Application of three-dimensional environment to manage knowledge in petroleum industries

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Abstract*:*

In this paper, engineering knowledge is introduced as a special form of organizational knowledge that managing it requires special solutions. Engineering knowledge, in gas and petroleum industries, includes the technical specifications, optimization algorithms, functional requirements, guides and engineering standards. It is saved and used as technical documents (e.g. plans, mathematical equations and graphs).

In the recent years, computerized three-dimensional (3D) platform is used, greatly, in this domain. This paper presents the advantages of using 3D environment for managing engineering knowledge. It introduces an innovative knowledge management system, in computerized three-dimensional environment, which is specifically developed for being used in the gas and petroleum industries. This system provides the possibility of linking the engineering knowledge, as the text, plans, pictures and multimedia descriptions to the geometrical models of the equipment and assets, in 3D environment.

The advantages of using this system for expressing, saving and accessing to the engineering knowledge is indicated. This system is integrated by technical management systems, such as preventive maintenance and inspection and emergency repair systems. The results can be used to manage technical knowledge in engineering and design departments of petrochemical industries.

Keywords : *Knowledge management; three-dimensional environment; engineering knowledge*

I. Introduction

Several experts have a role in the evolution and development of knowledge management concept. Knowledge management concepts are introduced and developed by Peter Drueker, Pawel Straws man, and Peter Senge [1].

The organizational knowledge is one of the most important assets of any organization because it is a valuable asset that guarantees the correct functioning of the organization and enhances creativity and innovation in the organization. It is because creative ideas integrate and combine knowledge and innovation in a new format. Therefore, development and application of creativity and innovation in an organization requires efficient and effective management of knowledge, in it. However, often these knowledge are neglected, because much of them as they are hidden.

In the competitive conditions, prevailing in the global services and industries, timely and rapid access to valid and reliable knowledge, is a competitive advantage for organizations and the creation of this advantage requires the application of knowledge management systems. In this environment, considering the "knowledge management", as a way to manage a corporate asset, it is very important.

In this paper, knowledge of administrative and engineering knowledge is separated into two different categories and characteristics of each of them are described.

II. ADMINISTRATIVE KNOWLEDGE AND ENGINEERING KNOWLEDGE

In this paper, administrative knowledge is distinguished from engineering knowledge, based on this idea that the tools and the methods that are used for each of them are different.

The administrative knowledge explains the favorable and unfavorable methods for implementing the administrative and bureaucratic operations. They explain how to perform current tasks, in successful ways. Such knowledge is, usually, prepared and published in the form of text, flowcharts and simple shapes and graphs. It can include methods of operation and how to correctly perform the coordination and control of operational processes, in service, agriculture and industry sectors. The management systems that are developed to manage this kind of knowledge are action – oriented, which means that each part of knowledge is organized and stored, in related to a specific task, and can be retrieved by mentioning this task. The assigned knowledge to a task, explains how the task is implemented, and how is controlled, and how the equipment and technology and other resources such as labor and capital are used, during this task .As an example, an administrative knowledge may be about to how to select and hire staff or control the balance of accounts, in an accounting system .The same procedures can be used to manage this type of knowledge, in all industrial and service organizations is similar.

At the other side, engineering knowledge is exclusively used to management of technical tasks and often is important in production and industrial units. This type of knowledge rarely can be expressed as text and are mainly is used by engineers and knowledge workers, in the form of technical drawings, diagrams, formulas and logical and mathematical models and algorithms.

To manage this kind of knowledge, it is required to develop special systems and tools to register, organize and use of technical knowledge and experiences, in an effective way. This paper presents conventional knowledge management models and introduces specific approach and tools to manage the engineering knowledge.

III. MODELS OF ORGANIZATIONAL KNOWLEDGE

Various models have been introduced to describe the structure and nature of organizational knowledge.

According to the model, presented by Nonaka, Ikujiro and Hirotaka Takeuchi, knowledge is divided into explicit and tacit forms. This model also includes the way that these kinds of knowledge are converted into each other [2].

As Figure 1 shows, Probst and colleagues illustrate the process by which knowledge managed through a cycle that includes the following steps [3]:

- Determine the knowledge goals
- Organize knowledge and identify their sources

- Gathering and knowledge acquisition
- Develop and classify the knowledge
- Distribute and share the knowledge
- The use of knowledge
- Maintain knowledge
- Assess the Knowledge

The final stage of the cycle (step 8) is to provide feedback to actualize knowledge goals according to the novel requirements. This is a return to step 1, and so these steps are repeated to form a cyclic process.

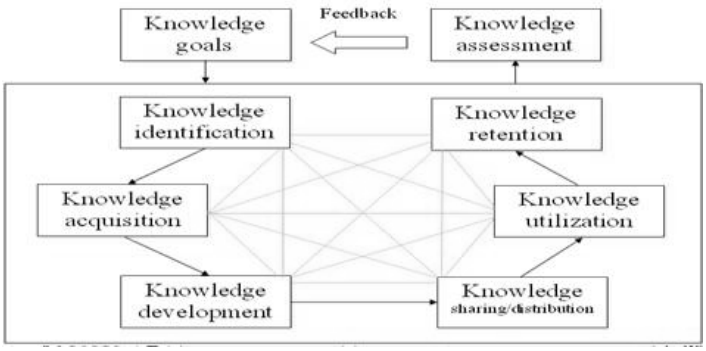

Figure 1. Knowledge cycle process model [3]

Figure 2 shows the structure of knowledge management in Fraunhofer IPK model. In this model, knowledge system corresponds to three categories of people, processes and information technology. This system will be implemented during the following steps [4]:

a) Determine strategies (strategies) that include analysis of culture and cultural barriers, PBO-KM analysis and analysis of information technology infrastructure.

b) Security features include improve communication and management, the transfer functions, knowledge structuring. To do this step modeling processes based on knowledge, selection and management of knowledge management tools is required.

c) Implementation, including creation of knowledge networks to measure the success and implementation of investigative knowledge.

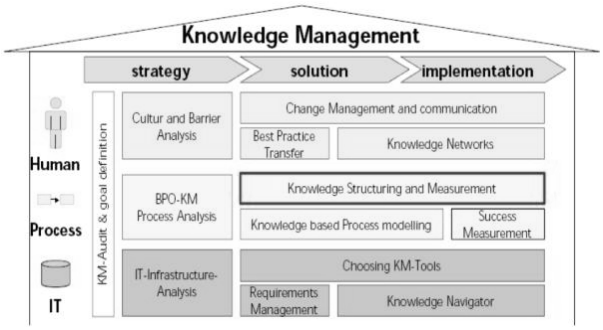

Figure 2: KM Fraunhofer model [4]

IV. KNOWLEDGE MANAGEMENT IN OIL AND GAS INDUSTRIES

From the mid 2000's, oil and gas prices rose sharply (Figure 3). To reply to this trend, active oil companies in the upstream field of supply chain and logistics. Given the geographic extent of economic activities in these industries, they set upped and coordinated the new transnational policies. They tried to increase the ability and efficiency in the areas of exploration and production, facilities management and operations optimization to exploit the deeper wells and use them in a more effective way. These companies reorganized their activities by using the integrated systems, consisting of administrative, financial and technical systems to concentrate facilities, operations, materials, services, contracts and logistics management. This places new emphasis on the transfer and manage knowledge, in these organizations. This causes more investment in new information technologies such as virtual reality, simulation software and knowledge management.

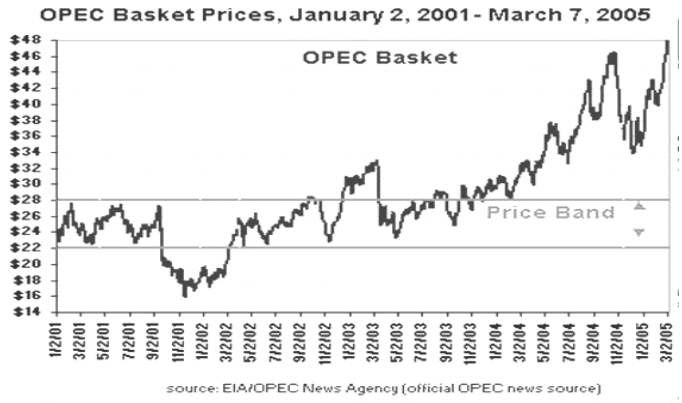

Figure 3: The OPEC oil basket price increase from January 2001 to March 2005

These developments led to oil companies to become the major customers of knowledge management software in the world. Studies show that in this period the volume of revenues from software knowledge management in America, from $ 2 billion in 2001 is reached about 10 billion dollars, in 2005 that indicate significant growth is 400%. This trend was more or less the same in all transnational oil companies. For example British Petroleum deploys a knowledge management system. It is a multinational oil company that it has over 100,000 employees working in more than 150 different types of careers in the oil, gas and electricity. The company has branches in 100 countries. Company management believes that to share knowledge is very effective in improving performance, especially after that company merged with Amoco, to establish cooperation between different specialties and exchange of knowledge among employees of two companies was necessary. So the company implemented the following procedures [5]:

a) Create a knowledge exchange model for sharing corporate knowledge assets

b) Create reference pages including company employees and experts and their fields of expertise

c) Create a forum within the organization and conferences for the exchange of knowledge between individuals

d) Create a system for gathering and obtaining knowledge at this company

On the basis of calculations, in 1998, in British Petroleum, thus creating a knowledge management system saved $ 260 million, in cost. The reasons for these savings are listed as follows [6] and [7]:

a) Ease of preparation and use of knowledge resources that has increased efficiency

b) Convert tacit knowledge to explicit knowledge by documenting the knowledge of its personnel.

c) Lack the vulnerability of the organization knowledge capital to leaving or retiring personnel.

V. APPLICATION OF THREE-DIMENSIONAL PLATFORM FOR MANAGING ENGINEERING KNOWLEDGE, IN OIL INDUSTRY

3D models using two different technologies, used for the industrial and geographical applications. The industrial model is exactly the desired object details and its shape is created by combining simple geometric shapes such as triangles. In contrast, geographical maps, are used to map an unknown environment, made of the connection points obtained by sampling from a limited number of irregular spots [8]. Many recent advances in the field of 3D mapping use satellite imagery and laser scanners to provide accuracy and speed [9]. The data related to the Earth gravitational field and underground mining is used for 3D mapping [10].

Activities of oil companies are often one or more of the following areas:

a) Upstream industries including oil and gas exploration and production of crude.

b) Midstream industries, including refining crude oil or natural gas by separating impurities, toxic and corrosive materials.

c) Downstream industries, including petrochemical industries, the initial distribution (usually by ship), storage, and secondary distribution (by truck or distribution network).

In the past decade, according to the following reasons, 3D images and four-dimensional (3 spatial dimensions and one time dimension) are used in upstream industries [11]:

- Ability to organize data and test data, they are close to reality
- Ease of presentation layers productive oil fields
- Create value with data processed using the data residing in dynamics

These companies are using 3-D geographic information systems (GISs) to determine and monitor the location of wells, buildings, oil installations, pipelines, utility networks, roads, tankers and analysis the effects of natural disasters such as earthquakes and hurricanes. For example, GIS has been developed by department of information technology of Aramco by more than 50,000 employees of the company for knowledge management, project management, logistics, crisis management and environmental studies of desert [12]. Venezuelan oil companies are also used the same technology that controls the activities of 20 000 oil wells in the oil field, in 2400 [12].

In petroleum industries, Computer-Aided Design software (CAD) are used since the project design, to construction and operation of it, for mechanical analysis, thermodynamics, acoustics, and many other types of analysis [13].

VI. CHARACTERISTICS OF THREE-DIMENSIONAL ENGINEERING KNOWLEDGE MANAGEMENT SYSTEM

In this paper, a knowledge management system consisting of text data and 3D maps has introduced, named TDEK system. This system uses a CAD platform (e.g. CATIA Dassault system®) to design, edit and view the 3D model of the installations.

In this system, the technical knowledge and information are organized as an equipment-oriented system, and are assigned to each of the parts or equipment. To do this, the related knowledge of equipment is stored in a SQL-server database and at the same time is linked also, to its geometrical representation in the 3D model.

This information may contain multimedia description, produced directly by capturing photos and movies from the screen. These medias are organized and prepared are registered in a database. Later, they can be used by all users through internet or intranet by using general web navigators or a three dimensional interfaces. Thus, engineering and technical knowledge and information related to design, procurement, maintenance, repair, energy use, production and quality are classified according the equipment. So that by deleting, moving and copying equipment in the graphical environment of CAD system, the engineering knowledge will be update, respectively. This system has been designed for being used in oil and gas industry sites, including the facility management, refining, transmission and distribution.

In this method, the CAD environment is used to create 3D model, simulate operations and advanced mechanical analysis, and without exiting from this environment, store important knowledge and information similar to the traditional knowledge management systems; with the advantage of producing the multimedia documents, in addition of conventional administrative knowledge formats (text and attached files).

The possibility of using 3D images that are taken directly from the computer screen, simplify description of the technical in a step by step approach and present knowledge and ask the practical questions. Moreover important information and knowledge can be represented by visual alerts by illustrate textual description on 3D models of equipment or by change its graphical properties (e.g. color) to easier and faster exchange the critical information with the operator. Figure 4 illustrates a screen shot of the developed software for TDEK system. This page corresponds to the edit/view the basic information of the equipment.

Figure 4. A snapshot of the developed software

The system also has the following features:

1. The ability of creating a knowledge library for continuous improvement of the equipment design and use.
2. Intelligent control of design criteria by checking compatibility with the regulations, stored in the knowledge base.
3. Send questions to experts and rank the answers and save them for future use.
4. Evaluating and ranking the knowledge based activities of personnel and working units in enriching the knowledge base and determining allocate the related reward.

Use the multimedia facilitates documentation and reuse of the knowledge and in this way encourages the company's personnel to participate, more effectively, in knowledge based activity.

Conclusion

In this paper the use of 3D models and their application in oil and gas industries has been discussed. Knowledge management capabilities, in the 3D environment, are described and a new knowledge management system is introduced, in a 3D environment. The objective of this approach is to facilitate the preparation the knowledge and record technical experiences and expertise in a simple and useful form. This motivates the experts for participating in knowledge management system activities. It integrates the technical and the economic and administrative information, in the same platform. This leads to an improved vision about the facilities and assist the training and decision processes. Use of 3D models makes the engineering knowledge to be recorded with special tools and also the risk of ambiguities and errors are greatly reduced. Register knowledge in this environment; for oil industry cause successful development and implementation of projects and provides expertise in particular areas, for perform engineering and reengineering activities, in the future.

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