey Research and the World Wide Web.* Boston: Allyn and Bacon.

Nonakak, I., & Takeuchi, H. (1995). *The knowledge-creating company.* Oxford: Oxford University Press .

Oxford University Press. (2011). *Oxford Essential English Dictionary* . Oxford: Oxford University Press.

Pellini, A., & Jones, H. (2011). *Knowledge Taxonomies.* London: Overseas Development Institute.

Petersen, N. J., & Poulfelt, F. (2002). *Knowledge Management in Action: A Study of Knowledge Management in Management Consultancies, Research in Management Consulting* (Vol. 2). (A. F. Buono, Ed.) Greenwich: Information Age Publishing.

PMBOK. (2008). *A Guide to the Project Management Body of Knowledge.* Pennsylvainia: Project Management Institute.

Robertson , J. C., & Robertson , S. (2006). *Mastering the Requirements Process* (2nd edition ed.). Addison Weasley..

Rowley, J. (2007). The wisdom hierarchy: representations of the DIKW hierarchy. *Journal of Information Science, 33*(2), 163-180.

Saint-Onge, H. (1996). Tacit Knowledge: The key to the strategic alignment of intellectual capital. *Strategy & Leadership, 24*(2).

Saunders, M., Thornhill, A., & Lewis, P. (2006). *Reaserch Methods for Business Students.* Financial Times/Prentice Hall.

Senge, P. (2004 2-3 November). Confrence Proceedings of KM Asia. Singapore.

Shedroff, N. (1999). *Information Interaction Design: A Unified Field Theory of Design.* (I. D. R. Jacobsen, Ed.) Cambridge MA: MIT Press.

Smith, P. G., & Reinersten, D. G. (2004). Shortening the Product Devlopment Cycle. In R. Katz, *The Human Side of Managing Technological Innovation* (pp. 573-582). New York: Oxford University Press.

Thomson, A. I. (2007). Distributed Team Design in Small and Medium Sized Enterprises - how to get it right. *Artificial Intelligence in Engineering Analysis and Manufacturing (AIEDAM) Special Issue on Support for Design Teams, 21*(3), 203-218.

Tipping, J. W., Zeffren, E., & Fusfield, A. R. (2004). Assessing the Value of Your Technoligy. In R. Katz, *The Human Side of Managing Technological Innovation* (pp. 373-390). New York: Oxford University Press.

Tiwan, A. (2000). *The Knowledge Managment Toolkit, Practical Techniques for Building a Knowledge Managment System.* Upper Saddle River NJ: Prentice Hall.

Trochim, W. M. (2006, October 20). *The Research Methods Knowledge Base, 2nd Edition* . Retrieved from http://www.socialresearchmethods.net/kb/

Ulrich , K. T., & Eppinger, S. D. (1995). *Product Design and Development* (erd edition ed.). New York: McGraw-Hill.

Warren, C. A. (2001). Qualitative Interviewing. In J. F. Gubrium, & J. A. Holstein, *Handbook of Interview Research: Context & Method* (pp. 83-101). Thousand Oaks, CA: SAGE.

Yariez, I. (2009). Metadata: Implications for Academic Libraries. *Library Philosophy and Practice (e-journal).*

Zins, C. (2007). Conceptual Approaches for Defining Data, Information, and Knowledge. *Journal of the American Society for Information Science and Technology, 58*(4), 479-493.

Appendix 1: Interview Transcript Senior Engineer Birmingham

Retrieval of Energy Figures in Schools

At current how do you retrieve any information/knowledge you need about energy figures in schools? Do you employee a specific process for finding information/knowledge on energy figures in schools?

K drive looking at a previous project that we have done on schools, on to her third schools project. Have got spreadsheets from previous projects that have got energy us in them no idea where it came from. Standards sibs guide building guide's good bench marks. BB guidelines. Passive house schools, standards, energy improvement factors u values. Start on a previous project. Poor trail because you don't know where it has come from in the beginning unless you have worked on that previous project. Liam spreadsheet work energy use saved on K drive Lester schools on project desk, Rain water collection Bristol school. K drive- internal contact- external contact dependent on what you're looking for, little bit on hard drive but usually repeated on k drive. Discuss things Rick. Social networking very important because you can relate it back to what you're doing. Doesn't use Hulley notes think that it is out of date and useless? Forgotten design guide existed.

Typically where would you find this, is this the only place

Is there anyone specifically that you would contact about finding it?

What systems would you use to find it; would these be internal and or external Systems? If these are internal are you satisfied with the way information is displayed when you access it is the format accessible?

Drivers, use project desk for emails. If I know someone has sent an email about energy figures will look for it. IHS building rigs, partnerships for schools project specific ones. Engineering tool box not go into to much detail but see that it makes sense that methodology makes sense.
Good to chat to people and wouldn't want it to change good to still have a discussion about it. Depends if I have done it first time round. If someone else has done it or it is a vaguely related project then no usually not. Just sent out a load of energy figures to eon to get them to price them standard charge for schools. CHP although I have the figures as a starting point will have to reformat them all and use different calculations. Depends what you want it for.

Would you look on the HK drivers to find information about energy figures in schools? i.e. is this information easily available on the HK drivers?

Yes, look on previous projects only within Birmingham office. Would look at other projects from other office if I could but don't know if I would trust the figures as I don't know the rationale behind it. Passive schools can't look at energy figures in isolation need to look at the project as a whole.

How is the information displayed when you access it, is the format accessible? Are you satisfied with the efficient and effectiveness of information retrieval can you think of a way that would make this information easily obtained?

If it's from within my office its ok. When things come down from Glasgow it has different formatting. Not difficult to interpret just not how expect to interpret it. Standard Birmingham spreadsheet. Will all start with a baseline spreadsheets. I think we need to standardize spreadsheets and basic calculations. Liam Lester me Coventry rick Marie Curie hospice two schools one hospice all being doing different stuff three different spreadsheets all want different things out of it in the early stages but then by stage three we will want the same thing. So it's not really a good thing that we go about it in such different ways. Information would be easily obtained if there was more standardization. More standard inputs for thermal modelling. Simulations Bruce is doing one in Glasgow but I'm doing on in Birmingham too. She knows the guys in Manchester or Glasgow have got information but we just don't us it. Would you be overloaded if you had so many conflicting ways of doing things? Not really worth while trying to sort it out when you could just do it yourself. Standardization big barrier and time constraints. Individuals do it differently offices do it differently?

What would you say your decision making process is for finding this information on energy figures in schools? *i.e. why would you look in x before y?*

Because we are doing eco active schools which is a word that we have made up off the back of Roachdale schools. A specific way of designing specific process for doing it for our office. Eco active based on carbon 60 reduction.

Is this process or description of retrieval of information of energy figures typical of the process for other topics like plant room sizes? Can you think of a topic where this would be different?

Would be the same process for different topic. Unless it was more of a project specific? Starting point is usually a rule of thumb then make it more project specific. Visual rules of thumb. Depends what stage the project is at.
Wind turbines HIS looking for a design guide SIBS never heard of a project involving that, individuals, ask around.

Information Use of Energy Figures in Schools

How do you use the knowledge/information about energy figures in schools that you retrieve? i.e. calculations, reports, and spreadsheets etc.

Plant sizing, design work, specification, bid submission, ITC bid clarifications. How does this compare to bench marks. CABE review, Thermal modelling.

Is the reuse of energy figures for schools typical of other topics such as plant room sizes?

Domestic water uses
Energy figures are used more in your early stages of your design. Then compare at the end. Other information might not be relevant in the early stages because you have not done your detailed design at this stage.
Look at in really big detail and that will inform the rest of your design. Other topics are not as important in the design.
One of your most important parts of the school design, more general and can be used for different schools.

Hospital such a small ceiling void that we can't have a single duct passing another duct. Very individual to that project.

Energy figures for schools is something that you can throughout. Standard design tools no matter. But the configuration is project specific. Not best practice but you must still try and achieve this. That's what it's all about trying to get best practice and deviating away from that if you need too.

Fear that someone will put something on the Knowledge Management system that is project specific and not necessary best practice.

New Knowledge on Energy Figures in Schools

After you have used the documents/information about energy figures in schools that you have retrieved do you add to the current documents, or create a new document containing your knowledge and the retrieved knowledge? ***For example if you were to update a calculation in a spreadsheet to reflect a new government standard, how would you account for this would you change it in the current document and insert a comment to explain you're rational or would you create a new document?***

Create new document, however if I was using a standard spreadsheet I would save the revision to my hard drive. But also on K drive so other people can use it. Means next time I only have two ports of call depending on what I want. Would try and put comments in. 3rd hand information any rational that had originally been passed on is lost. Try and work backwards to find out where the figures have come from. Big problem. Passive house standards.

If you create new documents about energy figures in schools do you use information from an external source? ***i.e. something from the library or a website, how would you note this?***

Yes, eg rain water harvesting bs out and has the calculations. But if I'm in a rush it can get forgotten about if it has come from another project though then you can't really reference it. More difficult to reference stuff if it has come from a past project. Helps yourself from getting stuck. If it is being communicated it would have hidden columns or copy it into word or create a pdf. Gordon building services book it good but you don't really get the wealth of experience behind it. Would look at external sources quite early on. If still stuck seek further information from someone else.

How do you use the new documents that you have created? What do you us it for?

Design team meeting to satisfy questions. In the design development need to be able to compare against your bb 87 benchmark figures carbon 60 reduction. Want to be able to compare what they expected to get and what they actually get. Renewable energy questions, planning bream requirements.

Do you combine internal and external documents to create a new document specific to Hulley and Kirkwood? ***i.e. could you combine and external document from a website with a internal document retrieved within HK to create a new document, how would you display your rational behind this would you label it or write a note with it?***

Yes, otherwise you won't stay up to date.

Would you see it as being common for most information and documents to be reused in the same way, for example if we think about another topic anything you want, or plant room sizes would documents relating to this be reused in the same way?

Generally yes, take it update it to be project specific. Each project will have different constraints. Not clear at the moment what peoples rational behind a document unless you have worked on it. Might be an improvement on a standard but unless you have worked on a project you won't know where that information came from. Sector specific for knowledge of standards.

Validation of Energy Figures in Schools

Now that you have created new documents in energy figures for schools, how do you check or validate that new document that you have created?

Compare it against a bench mark then get someone to look over it. Or compare it to a previous project

What is your decision making process behind checking documents in this way? ***Where would you start, why would you start here?***

Benchmark can tell whether I' wrong before asking. Then go to a senior.

Can you use an internal source to check it, for example check it against HK standards?

Can you use an internal or external contact to validate it?

Yes, Rick or Liam Thermal modelling go to Bruce. For simulation you can't go to a benchmark

How did you learn about that internal contact?
Email, telephone

How do you communicate with them?

Would you say that this system for checking documents or information is a typical process across HK i.e. if you had a document containing plant room sizes would you check it in the same way?

Bruce simulations, Bream Rain Water harvesting robin Sloan in Bristol, Hunter Ip bream

Can you think of a topic where the process for checking the information changes?

Bream very new in the office. But probably straight to Bruce. New emerging technologies because there is no internal. Talk to reps quite a lot when looking at new products. Colt rep heat core fan units for airport job but then doing it somewhere else we were able to transfer knowledge we had.

As soon as you go external you don't know whether to trust them.

Storage of Energy Figures in Schools

How do you store the new documents that you have created?

K drive or AMT and sometimes on my hard drive dependent on what it is. And emails on project desk

Are they stored in such a way that it is easily accessible for others to retrieve it? Please explain.

No so many folders on k drive, that's if you get the right project number. Find duplicates you don't know which one is the latest. AMT you will only get one of them. AMT keeps revisions up to date a nightmare to you get revisions takes twice as long to find anything but it really good at storing things.

What do you feel the factors are that stop you from sharing the new documents that you have created in regard to energy figures in schools?

If I wasn't sure if it was right. In the early stages I would not put it on k drive until it was complete. Will put it on when it is at a stage when it makes some sort sense. Would worry about putting it on because of someone else's interpretation.

Are there any topics were you think these factors would change?

Would you like to see this topic being generalized and stored with another topic, or another sector?

Yes, defiantly standard spreadsheet that you fill in based on a figure from a sibs guide. It is the same process for every project its just project consternates that stop. It's a similar way of designing. As long as you don't go round in circles. Rick set up a spreadsheet but it is very complicated.

Would you like to see information about different topics being stored here as well?

Ventilation strategy and renewable energy. Biomass CHP ways of achieving your carbon 60. daylight lighting. Standard school. Hours.

General Knowledge Management Discussion

These questions are more related to the presentation aimed at trying to find what the employees want and expect to get out of the project; also what areas an improvement in Knowledge Management would help them.

What do you feel better Knowledge Management would mean for Hulley and Kirkwood?

More productive if we can get knowledge quicker and know that it has already been validated. You would only need to self-checking so that you're happy to use it rather than having to check it to make sure it's right. Would be easier as long as your still discussing it. Would be good to know what others are working.

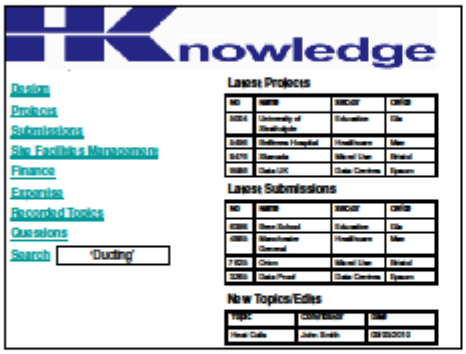
What area if improved upon by the new Knowledge Management system do you feel would make the greatest impact to your job? i.e. what would make you more efficient, what could make your job easier?

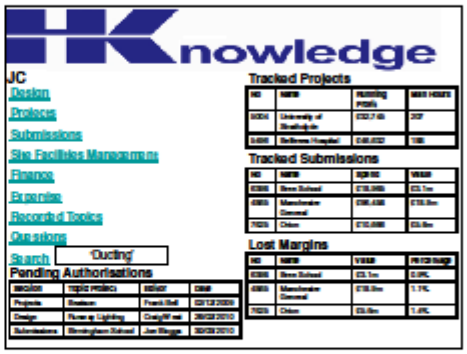
Standardization across offices and within projects. Be good to have stuff already almost there.

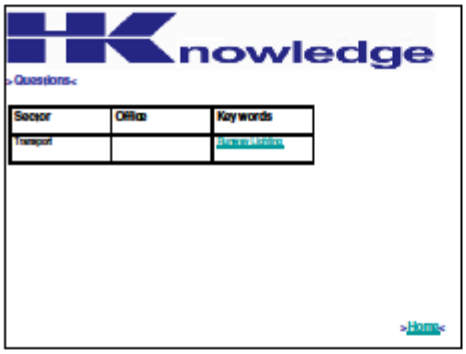
What area of any new system do you feel would have the greatest impact on Hulley and Kirkwood?

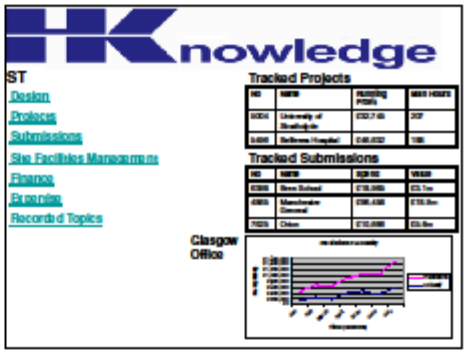
Standardization. Spreadsheets, no standard hatching, cad standards, cad standards are out of date. People's attitudes need to allow for change. Standard reports not necessary up to date every office is different.

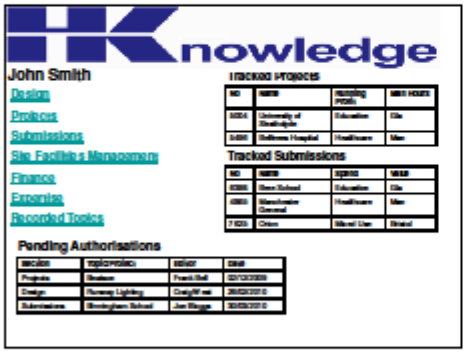
Appendix 2: Electronic Prototype Screen Shot Extract











1

Appendix 3 Extract from Software Specification

Engineering

The engineering groups within the business are those that will be using the system the majority of the time, they can broadly be divided between electrical and mechanical engineers. However for the purpose of the software specification and identifying the different user classes and groups it is better to identify them as follows; graduate engineers, intermediate engineers, senior engineers, associate engineer, regional director, and managing directors. They would be identified in this way as their user classes and characteristics would be the same regardless if they were from the electrical or mechanical side of the business; they would also be more dependent on the system than the groups previously identified.

Graduate Engineer	
Graduate Engineer Defined	Graduate engineers will assist the team in a wide range activates across a variety of sectors. They will support design of projects issued by line managers to the clien specification. Graduates will be required to attend internal a external meetings and prepare calculations. They will also responsible for improving their technical ability throu industry seminars and CPD courses.
Business Specification Requirement	Graduates would want to be able to use the system in the f place to satisfy softer requirements that they have. L communication and the ability to communicate with ot offices, gaining an understanding of the types of projects t the other offices are working on, and identifying where expertise lies across the other offices. It would also info them of the different requirements that are needed for different types of projects and work that they carry out. As w as educating those on the bigger picture and some financ information involved as well.
Importance	Graduates make up 11% of the current H&K staff. T graduates will be the senior engineers, associates, and direct of the future. This makes them a highly important group for KM system.

Intermediate Engineer	
Intermediate Engineer Defined	Intermediate engineers would be working towards charte status. They would be expected to lead smaller proje between £1-3m or provide support for several smaller proje between £5-10m. They would also prepare designs to clien specifications, write reports, undertake audits, and men junior staff.
Business Specification Requirement	Intermediate engineers have different user needs to graduates. They will for the most part well integrated into company and aware of the expertise within the different offi

		and the diversity of projects that they are working Intermediate engineers will be looking for information topics so will want the ability to view information topic speci as well as project specific. They will also want the ability gain more insight into financial information that is involved projects. Again like graduates there would be limits to levels of information that they would have access too and changes they could make to information on the system.
Importance		Intermediate engineers make up 15% of the H&K workfo which is a reasonable proportion of the workplace meaning t their user needs must be given careful consideration.

Senior Engineer		
Senior Engineer Defined		Senior engineers will be chartered or nearing chartered stat They will be required to lead several small projects (up £10m) or lead one medium sized project (up to £50m) support one large project (£50m+). They are responsible feasibility and validity assessments. Preparing conceptual a detailed design in line with the client's requirements. They v also contribute to resource specification; manage resour within agreed internal project. Finally checking and approv work, and mentoring junior members of staff.
Business Specification Requirement		Senior engineers will have much wider access to informat that is stored on the system and will have the ability to ma changes to the majority of this information. Senior engine will have more contact with external third hand sources information and will require a process for referencing a capturing this information and the rational behind it, on system. They will also want the ability to ensure that w carried out on previous jobs are still valid and that it can repeated in future work. As well as a further depth understanding of the financial information involved in projec
Importance		Senior engineers make up 19% of the H&K workforce senior engineer group makes up the majority of engine within H&K company wide. This makes them a very import group not just because of the majority but because they v mentor junior engineers and encourage them to use the syster

.

Associate Engineer		
Associate Engineer Defined		Associate engineer
Business Specification Requirement		For associate engineers the biggest use of the new system w be in the way in which it allows them to inform their proj team with information. Instead of engineers continently go back to their associate engineer with queries they will be able check information on the Knowledge Management syste Associate engineers will have the responsibility for ensur

	that a lot of information gets put on to the system whether t is personally of through third hand sources. Some would a have the responsibility of validating information on the syste This being the case it must be recognized that adding a validating information on the system is quick and easy. T will ensure that the associate engineers make use of the syste Associate engineers are an important user group as they wo direct others to the system.
Importance	Associate engineers make up 9% of the H&K workforce. T is not as big a percentage as some of the other groups that ha been mentioned. But the associate engineers are fundamental the Knowledge Management system as they head up teams a have the power to ensure that information is added to system and that it is used by them and those that they mentor

Director	
Director Defined	Directors
Business Specification Requirement	Directors at both levels regional and managing will have v different usage characteristics and requirements from system compared to the requirements of the engineers. Th would want to see a large amount of information displayed a high level from which they could disseminate what w relevant. For regional directors this would be high le information about jobs relating to their office and others wh they could disseminate for future reference. For manag directors the focus would be more in acquiring knowledge t would allow them to shape the long term direction of company.
Importance	The directors make up 9% of the total overall company sta although this is only a small percentage. The directors are group within the company that wields the most power a influence. This means that their buy-in can ultimately dec whether the project is a failure or a success.

SFM Enginee	
SFM Enginee Defined	SFM engineers Waiting on definition from HR
Business Specification Requirement	SFM engineers
Importance	SFM engineers make up of the H&K workforce

.

Operating Environment

There are several different operating environment constraints that the new system will need to adhere too. H&K use a Lotus Notes sequential database system for as their information and communication management. The operating system for majority desktop and laptop

computers is Windows XP Professional 2002 service pack 3, however some are now on windows 7. These are the two main operating environment constraints that the new system will have to deal with. There are a number of other applications that the company run such as CAD and AMT. A vital aspect of the new system will be the ability to subtract information from the existing systems, combine this with knowledge inputted by the users to produce malleable formatted knowledge and information. This would mean that the new system would to be compatible or be able to communicate with Lotus Notes.

Access to any H&K system is staff only, and access is only granted to those that have a lotus notes email account through H&K. These access requirements will be mirrored on the new system as well. As well as this there will also be access levels among the different user groups to use the system as a well. At current the groups with the highest levels of access are the directors and the administration groups. Other groups within the system have much lower levels of access. There are also two different types of access within the organization read only access and full edit access. Full edit access will be reserved for the directors and some of the administration staff. Some of the director level systems are also used by associates although they will only have read access to these systems and will not be able to edit any of the information displayed on them. There is also document level access only were you are only able to view information that you personally have created.

On the server there are many different drives with different access levels, the K drive is open access for everyone whereas the clerical, admin and director databases are secure with access restrictions, as well as this any human resources related information would have further restrictions. Everyone has a personal Z drive, and there is also CAD, projects, and a drive for storing blocks.

In the current systems when external access is required, it can be achieved in two ways. Firstly accessing lotus notes is achieved through lotus notes access client through their own laptop. The second method of access is through virtual private network (VPN), this is access as if you were in the office to all systems through any PC using a secure ID. This means that this system is in place and will be required on the new Knowledge Management system as well.

There is also various software applications that the KM system must co-exist with. Project Desk is the project correspondence database; it records all correspondence relating to a specific project under a unique project number. Project Registration Database (PRDB) allows you to view the percentage of which the project is complete and the amount of fees that have been paid. There is also the submissions database in which the documents created for submitting tenders for projects are completed and stored. Work in progress (WIP) informs you of the running profit in relation to the progress made in that job and the issued and paid fees. The KM system would require the ability to subtract information from all of these different systems and display it in different areas of the KM system.

Design and Implementation Constraints

The KM system should have the ability to search all of the information in the current system as will as the new tacit information that it would capture. Searching all of the information in the current system would be a huge and timely task; it would be impractical to search through this information everyday when a search was carried out. Therefore when searching the new system it is essential that search results are displayed in a timely fashion.

User Documentation

User documentation will be created that will assist users when using the system. There will be several types of documentation created to assist the users such as; user manuals, on-line help, and tutorials. The user manual will be developed at an early staged when testing the system with focus groups. This will lead the way to create on-line help menus within the system and developing taught tutorials. This will mean that the system will need to be flexible so that after the testing stage on-line help tutorials can be added to the system.

Assumptions and Dependencies

At present we have made the assumption that individuals from within H&K will take responsibility for validating certain areas and topics in the new KM system. When a user edits information on the system the change will not be seen by the other users until it has been validated by individual responsible for validating that area or topic.

The new system will be pulling a large amount of information from different areas and a lot from the existing systems, we assume that it will have the ability to do this, and are dependent on the fact that it is able to search information from the existing system in a timely manner and display this information and knowledge. As the users will have a expectancy about how long they will have to wait on search results.

We also assume that the system will be easy to use and that the user interface will be similar to the existing systems in terms of colour schemes and logos. It will also restrict access rights depending on the user's level within the company. The system is also dependant on user usage, and users exploring the system and editing various parts of it, in order to keep the information up to date. We also depend on an even spread of users from the different user groups within the organisations in order to ensure that these different user groups are well represented within the new system. One of the groups within the company that we are dependent on is the IT department, we are dependent on the fact that the new system will be easily maintained and administrated by them.

Another one of the assumptions that we make about the new systems is that it will have the same ability to restrict access and have different levels of access that the current systems have. In the current systems there is different access group's dependant on the individual's level within the company. For example it would only be the H&K director and administration group that would have access to the parts of the system that contain financial information. This should be the same in the new system and the access levels should transfer over into the new system. However we also assume that the users will be able to access some files on the new system that they are restricted from at the moment, as in future it maybe that H&K wish this information to be shared.

Appendix 4: Software Selection Matrix

	Proprietary Software						Open Source								
Software Requirements	Lotus Notes	Share Point	Jive SBS	Oracle Beehive	Novell GroupWise	Central Desktop	Bespoke PHP	Open KM	Joomla1.5.15	Tikiwiki	Drupal	Knowledge Tree	eGroupWare	Zimbra	Open Xchange
Compatible with Lotus notes version 8.	Yes	Yes	Yes (?)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Subtract information from Lotus notes version 8.	Yes	Yes	Yes (?)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Ability to co-exist with the other software such as project desk, PRDB, and WIP etc.	Yes	Yes	Yes	Yes			Yes	Yes	Yes		Yes				
Support up to 200 users, across ten locations.	Yes	Yes	Yes	Yes	Yes	Yes	Yes		No	No	Yes		Yes		
Each project that H&K undertake will have its own project file within the KM system, that will contain specific information about that project.	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes		Yes				
Each SFM project will have a unique file on the KM system	Yes	Yes	Yes	Yes	Yes		Yes		Yes		Yes				
Each Submission will have a unique file on the KM system	Yes	Yes	Yes	Yes	Yes		Yes		Yes		Yes				
Files will have areas that will act as a document depositary for key areas relating to; projects, submissions, design section, SFM, and recorded topics. The system will have to mirror these documents in one or more of the doc depos.	Yes	Yes	No	Yes	Yes		Yes		Yes		Yes				
There must be sections in the system where they user can leave user edited feedback	Yes	Yes	Yes	Yes	Yes		Yes		Yes		Yes				
There will be a procedure for the validation of edits to the system and the addition of new information the system must facilitate the validation process by alerting those responsible for validation when a edit has been made and not displaying that edit until the validation has been completed.	Yes	Yes	Yes	Yes	Yes		Yes		Yes		Yes				
Must be able to set access levels and security roles	Yes	Yes	Yes	Yes	Yes		Yes		Yes		Yes				
The system must record those that have contributed to information and what section they have contributed too.	Yes	Yes	Yes	Yes	Yes		Yes		Yes		Yes				
Users must be able to perform sophisticated searches on the system, specifying specific values.	Yes	Yes	Yes	Yes	Yes		Yes				Yes				
Must be easy and timely for the user to edit and place information onto the new system	Yes	Yes	Yes	Yes	Yes		Yes				Yes				
Must be easy and timely for the user to give the new information on the system metadata tags.	Yes	Yes	Yes	Yes	?		Yes				Yes				
Must be easy for the internal IT department to maintain the new system	Yes	Yes													
Cost of introduction and implementation of the new system must be within H&Ks budget	Low	High	High	High	High		Low				Low				
Produce search results in a timely manner.	Yes	Yes	Yes	Yes	Yes		Yes				Yes				
Compatible with current servers	Yes	Yes	Yes	Yes	Yes	No (web)	Yes			Yes/No	Yes			No	
Secure, and the ability to update the software with security fixes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	No		No
User can view information in tables at a high level so that it is easy for them to disseminate what is valuable information and what is not.	Yes	Yes	Yes	Yes	Yes		Yes		Yes		Yes		Yes		
Secure access, access can be controlled through the exsisting Lotus Notes system. Current groups have been created in Lotus Notes can be exported to the new system.	Yes	No	No	Partialy	Partialy		Yes	Yes	Yes		Yes				
Offer mobile device support	Yes	Yes	Yes *	Yes	Yes		Yes	Yes			Yes -				
It must be easy for the engineers to generate metadata tags for pieces of information.	Yes	Yes	Yes	Yes	Yes		Yes		Yes		Yes				

Appendix 5: Training Videos Examples

1. What is Knowledge Management?
2. Logging into the system.
3. Approving knowledge and information in the system.
4. Tagging knowing in the system.
5. The projects section of the Knowledge Management system.
6. The design section of the Knowledge Management system.

Appendix 6: Authoriser List

Name	Position	Topic
Nigel Yemm	Director	Energy Audits
Tim Crocombe	Regional Director	
Gordon Mcinnes	Director	Fee's, Submissions
Mark Foster	Mark Foster	Stripping Out,
Philip Smerdon	Public Health Eng	Rainwater Harvesting
Justin Lees	Associate	GSHP
Donald Wood	Director	Energy Targets/Models, LZCT (Low and Zero Carbon Technologies)
Allan West	Associate	Domestic Hot Water and Cold Water Services, Sprinklers, Wet and Dry Raisers, External Water Hydrants, Laboratory Ventilation Systems, Plant and Riser Space Requirements (Mechanical), Specialist Ventilation, Airport Design
Criag Mcdade	Senior Engineer	HV Switchgear, LV Switchgear, Lighting and Lighting Controls,
Bruce Elrick	Senior Simulation	BREEAM, EPC's, Sustainability, Thermal Modelling
Douglas Fulton	Design Engineer	External Lighting, Nurse Call, Cell Call,
Greame Strachan	Senior Engineer	Hot Water Heating Systems, Natural Gas Systems,
Bill Kilpatrick	Director	BIM/CAD, CDM, Health and Safety, Quality Assurance
Colin Lindsay	Finance	Finance
Colin Peacock	Associate	Chilled Water Systems, Ventilation Systems, Steam and Condensate
David Symington	Senior Engineer	CCTV, Access Control,
Gary Dyer	Senior Engineer	Fire Alarms,
Gillian Carmichael	HR	Health and Safety
Gordon McNeil	Associate	Fire Extinguishing,
Gordon Murry	Design Engineer	Lightning Protection
Hugh McArthur	Senior Engineer	Thermal Insulation, Operation and Maintenance Manuals, Standard Design Details (Mechanical)
Ian Sandford	Medical Gas	Compressed Air Systems, Medical Gases, Specialist Gases, Commissioning Management, Healthcare Authorising Engineering, Lessons Learned
Jillian Vincent	CAD	BIM/CAD
John McEwan	SFM	Testing and Starting Up, Commissioning, Commissioning Management, Lessons Learned, Maintence Contracts/PPM, Water Hygiene
Julie Reid	HR	Human Resources
Laura Batton	Design Engineer	MoD Design (Mechanical)
Paula McGinley	Admin Assistant	Quality Assurance
Paul Winning	Associate	Building Management Systems, Water Filtration Systems, Calculations (Mechanical), Hydro, Tidal,
Simmy Telfer	Director	Management
Steven Duffy	Design Engineer	Earthing, Induction Loop,
Steven Reilly	SFM	Testing and Starting Up, Commissioning, Lifts/Escalators, Commissioning Management, Lessons Learned, Maintence Contracts PPM, Whole Life Costing

Stuart Morrish	Graduate Engineer	Disabled Alarm,
David Liningston	Director	Utilities (Mechanical), Specific Client/Sector Specialist (Mechanical) Hotels, Marketing, Submissions
Peter Metcalf	Associate	Generators, Utilities (Electrical), Calculations (Electrical), Standard Design Details (Electrical)
Paul Cairns	Senior Engineer	CHP
Steve Dewberry	Senior Engineer	Cabling, Conduit and Cable Trunking, Cable Tray, Cable Ladder and Cable Basket, Small Power, Data and Voice Cabling, Intruder Detection, Mechanical Services, TV and Radio, Costings (Electrical), Daylighting, Plant and Riser Space (Electrical) Specific Client/Sector Specifications (Electrical) Hotels, Healthcare and Retail, Healthcare Design,
Paul Wright		Refrigerant Pipework Systems, Testing and Commissioning, Natural Ventilation,
Simon Mckenzie		Renal Water, DI Water
Stephen Harris	Regional Director	Transformers, Excavation/Trenching, Public Access/Voice Alarm,
Phil Ward	Principle Engineer	Smoke Extract
Will Jones		ASHP, Costings (Mechanical),
Tony Davis		Drainage Systems
Paul Stevens		Photovoltaics
Daivd Stewart	Director	UPS/IPS, Meigan,
Michael O'Donnel	Director	Clean Rooms
Ron Nolan	Associate	Intercom,
Ian Ezzi		Pneumatic Tube Systems
Jonathan McMillan		Biomass, Solar Thermal, Wind Turbines,
Tim Crocombe		Emergency Lighting