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DNDO Analysis Cell Concept

March 2014

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Abstract

The Domestic Nuclear Detection Office (DNDO) has a mission of implementing rad/nuc interdiction capabilities for a managed and coordinated response to threats, integration of federal nuclear forensics programs, and coordinating the development of the global nuclear detection and reporting architecture. In the process of executing this mission, DNDO has generated substantial information, data, technical results, operational workflows and analytical tools. The effective utilization of these resources is an overarching goal of the organization.

After nearly a decade of performing work, DNDO faces a challenge in capitalizing on the large amount of data, reports, processes, tools, and people. As new work is being planned, managers and researchers need to have an understating of what information has been collected, what tools are available, the collaborations which can be utilized to propel the work forward, processes to plan and execute, and how to present conclusions and results that can assist the government in making decisions. This type of challenge can be met through the use of a series of organized and connected elements which form a broader structure (cell) that promotes cross utilization of elements such that they can be tailored (analyzed) to fit the context of the problem to be solved. The development of an analysis cell for DNDO will address the challenges of utilizing existing elements, identifying gaps, annually reporting the performance of rad/nuc interdiction instrumentation, and planning the execution of future work.

The Elements of an Analysis Cell

The guiding principal of an analysis cell is to structure the elements which are contained inside to make rapidly available the relevant contents of each element and to manipulate those contents in order to meet the specific needs of the problem at hand. The four main constituents of an analysis cell are Workflows, Tools, Collaboration, and Information/Results. Shown in Figure 1 is a diagram depicting the relationship of these elements within the analysis cell.

Traditionally, the contents of an element would be organized in a hierarchical structure which requires a user to dig through each element to try and unearth what is relevant. Rather, the contents of an element need to be organized in such a way that the user can easily search (much as modern web portals do for information on the internet) and display contents in an intuitive manner that provides identification of all relevant information. For instance, if a request was made of the analysis cell with respect to a radiation detection instrument, then the cell needs to intuitively provide to the user the contents of each element such as the computer models of that instrument, the experimental data sets taken with that instrument, deployment information regarding that instrument, current collaboration ideas upon limitations and improvements to the instrument, and the reports which show the conclusions of modeling and experimental studies. Having the connectivity with all of the data, tools, workflows and ideas available positions the user to better assess the problem holistically resulting in more informed and defensible decisions.

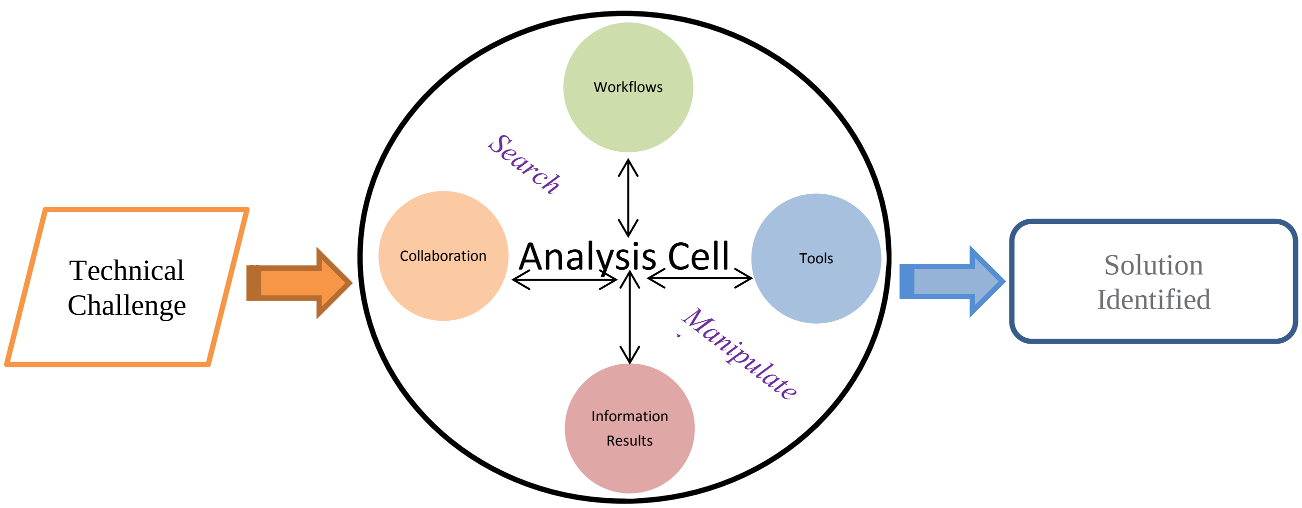

Figure 1 – Logistical Structure of Analysis Cell

In addition to the ability to find the material that is relevant, a requirement of the analysis cell is to manipulate the material found into a desired end product. Manipulation can take many forms such as a general display or dashboard organizing commonly utilized information or comparing different alarm algorithms to a data set. Manipulation can also take on the character of a tool to convert from one common instrument data format to a different data format. The ability to adjust the display of search results (application of filters or other display tools) is yet another example of manipulation. The general framework of the analysis cell needs to organize each element, support the rapid retrieval of material, and provide the ability to manipulate that material. Let's explore the details of each of the four elements and how they interact with each other.

Workflows

The ability to define and apply a workflow to activities produces standardization in outcomes and the ability to apply the best practices and lessons learned to future efforts. The workflow element contains 'simple-as-possible' process flows showing the start-to-finish activities with references to expand the details of each process step. For instance, if *rapid response testing* were required to obtain data regarding an immediate need, as was the case for the Fukushima accident, then the test team would be able to access the rapid testing workflow from the analysis cell. That workflow would provide the *planning, execution, and reporting steps of the test*, prompting the team to consider often overlooked test features such as documenting test objectives and establishing the method to analyze results. Larger testing would also have a workflow, outlining the OI-1 or OI-4 Test Event Planning Process. The specifics of that process can be further expanded with aids to the researcher such as examples of analysis plans, documentation explaining the statistical design of experiment methodologies, a catalog of methodologies for estimating detection system performance, and standardized reporting requirements. Workflows of other types of analysis, such as modeling and simulation or gap identification would also be contained in this element so that standardized products would be generated and results would be readily understandable to decision makers.

Tools

Tools are the things or concepts utilized to produce results based on sets of scientific data or technical information. These tools are utilized by collaborators to execute workflows upon information/results. The content of this element includes computer models, alarm algorithms, decision making tools, equipment descriptions, and other items that support analytical tasks. One user may take the statistical tools and utilize them to plan a test campaign in the analysis of detector data. Another user would utilize modeling tools to simulate a detection scenario with a group of proposed detection instruments to compare performance. A different user may utilize a collection of alarm algorithms and receiver-operator curve (ROC) generators to provide a decision maker the tradeoffs in technology.

Collaboration

Many types of users need to interact with an analysis cell in order to obtain information/data and perform work. Users are more effective when they obtain an understanding of the best each technical discipline has to offer for their particular task. Collaboration of researchers and managers is vital to the type of work performed at DNDO and an analysis cell must contain an element which fosters rather than hinders the exchange of workflows, tools, and information. One facet of collaboration is the creation of workspace using such tools as a Wiki to document what is known about a subject and provide whitespace for the development of ideas. Connection of researchers and managers is another mechanism whereby an analysis cell propels work forward. Matching a researcher with a prior test director to help mentor through as test development workflow or connecting a scientist with a statistician to examine the state-of-the-art in data interpretation makes better products in a rapid and cost effective fashion. Collaboration eliminates institutional stove piping and directly connects the need with the right resource.

Information/Results

Information in the form of reports or visualization summaries, data from instrument tests and computer models, and technical and decisional results comprise the last element of an analysis cell. This cell would provide access to the database of data collection experiments and operational tests for researchers to perform many tasks including verification and validation of computer models, alarm algorithm comparisons, minimum detectable quantity determinations, and the exploration of system improvements. Technical reports contained within the cell would allow managers planning future work to determine the capability status of radiological and nuclear detection or researchers to understand what has already been considered to eliminate duplicative and time wasting work. Also contained within this element is the formation of dashboards which allow the summarization of information for management. For instance, testing progress and issues can be displayed in a simple format indicating planned verses actual with an ability to quickly reach relevant information. It is also possible through collaboration between managers and researchers to have milestone tracking and regular project reporting visible to each helping to communicate technical and schedule risks.

PNNL's Contribution to the Development of a DNDO Analysis Cell

The development of an analysis cell for DNDO is a natural integration and extension of the signature capabilities of PNNL. PNNL's Common Operating and Response Environment (CORE) is just one example where a collaborative framework was established to execute testing workflows, provide display and analysis tools, and collect and transfer information and data to users. PNNL was also a thought leader in establishing computer models that were modular in nature allowing users to fit them together to perform scenario analysis. These models are now being organized at PNNL into a database on behalf of DNDO. The generation of the Compendium of Material Composition Data for Radiation Transport Modeling (PNNL-15870) by PNNL provided not only project consistency in PNNL analysis, but has been utilized broadly in the community to make work more efficient and technically sound. The development of an analysis cell would synthesize the work which has already been performed by PNNL for DNDO and create a new framework to centralize the other superior within the broader technical community.

Given the size of the potential scope of each element within the analysis cell; the development work should take a phased approach, establishing the baseline for today's priorities while building in the flexibility to accomplish the future mission of the analysis cell. Additionally, as features and content become available to the users of the analysis cell, improvement campaigns providing user feedback need to be designed into the development cycle. Priorities also need to be established on a continuous basis with the analysis cell management team to ensure the features with the greatest impact are given primacy.

Software Development

PNNL brings both the proven ability to provide a software platform, such as the CORE system or other products such as the Velo Knowledge Management System, for hosting a data and modeling repository and capabilities in data visualization, knowledge discovery, and informatics. PNNL provides a comprehensive, secure web-based capability for authorized analysts and end users to access the people, tools and information represented by the analysis cell. This capability will provide controlled, role-based access to satisfy security requirements while promoting collaborative space for manager and researchers to connect.

PNNL will also utilize its experience in visualization and informatics to generate dashboards of summary information, create smart search capabilities to organization information, and utilize advanced tools to interpret the collections of DNDO information. Capitalizing on internal PNNL signature discovery research and predictive analysis it is possible to create new ways to connect information for researchers and managers.

Content Collection and Generation

PNNL currently has a wealth of content available today in many technical areas: test data, alarm algorithms, radiation transport models, materials compendium, and detection equipment descriptions. PNNL also has several subject matter experts from which to draw upon to generate new content and tools for the analysis cell. Collaborations with researchers from other organizations also exist today and through the positive working relationships additional tools, workflows, and information can be generated and made available. The CORE team has significant experience in working with test teams to capture test data and their best practices can be captured into the analysis cell work plan.

Within each of the information areas a plan would be generated which would identify, prioritize, and schedule content collection or generation. Many data sets exist today and new ones are being generated constantly. PNNL would establish an interface between data repositories, with new data sets being a priority due to the ability to establish the conditioning of new data rather than the conversion of existing datasets. Existing workflows will need to be incorporated into the developed framework and new workflows identified and developed by working teams to generate the new content.

PNNL is uniquely positioned to be the enabler for DNDO to establish an analysis cell which would begin to address today’s needs and make for a more effective tomorrow. By leveraging the expertise PNNL holds in software architecture, data visualization, and informatics a system can be created which is robust in providing what is desired but flexible to adapt to changes which future capabilities will require. Since PNNL provide a wide spectrum of analysis for DNDO, they also understand how analysis needs to be tied together through collaboration and holds many tools which initially need to be available for the analysis cell to be effective.

Recommended Path Forward

PNNL is one of several Department of Energy National Laboratories that have technical expertise and capabilities that can contribute significantly to the development of an analysis cell. Given that many of the assets needed to develop an analysis cell reside at PNNL, our primary objective would be to lead the multi-laboratory effort needed to achieve the following tasks associated with the implementation of the analysis cell:

(1) Define and refine the functional requirements of the analysis cell (using some of the concepts described herein as the basis for initial discussion)
(2) Define technical requirements of the analysis cell. The requirements could include communication and access protocol, quality assurance measures, component and capability integration, intellectual property considerations, data formatting, and component organization.
(3) Develop a detailed implementation plan and integrated master schedule to coordinate the work required from the different national laboratories.

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