

## **Knowledge Framework Implementation with Multiple Architectures - 13090**

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### **ABSTRACT**

Multiple kinds of knowledge management systems are operational in public and private enterprises, large and small organizations with a variety of business models that make the design, implementation and operation of integrated knowledge systems very difficult. In recent days, there has been a sweeping advancement in the information technology area, leading to the development of sophisticated frameworks and architectures. These platforms need to be used for the development of integrated knowledge management systems which provides a common platform for sharing knowledge across the enterprise, thereby reducing the operational inefficiencies and delivering cost savings. This paper discusses the knowledge framework and architecture that can be used for the system development and its application to real life need of nuclear industry. A case study of deactivation and decommissioning (D&D) is discussed with the Knowledge Management Information Tool platform and framework.

D&D work is a high priority activity across the Department of Energy (DOE) complex. Subject matter specialists (SMS) associated with DOE sites, the Energy Facility Contractors Group (EFCOG) and the D&D community have gained extensive knowledge and experience over the years in the cleanup of the legacy waste from the Manhattan Project. To prevent the D&D knowledge and expertise from being lost over time from the evolving and aging workforce, DOE and the Applied Research Center (ARC) at Florida International University (FIU) proposed to capture and maintain this valuable information in a universally available and easily usable system.

### **INTRODUCTION**

Knowledge is commonly distinguished from the data and information. Data represents observations or facts out of context, and is not directly meaningful. Information results from placing data within some meaningful context, often in the form of a message. Knowledge is what we come to believe and value, based on the meaningfully organized accumulation of information (messages) through experience, communication or inference. Knowledge is viewed both as an object to be stored and manipulated and as a process of simultaneously knowing and acting - that is, applying expertise. As a practical matter, organizations need to manage knowledge both as an object and a process.

According to G.D. Bhatt [01], the Knowledge Management process can be categorized into knowledge creation, knowledge validation, knowledge presentation, knowledge distribution, and knowledge application activities. To capitalize on knowledge, an organization must be swift in balancing its knowledge management activities. In general, such a balancing act requires changes in organizational culture, technologies, and techniques. A number of organizations believe that by focusing exclusively on people, technologies, or techniques, they can manage knowledge.

However, that exclusive focus on people, technologies, or techniques does not enable a firm to sustain its competitive advantages. It is, rather, the interaction between technology, techniques, and people that allow an organization to manage its knowledge effectively. By creating a nurturing and “learning-by-doing” kind of environment, an organization can sustain its competitive advantages.

Many knowledge management systems are built around independent business units which are not coordinated. Each independent organization has its own processes, business units and delivery channels. This results in the collection of isolated monolithic systems, using different platforms and standards that make it extremely difficult to access the right information at the right time. Organizations are unable to efficiently and effectively integrate information within their own domain. Legacy systems are restricted by the technological challenges and are not user friendly as they are dependent on rigid old business processes.

Knowledge problems in organizations as mentioned by V. Sambamurthy and M. Subramani [02] can be viewed as a combination of the problems of knowledge coordination, knowledge transfer, and knowledge reuse. These knowledge problems reflect difficulties with respect to the access, application, and sharing of knowledge within and across the firms. Knowledge coordination problems are linked to the difficulty of locating knowledge sources or identifying knowledgeable individuals or groups for the knowledge required to diagnose or solve specific problems. Knowledge transfer problems are linked to the complexity of transferring or obtaining the knowledge required to solve specific problems. Knowledge reuse problems are linked to the difficulty of ensuring the application of preexisting knowledge to situations when redeployment of prior knowledge fails; a fresh effort to develop novel knowledge is advisable.

The delivery of information from various repositories within the organizations and departments, which often have no regular or formal connections and communication, is error prone. Every department within the organization and across the geographical area implements their own business processes and knowledge distribution channels. In order to get the information, a user has to deal with a number of departments, units and the individuals that do not work together in an integrated way. With information technological innovations such as the web, mobile devices, tablets, and wireless communication, there is an opportunity to develop the knowledge framework and redesign the way many of the services are consumed and delivered. The main aim of this process is to move towards a knowledge framework of interconnected, easily available, efficient and reliable services. Every organization is making an effort to deliver the appropriate information at the right time in the most efficient and effective way.

Existing knowledge systems can be categorized into three different groups based on their characteristics. A Standalone Legacy environment is one in which systems are standalone old applications and often with paper based inputs and interfaces. These systems perform important functions that are vital for the organization. Very low levels of integration or interoperability are possible within these systems which often come from different IT companies like IBM, Oracle, Microsoft, Sun Microsystems, and Hewlett Packard, etc. The most important feature of this kind of system is that the business process is limited in scope to one or two applications. The execution process is controlled manually with interpretation of events and situations. Data is

usually stored in proprietary formats which are difficult to access and present synchronization problems.

An Integrated Legacy environment is one in which attempts are made to integrate the legacy systems. This involves creating a larger all embracing application that addresses a specific functional area and enables interoperability between the different areas. These are Business-to-Business (B2B) applications where one system interacts with another system. Large databases are merged together by removing structural differences and standards based data exchange capabilities are implemented.

Current systems are moved from a Business-to-Business (B2B) scenario to a Business-to-Consumer scenario. End users are connecting through virtual communities and turning to online knowledge resources. This is achieved through knowledge portals, unified communication systems, mobile devices and support centers. It is evident from the current systems that the data and knowledge is fragmented across multiple data centers and are not available to end users in an integrated form.

Advancements in Information Technology have lead to the development of a Service Oriented Architecture platform. Service oriented architecture [03] is the best development model for building distributed applications in the heterogeneous environment. It depends on passing messages between the services. A service is a program that performs a task and can interact through well-defined messages. A message consists of XML and includes a request to perform an action. The response from the service is also a message and consists of XML. Request and response messages conform to Simple Object Access Protocol (SOAP) standards. An application based on service oriented architecture consists of loosely coupled services that communicate through messages and contracts. Contracts [04] define the type of request that can be made to the service and how the service responds to the request message.

The SOA based knowledge framework is agile in nature and built on open standards. The services support seamless interoperability between the platforms and vendors. The entire knowledge framework is modular in nature, secure and highly scalable. SOA Based frameworks can act as an enabler for broader reach and improved quality and effectiveness of services. With architecture based on an SOA Knowledge Framework, systems are in an excellent position to offer easy and convenient access to the information and services. They are also able to reduce costs and resources required by legacy delivery methods.

XML Web Services [05] are fundamental building blocks for distributed computing over the Internet. Open standards and communication/collaboration among the applications have developed an environment where XML Web Services have become the platform for application integration. Applications are constructed using multiple services from various sources which work together seamlessly regardless of where they reside and how they are implemented. One of the main advantages of these services is that it allows programs developed in different languages and hosted on different platforms to interact with each other using open standards.

Figure 1 shows different business components of Service Oriented Architecture. It consists of different Service layers like Presentation Layer, Business Layer, Data Layer, Database and External Systems [06].

## Presentation Layer

The Presentation Layer interacts with end users. User Interface Components allows interaction between the application and the end user. User Interface components display data on desktop machines, smart phones, tablets, etc. User interfaces are implemented using ASP.Net Web forms, Windows client applications, and mobile browsers, etc. Their job is to format and display data, perform input validation, and display static and dynamic contents. User Interface Components interact with Business Process Components to ensure that the transaction is completed. This communication uses service oriented processes to complete the transaction.

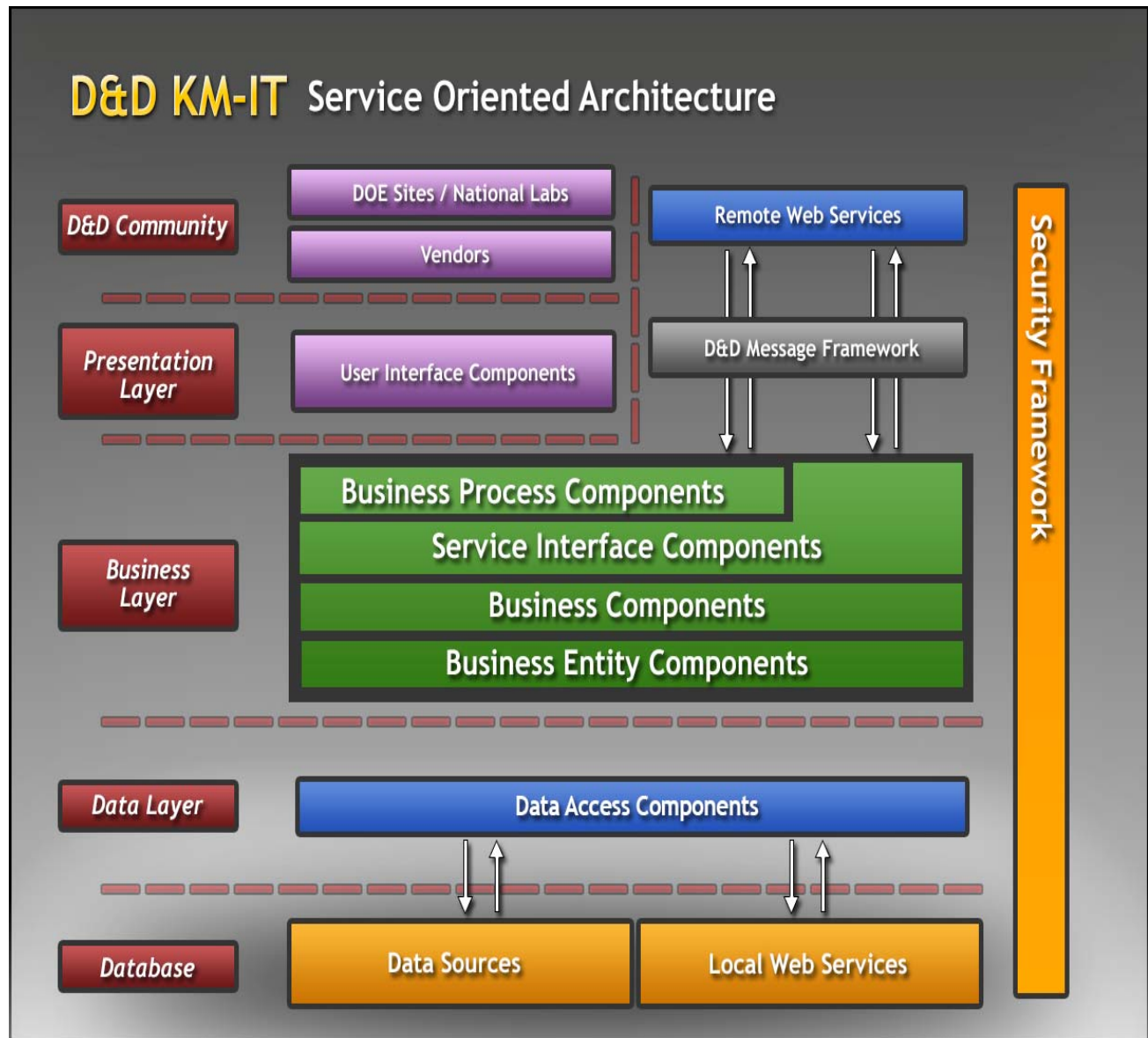


Fig. 1 D&D KM-IT based on Service Oriented Architecture

## **Business Layer**

The Business Layer performs consumption and publishing of business service. Various applications perform business tasks by implementing business logic using business rules, data validation, insert update and deletion of data, execution of various business processes, and making data and business functionality available to the businesses and consumers. The Business Layer consists of Business Components, Business Process Components, Business Entity Components and Service Interface Components.

Business components handle business rules, manage business data, and expose services to be used by business process components. Business process components can handle multiple step business process, initiating applicable functionalities in the right sequence and at the right time. They are also responsible for getting and saving the data at the correct stage of processing by communicating with business components, thereby providing the required data processing abilities and functionality.

There is a possibility that many business processes may take a longer time to run which requires the business process components to be aware of the status and should be able to respond, suspend, restart and roll back processes as the execution moves or is abandoned. It may be possible that the component may need to initiate other processes based on the status and condition of the workflow. The whole process is referred to as Orchestration.

Business entity components manage the movement of data between different business components. These work with the logical level and maintain the data model controlled by the business components. Service interface components expose the functionality of business components (business logic) and owned data of the business components (business entity) as a set of related services. Service Contracts are supported by describing the available data and functionality and the method for calling as well as the message format information, security restriction, access restriction, etc.

## **Data Layer**

The Data layer consists of Data Access Components and Service Agents. Data Access Components manage the writing and reading of the data to the database that is used to build the application. Data Access Components are responsible for data management and the business layer is unaware of physical data storage or any information associated with the storage. Data Access Component is responsible for logical and physical views of data. This process also helps to share data between various applications.

## **D&D Knowledge Management Information Tool**

The D&D Knowledge Management Information Tool (KM-IT) is a web-based tool custom-built for the D&D user community by the Applied Research Center (ARC) at Florida International University (FIU) in collaboration with the Department of Energy, the Energy Facility Contractors Group (EFCOG), and the ALARA Centers at the Hanford and Savannah River Sites.

D&D KM-IT serves as a centralized repository and provides a common interface for all D&D related activities. The main purpose of this process is to improve efficiency by reducing the need to rediscover the knowledge and to promote reuse of the existing knowledge. D&D KM-IT is a community driven system. It facilitates the sharing of knowledge within the D&D community by gathering, analyzing, storing and displaying D&D related information.

D&D KM-IT has the ability to define, store, categorize, index and link digital information corresponding to D&D problem areas. The system has the ability to allow users to search for and subscribe to relevant content and presents the content with sufficient flexibility to render it meaningful and applicable across multiple contexts of use.

Too frequently, people in one part of the D&D community “reinvent the wheel” or fail to solve problems quickly or in an optimum fashion because, while the knowledge they need may exist elsewhere, it is not known or accessible to them. This knowledge management tool helps to enhance collaboration and knowledge sharing while building upon the D&D knowledge base within the EM’s D&D community. As the generational cycle of the D&D cleanup progresses into the future the knowledge pool and its best practices for D&D applications will expand.

D&D KM-IT promotes knowledge innovation where new knowledge will be created and converted into valuable goods and services. This tool provides an environment where creativity and learning will flourish and knowledge will be encapsulated in a form that can be applied.

D&D KM-IT aims to get the right content to the right people at the right time and in the right form. It uses the World Wide Web as the primary source for content in addition to information entered by the subject matter specialists and the D&D community.

In this paper, FIU ARC will present the various new modules added to D&D KM-IT in fiscal year 2012-2013 that are designed to capture information from the D&D community and build the knowledge base for future use.

## **MATERIALS AND METHODS**

The requirement from DOE Headquarters was to develop a repository and a dynamic system that will make excellent use of the knowledge that exists within the D&D community by allowing D&D project managers around the DOE complex to share innovative ideas, lessons learned, past experiences, and practices.

D&D KM-IT is being developed and deployed in multiple phases, providing solutions to the D&D problems, sharing best practices, a specialist directory of D&D experts, customized web searching, technology solutions, etc. It is a centralized high-end knowledge repository where D&D scientists and engineers can search for information related to their field of expertise.

The underlying system and information technologies provide a shared conceptualization to describe people, processes and content. They provide a semantic framework from which information can be harvested, modeled, published, retrieved, used and shared. The next generation of information technologies is being used to create, manage and extract value from their knowledge assets and to integrate these technologies to create a complete approach to the knowledge life cycle.

As there was no off-the-shelf computer application or integrated solution available for building the D&D knowledge base, ARC has built an approach that is servicing the DOE complex with a, high performance, n-tier web-based system for capturing the information from the DOE sites/facilities, EFCOG and the D&D community as a whole.

This system was built using Microsoft.net framework®, SQL server 2008®, and SQL server reporting services®. Visual Studio 2010™, Dream Weaver® and Photoshop® were also used as development tools to construct the system.

## **RESULTS AND DISCUSSION**

D&D KM-IT can be accessed from the web at [www.dndkm.org](http://www.dndkm.org). The system home page, shown in Figure 2, provides the interface to connect to the various components of D&D KM-IT. The D&D KM-IT home page was completely redesigned and given a fresh look to address the needs of U.S. and international D&D community members.



**Fig. 2. D&D KM-IT website home page**

D&D knowledge management is the overall strategy, approach or philosophy followed to build the D&D KM-IT, which is the information tool integrating knowledge management in the D&D area. The following are the new components or modules of D&D KM-IT that were successfully developed and deployed in fiscal year 2012-2013:

- Global Search
- Multiple SMS Support for Hotline
- Dictionary Module
- Mobile System for Picture and Technology module



## GLOBAL SEARCH

Global search is deployed on the home page which searches through all the modules of the D&D KM-IT. In order to deploy global search, the D&D Web crawler is used on the home page which is customized to search through all the modules of KM-IT based on the entered keywords and display search results in a well formatted screen. Global Search can be accessed from the home page – top right area of the screen. This search feature is also available on all other pages as well as modules.

The screenshot displays the D&D KM-IT Global Search interface. At the top, the logo 'D&D KM-IT' is visible, along with the text 'Knowledge Management Information Tool'. A mobile version link 'Mobile: m.dndkm.org' and a search bar with a 'Search' button are also present. Below the logo, there are navigation links for 'Home', 'About', and 'Contact Us', and a 'Welcome Guest' message with a 'Login' button. The main content area features a search bar with the text 'Search' and a yellow arrow. Below this, the search results are displayed under the heading 'D&D KM-IT Global Search Results: "Fixatives"'. A search form is shown with the text 'Search for' and a search button. The search term 'Fixatives' is entered in the search box, and the search type is set to 'all of the words'. The sort type is set to 'hits'. Below the search form, the search results are displayed under the heading 'Search Results'. The request is 'Fixatives' and 226 document(s) were retrieved. The results are shown in a table with columns for 'Score' and 'Document'. The first result is 'Whirly nozzle for applying fixatives' with a score of 100% and 7 occurrences. The second result is 'List of Fixatives' with a score of 99% and 4 occurrences.

Score	Document
100%	<b>Whirly nozzle for applying fixatives</b> Occurrences: 7
99%	<b>List of Fixatives</b> Occurrences: 4

Fig. 3. Global Search.

## MULTIPLE SMS SUPPORT FOR HOTLINE

The previous Hotline module supported one subject matter specialist for all the D&D areas and one content coordinator to review all the content before publishing. Under this task, primary subject matter specialists will be identified for each of the 4 D&D areas (characterization, decontamination, dismantlement/material disposition, worker safety). Email notification is sent to the primary SMS when a question is posted in their D&D specific area. The Subject Matter Specialist reviews the question and sends email to registered SMSs through multiple SMS automated emailing process from the hotline module. Once a response is received, it is reviewed and published in KM-IT. Solutions posted on the hotline module get associated to the SMS who provided the solution.

## DICTIONARY MODULE

This new module acts as a data dictionary for D&D terms. Using D&D KM-IT web statistics (Google Analytics), FIU identifies popular search keywords used by the D&D community on the KM-IT system and terms identified by subject matter specialists and develops dynamic web pages defining these terms as well as providing detailed information. This acts as a source of D&D related terms and the information is captured by DOE Fellows (FIU students participating in the FIU-DOE Workforce Development Program) using D&D publications, the Web and other resources.

The screenshot displays the D&D KM-IT Knowledge Management Information Tool interface. At the top, the logo 'D&D KM-IT' is prominent, with 'Knowledge Management Information Tool' underneath. Navigation links for 'Home', 'About', and 'Contact Us' are visible. A search bar with a 'Search' button is located in the top right. Below the navigation, a menu bar includes 'Training', 'Classroom', 'Certification', 'Videos', 'Documents', 'Conferences', and 'Dictionary'. The main content area is titled 'D&D Dictionary' and features an alphabetical index from A to Z, with 'View all' at the end. Three dictionary entries are shown: 'Acid Digestion', 'Administrative Record', and 'Agreement State', each with a brief description and a 'Continue Reading' button.

Fig. 4. D&D Dictionary.

## MOBILE SYSTEM

In the past, access systems in telecommunications or computer networks were mainly based on fixed wired access, making the device immobile. The introduction of wireless access technologies allowed a higher degree of mobility. This enables users to communicate or to transfer data independent of their current location or their movement. A second important aspect was the removal of cumbersome cables from the network system on the client side. Wireless access focuses on bi-directional connections between the user's wireless device and a counterpart on the network side.

The mobile system for D&D KM-IT will provide access to important features of the system through wireless devices. The D&D community users can access the hotline, technology information, specialist directory, lessons learned titles, news/alerts, announcements, event calendars, and vendor information on their wireless devices. This list can be expanded based on the additional modules or features added to the D&D KM-IT system. Figures 5 and 6 illustrate the mobile systems.

### Technology Lite

The Technology Lite application allows searching of technology information based on the search string provided by the user on the mobile device. The search process uses the search string as a keyword and searches through the technology and demonstration database of D&D KM-IT. It returns technology titles matching the search criteria in a summary format. Technology names are displayed in the list format and the user can click on the technology link to obtain a summary of the technology.

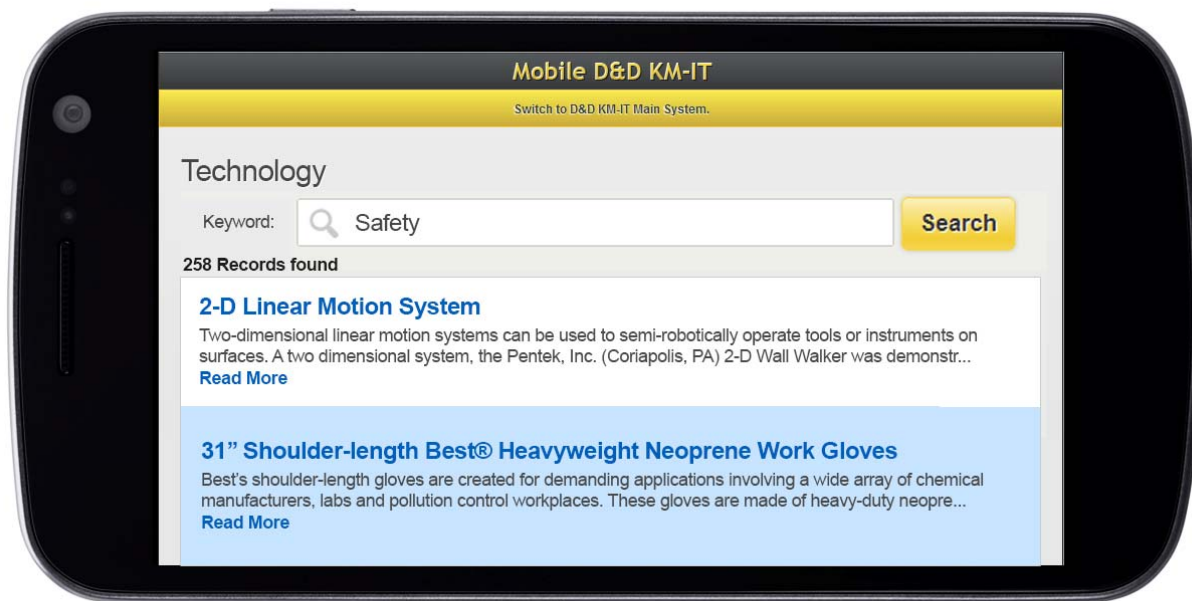
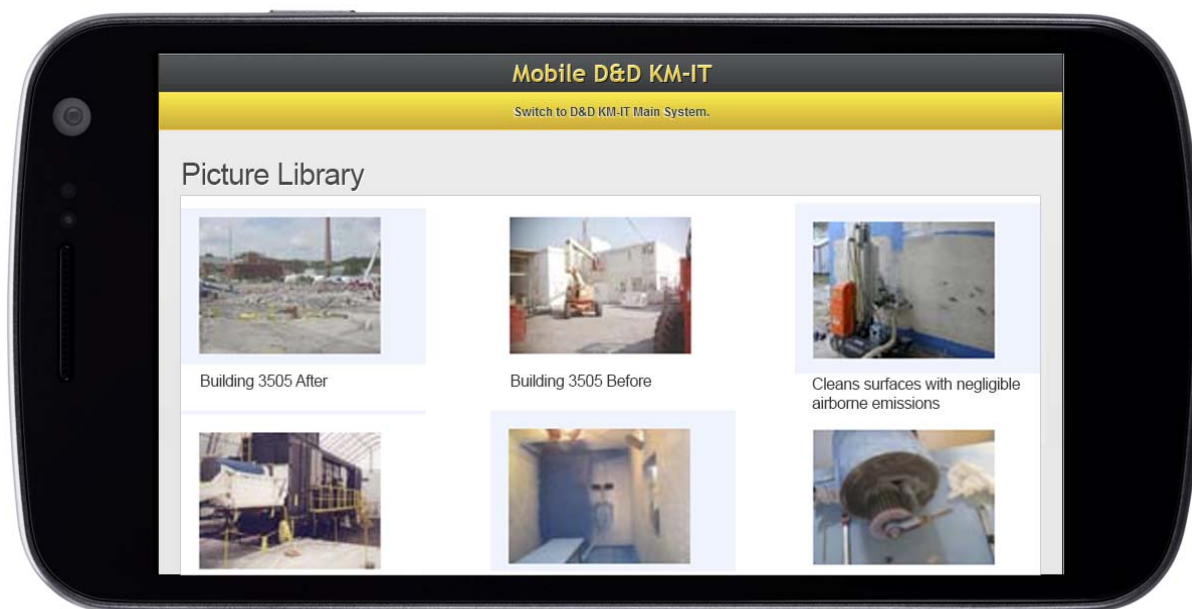


Fig. 5. Technology Lite module on mobile system.

## Picture Lite

Picture Lite is a mobile application that allows community users to search technology and demonstration pictures through mobile devices. The Picture Lite includes pictures of past and present D&D projects. It can support GIF (graphics interchange format), JPEG (joint photographic experts group), PNG (portable network graphics) formats. Pictures on the mobile device are displayed as thumbnails and viewed as a slideshow.



**Fig. 6. Picture Lite module on mobile system.**

## CONCLUSION

D&D KM-IT has mixed architecture where some modules are built on n-tier architecture and other ones are developed using service oriented architecture. The system is being migrated to service oriented architecture in future developments.

D&D KM-IT provides single point access to all D&D related activities through its knowledge base. It is a community driven system. D&D KM-IT makes D&D knowledge available to the people who need it at the time they need it and in a readily usable format. It uses the World Wide Web as the primary source for content in addition to information collected from subject matter specialists and the D&D community. It brings information in real time through web based custom search processes and its dynamic knowledge repository.

Future developments include developing D&D information access on mobile devices for the additional modules and data/ content management. The goal is to deploy a high-end sophisticated

and secured system to serve as a single large knowledge base for all the D&D activities. The system consolidates a large amount of information available on the web and presents it to users in the simplest way possible. KM-IT is planned to expand to other environmental management areas like Soil and Groundwater and High Level Waste.

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