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ENVIRONMENTAL DATA MANAGEMENT AT FERNALD

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What is Fernald?

The U.S. Department of Energy's Fernald site is located about 20 miles northwest of Cincinnati, Ohio. Fernald produced refined uranium metal products from ores between 1953 and 1989. The pure uranium metal was sent to other U.S. Department of Energy (DOE) sites in South Carolina, Tennessee, Colorado, and Washington in support of the nation's strategic defense programs. Over the years of large-scale uranium production, contamination of the site's soil and groundwater occurred. The Fernald site was placed on the National Priorities (Superfund) List in 1989. Production was suspended in July of 1989, and Fernald's mission has been changed to one of environmental restoration.

The Information Challenge

FERMCO, the Fernald Environmental Restoration Management Corporation, is DOE's contractor for the safe shutdown and cleanup of the Fernald site. FERMCO, a wholly-owned subsidiary of Fluor Daniel, Inc., of Irvine, California, includes Jacobs Engineering Group Inc., Brown and Root Environmental Corporation, and Nuclear Fuel Services as principal subcontractors.

FERMCO supports DOE's ongoing initiatives for the continuous improvement of site restoration through the development and application of innovative technologies. A major thrust of FERMCO's efforts has been the enhancement of environmental data management technology for the site. The understanding of environmental data is the fundamental basis for determining the need for environmental restoration, developing and comparing remedial alternatives, and reaching a decision on how to clean up a site. Environmental data management at Fernald is being focused on two major objectives: to improve the efficiency of the data management process, and to provide a better understanding of the meaning of the data at the earliest possible time.

Data Management

Environmental data at Fernald is typically a soil or groundwater sample collected by one of our field geologists. These samples are then shipped to one or more laboratories for analysis. After the analyses are returned from the laboratories the data are reviewed and qualified for usability. The data are then used by environmental professionals for determining nature and extent of contamination. Additionally, hazardous waste materials whether generated during production or during cleanup, may be sampled to characterize the waste before shipment or treatment. The data management process, which uses four major software systems, is presented graphically in Figure 1.

Laboratories at Fernald use either the FACTS or ANALIS system for reporting analytical results and tracking sample status. The FACTS system will completely replace the older ANALIS system by the end of 1994. FACTS is based on a commercial system, SQL*Lims purchased from P.E. Nelson, using the Oracle relational database. FACTS runs on our VAX 7620. The older ANALIS system also runs on our VAX system and is written in VAX Fortran.

The primary repository for analytical data is the Sitewide Environmental Database, or SED. The SED accepts electronic data transfers (EDT) from off-site laboratories and the FACTS and ANALIS systems. This system also provides double key data entry screens and a wide variety of reporting tools. The SED is the primary database used in the development of Remedial Investigation and Feasibility Study (RI/FS) documents at Fernald.

We currently keep track of our hazardous materials and wastes using a number of separate systems; these systems will be replaced by a single Oracle-based system, called SWIFTS, by the end of this year. The primary inventory program for containers of waste is the All Materials Inventory and Tracking System (AMITS), written in COBOL and running on a HP-3000. A separate PC based system, called "MEF" is currently used to maintain the waste characterization database. Phase I of the SWIFTS implementation focuses on reconciling the waste inventory database with the characterization database. Phase II, already under way, focuses on the data modeling and integration using a central Oracle database. Haz-Trak is our program for tracking hazardous materials on site and is used to generate SARA reporting. Haz-Track is also being integrated into our single Oracle-based system, SWIFTS.

Professionals at Fernald access our environmental data via a PC network of approximately 2000 PC's. This wide-area network of IBM compatible PC's, Intergraph workstations, and Novell based servers allow users to share data, reports, and drawings generated on by any of our environmental applications.

Intergraph's CAD and GIS software are used at Fernald for superimposing analytical data with other types of spatial data, like maps of land use or CAD drawings of process piping or utilities. The results of groundwater modeling or isopach analysis can be easily overlaid over site maps to develop an understanding of the results in their geographic context. For example, we routinely, (1) produce isopachs delineating areas on which fill material has been placed, (2) superimpose this over plots of soil contamination using MGE, and (3) combine this with an aerial photograph from a time period of interest using Intergraph's IRAS 32 software for working with scanned raster images. This integration of differing data products allows us to better understand the sources of contamination, the extent of contamination, and impacts on the environment. Furthermore, we have found it an extremely effective communication tool in both

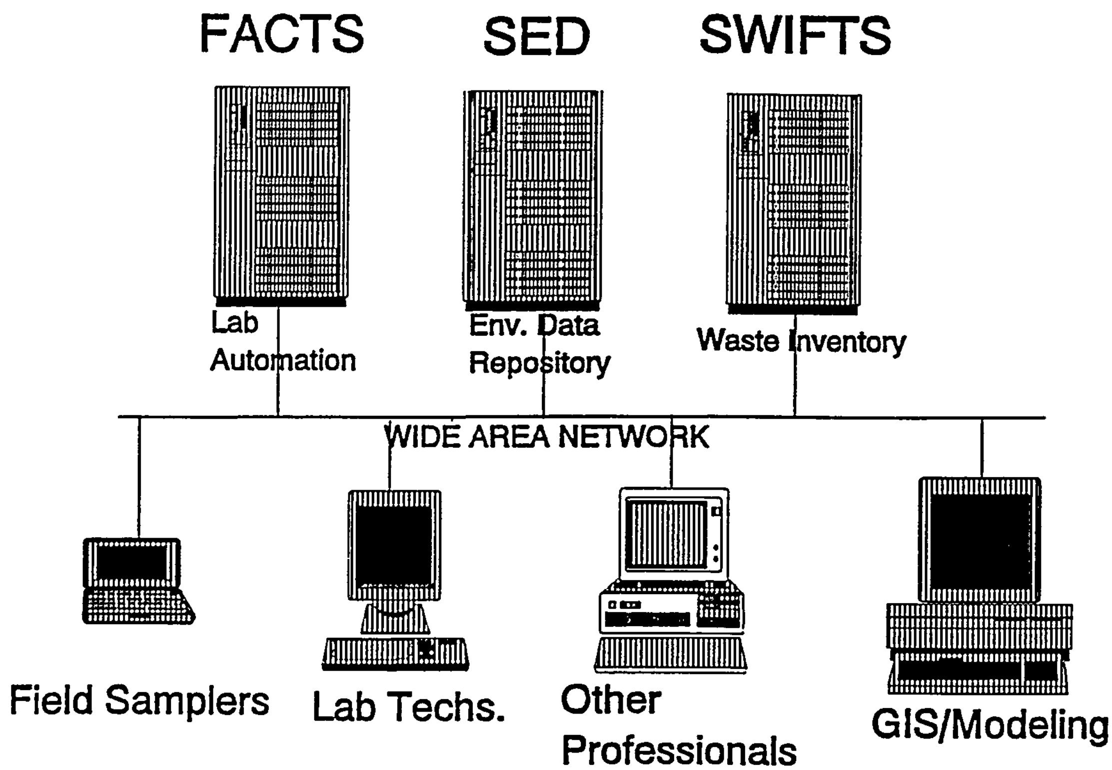

Figure 1 Schematic of Environmental Systems

presentations and reports.

One of the real success stories at the Fernald site has been the use of Intergraph's MGE Voxel Analyst (MGVA) software for developing and visualizing three dimensional models of subsurface contamination. Once a 3-D model has been created, usually from the soil or groundwater samples, the real power of MGVA becomes apparent. The application of this technology at Fernald is called Solid Block Modeling. A variety of display tools are available to peer into the model, such as:

- Chair diagrams ... Blocks of the model representing contamination with a notch cut out of one corner.
- Sections through the model at any orientation.
- Iso-surfaces ... Three-dimensional surfaces of constant value for one attribute, the 3-D equivalent to contours in 2-D modeling. This can be visualized as a three-dimensional "blob" of contamination, for example.

We routinely use this product to model the extent of subsurface soil contamination and to compute estimates of the volume of contamination. Since MGVA does not directly access our analytical database, we are using Intergraph's DBACCESS and RIS to extract Oracle data files as input for the modeling process.

Applications to the Superfund Process

The Superfund process has been ongoing at Fernald since 1989. In October 1992, two months before FERMCO was awarded responsibility for the cleanup, the Remedial Investigation (RI) Report for OU-2 was submitted to the EPA and Ohio EPA. On December 15, 1992, two weeks after the transition to FERMCO, the EPA's disapproved the OU-2 RI Report, finding that the nature and extent of contamination had not been sufficiently determined in order to assess whether or not remedial action would be required, and that the collection of additional field data would be necessary.

The Superfund process at Fernald is governed by a Consent Agreement, which stipulates significant penalties for delays in completing required documentation, specifically including RI Reports. Therefore, it was imperative that the RI be completed in the shortest possible time. Successful resolution of the issues required the rapid acquisition and management of environmental data to: (1) identify all significant data gaps in the original RI Report, (2) design a Phase II Field Investigation Work Plan to eliminate the data gaps, (3) obtain regulatory agency approval of the Work Plan, and (4) review ongoing data collection and interpretation efforts in real time to ensure that the field investigation objectives are being met.

Fernald's approach to meeting these needs was to fully integrate Solid Block Modeling into the project planning and execution process. Data from the October 1992 RI Report, including geology, lithology, topography, hydrology, and contaminant data, were used to create a color coded, three-dimensional Solid Block Model of OU-2. The model was used to identify and visualize data gaps in the existing study, e.g. what was the relationship between observed uranium contamination in soil to present and future uranium contamination in the underlying aquifer?

It was then relatively straightforward to determine the position for the necessary samples, (surface samples, soil borings, groundwater samples, etc.), and they could be visually represented in their proper location, orientation, and physical scale. Thus, we were able to create and display the key elements of the Work Plan directly within the Solid Block Model. The Work Plan was presented to the regulatory agencies in January 1993 using an Intergraph workstation and large screen projection monitor to display and manipulate the Solid Block Model. We received immediate verbal approval and notice to proceed with the Phase II Field Investigation during this presentation!

As data from the OU-2 phase II investigation became available it was entered into the Sitewide Environmental Database and used to periodically update the Solid Block Model. Hence we were able to visualize our improving understanding of the site and evaluate progress in eliminating data gaps while field work was still in progress. Subsequently, the Solid Block Model and supporting software were used to prepare maps, engineering drawings, cross-sections, and contaminant volume calculations that were used in the RI and FS Reports without modification.

After completion of the phase II field work, the model was used to present the results and conclusions of the RI Report to regulatory agencies and the public. Use of the Solid Block Model as a communications tool has been very well received. In a sense, the five-volume, 3,500 page RI Report can be represented, with improved understanding, in a one-hour, computer-based presentation.

Lessons Learned

The application of sophisticated database and data visualization technologies, when made in integral part of the project planning and execution process, can save significant time and money, and can provide real analytical and communications benefits. Effective applications will require a shared, centralized, environmental database for successful coordination of the many different projects that must all use the same data. However, there is increased "overhead" in having to communicate between different groups working with overlapping data sets. Likewise, large relational databases require powerful, and therefore expensive, computer installations and a sophisticated support staff as well.

Issues of data ownership -- who is responsible for the data in your database -- must be resolved at the earliest possible stage in the project. Customer/user groups can only be responsible if their data is NEVER used by other customer groups, or else other users are locked in by the decisions made by the first customers.

Standards and procedures vary over time. This is particularly true for large DOE sites at which environmental data will be collected over a period of years. Data that was collected earlier in the life of your facility may have been analyzed and interpreted inconsistently over time, or may be incompatible with data you collect in the future. Rigorous evaluation of data compatibility should be made prior to combining or comparing data from previous studies. Our experience indicates that in certain cases historical, "legacy", data can cost more to straighten out than it cost to collect the first time.

In short, data management systems are crucial components in a major environmental project. Early, effective planning and management of these systems of hardware, software, and people will enhance the project's prospects for success.