AKSIO – Active knowledge management in the petroleum industry

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Abstract. The AKSIO project is developing a process-enabled knowledge management system to support operations of offshore oilfields. The system will provide timely and contextual knowledge for work processes. Experiences will be processed and annotated by experts and linked to various resources and specialist knowledge networks. AKSIO will allow discovery of experiences through the support of a domain ontology. Core functionality of the AKSIO system is provided by careful application of Semantic Web technology, including ontology-based annotation and contextual ontology driven retrieval of content.

1 Introduction

As the third largest exporter of crude oil (ca. 3 million barrels/day or 4% of the world's oil production), the oil and gas industry is of major importance to Norway. The petroleum resources are located in the North Sea, a challenging environment for oil and gas production. Oil companies have deployed advanced technology to increase output and reduce cost. Increased output from the fields is possible due to new use of technology and methods e.g. injection of Natural Gas, Water and CO_2 in the oil wells.

To various degrees all major operators and service companies in the North Sea are implementing the concept of Integrated Operations (IO). In IO, the offshore oil platforms are connected by high-speed data links to on-shore control centers, where multidisciplinary teams collaborate to optimize operations and rapidly solve any problems. The ultimate goal of IO is to maximize value created from petroleum resources, which can only be ensured by a continuous stream of right decisions made at the right time.

The largest operator in the Norwegian Continental Shelf, Statoil, has about 20 ongoing drilling projects in the North Sea, Venezuela, and the Middle East. Through massive use of IT for on-line monitoring, analysis, and decision tasks, knowledge transfer within projects are satisfactory, but still sometimes failing between projects, resulting in costly repeated failures. In the drilling process, downtime costs around $0.5 - $1 mill/day, which calls for systems that focus on knowledge-enabled work processes, and use of semantic technologies to facilitate reuse of knowledge from the

drilling process. Appropriate and timely knowledge has to be presented to decision-making processes both in planning and subsequent drilling operations.

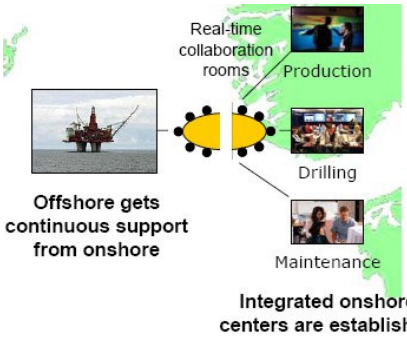

Fig.1. Integrated Operations

Active Knowledge Support in Integrated Operations (AKSIO) is an active socio-technical system for knowledge transfer between drilling projects, through documented experiences, best practices, and expert references. Our hypothesis is that an active knowledge system needs to be completely embedded in main work processes and be part of daily work.

The general idea is to provide decision makers with the best available knowledge in a task-relevant, timely, and contextual manner and provide feedback loops to capture new or delete obsolete knowledge.

2 Use Cases

Experience transfer is a social process, involving knowledge creation and knowledge reuse, where there is a win-win for everyone involved. The system is created around these two use cases.

1) Capture and qualify knowledge gained in drilling operations, and
2) Supply relevant and timely knowledge to planning of new wells

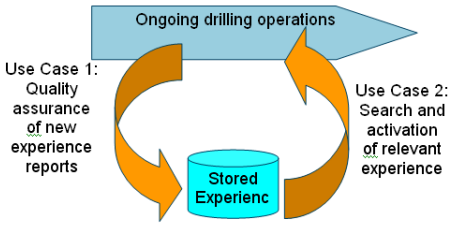

Fig.2 . AKSIO use cases

3 Business challenges with current approach

The individual drilling projects are responsible for recording positive and negative experiences encountered during the drilling operations in a database-system called Daily Drilling Report (DBR). These reports are recorded mostly in free text, with minimal metadata. Based on experiences they keep an up-to-date local best practice.

The main challenge with the current approach seems to be that the knowledge processes are not well connected to existing core working processes.

For instance the recording of the experiences shows great variation, and there is no feedback loop to the originator of the experience telling him that the experience was useful or not. “Quality in the first step”, is being used as a slogan to ensure the quality of the original experiences; reality however shows that experiences are quite project specific and some are just random notes.

The annotation process relates the experience to best practices, people and actions. The challenge here is to make this part of the daily work performed by the discipline advisors, and not seen just as “extra work”.

On the consumer side, especially during operation, users rarely search for experiences outside their own projects. Interviewed users claim that they use their own networks to find out what is happening in other projects, and not the existing knowledge base. AKSIO needs to take a non-invasive process driven search where information is pushed to the user in the context he is in. This process driven search will require detailed contextual data about the process, user, and well in question.

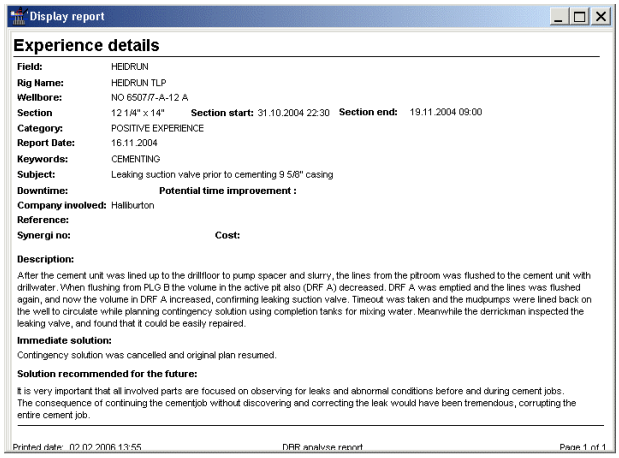

Fig.3. Sample experience report

The current DBR Experience system has a simple approach to categorizing experiences. The editor of the experience can select a single pre-existing keyword from a list of terms containing both activities and equipment, and in various details. The approach is seen as inadequate for aiding in retrieval, and calls for a more advanced and complete taxonomy driven approach.

4 Producer use case

The first use case involves creating a cross-project quality assurance process involving discipline advisors, experts in various technical areas required for drilling projects. Discipline advisors have self-interest in keeping best practices for their discipline, and to keep a network of experts on the given discipline.

In practice the use case involves cleaning the knowledge base of experiences not relevant for cross-project reuse, adding annotations from discipline advisors, classifying the information, and linking to experts, best practices and actions.

5 Consumer use case

The consumer use case is driven by drilling projects, either in the planning stage or ongoing operations. The objective is to discover relevant experiences that could affect their current or planned operation. This can for instance be that some particular equipment planned to be used has shown failure under certain circumstances, or that a certain procedure could save time and money.

AKSIO provides a search engine utilizing a shared ontology for discovering relevant experiences, and embeds this in the existing work processes. The information will be presented in such a way that it shows the relevance to the project and references to best practices, experts and who made the experience.

6 Drilling ontologies

The oil industry has for many years worked to establish dictionaries and taxonomies for the industry.

- The Posc Caesar organization [1] promotes the development of openly available specifications to be used as standards for interoperability for the oil sector using ISO 15926, “Integration of life-cycle data for process plants including oil and gas production facilities".
- IIP [2] aims to create an information platform for the industry by integrating ontologies from several industrial data and technical standards and also by adding new ontologies. The project integrates data and information for subsea seismic, equipment, drilling, production, operation and maintenance. IIP includes information from Posc Caesar and currently has some 60.000 classes described in ISO 15926-7, using OWL, most of which concerns equipment.
- There are also other schemas and taxonomies focused on reporting to the government – ongoing work. Because of the nature of reporting, the engineers find these inadequate for annotation of experiences.

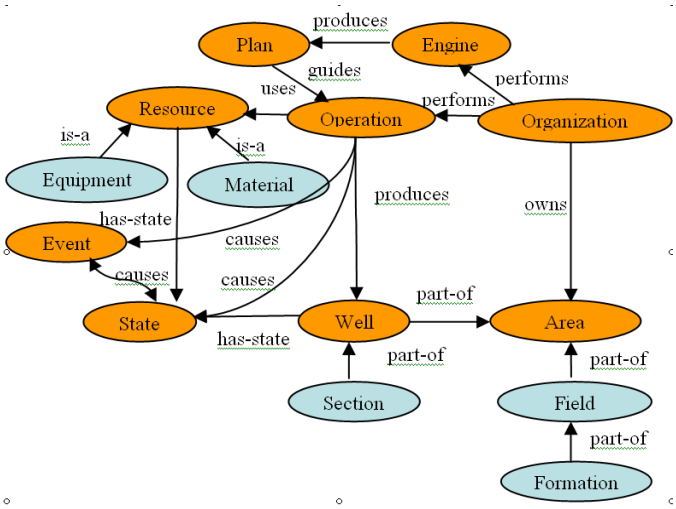

Fig.3. Top-level terms in the drilling ontology

Though it would be interesting to use the IIP ontology in a stage where it is more complete, AKSIO has a demand for establishing the relationships between various equipment, disciplines, and activities, which is currently not supported by this ontology. AKSIO is to use the ontology to annotate experiences, and to utilize it in retrieval; it seems reasonable to only use a subset of IIP as the ontology may become quite large.

Based on this AKSIO has established its own drilling ontology for this purpose. The ontology is scoped around a few main top-level classes: Equipment, Material, Operation, Plan, Engineering, Organization, Area, Well, State, and Event and relations between these terms.

7 Process support

Statoil has rolled out Microsoft SharePoint as their portal framework. Each drilling well has a Web site (SharePoint) supported by an underlying document management system that tags all documents with the wells metadata.

The user interface of the system is implemented using Microsoft SharePoint Custom Web parts. This gives access to exchange services like tasks and email and metadata about the well.

8 Use of semantic technologies

AKSIO leverages the Semantic Web standards RDF and OWL for semantic annotation of experiences and to link information and experts to build a social and intelligent knowledge support for operations.

Structured information from relational databases and LDAP directories creates virtual RDF graphs to be queried by federated SPARQL queries.

Annotations and links to resources (information and people) are made in RDF and stored in a common Knowledge Resource Map using Jena

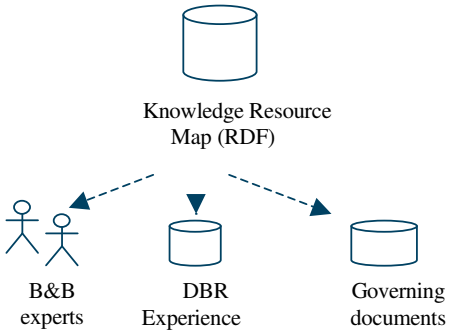

Fig.4. AKSIO knowledge base

Common metadata vocabularies like Dublin Core, Friend-of-a-friend (FOAF) are used to represent common concepts, a.k.a microformats, mixed with more complex structures. This allows for easy rendering of common features as events, business cards etc. in the user interface.

The drilling ontology shown above is implemented in OWL and serves as the basis for annotation.

A flat folksonomy tagging approach is also included to facilitate creation of new ontology concepts.

The drilling ontology and relations between terms within it serves as a reasoning engine for query expansion during retrieval. Various tactics, such as specialization, part-of etc. are used for ranking the results.Metadata is attached to the individual steps of the process, and in addition to login role-details the metadata is used as contextual data to automatic search execution (a.k.a pull) as well as to narrow the query results.

Results from the engine are presented with links to other resources by additional investigation of the ontology.

9 Socio-technical challenges

The socio-technical approach to knowledge management taken by AKSIO includes finding approaches to answer among others the following questions:

- Whose job is it to improve the quality of experiences, and how can we make this a more social process including the originating project, discipline advisors and end-users?
- Why is an ontology approach better than using mere keywords? And how can we include the stakeholders in establishing the required ontologies?

- How can we leverage contextual information, and existing metadata initiatives to increase search precision and improve recall?

10 Lessons Learned

The production use-case was run over a period of a month end of 2005 [3]. Results show that some 60% of the experiences added were marked as suppressed due to either incomplete information or only local relevance. Of the remaining experience reports, the AKSIO process involving specialist annotation resulted in significantly improved explanation, analysis, and recommendation for future practice.

The next pilot aims to show that a process driven approach in where the search is conducted by the context will discover useful experiences otherwise undetected. A drilling ontology will serve as the backbone for the search.

The problem described in this paper could possibly be solved with other technologies. However, we believe that using semantic web technologies will enable improved search as well as scalability for bridging the structured database world with the unstructured world of text and metadata.

11 Future work

The AKSIO project continues until 2007, and over the next year we will inclusion of other relevant structured and unstructured sources by federating the queries and query rewrite., look more into information extraction tools for annotation, and using Oracle 10g as the backend RDF store

We will also look more into the reuse of domain ontologies, documenting approaches for ontology development and scoping of these, and improved integration into work processes.

In a continuation prospect we will also look into a collaborative decision making process for integrated operations.

12 Conclusions

The AKSIO project is developing a process supported knowledge management system to support operations of offshore oilfields. The core functionality of the AKSIO system is provided by careful application of Semantic Web technology, including ontology-based annotation and contextual ontology driven retrieval of content.

Preliminary results show that by eliminating noise and precise annotation we have been able to improve the quality of the experiences applicable for cross-project reuse. Subsequent tests will show if we are also able to improve the use of search and the precision and recall for the searches, and thereby the ability to avoid million dollar mistakes in the future.

Acknowledgements

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References

1. Posc-Caesar Assosiation, http://www.posccaesar.org/
2. Integrated Information Platform for Reservoir and Subsea Production Systems Project (IIP), http://www.posccaesar.org/downloads/POSCCaesar_IIP.pdf
3. Semantic Support for Knowledge Recall in Integrated Operations, R. Fjellheim and D. Norheim, Semantic Technology Conference 2006, San Jose, CA, March 2006