Task 39

Knowledge-Based Information Resource Management System for Materials of Sodium-Cooled Fast Reactor

S. Hsieh

BACKGROUND

In the development of advanced fast reactors, materials and coolant/material interactions pose a critical barrier for higher temperature and longer core life designs. For sodium-cooled fast reactors (SFRs) such as the Experimental Breeder Reactors in Idaho and the Fast Flux Test Facility in Hanford, experience has shown that qualified structural materials and fuel cladding severely limits theIR economic performance.

Liquid sodium has been selected as the primary coolant candidate for the Advanced Burner Reactor (ABR) of the Global Nuclear Partnership (GNEP). Materials improvement has been identified as a major thrust to improve fast reactor economics. Researchers from universities, national laboratories, and related industrial participants have been continuously generating data and knowledge about materials and their interactions with coolants for the past few decades. Considering cost and time, the paradigm of designing and implementing a successful advanced nuclear system can be shifted and updated via the integration of information and internet technologies. Such efforts can be better visualized by implementing collective (centralized or distributed) data storages to serve the community with organized material data sets. Material property data provided by MatWeb.com and the ongoing development of a web-based material handbook for the Generation IV (GEN IV) advanced reactors are a few examples.

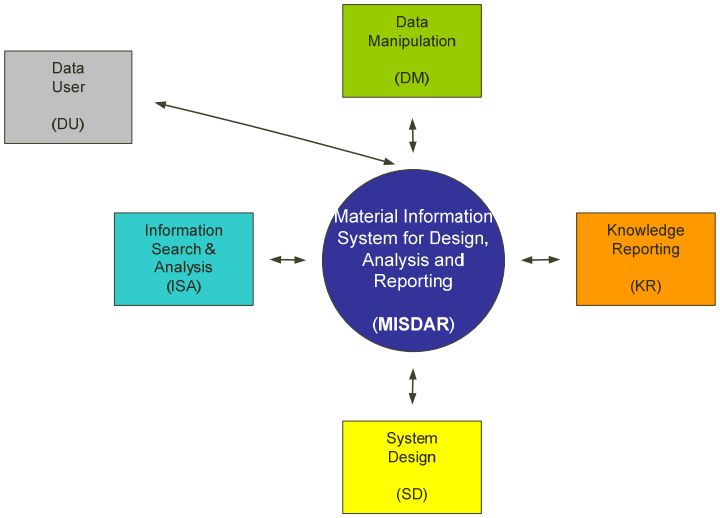
From a system design perspective, SFRs proposed in the GEN IV system have been significantly developed. Major activities defined in the current SFR research and development (R&D) plan can be summarized as the following:

- Ensuring that the needs and goals of the program are followed by the GEN IV International Forum (GIF) countries,
- Documenting and sharing the R&D progress and accomplishments, and
- Integrating relevant activities from GIF SFR R&D with GNEP.

All of these activities follow the path of data generation, analysis, knowledge discovery and, finally, decision making and implementation.

RESEARCH OBJECTIVES AND METHODS

This project proposes to create a modularized web-based information system with models to systematically catalog and analyze existing data, and guide the new development and testing to acquire new data. Technically speaking, information retrieval and knowledge discovery tools will be implemented for researchers with both information lookup options from material databases and technology/development gap analysis from intelligent agent and reporting components. The goal of the system is not only to provide another database, but to also create a distributable and expandable, platform-free, location-free online system for research institutes and industrial partners. Such knowledge discovery and data mining processes generally include data integration, preparation and transformation, data mining and evaluation, and data visualization. Parallel to the development of these front-end analysis tools, web-based data updating and portal administration interfaces will also be designed and developed. Data collection will start during the early stage of the project due to its time consuming nature. The research objectives have been further divided into seven parts, described below:



Main data flow diagram for the MISDAR.

1. To effectively identify research gaps. Past research on liquid metals need to be initially collected and documented.
2. To conduct requirement analysis on stakeholder identification, data-structure definition and analysis tool definition.
3. To design the multi-tier application architecture based on the requirement analysis. Two data sources, configuration settings and application contents, are stored in an XML (eXtensible Markup Language) file and Microsoft (MS) SQL Server database, respectively.
4. To develop the online system prototype to include database development, portal functionality development and portal presentation development.
5. To implement the web-based resource management system that integrates web portal programming and web server hardware configuration. A Windows-based resource management system will be designated as a web server while database servers can be located onsite with the web server, or at various locations depending on the accessibility of data sources.
6. To conduct system testing, debugging and refinement after the system is initially implemented.
7. To instruct graduate students and publish results related to information retrieval, and material search algorithm development.

RESEARCH ACCOMPLISHMENTS

The final project scope of the “Material Information System for Design, Analysis and Reporting” (MISDAR) was developed in collaborators from LANL. Identified functionalities of the MIS-

DAR are:

- Data manipulation (DM) with data uploading/updating/ validation capabilities,
- Information search and analysis (ISA) with advanced search engine and organization algorithms
- System design (SD) with flexible data search engine and analysis tools
- Knowledge reporting (KR) with on-demand reporting tools.

Although the MISDAR is designed to document sodium-related data and information, the "Handbook on Lead-bismuth Eutectic Alloy and Lead Properties, Materials Compatibility, Thermal-hydraulics and Technologies (2007 Edition)," by the OECD/NEA Nuclear Science Committee, was initially used as a baseline reference and guideline on data classification, analysis, and presentation. The system under development will initially include thermo-physical and electrical properties, materials and testing issues, thermal-hydraulics and system technologies, existing test facilities, safety guidelines and open issues and perspectives. Unlike the linear chapter arrangement seen in the paper material handbooks, the material properties and design objects of interest will be effectively presented through a sequence of search results, summary tables, and charts with reference hyperlinks.

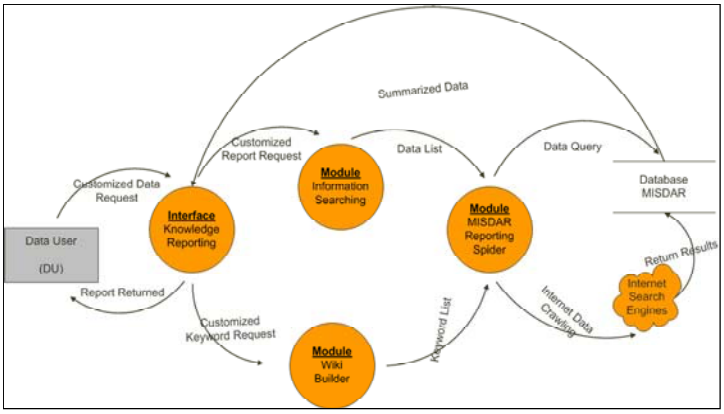
ACADEMIC YEAR HIGHLIGHTS

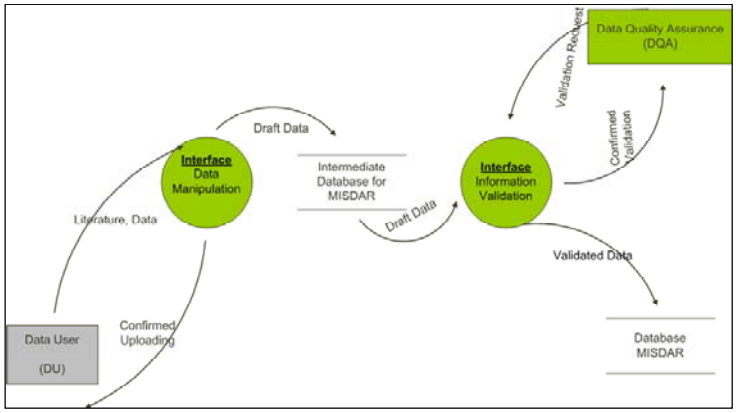
- A graduate student from the Department of Informatics, was identified to work on information reporting and algorithm development subtasks.
- More than 70 sodium related references have been collected.

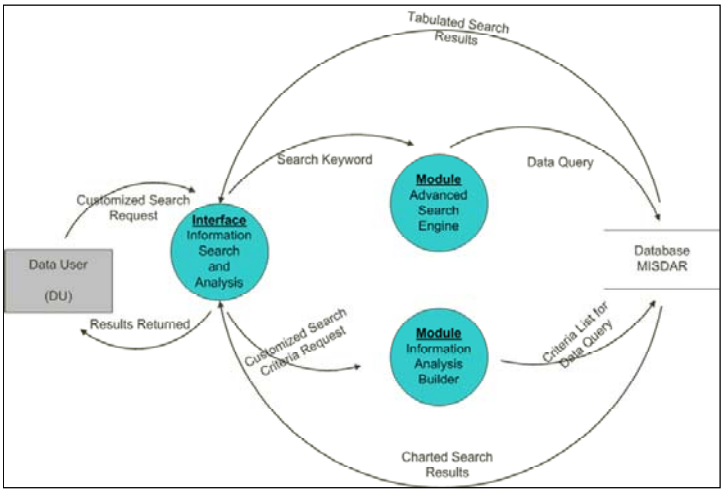
The functional structures with the associated priority for the MISDAR implementation are: Portal Management (high), Portal Presentation (high), Data Manipulation (high), Knowledge Reporting (high), Information Search and Analysis (medium), and System Design (low).

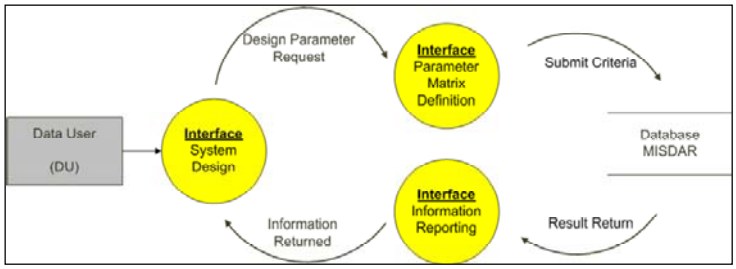
FUTURE WORK

Future work will include implementing and testing online system interfaces, and providing a feedback interface for further improvement.









Detailed data flow diagrams for modules related to data manipulation (DM), knowledge reporting (KR), information search and analysis (ISA) and system design (SD).

Research Staff

Sean Hsieh, Principal Investigator, Research Assistant Professor, Mechanical Engineering Department; Center for Energy Research
Ling Kwan, Professional Staff Database Programmer

Student

Chang Yeol Lee, Graduate Student, Informatics Department

Collaborator

Ning Li and Jinsuo Zhang, Los Alamo National Laboratory