A Conceptual World Information Library (WIL) and Land Use Information System (LUIS) – 16181

Russell Patterson*, Mindy Toothman**, John Callicoat***, Tom Klein****
*U.S. Department of Energy, Carlsbad Field Office, Russ.Patterson@cbfo.doe.gov
575-234-7457
**AECOM, Professional Solutions, Mindy.Toothman@wipp.ws, 575-234-3223
***AECOM, Professional Solutions, John.Callicoat@wipp.ws, 575-234-3235
****AECOM, Professional Solutions, Thomas.Klein@wipp.ws, 575-234-3205
4021 National Parks Highway
Carlsbad, New Mexico 88220

ABSTRACT

The Organization for Economic Co-operation and Development Nuclear Energy Agency initiative on the Preservation of Records, Knowledge and Memory is addressing the topic of communicating with future generations on the location, specific contents, and potential risks associated with deep geologic nuclear waste repositories. At the Waste Isolation Pilot Plant (WIPP) in the United States, the U.S. Department of Energy (DOE) has committed, prior to the facility closure, to develop a Passive Institutional Controls (PICs) program designed to last as long as practicable. A portion of this PICs program includes development of records packages, selection of data storage materials and methods, and a determination of records retention/storage locations. The approved plan for record retention at WIPP includes the storage of information including hard copies of data, figures and maps in multiple libraries and archive record centers. With this in mind, it is easy to envision reams of various paper documents in a robust physical archive record center similar to one of the museums in Washington D.C., or DOE's Legacy Management facility in Morgantown, West Virginia.

While some portion of records for nuclear waste burial sites should be maintained in this fashion for near-term retrieval purposes, it is widely accepted that this is not an efficient way to communicate with future generations even 1,000 years from now. Transmitting large detailed volumes of information to the future should be captured in an electronic format; maintained on computers, translated by computers, and perhaps updated by artificial intelligence as machine and human languages change over the centuries.

In addition to a physical records development and storage process for transmittal to future generations, a web-based electronic database system should be developed. A World Electronic Library (WEL) database could be funded from various nations and perhaps sanctioned by the United Nations and/or the IAEA. This WEL could contain information regarding several different subjects with the intent of being a one-stop-information-shop for future generations. This database would require updates and maintenance for as long as there is a recipient.

One subset of the WEL would be a spatial database containing all the information available to any set of GPS coordinates, anywhere within the world. This Land Use

Information System (LUIS) database would contain information on past and present land use, natural resources, known geology, hydrology and atmospheric conditions, potential warnings, and other pertinent information. The LUIS database is where specific electronic information, a subset of all the records data gathered for a nuclear waste repository, could reside. For not only would LUIS provide the information on a nuclear waste repository when specific GPS coordinates were entered; but a search from the LUIS on "Nuclear Waste Repositories" could bring up information, including data on location of repositories, radionuclides, operations, D&D, maps, and regulations, plus many other details for locations throughout the world. This tool could be used by future generations for a number of land use or resource exploration decisions.

So what can we do now? We can agree to the types of information that should be captured into an electronic database for nuclear waste repositories. We can agree to the levels of detail, the file names and the formats, for ease of combining information sets in the future. Perhaps we can agree to a central electronic data storage site, or sites, where this information will reside for import into a centralized electronic record system, if one is ever developed.

INTRODUCTION

The Organization for Economic Co-operation and Development Nuclear Energy Agency (NEA) initiative on the Preservation of Records, Knowledge and Memory (RK&M) is addressing the topic of communicating with future generations on the location, specific contents and potential risks associated with deep geologic nuclear waste repositories. At the Waste Isolation Pilot Plant (WIPP) in the United States, the Department of Energy (DOE) is required by Title 40 CFR Part 191.14(c) and Title 40 CFR Part 194.43 to develop a Passive Institutional Controls (PICs) program designed to last "as permanent as practicable" prior to the facility closure [1]. Portions of this PICs program include the development of records packages, selection of data storage materials and methods, and a determination of records retention/storage locations. The current plans for record retention at WIPP include the storage of information, which includes hard copies of data, figures and maps in multiple libraries and archive record centers. These hard copy records could easily consist of reams of various paper documents; and perhaps metal cabinets full of microfiche, in folders, stored in a robust physical records archive center in accordance with the best practices in archival science.

While this plan is good for the near-term, indeed some records for nuclear waste burial sites should be maintained in this fashion for near-term retrieval purposes, this is neither an efficient nor effective way to communicate with future generations over the long-term. With current archival technology, high quality paper and ink may be legible for several hundred years and microfiche for perhaps 500-600 years under ideal conditions [2]. For any hope of communicating medium to large, complex volumes of information to the future, other than a basic message such as "this is a dangerous place" (Skull and crossbones symbol); or "something took place at this site" (Stonehenge), the records packages that provide the detailed information will have to be captured in electronic format; stored in computers,

translated by computers, and perhaps updated by artificial intelligence as machine and human languages evolve over the millennium.

The complete records for a nuclear waste repository, and/or any sort of hazardous waste facility and disposal location will be too voluminous and contain much more information than is necessary for the basic future reader to discern the history and significance of the location. To ensure that this basic message is transmitted to far-future generations, a specific subset of the records data should be electronically captured, updated and maintained.

A Concept

This generation is hooked on, and relies on, the ability to have electronic information at their fingertips. This was recently illustrated by a story of three young ladies from Wisconsin lost in the northwest Wyoming wilderness area, and commenters stating “Didn’t Google maps work”, “Didn’t they have cell phone service” and, “There is a compass App you know [3].” In the near future, we can expect this dependency to only get stronger and manifest at a younger age, as evidenced by my 3 and 5 year old granddaughters fighting over the tablet computer so they can watch their favorite cartoons. As we have already witnessed, individuals Bing® or Google® search the tourist attraction they are standing in front of, using their phone, and read the story behind what they see. This is the new norm.

In the near future (next 200-300 years) an individual will expect to obtain information regarding the strange symbol on the metallic disc they picked up during a hiking trip; or the large cement structure design seen on the Google Earth™ mapping service, using their electronic computing device. This is conceptually where the Waste Repository Information Database (WRID) becomes a valuable resource. The WRID would be an electronic data set that contains a subset of the information available about Nuclear Waste Repositories. A public access link to the WRID could be added to the future RK&M Wikipedia page. This subset would consist of information such as; location (maps), depth to waste, types of waste, symbol identification and meaning, plus other information that the general public may want with pointers or links to additional detailed data. The WRID could be developed through the IAEA/NEA/RK&M initiative, with agreed upon data types, input sets, software codes, and electronic platforms. Easy digital access to information based on specific geographic locations is already the expected norm, and for waste repositories, the WRID could serve to provide that functionality to the future.

In a future scenario that involves a hypothetical post-apocalyptic world, impacting survivors on a local, regional and global scale, survivors will recall their past lives and will be looking for ways to rediscover lost knowledge and technology that could help them survive and rebuild. In addition to a physical records development and storage process for the communication of information of high-importance to future generations, a web-based electronic database system will be needed. A world information library database should be constructed with funding from various nations and perhaps sanctioned by the United Nations and/or the IAEA. This World

Information Library (WIL) would contain searchable information regarding subjects such as; medicine, agriculture, wildlife, and many others. This data bank would be a one-stop shop for future generations to review and learn from or a source for post-apocalyptic generations to rediscover lost knowledge and technology that could help them survive and rebuild. This database and its associated hardware, as with all the databases that are proposed in this paper, would need to be updated and maintained for as long as there is someone that uses them either by human hands and minds or artificially intelligent machines.

One subset of the WIL would be a geographic information system (GIS) containing multiple spatial databases that would represent all the information available for specific Global Positioning System (GPS) coordinates, anywhere within the world. This GIS would be called the Land Use Information System (LUIS) and would contain information on past and present land use, natural resources, known geology, hydrology and atmospheric conditions, potential warnings, and other pertinent information. A future explorer, developer, seller, buyer, regulator or individual could simply plug in GPS coordinates and the LUIS would provide detailed information available at that location or surrounding locations up to a proposed 1kilometer radius. However, even this proposed small radius can present a potentially unmanageable amount of information for the future if, for example, the geology and hydrology varies significantly within the 1 kilometer radius.

In this vision, a hypothetical explorer in the year 2355 would input a location, for example GPS coordinates of WIPP and ask LUIS for the information, in whatever language is used at that time. The LUIS search would return the following critical information, “This is the location of a nuclear waste repository, operated between the years 1999 and 2155 by the United States Department of Energy 650 meters (2150 feet) below the land surface. For more information click here. Petroleum reserves in this area were located from a depth of 2360 to 2740 meters (7750 to 9000 feet). All petroleum reserves within 1 km were removed through various extraction techniques in 2026. For more information click here. Additional data ….” This tool could easily and effectively be used by future generations to make land use or resource exploration decisions.

The capabilities of this GIS are of particular interest and potential use for nuclear waste disposal facilities. The LUIS would be a user-accessible outgrowth of the WRID, and would contain all the information in the WRID as a subset of all the records data associated with land use. Not only could LUIS provide the information on a nuclear waste repository when specific GPS coordinates were entered, but a search of LUIS on “Nuclear Waste Repositories” could bring up relative information including the locations of repositories, disposed radionuclides and hazardous waste, operational history, deconstruction & decommissioning, maps, regulations, and many other details for locations throughout the world.

Concept Practicality

As you can see, the development of these databases will be a monumental task, with numerous parts, questions, concerns and input from multiple organizations

and countries to be considered and implemented. As with any task of this enormity, it is recommended to start small, take measured steps within a localized area, address lessons learned, and finally model the information for implementation on a larger, world-wide scale. The RK&M initiative or a committee commissioned by the RK&M initiative could decide the types of information to be gathered from nuclear waste repository projects for inclusion in to a database, the computer software to be used, the hardware location(s), the QA requirements and maintenance of electronic storage, the template designs, forms and other such items. This may take several years, but we can start now, by agreeing to the concept, and developing a list of data to be captured. Examples of data sets to be incorporated into the WIL is provided in Figure 1 below:

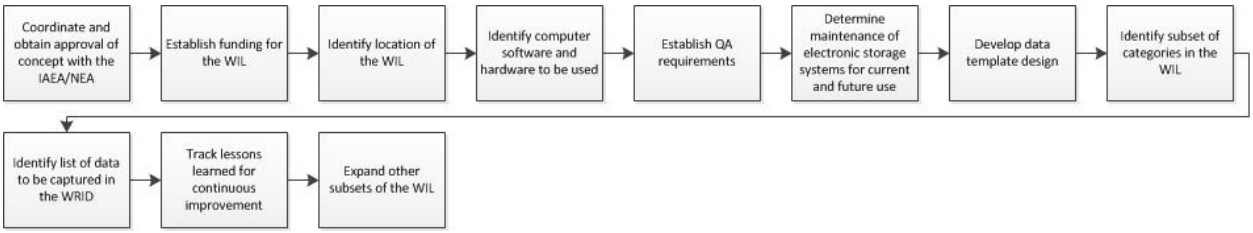

Figure 1 Flowchart of Information to Develop the WIL

Each country and organization associated with the RK&M initiative may have information that has been gathered by repository operators/developers, regulators and other scientific entities which could be assembled into the WRID system. Once the WRID system is developed and populated with information and the computer hardware, software, and storage of data has been initiated; then we can initiate the second step, build the LUIS.

A large component of the information for LUIS already exists online in the Geographical Information Systems record systems. In the United States, land use information on properties can be found in United States Geological Survey files, individual state natural resource or land use records, and/or county/local property records information. Most of this data may be electronic; however, some may only be available in paper form. Given the charters to do so, an entity with the financial and political backing of multiple governments could develop LUIS for each country in the world, or at least for each IAEA member country. This is not an easy, short-term, or quickly developed database; but one which will take multiple years, multiple organizations, and long term support and funding to complete. Or perhaps a community of GIS professionals would be the right resource to compile information and government officials could verify accuracy.

The LUIS and the WIL could both technically be developed using the same process and methodologies, and in fact could be developed concurrently by the same team of international technical experts. Politically, both databases would take a multinational, multi-government agreement to the types of information to be gathered and shared with the rest of the world.

Proposal

We propose to start by agreeing to the development of the WRID. The WRID is a building block for the LUIS, which in turn will feed into the WIL, as shown in the Figure 2 below.

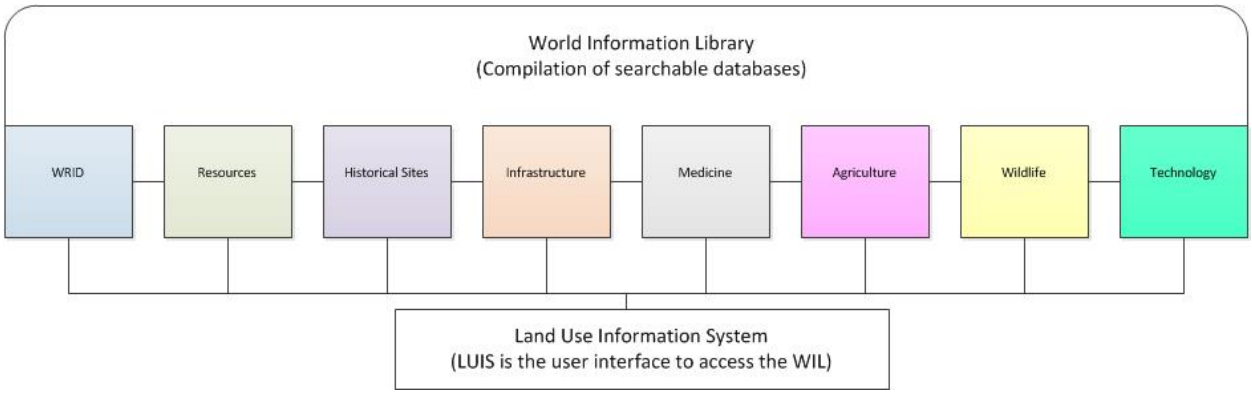

Figure 2 Structure of the World Information Library

A feasible start to begin development is to agree on the types of information that should be captured in an electronic database for nuclear waste repositories. The types of information could be drawn from what RK&M has already done during "Scoping of the Issue" in Phase 1 [4]. We can agree to the levels of detail, the file naming conventions and the file formats, for ease of combining information sets in the future. Perhaps we can also agree to an electronic data storage site, or sites, where this information will reside for import into a centralized electronic record system, if one is ever developed. Essentially unprecedented amounts of long term data storage would be needed, which could come with a significant price tag. However, if technology such as the "molecular computer" was available or come available in the near-term, the servers could last essentially forever without data corruption. A "molecular computer" is made of organic molecules, has the ability to heal itself, just like brain cells and is able to regenerate to some extent [5].

CONCLUSION

In a future world, an explorer, hiker, land developer, or just a curious person will see a symbol on a monolithic stone, an architectural anomaly, or strange shape on a map. This individual will enter the coordinates into an electronic device and all the most relevant information for the location, perhaps a nuclear waste repository, will be available. This information will be available through the Waste Repository Information Database (WRID) developed by the RK&M initiative. The WRID contains site specific information on nuclear waste repositories and is tied to a centralized GIS for location information. It is a subset of the Land Use Information System (LUIS) database and is a part of the overall World Information Library (WIL) that will be developed by the United Nations and the IAEA Member Countries as a resource for the future of all of human kind.

Does this sound like science fiction? Perhaps it does. Sixty years ago, before the advent of cell phones and when computers took up the entire basement of universities, Dick Tracy, an American comic character, spoke into his watch. While this was advanced technology at the time, we now have smart watches such as the Apple Watch®.

This is a concept. Development of the World Information Library (WIL) or the Land Use Information System (LUIS) would require multinational funding, support, cooperation, and collaboration over several years. However, development of the WRID, through identifying needed information and developing an interface to access information can commence immediately. Lessons learned from the WRID development can be shared with the RK&M Initiative for implementation on the larger WIL and LUIS scale.

REFERENCES

1. United States Federal Register 40 CFR Part 194 - Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations, February 9, 1996.
2. Passive Institutional Controls Implementation Plan, August 19, 2004.
3. http://www.nbc15.com/home/headlines/3-Wisconsin-sisters-missing-in-northwest-Wyoming-312608641.html
4. https://www.oecd-nea.org/rwm/rkm/
5. http://www.gizmag.com/organic-molecular-computer/15041/