UNIVERSITY OF TWENTE - THERMAL ENGINEERING

Knowledge Management System Pilot
Exploration of knowledge management

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ABSTRACT

The report describes the process of creating a knowledge management pilot. Next to this a knowledge management system is created and described. The program is created using Microsoft ACCES and Visual basic code language. The existing databases of NEM are indexed and or handled in such a way that no copies are made and a search query takes up very little time. To create such a system, knowledge management as a whole is being described. The knowledge management system is created using the knowledge methodology as a base requirement. The result is a system supporting knowledge management and gives a good conceptual definition. This pilot with background research provides an impulse to develop knowledge management in the company. Keywords: knowledge management system design programming consulting design

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1 INTRODUCTION

Search engines and index systems are widely available providing information and knowledge to the common people. When searching on the internet for example for experience with specific restaurant around the corner. This type of system can be implemented in a company in order to retrieve experience with for example safety procedures in a heat recovery unit. Such a system is not yet available within the company of NEM to search within all the files of knowledge or projects in the company. In the current situation information can be gathered by an extensive labour intensive search and most of the knowledge is in the head of the engineers. The knowledge concerned with this matter is experience or typical product knowledge which in theory easily could be written down.

When creating a typical NEM product engineers are required to design this product in accordance to the customer. The design process is for a large part concerned with decision making. The knowledge required to do so is considered to be common knowledge for the most of the engineers of the company. The down side is that the knowledge practically inaccessible for colleagues other than asking them about their experience or knowledge. The consequence is that there is a high probability of rework, known experience can be left out in the decision making due to the fact of difficult knowledge exchange. This is due to the fact that there are multiple project teams working on similar projects with ever changing configuration of experience levels of the participating engineers, the hiring of new staff or letting go of experienced staff, with the downside of loosing knowledge.

Knowledge management can ease the knowledge exchanging and preventing knowledge loss due to other human effects such as usual memory loss due to focus change over the years. In order to show the effectiveness of knowledge management a pilot is created of such an knowledge management system accompanied with research about knowledge management as a whole. The pilot is a requisite for the company management to justify further investing in knowledge management.

The experience of the project showed that the system was targeting the passive user, experiencing the benefits of a quick and easy to use search system. However it should be stressed with capitals that without input from the engineers such a system will not work. Knowledge management concerns the company as a whole; different aspects will be discussed in this report.

1.1 NEM

The main focus of NEM is to design heat recovery units for steam production. These boilers can be fired, via gas burners, or be used in combination with an gas turbine for heat recovery. The goal of NEM is to provide a suited boiler for every costumer with high power or steam demand by mostly large scale customers. With most of the deals NEM creates a lifetime package: from first screw of building till periodically servicing of the working boiler. NEM is highly skilled in delivering a custom heat recovery for every customer. Every project is a one of its kind, making NEM unique in its market.

The company has been took over by Siemens; Siemens is now able to provide a full package deal: gas turbine, generator, energy recovery units(previously provided by NEM). Currently the old NEM company is still operating with an own management apparatus with substantial autonomy. Contact between the two parties, Siemens and NEM, is only present at the higher marketing levels and management.

2 PROJECT PLAN

2.1 PROBLEM DESCRIPTION

The oil-price is currently at a low value next to this the world economy has been trough a depression and in its recovering stage. The consequence is the drop in amount of accepted large scale projects for NEM. The focus of the market of NEM is shifting due to the lack of demand for high powered facilities. The normal project time of such large projects is around 2 years. With the smaller projects being accepted this project time is not reduced, however the financial coverage usually provided by

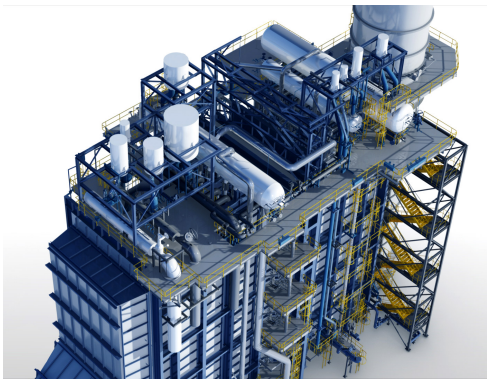

Figure 1.1: Heat Recovery Steam generator as designed by NEM.

the large projects is reducing. Therefore the time that NEM needs to produce a working heat recovery unit has to be reduced. The amount of time can be reduced by delivering more standardized solutions for their customers as improving their internal processes, in this case knowledge management.

To reduce the project and proposal time of the company to design for example a heat recovery unit, a new set-up of knowledge management was required. A first attempt to deal with this problem was to create a knowledge bank. The knowledge bank was a system where engineers were supposed to find important knowledge. However due to the large amount of design work this system was not further implemented in to the company. Next to this a lack of a clear philosophy behind the knowledge bank made the knowledge bank fail. However, technology developed quickly and with intelligent search engines available on the internet the possibility to implement such search technology into the company should be there. During brainstorm sessions the idea of a knowledge management system arose. Knowledge management does not only contain a knowledge bank or system. It will describe how to handle knowledge in a variety of ways: how to handle, exchange and store knowledge. For the pilot an investigation towards this management will be conducted; how should it work. The second goal for the pilot is to create a knowledge management system which would eventually support knowledge management.

The interface provided by the KMS should be easy and understandable in use and data should easily be found. A pilot was to be created in order to prove the effectiveness of a knowledge management system. The pilot should be created in PLM software 'Teamcenter' delivered by 'Siemens software solutions'.

2.2 Specific Project Goals

Knowledge management will have to meet the following demands of the company:

- The knowledge management system prevents the engineer of reinventing ideas or methods and this will make him more productive which will reduce the proposal and project time.
- The system will have the ability to make knowledge explicit.(*explained later*)
- The system will increase the curiosity by giving the engineer the tools to search for information and to see the bigger picture and as a consequence getting the best out of the engineer.

Although the goals are not specified in measurable units they give a clear direction of the knowledge management in terms of what it should produce.

Deviations: Program environment Due to improper communications and badly orchestrated ICT rights the creation of the pilot in PLM - Teamcenter was not possible in the given time frame. The pilot is programmed in Microsoft Acces. This is done to prevent the intern-ship from failing and with hindsight this creates a very clear specification to the next software designer which hopefully

will be able to create a knowledge management system in Teamcenter. The reason to remain with 'PLM-Teamcenter' is that this software package provides other needed solutions within NEM. Using fewer software platforms makes the exchange of data between multiply applications easy. Next to this the engineer is confronted with another piece of software, with different interface. Engineers do not tend to like to have all kinds of different software packages as concluded from interviewing the staff of NEM.

3 KNOWLEDGE MANAGEMENT

KNOWLEDGE In order to manage all the knowledge and to get a grip upon the matter it is wise to consider its definition. The theory behind knowledge is yet to be defined. Years of research have not proven an overall accepted answer to the question: 'how to define knowledge?' Lets assume for this pilot that knowledge is defined as proposed by Davenport and Prusak: "Knowledge is the combination of organized experiences, values and beliefs that set up a framework to evaluate new experiences, information and knowledge." This means that before the engineer starts his research, he has to know about the subject he is looking for. Without it he will not be able to interpret the information or knowledge that he will find. Using knowledge management is only viable in a organisation where the people are trained and educated to a set level.

The main goal of knowledge management is to efficiently use the available knowledge in decision making. Knowledge management is a process which involves all the engineering and management staff of the company. Looking at the definition of knowledge,'the combination of organized experiences, values and beliefs...' everybody in the company participates in these experiences, values and beliefs.

3.1 PROCESSES

Knowledge management will constantly be changing to the current project or proposal demand. This requires knowledge about the internals of knowledge management: it consists out of 5 sub-processes. Every process follows the previous one, where the first process is the successor of the last.

- *Knowledge creation* Creating knowledge concerns the individual research, study. When brainstorming or creating new products. Seeing knowledge as creating experience by doing something new, or investigating something new, can help to understand this process
- *Knowledge gathering* When gathering knowledge it is as if one would collect the experience from someone else. Example: participating in a training, or getting instructions how to properly build a house. Gathering of knowledge can also mean to transfer implicit or tacit knowledge into explicit knowledge.
- *Knowledge storage* Due to the vast amount of knowledge within NEM the storage becomes even more important. Knowledge has to be found, modified and adapted easily. These aspects rely on a logical, accurate and efficient knowledge system of storage.
- *Knowledge exchange* Knowledge that is being exchange is of importance to the company. Effective storage is a requirement for easy exchangeable knowledge. The IT-department can deliver a great deal in this aspect but we must not forget that conventional ways of communicating will become more important if the knowledge density increases. A highly experienced engineer can for example create a series of lectures. In order to do so he should have the advantage to quickly find relevant infographics, examples and articles produced by the company in the past.
- *Applying knowledge* The company is mostly after applying knowledge. Rework can be avoided by checking methods or knowledge that exists. Usually companies only use a small portion of the knowledge available in the company. If knowledge is accessible it is often used more often.

3.2 Creation of Knowledge

The first sub-process 'knowledge creation' is further under investigation. This is due to the fact that this is a very personal and delicate process depended on the company culture. Describing knowledge creation will guide the recording of knowledge and influences the way a knowledge management system is designed.

Using a knowledge management system interface is directly in touch with the personal experience of the user. Therefore to create a knowledge management system the way knowledge is created has to be clear at first. The way knowledge is created is trough four stages; socialisation, externalisation, combination and internalisation. These stages of creating knowledge will be the framework upon which the knowledge system is created. These stages will follow up in the way they are described. Every time a new concept is learned the process is roughly described by the following.

- *Socialisation* is characterized by the exchange of knowledge trough verbal instruction or copying behaviour. For instance learning how to use a kite from a friend on the beach by instruction and copying his moves.

- *Externalisation* The knowledge is being written down or recorded and stored. This is where implicit knowledge becomes explicit. When a conceptual definition of a process or a behaviour is given. Due to making knowledge explicit the knowledge becomes a lot more easy to share and to store. A company should excel in making implicit knowledge explicit because of mentioned benefits. In the example of kiting externalisation can be seen as writing a manual, but next to that, even more important, writing your experience with kiting. For example adapting the surface of the kite to the current wind source.

- *Combination* Different concepts are combined and/or knowledge is being reworked. Combining different concepts results in new contextual knowledge for example: combining snowboarding with kiting into kite-surfing. For the most part these are ideas and thought experiments.

- *Internalisation* In this stage one is redefining knowledge to the context at hand. This process renews insight of the individual and supports the renewal of the entire organisation. This process can be recognized when the individual or team is starting to start taking new directions using the new knowledge.

People have the normal tendency to adapt their focus to the ever changing situation. The consequence is that created knowledge and experience tends to be forgotten, mostly the details. In order to prevent this from happening, implicit knowledge should be recorded in any way. For instance creating a lessons learned, a review (Like on internet when searching for products) or a WikipediA style like page. This will prevent knowledge loss throughout time and with the leave of colleagues. The point as mentioned stresses again the importance of externalisation, this should be one of the ultimate goals of the company.

4 FileFetcher

The company NEM works solely with digital files these days. Every project has a clear file structure with organized so-called file-keepers: describing the status of each document. However, all the other company files are roughly organized by their departments. Finding files in these large data banks is almost impossible. The lead-engineers of the departments have rough ideas of where to find files. The default search engine of embedded in the operating system is not capable of searching effectively trough all the files. In order to resolve this issue a file-fetcher was designed as a coding exercise. The huge benefit of it was the quick retrieval of a lot of files. During the design process this simple program created a lot of goodwill among the engineers for a knowledge management. This system can be used in conjunction with the knowledge management system. At the moment of writing the

two systems are separate, at the grant of continuing development, the file fetcher should be working at the background to present the user with files containing relevant information when it finds some. The user should also be given the possibility to freely search the knowledge bank, K-station for the NEM-environment, at its own will. Therefore the interface should be adapted in order to chose the search type to the users preference.

4.1 File-Fetch Design Process

As described above finding files is a exhaustive task. Example of severity: 'Even remaking a one hour presentation could save time instead of searching for the presentation.' quote by several engineers. The file-fetcher program should meet the following requirements:

- Finding files based upon:
  - creating date
  - modification date
  - file type
  - file name
  - author
  - engineering department
- Search time less than 10 seconds
- Show file location
- Open specified file
- Have basic interface functionalities
- Programmed in Access and visual Basic
- Quick indexing methods
- Indexing of all files of the 'K-station'

Basic interface fucntionalities The interface of the file-fetcher should be easy to operate, with buttons that resemble clear functions. It should require a minimum amount of instruction of operating it.

4.2 Requirements analysis

The speed of searching trough all these files is determining for the way the program will work: it will have to be independent of the operating system. This implies that the location of the files and its metadata are to be stored elsewhere. Using a program written for 'Microsoft Office Excel' named: 'Directory Tree Builder' it is possible to create an inventory of files at a specified location by the user. Several aspects could be taken into account in this system: creation date, modification date, file type, engineering department(Based upon file location), file location. However, the author could not be extracted. The resulting excel file, now a database with all the selected information, is to be imported into the access environment. Within the given time it was not possible to write an indexing program, therefore the use of a third party program is justified.

The access engine is programmed such that it will search for text strings matching parts or the whole string provided by the database. Next to this the interface is made functional using visual basic. The search engine of access is also controlled by visual basic.

4.3 Result analysis

The search engine is capable to search within several engineering departments separately or all the departments at once. The file location can be opened just as the file itself, this is depended on the operating system; a program linked to the file extension has to be present to open the selected file.

Indexing the system is a time-consuming task which can be run in the background. For this reason only interesting parts of the K-station are indexed. Due to the indexing method the author is not included. Documents that contain written text have usually the author stored in the metadata. However, small survey suggested that the author provided by the metadata is not the actual author of the file. Several presentations were rewritten or created by other authors than shown in the metadata. In order to show the principle authors were added manually to the specific files. In order to resolve this issue a program could be created to search within the presentation or document for strings that may contain the author. The time it takes to produce search results is around 2 seconds in the case of all the engineering departments involved. A screen shot is included, see figure 4.1. As example the documents written by mister Wester are on display.

With retrospect: writing the programs functionality in visual basic proved to be a sufficient exercise in learning the basics of the programming language.

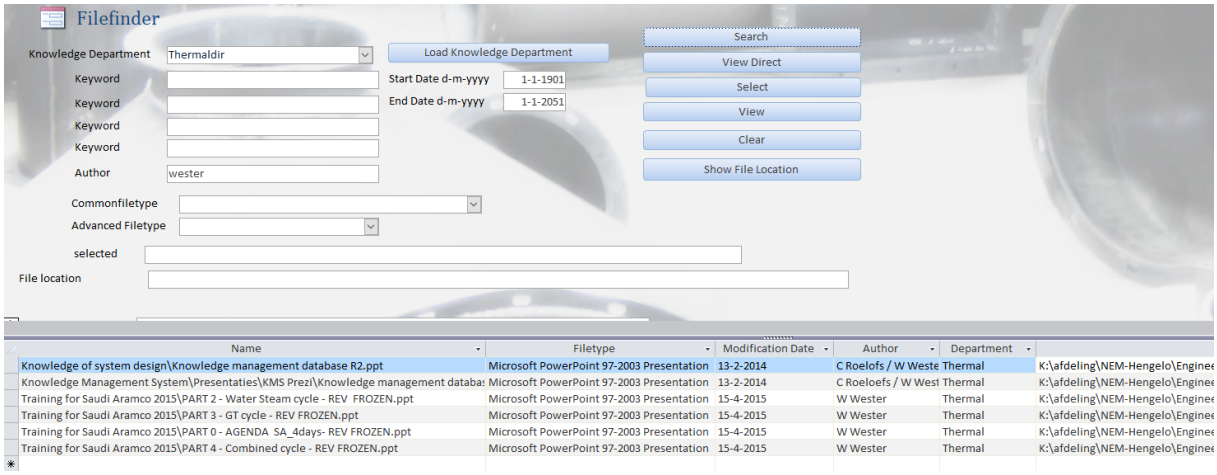

Figure 4.1: Screen shot of the file fetcher, a program to quickly search files of the K-station.

5 Knowledge management system design

This will be the second system which will serve the goal of the internship: implementing knowledge management. The way to do that is designing a program with KM as main interest. To support KM, several aspects of KM have to represented in the program: storing knowledge, and exchange of knowledge. The system will also provide the possibility to externalize knowledge as explained in section 3.2. The database to provide storage will be designed in such a way that user interfaces will accommodate easy access to knowledge. As a consequence the gathering of knowledge is also easily possible. Due to the architecture of the system the knowledge creation stage 'combination', usually done by the intelligence of the human itself, can be assisted.

The process of 'applying knowledge' is not resembled in the program. Applying knowledge is where the engineer is using knowledge provided by for example the to be designed system.

5.1 Software Design

The idea behind the program is that the engineer is working on a project and is in need of knowledge about specific aspects of his project. The engineer seeks out knowledge using this to be created program and he will find similar solutions to his similar problems. Perhaps generic experience has been

written down in the 'lessons learned' section, with these problems and armed with this experience the engineer will save time. The next benefit is the productive meeting the engineer will have with the senior engineer who wrote that piece of experience when discussing this problem if needed.

Example: Ten years ago a certain injection cooler is used during a project with a typical gas-turbine. The material of this injection cooler tends to fail every 5 years. This knowledge is stored within NEM, written down in lessons learned and recorded in the experience of the responsible engineer. A new engineer is working on a similar project without knowing about this case and he has access to this kind of knowledge via knowledge management and is able to select a different material, perhaps deviating from his own standards. He will record his experiences: describe he found this piece of knowledge and describe how and why he altered the design. The knowledge management can set a reminder for the engineer so the engineer can in time describe the long-time experience with his newly designed injection cooler. This cycle will in time create highly optimized systems and a highly experienced company. As can be seen in the example the young engineer has the knowledge available of the experienced engineer ensuring the quality of the products delivered by NEM.

5.1.1 Design Requirements

The system should resemble the idea of knowledge management as described before, during brainstorming the following items must be on display when the system is working:

- The system should contain approximately 1000 records of information and or knowledge.
- Quick, accurate and consistent search results when looking for knowledge.
- Knowledge should be on display where available.
- Users will be able to easily store their knowledge.
- The all sorts of file types should be retrievable.

The scope of the type of documents are: presentations, articles, design reports, supplier product information and lessons learned. These files are not available on the free internet. The search engine will not have access to the free internet nor search this domain.

Out of Scope This project will not deal with the product development of Teamcenter nor the implementation of the software.

Culture As mentioned before, this project has the tendency to only show the part of the system where the user can benefit in a receiving way. This is to gain momentum for the implementation of knowledge management. During interviews several engineers were sceptical about the idea. Next to this engineers have all their own idea about how to resolve this issue. With a exaggerated nice looking and good working system gaining momentum towards the implementation and use of knowledge management was the reason to show more of the beneficial side of knowledge management. The user and owner of the system should be aware of the fact that without active knowledge and or information supply knowledge management will fail. It is of great importance to create a working environment where knowledge supply is secure.

5.2 Database Architecture

Due to the large amount of contextual knowledge, sub-domains, have to be defined in the knowledge domain. Based on tags or characteristics of knowledge entities the domains can be created. The characteristics are linked via contextual relations due to the nature of the contextual knowledge. Using them it is possible to create any set of records based upon search queries. A simple example of this principle is when looking for restaurants nearby a certain location: first all restaurants are selected

out of all the possible places to visit, second all addresses of those restaurants have to be limited to a travel range of x meters. Lastly filtering the remaining by type of restaurant(ie grill or sushi) or rating based upon customer experience will result in the desired selection.

In order to show this principle in the knowledge management pilot, the projects-overview-database is used as a starting point. This database provides all the projects that are done with NEM as lead engineering company. The database contains several aspects about each project, for example: number of boilers, type of boiler, year of commission and type of heat source. The user will be able to select based upon these aspects the type of project the engineer is working on.

All the projects within NEM have characteristics which can be used to select a set of projects (With a minimum of one). Each project has its own complete set of documentation. This documentation is summarized in one database which will be made available. The summary of documentation also provides all kinds of characteristics of each file, for example: status of document(final, third party approved), department of engineering and author. The most important characteristic provided by this database is the one-sentence-summary, describing the contents of the document. Using several characteristics of these documents they can be linked to knowledge, for instance the available lessons learned at the start of the project.

To summarize there will be three databases available that can be linked together in the way the user wants. The databases are: the projects database, the documents database and the lessons learned database. This creates a 3 dimensional search query.

The idea is that eventually a multi dimensional database is created including supplier information, price databases and design standards. See figure 5.1 for an example of this idea. The figure selects a set of entities that have something in common with each other and are therefore selected.

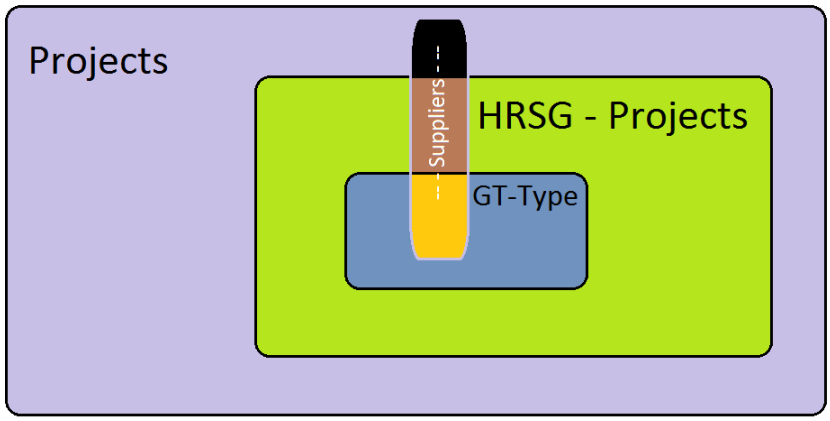

Figure 5.1: Example of a subset that can be created using the architecture

5.2.1 Data, information and Knowledge supply

To initiate the system the database of this system is fed by copying the meta data of the projects (project database) and corresponding documents (project documents). To prevent large disk usage inventories are used so no large file containers are copied or stored elsewhere. The system of project document storage as it is, working for the engineers, is left in tact. However, the meta data is stored again in the database. As a quick investigation shows the amount of 're-storage' space required is about 1 promille of the original file size. In order to remain up to date the KMS should be recording changes and update its own index. The knowledge management system listens so to speak to the company databases and the program database is updated by what it notices. The KMS will keep the following databases in check:

- Project databases.
- Project Documents

- Lessons Learned databases.
- Document databases. (K-Station to be NEM specific)

Using this method it prevents double or tertiary data copies and is always up to date.

Next to this the system is an actual text finder, something which nowadays can be executed very fast.

5.3 Secondary system

By default the search engine is only as smart as its user. Looking at the definition of knowledge the user has to know about his subject before he can understand new knowledge. However, with new knowledge sometimes come new words or acronyms. So the knowledge management system has to be made a little bit smarter by the previous user who implemented the new knowledge.

In order to smarten the system a secondary system is created: the 'knowledge-words-list.' This will try to provide the user with only relevant information about his search query. When a user is searching for information or knowledge this system will secretly search with the input query trough the knowledge bank, in this case the lessons learned from previous projects. Due to the fact that lessons learned are linked to project characteristics, the searching user will not always find knowledge about his subject when he is looking trough projects that resemble his own project. When this happens he could miss out important information, the secondary system will prevent this from happening using common words.

When the knowing user is providing his lessons learned he will provide the system with keywords which will be stored in the knowledge-words-list. This creates a smart and organic system. Next to this the knowing user can attach the project to provide a more contextual picture of his knowledge. Initially the 'knowledge-words-list' is created based upon typical recurring engineering words in the field of boiler engineering.

This system listens to the input query of the user and will activate secondary search queries when the input query matches words. The secondary search queries will look for lessons learned or other relevant knowledge stored in the system.

Company Culture As suggested already in this report the supply of knowledge has to be ensured. The advantage of such systems is the ease of doing investigation the supply of knowledge provided by the employees. Bonuses can be provided to those who supplied a specified amount of knowledge for example. Next to this the employees of the company should be aware of the advantages of such a system. Any uncertainties should be eliminated by the employees.

5.4 Interface

In order to work with the knowledge management system an interface has to be provided. This interface is designed with the idea of promoting knowledge management. The design tries to promote knowledge management by implementing easily recognizable elements into its interface. Every interface page will concern a dimension of the database. The database represented is a database created by the engineers themselves, concepts that they are familiar with for several years.

For now every interface page is fixed and can not be altered by the user. This could become a requirement if the system would be heavily used. This will be explained later. On every interface page the user can use search fields to create his own set of data he is interested in. The following interface pages will be presented in this order:

- *Project Selection* This interface will present itself immediately after the starting of the program. It enables the user to make a selection of projects based upon: Client name, location of build, type of Boiler, type of GT (if provided) and MCR. The engineer can start to select the aspects of the information or knowledge. See figure 5.2.

- *Document Selection* When the set of projects is selected it is possible to search within the documents of these projects. Based upon keywords provided by the user matching the description of the documents. The documents have been left out for the report for company privilege reasons. The product of the search query so far will consist out of two types: documents and, if available, knowledge and if not available a message will appear to invite the engineer to write about his experience once he has it. See figure 5.3.

- *Lessons learned* When the user is searching for subjects that are discussed in the lessons learned; there is knowledge about these subjects other than common knowledge, the user will receive a warning. The user can then view the lessons learned. See figure 5.3 for the warning of existence of lessons learned and figure 5.4 for the invite to provide knowledge. The lessons learned will be displayed as can be seen in figure 5.5.

- *Store Knowledge* If the amount of records is low enough during the search through the project document the user is asked to provide knowledge about the subject he is referring to. He than can provide his knowledge at the 'Store knowledge' interface. The next time this subject is being searched for the user will be provided with this stored knowledge. This interface page is on display in figure 5.6.

The interface that will be created has the main goal to show the speed, accuracy, and interaction with a knowledge management system.

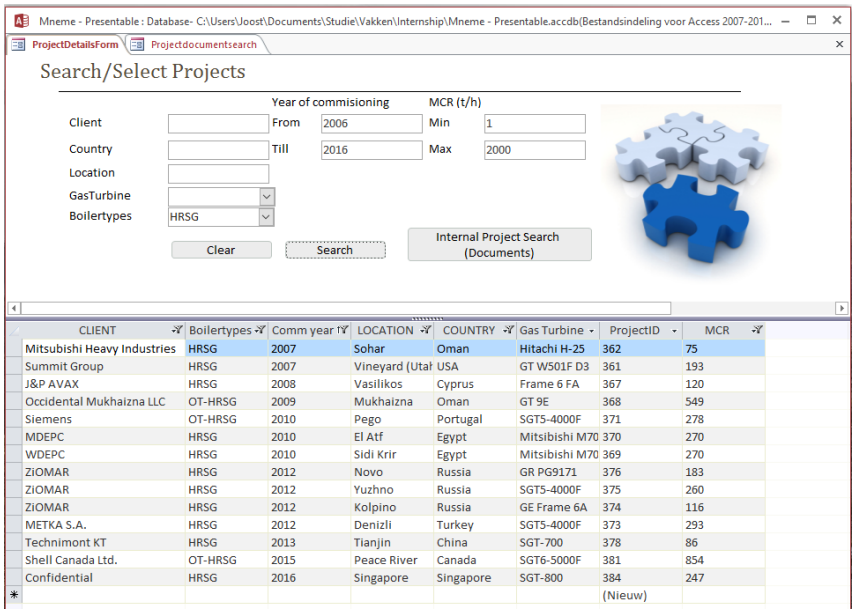

Figure 5.2: The first interface page: the project selection page. Several selection criteria can be imposed as can be seen in the figure.

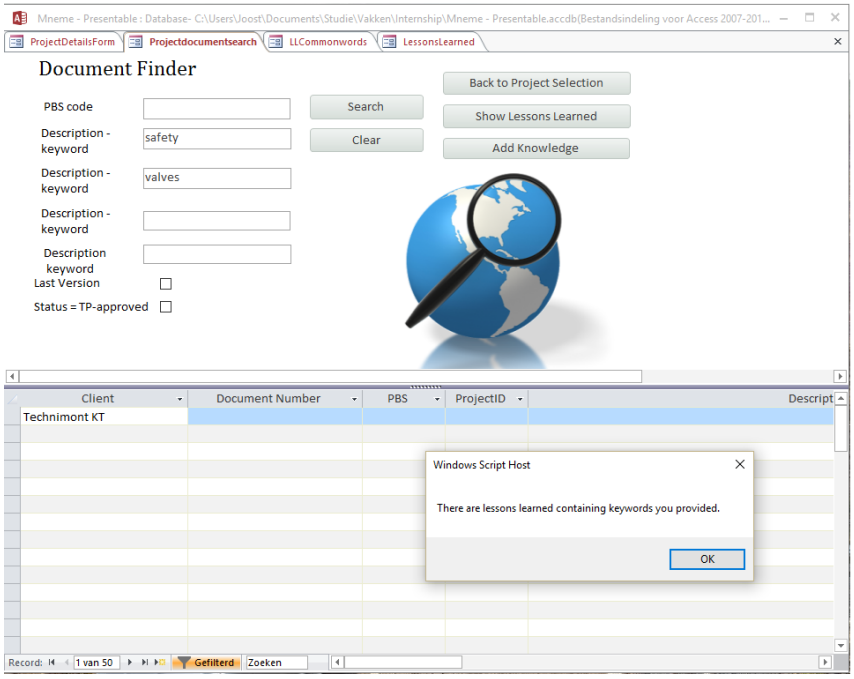

Figure 5.3: The second interface page: the document selection page. Several selection criteria can be imposed as can be seen in the figure.

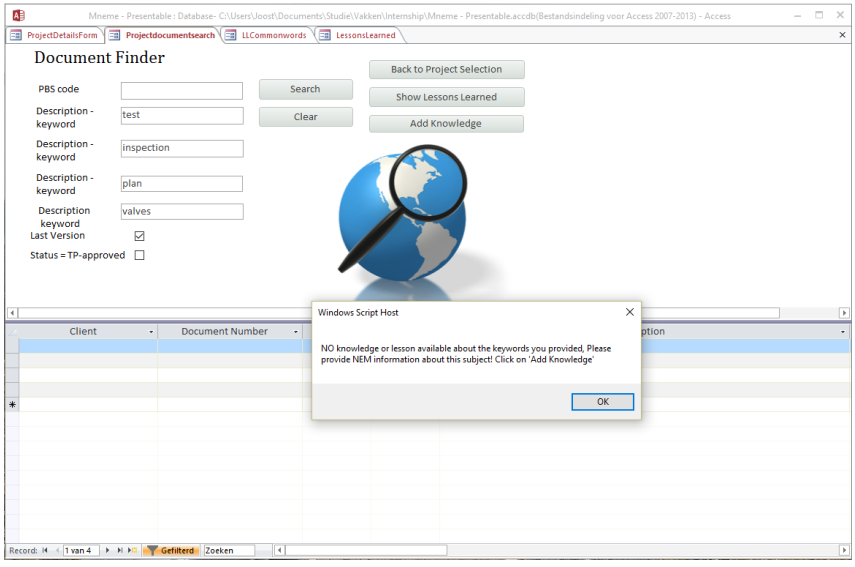

Figure 5.4: The second interface page: the document selection page. Several selection criteria can be imposed as can be seen in the figure. Now the invite is on display to provide and store knowledge.

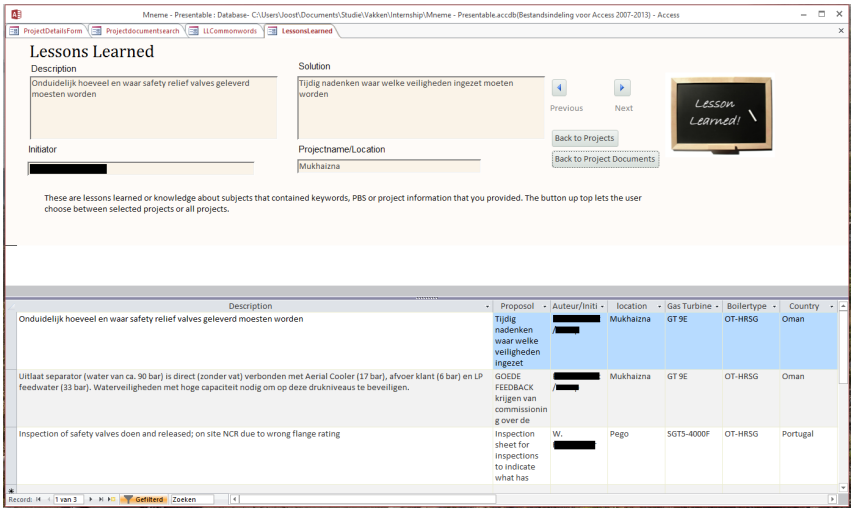

Figure 5.5: The lessons learned interface page: here several lessons that might be related to the user his search query can be viewd.

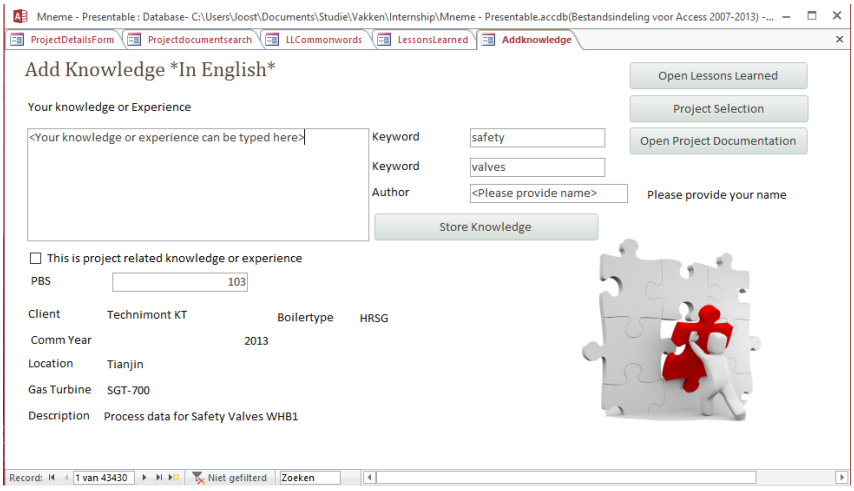

Figure 5.6: When the user is asked to provide knowledge he can store his knowledge here.

6 RESULT

The final program is made operational with 5 projects with all their documents. Although a selection can be made out of all the NEM-projects, only 5 of them will provide the user with project documents or lessons learned. This makes that the KMS can be used for presentations and proof of concept. During presentation a case can be presented whereby the fully documented projects will serve as knowledge provider.

Lastly the program functions as a live example of requirements for a future IT-engineering project. The KMS can be used to give very clear instructions to future programmers about the functionality of a future KMS.

6.1 REQUIREMENTS EVALUATION

For this project requirements where not specific, although several measurable requirements where provided the shape and functionalities where not specified. The assignment was not to create a program with accordance to specific functionality demands. During the design process the deficiency of such a system was made clear. Based upon vision and ideology this system got its shape. The design process can also be defined as a more creative process. However, evaluating the requirements is a mandatory part in the design process and acts as a clear reference to check if the program will serve its goal.

- The system was to contain around 1000 files of knowledge or information: the system pilot contains approximately 50.000 files. Determining whether all these files are information or knowledge is of course a daunting task. Using the given knowledge definition per project around 3000 files can be stated as knowledge. These are files that are third party approved. Meaning that an other engineering company has checked the document on content. Most of the time there will be 2 draft documents before the final or third party document. These documents are also recorded. They can be classified as information. If the file fetcher is used in conjunction with the knowledge management system, the total system can search trough 200.000 files.
- Lessons learned are also included in this system. They originate from project leaders who believed it was important to record experiences. There are around 100 relevant lessons learned included.
- This pilot demonstrates the speed of retrieving deeply stored information. The amount of time to retrieve vital information can be reduced to a absolute minimum, keep in mind though that knowing the NEM-language can greatly help the user finding relevant information. (Example 'stack' instead of 'chimney') When testing the system it proves to be accurate and consistent.
- When using the system pilot the knowledge is being displayed when there is available. The user is asked to provide knowledge about his experience in a separate interface.
- The system is only able to provide project documentation. When background knowledge is required the KMS can provide the department of engineering. Using this department can help with finding background information using the file-fetcher.

The database the KMS uses is one containing all the documents of the included projects, organized by project. The system uses different fields to select project documents, depending on the interface-page is being used. The project-selection-page uses the first several fields to create a first selection. Fields containing date, type of boiler and type of gas-turbine for example. The project-document-selection page uses these selection criteria where the user is asked to provide even more selection criteria. This time the program uses other fields of the same database. Fields containing PBS, one-sentence-summary words and department for example. In the end the user has created a string with all different kind of selection criteria. If there are still documents left matching these criteria those will be shown.

The pilot creates a good conceptual definition of a knowledge management system according to the project sponsors. Several NEM engineers have been subjected to the program and are very satisfied with its results. They believe it has a good chance of becoming a successful program. The project sponsors are very satisfied with the product and permission is granted to continuing the development of knowledge management.

VISUAL BASIC In order to create a working interface as described before all the functionality is programmed in visual basic. The exercise of creating a file fetcher first was of great help. The code is added to the appendices to provide some further in-sight if needed.

6.2 INTERFACE

6.3 PRESENTATION

In order to kick-start the notion of knowledge management in the company a presentation and demonstration for three groups of people was conducted. Using the pilot system and explaining knowledge management as a whole. The first group consisted out of the management team of NEM - Hengelo, the second group consisted out of the teamleaders, keypersons and technical specialists. The third group were engineers of the *thermal and process design* group. Interesting was to see the response upon the pilot. All groups were interested in the methodology and the idea of knowledge management. All groups were immediately concerned with some technical aspects of the pilot: how to ensure the data transfer to the system. This technical issue is only of concern of software engineers and can be dealt with easily. However the first and second group were also concerned with the culture change that is need for the system to work. This concern was already mentioned in literature studies about the implementation of knowledge management. The culture change can be tackled by ensuring a informed consent across the pilot group or entire company. Next to this an efficient implementation program with the possibility of adaptation to changing circumstances has to be created.

6.4 DISCUSSION

As with many design processes the product, the program is never finished. The interest for knowledge management has been initiated. However, to provide valid reasons to continue the investment for knowledge management the following ideas should be considered. The pilot has proven its point very well according to the client. The discussion and improvement points can be considered as strong recommendations to continue the development of knowledge management and its system.

6.4.1 DEVELOPMENT

If improving this system is granted than the following items should be attended to.

- The architecture of the domains should be made more flexible, to allow the user to create his own final set of records.
- The user should be able to chose his way of storing or adapting knowledge. For instance: create a lessons learned, a side note or perhaps a whole wikipedia page on the subject.
- The program should allow for super easy knowledge and information sharing with a minimum amount of effort. This would support the 'knowledge sharing' process of knowledge management.
- The interface should be customizable by the user; there exists a vast amount of characteristics to each entity, upon which solutions sets can be created, within NEM.

- Dynamic databases. For this project a snapshot of the current data is used making it old the second it is in use. Dynamic databases will ensure the user has access to all current knowledge, information and data.
- Price databases should be included.
- More project characteristics should be added.
- In terms of knowledge exchange this system lacks an easy sharing method. In order to organize a proper meeting to discuss found knowledge in the system it should be able to easily share the knowledge. To send the location of the files with a minimum of mouse clicks via e-mail for example.

6.4.2 CHALLENGES

During the design of this system several challenges presented itself. Such as research to the effects of knowledge management, how the variety of programs can be organized to less software platforms and creating an artificial intelligence.

LEAN SIX SIGMA For the program to be validated for its purpose to the full an investigation of its effectiveness should be carried out. As indicated in the project plan the time to release a project or proposal should be shorted with the use of knowledge management. This time reduction can save the company valuable assets: money and engineering time. To make this reduction measurable the designer advices to create surveys as conducted when doing lean or Six sigma analysis.

PROGRAMS The first concern is to address the amount of programs the engineer has to deal with. In the future is recommended to implement the functionality of the pilot into an other software environment.

SOFTWARE USABILITY Perhaps the amount of documents is not reduced yet to only two or three nor is the system able to answer the engineers question. I have created this program with little knowledge about Microscoft Acces and Visual basic code language perhaps that the underlying code can be improved. Due to the improper communications at the start of the assignment time was lost with respect to creating the pilot in MS ACCESS. In the end I am happy with the result and providing the company of NEM with an impulse into knowledge management.

ARTIFICIAL INTELLIGENCE As attempted with the secondary words list, the system can be made more intelligent. It could relate typical search queries to accepted answers and therefore more quickly provide the user with relevant answers. Using the typical words list it could be used as typographical errors assistance.

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