SANDIA REPORT

Sustaining Knowledge in the Neutron Generator Community and Benchmarking Study, Phase II

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Sandia National Laboratories

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Abstract

This report documents the second phase of work under the Sustainable Knowledge Management (SKM) project for the Neutron Generator organization at Sandia National Laboratories. Previous work under this project is documented in SAND2008-1777, Sustaining Knowledge in the Neutron Generator Community and Benchmarking Study.

Knowledge management (KM) systems are necessary to preserve critical knowledge within organizations. A successful KM program should focus on people and the process for sharing, capturing, and applying knowledge. The Neutron Generator organization is developing KM systems to ensure knowledge is not lost. A benchmarking study involving site visits to outside industry plus additional resource research was conducted during this phase of the SKM project. The findings presented in this report are recommendations for making an SKM program successful. The recommendations are activities that promote sharing, capturing, and applying knowledge.

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

NOMENCLATURE

Term	Origination
APQC	American Productivity & Quality Center
CEC	Customer Experience Center
CEO	Chief Executive Officer
CIO	Chief Information Officer
CKO	Center Knowledge Officer
COP	Community of Practice
CSA	Current State Analysis
DOE	Department of Energy
EDP	Employee Career Development Plan
FAQ	Frequently Asked Questions
GKC	Global Knowledge Center
KB	Knowledge Broker
KL	Knowledge Leader
KLT	Knowledge Leadership Team
KM	Knowledge Management
KMS	Knowledge Management System
KS	Knowledge Spiral
LKC	Local Knowledge Champion
LM21	Lockheed Martin 21st Century
LM	Lockheed Martin
MAKE	Most Admired Knowledge Enterprises
NG	Neutron Generator
PMF	Performance Management Form
R&D	Research & Development
RNGPD	Responsive Neutron Generator Product Deployment
S&M	Sales and Marketing
SAP	World's largest business software company
SEA	Systems Engineering and Analysis
SEA KM	Systems Engineering and Analysis Knowledge Management
SKM	Sustainable Knowledge Management
SME	Subject Matter Expert
SOP	Standard Operating Procedures
TGS&M	Toyota Global Sales & Marketing
TWSM	Toyota Way in Sales and Marketing
WWIFM	What's In It For Me

EXECUTIVE SUMMARY

This report documents the second phase of work under the Sustainable Knowledge Management (SKM) program for Organization 2700, Responsive Neutron Generator Product Deployment (RNGPD) at Sandia National Laboratories (Sandia). Previous work for this program is documented in <u>SAND2008-1777, Sustaining Knowledge in the Neutron Generator Community and Benchmarking Study</u> [1].

Knowledge management (KM) can be described as the systematic process of identifying, capturing, managing, and sharing information. KM has proven essential to many organizations across Sandia and across industry as a whole to ensure the preservation and communication of critical knowledge within an organization.

The SAND2008-1777 report includes a historical retrospective of KM within the RNGPD and the initial benchmark case studies of 25 companies that have implemented KM. The current Phase II report documents the KM research and case studies conducted since the 2008 report and makes recommendations for a successful SKM program.

The case studies include the findings of the SEA KM team's onsite visits to two external companies: the Toyota Motor Corporation (Toyota) and the Halliburton Company (Halliburton). Both Toyota and Halliburton have internal organizations dedicated to KM. The successful implementation of KM at these companies includes

- management support for KM at the top levels;
- assignment of KM roles (such as knowledge broker and knowledge champions);
- knowledge sharing activities (such as communities of practices), knowledge sharing conferences, and best practices publications;
- provision of tools to help foster collaboration and sharing; and
- collection of metrics and success stories to assess the value of KM.

The SKM program recommendations in this report are based on findings from the site visits as well as research into the concept known as the Knowledge Spiral (KS). The KS is a knowledge creation process that consists of four phases: socialization (knowledge sharing), externalization (knowledge capture), combination (knowledge system), and internalization (knowledge application). During the socialization phase, team members share their knowledge by communicating with others directly. In the externalization phase, team members document the knowledge shared during socialization. In the combination phase everything that has been documented is organized into a tool that enables access to the knowledge. In the final internalization phase, team members practice what they have learned and make it "their own." The KS process is continuously repeated as knowledge changes and grows.

In addition to activities that are performed in the KS process, it is important that a SKM program include management support, strategic planning, KM roles and responsibilities, knowledge sharing activities, incentives, tools and metrics. These activities are also addressed in the recommendations at the end of the report.

1.0 INTRODUCTION

This report documents the Phase II research, findings, and recommendations of the Systems Engineering and Analysis Knowledge Management (SEA KM) team for Organization 2700, Responsive Neutron Generator Product Deployment (RNGPD) at Sandia National Laboratories.

The SEA KM team defines knowledge management (KM) as a community's process of sharing and consistently documenting the flow of critical information throughout a product's lifecycle. This report contains

- insights gained from site visits to the Toyota Motor Corporation (Toyota) and Halliburton Company (Halliburton),
- research findings concerning KM aspects (such as the KM creation process), and
- recommendations for implementing a sustainable KM program within the RNGPD.

1.1 Background

A wide range of specialized expertise is necessary to design, develop, and produce neutron generators. Various types of equipment, processes, and procedures encompass the entire effort. It is critical to ensure this knowledge is captured and preserved for the future.

In 2004, the SEA KM team began developing KM systems for the RNGPD to capture the expertise, experiences, and research on work significant to the design, development, and production of neutron generators (NG). These KM systems took the form of websites with each website containing knowledge about a particular domain in the process for producing neutron generators. The information for these websites was captured by interviewing subject matter experts and by gathering key references on the subject. However, it was found that these interviews captured experiences from a high level but the detailed, contextual information was often lost. Additionally, timeliness is important to this process and using an interview approach as the sole mechanism for knowledge capture often leads to information gaps. These issues initiated the research for a <u>sustainable</u> KM (SKM) program that would allow engineers and scientists to capture their expertise and critical data. The SEA KM team developed an "as-you-go" approach to capturing critical knowledge; whereby engineers capture their own knowledge as they learn. In this way, knowledge could be documented in real time and shared with others. This approach supported the SKM objectives.

One of the first steps the SEA KM team took towards this approach was to conduct a benchmarking study of how other companies across industry were successfully implementing KM. The benchmarking study of 25 companies was documented in <u>SAND2008-1777, Sustaining Knowledge in the Neutron Generator Community and Benchmarking Study</u> [1]. The 2008 report also provides the history of the KM systems built for the Sandia NG community and provides initial recommendations for the SKM program.

1.2 Report Summary

Section 1.0: Introduction and background to the SKM program

Section 2.0: Overview of site visits to Toyota and Halliburton

Section 3.0: Additional research and considerations including the knowledge creation process and the core principals of the RNGPD.

Section 4.0: Final recommendations for an SKM program within the RNGPD

Section 5.0: General conclusions

2.0   SITE VISITS

As part of the second phase of KM research and investigation, the SEA KM team visited Toyota and Halliburton for a firsthand look at how KM succeeds at these companies. The goal was to understand the KM activities, tools, best practices, and implementation at the two companies.

Toyota previously won the Most Admired Knowledge Enterprises (MAKE) award, which recognizes successful implementation of KM. The team visited two Toyota centers; the Global Knowledge Center (GKC) and the Customer Experience Center (CEC).

Halliburton was chosen because it ranked high in the first phase benchmarking study plus the team wanted to learn more specifically about Halliburton's "knowledge broker" role.

2.1   Toyota: Global Knowledge Center

The GKC is Toyota's resource for sharing ideas and global knowledge of best practices in sales and marketing from around the world. The GKC provides mechanisms for distributors to connect, communicate, and collaborate with each other. The foundation for KM at Toyota is based on ISO-14001; a specification that focuses on processes instead of the product. ISO-14001 is an upgrade from ISO-9000 that is more environmentally aware and a safer process [2].

Business at Toyota is done the "Toyota Way", which is based on the "Guiding Principles" at Toyota. It defines the mission of Toyota as a corporation and the values the company delivers to customers, shareholders, associates, business partners, and the global community. The sales and marketing sector of Toyota identified the need for their own version of the "Toyota Way" and created the "Toyota Way in Sales and Marketing" (TWSM) [3]. The TWSM vision is to become the most successful and respected car company in each market around the world by offering customers the best purchasing and ownership experience. Toyota Sales and Marketing includes dealerships and customers spread throughout more than 160 countries. The KM activities that were shared during the site visit focused on people supporting KM, knowledge sharing activities, tools, and metrics.

2.1.1   Management Support and Knowledge Leaders

The GKC reports to the Executive Committee of Toyota Sales and Marketing. Under the Executive Committee is a steering committee that meets twice a year. Toyota Sales and Marketing also established "Knowledge Champions," representatives of the top 30 markets around the world. The champions meet annually to share best practices and to find out what is going on in each of the markets. The champions also conduct an annual strategic meeting to assist in setting GKC goals for the following year. The GKC distributes a survey prior to the strategic meeting and presents the survey results at the meeting. The meeting helps determine the top 10 priorities for KM. For example, one top priority established during a strategy meeting was "to expand used cars sales." This priority resulted in the creation of a Best Practice Bulletin about used cars to assist in used car sales.

After the steering committee sets the top 10 priorities, the GKC creates a three-year plan and presents this to the Executive Committee. The Executive Committee helps determine the GKC objectives for the year.

2.1.2   Knowledge Sharing

The goal of the GKC is to help distributors connect to share knowledge and best practices. The GKC provides conferences, workshops, training, and publications to allow distributors and dealerships to share information. For example, the "Kaizen Experience and Exchange Network" is a regional forum that targets Toyota distributors. This event allows the distributors to meet and share information while also serving as a reward/incentive by offering employees the opportunity to travel and learn from distributors in the region.

The GKC produces two publications, a newsletter and a best practices bulletin. Each newsletter highlights two GKC events and is posted on the GKC website bi-monthly. The <u>Best Practices Bulletin</u> is a bi-monthly publication that features best practices on a particular topic. The publication is bi-monthly instead of monthly because GKC found that more solid practices resulted if they were developed less frequently. Featuring GKC organizations in the bulletin has proven to be a successful incentive for organizations to participate in KM activities. GKC hires an outside company to interview people for the best practices. The best practices are successful because they coincide with the priorities of both the dealers and distributors. The dealers and distributors see value in the best practices bulletin; they have voted it the "number-one-value" provided by the GKC.

All KM processes are documented to ensure knowledge is not invested in one person. If a person retires or transfers, another person can easily take their place because the process is documented. Additionally, once a KM process is documented, multiple people are trained on that process. Toyota establishes Standard Operating Procedures (SOP) for company processes that includes process maps and templates. The GKC holds a meeting to share SOPs and provides hard copies of the SOP packets to everyone.

2.1.3   Website

The GKC uses a website, which is not on the intranet, to assist knowledge sharing. Anyone holding a Toyota email address and account has access to the website from any location. The website contains

- on-line communities that are created by users with identified discussion topics to collaborate and share documents, etc., and with restricted access if necessary;

- documents and video files;

- knowledge assets (such as publications and promotional items) that users can download;

- expert profiles of anyone registered on the website that users can locate and view;

- course and sales training material; and a

- Google search capability with the option to narrow searches within a website section, such as best practices.

There is a review process whereby the GKC team reviews content before information is posted on the website. The posted information is tied to the submitter's name and the submitter is held accountable for that posting. There have been no problems with the type of information posted.

2.1.4 Metrics

The GKC collects metrics to assess their programs. Metric examples include the number of

- downloads from the website,
- "hits" on the website,
- GKC accounts, and
- publications produced.

2.2 Toyota: Customer Experience Center

The CEC was developed to assist Toyota customers with their experiences, concerns, problems, and information relating to Toyota products. The CEC also assists CEC representatives in gathering appropriate information requested by the customer.

2.2.1 Management Support and Knowledge Leaders

A KM consultant serves as the liaison to external sources. The KM consultant resides in the "University of Toyota" and is not directly part of the CEC. This separation enables the consultant to remain neutral between the CEC and external sources, which is important when establishing credibility and managing relationships. For KM to succeed, the CEC believes there must be dedicated personnel in charge of maintaining the content; therefore the CEC established "content managers." Content managers also serve as "coaches." The CEC also believes that there must be an executive governance board and executive support. The chief information officer is on the governance board. According to the CEC, management support keeps the KM application going.

2.2.2 Knowledge Management Tool

Customer service representatives in the CEC must access information quickly to answer customer questions. Previous to KM efforts, the information was not readily accessible to the customer service representatives although that information was already captured and available. The problem was that the information was separated across a variety of locations. To remedy the problem, the CEC developed a KM tool containing information from separate sources and tied them together into one interface. The customer service representatives (i.e., users) were instrumental in the development of the tool. The mantra for this tool was "by the reps for the reps."

The tool contains a search that tells the user where information originates and whether it is access controlled. Users can search the "frequently viewed information" section. When the user clicks on information, a message tells them who can share the information and whether there is an attachment. The tool also provides the capability for rating the tool content and noting what content needs to be changed. Each tier has a content manager who reviews user content submissions. The tool has a workflow process.

Two of the support software tools used by the CEC for the KM tool are

- "Right Now Technology," which supports SQL, Oracle, and MySQL; and
- "Hyperion Performance Suite Report Tool" (i.e., Brio), which supports development of reports.

2.2.3 Metrics

CEC has found that metrics are hard to collect. The metrics currently collected include

- usefulness of content,
- number of documents viewed, and
- percentage of content viewed.

2.3 Halliburton

Halliburton is one of the world's largest oilfield services companies. Halliburton views KM as more than just a "nice to have" initiative; it considers KM to be a strategic imperative. Halliburton's vision is to be the "real-time knowledge company" servicing the industry.

The KM program at Halliburton is based on "communities of practice" (COP) that focus on solving problem.

2.3.1 Management Support and Knowledge Leaders

Initially, experienced Halliburton members delivered a KM presentation to the Chief Executive Officer (CEO). Once onboard, the CEO pushed for a KM program. Upper management was involved primarily to ensure middle managers took action because the middle managers were not initially willing to support KM.

When the KM program first began, there was a small team of people involved that included an external consultant from the American Productivity & Quality Center (APQC). The APQC is a nonprofit organization that helps organizations with process and performance improvement. KM is one of the focus areas APQC emphasizes.

Today, KM at Halliburton has top management support with many managers playing a role within the COPs. However, when a manager becomes part of a COP, the manager is considered a peer within that community, not a manager. The KM specialists at Halliburton believe that KM would not be successful without management support.

Other important KM roles at Halliburton are listed in Table 1.

Table 1. Halliburton KM Roles and Responsibilities

Role	Responsibility	Comment
Knowledge Broker (KB)	• Champions knowledge sharing. • Facilitates interaction between the members of the COP. (KBs connect people who have questions with those who have answers. • Ensures KM repository is current and is relative to the needs of the users. • Manages the KM repository content and ensures system integrity. • Ensures the community is trained. • Filters information. • Ensures solved issues go into the "solution box."	• Typically someone who has been in the organization for 5-7 years and understands the organization. • Must be resourceful in order to answer questions and find information for others. • Not a permanent position. It is a full-time position while the COP is active, but once the problem has been solved and the COP is closed, the KB moves to another position.
Subject Matter Expert (SME)	• Shares knowledge and helps the KB (but should not be the KB). • Validates solutions for the repository and the COP.	• The SME and KB are separate roles; together they decide what information goes into the repository. • <u>Important</u>: SMEs can be anybody, not just senior staff members. A person who just completed a task or solved a problem may have the knowledge of how to do the task and can answer questions best due to that recent experience.
Local Knowledge Champion (LKC)	• Spreads the "word" about KM. • Helps with the initial deployment of the COP. • Trains and helps other community members with how to use the KM solution. • Coordinates activities of the local COP and encourages participation and collaboration among members.	• Works closely with the KB. • This is a part-time role after the COP has been deployed.
KM Core Team	• Implements and maintains the COP. • Manages Information Technology (IT) support of KM tools. • Develops IT KM strategies. • Builds customer collaboration. • Develops new COPs. • Identifies the KB for COP. • Develops a communication "tool" for COP.	• Each COP has a core team.

2.3.2   Knowledge Sharing

It takes people to share knowledge; this is core to the success of the KM COPs. Halliburton's primary KM activities are implemented through 26 KM COPs, which focus on solving problems. There is one COP for each product line. Some communities have 1,000 users a month and there is the potential for 2,000 users.

There are several different kinds of COPs. For example, the "New Employee COP" helps train new employees and the "SAP COP" helps people learn how to use and customize

software based on SAP. However, the COP approach has been a struggle for some Halliburton areas; for example, Research and Development personnel are hesitant to use a COP due to the fear of losing control over proprietary information and patents.

Halliburton has assigned two KM specialists to help develop COPs. To start a new COP, a person must contact a KM specialist. The KM specialist scopes the project to find out what information is needed. Even though the KM specialists help start the COP, the COP is not owned by them. Each business unit owns both the KB and the COP; the KM specialists feel the COP would fail if it was not set up this way.

When a COP is under development, a scoping session must occur. The scoping process should include 3-5 people working full-time. During the scoping process, the project scope and team are defined. The team develops the COP plan and deploys the KM solution. The KM specialist uses a scoping document to assist with the initial process. The document includes the following fields:

- Community name

- Business unit

- Business case (very important)

- Purpose/strategic alignment (very important)

- Cost/benefit analysis

- Impact assessment

- Ownership

- Sponsor

- Administrator

- Problems that can be addressed by using KM.

2.3.3   Knowledge Management Tools

Halliburton uses two primary tools for the KM website, a portal technology tool and an in-house collaboration tool. The current portal technology used is Plumtree but is being moved to the Microsoft SharePoint portal.

The KM website includes the following:

- Community portal used as a message board and for announcements

- Collaboration to hold discussions in a single community

- Knowledge selector that contains templates, documents, and best practices

- Search capabilities

Collaboration: The collaboration tool is mainly a discussion board for those in the community. It is the main part of the KM website, because this is what the COP uses to communicate. The discussion board contains the following fields:

- ID

- Topic

- Status (Open or Closed)

- Date
- Last Updated

Pictures can be uploaded into a discussion. A facilitator for each discussion is required although anyone can post or reply to a discussion using the collaboration tool. People can search and share discussions and discussions may be shared across COPs. Participants can also save discussions to documents.

The knowledge broker (KB) maintains the COP using the collaboration tool. The broker can customize the page. KBs can look at a discussion at a single COP and share across COPs. The KB can share discussions with another COP and make it look like the discussion was originally a part of that COP. In order to share discussions, each KB must approve or accept the discussion. KBs can see who read the discussion and ensure the appropriate people see the discussion. KBs can send notifications to discussion participants and can also post to the discussion.

Search: There is no search capability for the knowledge selector, which stores all the documents. However, documents are categorized by the KB and there is a search capability within the collaboration tool.

2.3.4   Rewards and Incentives

Halliburton does not have any extra rewards or incentives for those who participate in a COP. The point of the information is to create value. The reward and incentive for the employees are to see value in participating in the COP. With the emphasis on providing value, people feel safe about sharing their problems.

2.3.5   Metrics and Story Telling

Metrics are very important in understanding the degree of success of the KM program. However, metrics are often hard to collect. Halliburton has managed to collect some metrics; for example, portal usage, satisfaction/dissatisfaction, value and efficiency gains, unique users, access, and percent of problems solved.

Halliburton currently has 50,000 employees using 30,000 computer systems with 13,000 KM users. About 4,000 (over one- third) of the KM users are new and used a KM COP for training.

Metrics collected on the portal include the following:

- Hits per portal page
- What page displayed value to the user
- Who returned to a page
- Usage by age (found that older people initiated discussions)
- Customer dissatisfaction (dissatisfaction changed from 3% to 4%)
- User metrics (what type of people use the community, amount of users, how much do they access the portal)

Halliburton has tried to collect metrics on how much money has been saved. The discussion tool allows KBs to enter how much money was saved once a discussion has been closed. Halliburton has found that money was saved by hiring a full-time KB.

Management may not understand or trust metrics but do seem to believe stories associated with how a KM COP helped. Halliburton has recorded participant stories of how the COP helped them. For example, there is an audio story of how looking up a question on the collaboration portal about pumping a new product into a well saved 3-20 million dollars. Stories "sell" KM. Halliburton sponsors training in story telling by sending some employees to a 1-3 day course on story telling. KBs collect stories monthly and post them to the COP portal.

3.0 ADDITIONAL RESEARCH AND CONSIDERATIONS

Two other KM tasks were undertaken by the SEA KM team to clearly identify activities and processes appropriate for the NG organization. First, research continued into KM activities, processes, and standards across industry resulting in the identification of a KM creation process that could be customized to meet NG organization KM needs. Secondly, the SEA KM team developed a principle-based system for KM activities for the RNGPD.

3.1 Knowledge Management Spiral

In addition to the site visits described in section 2, the SEA KM team continued research into other KM resources. Two difficult aspects of KM came to the forefront; what is knowledge and how can knowledge be created. Further, an organization should have a process to share, capture, organize and apply knowledge. The SEA KM team found an existing framework that addresses these KM aspects, the Knowledge Spiral (KS) process.

The KS process describes four necessary phases an organization goes through to create knowledge [4]. Knowledge is created and expanded through social interaction between tacit knowledge and explicit knowledge [4]. Tacit knowledge can be described as knowledge in people's heads that is hard to formalize and communicate. Explicit knowledge is knowledge that can be verbally explained or written down. There are four phases of knowledge conversion in the KS process in which knowledge is created through the interaction between explicit and tacit knowledge: socialization, externalization, combination, and internalization.

3.1.1 Socialization Phase

In the socialization phase, knowledge is shared with others. The key to acquiring tacit knowledge is experience and, in this phase, experiences are shared with others. Activities that foster the sharing of tacit knowledge include demonstration, shadowing, and observation. The conversion in this phase is from tacit knowledge held by one individual to tacit knowledge held by another and the communication mode is not in a written format.

KM activities for the NG community in this phase include

- participating in a COP,
- creating a knowledge map of the organization's skills and expertise,
- job shadowing,
- one-on-one mentoring,
- cross training, and
- video capture.

Socialization is a key phase because critical knowledge is transferred from one person to another. The Sandia NG community consists of a culture of experts. This phase is important in extending this culture into one that shares knowledge.

3.1.2   Externalization Phase

Knowledge is documented in the externalization phase. Externalization is trigged by a dialogue between individuals. Knowledge that was learned in the socialization phase is now documented in metaphors, concepts, or models. In this phase, tacit knowledge becomes explicit and ensures that the knowledge is captured. KM activities for the NG community in this phase include

- note-taking,
- report/document generation,
- process maps,
- diagrams, and
- product metaphors or analogies.

3.1.3   Combination Phase

The combination phase involves the process of organizing the documented information into a "knowledge system." KM tools are used in this phase because the knowledge that has been captured can now be organized so it can be retrieved at a later time. The conversion in this phase is from explicit knowledge to explicit knowledge. There are many different tools that can be used to organize the information. KM tools that can be used in the NG community for this phase include

- websites,
- discussion boards,
- portal technology,
- collaboration tools,
- wikis,
- content management systems, and
- document repositories

3.1.4   Internalization Phase

The internalization phase contains the process of applying captured knowledge. Individuals gain their own knowledge by putting what they have learned into practice. It is believed that this phase is where innovation occurs. In this phase, explicit knowledge becomes tacit knowledge. KM activities for the NG community in this phase include

- job rotation and
- cross training

Individuals gain knowledge throughout the four phases of the KS process. Once an individual has internalized the knowledge, he/she returns to the socialization phase and shares what was learned with others. The spiral of knowledge creation begins again;

knowledge does not just stay with the individual but the whole organization gains knowledge.

A diagram of the knowledge spiral is depicted in Figure 1. Recommendations for KM activities in each phase of the spiral are highlighted in blue. Section 4 describes these recommendations in detail as they pertain to the NG organization.
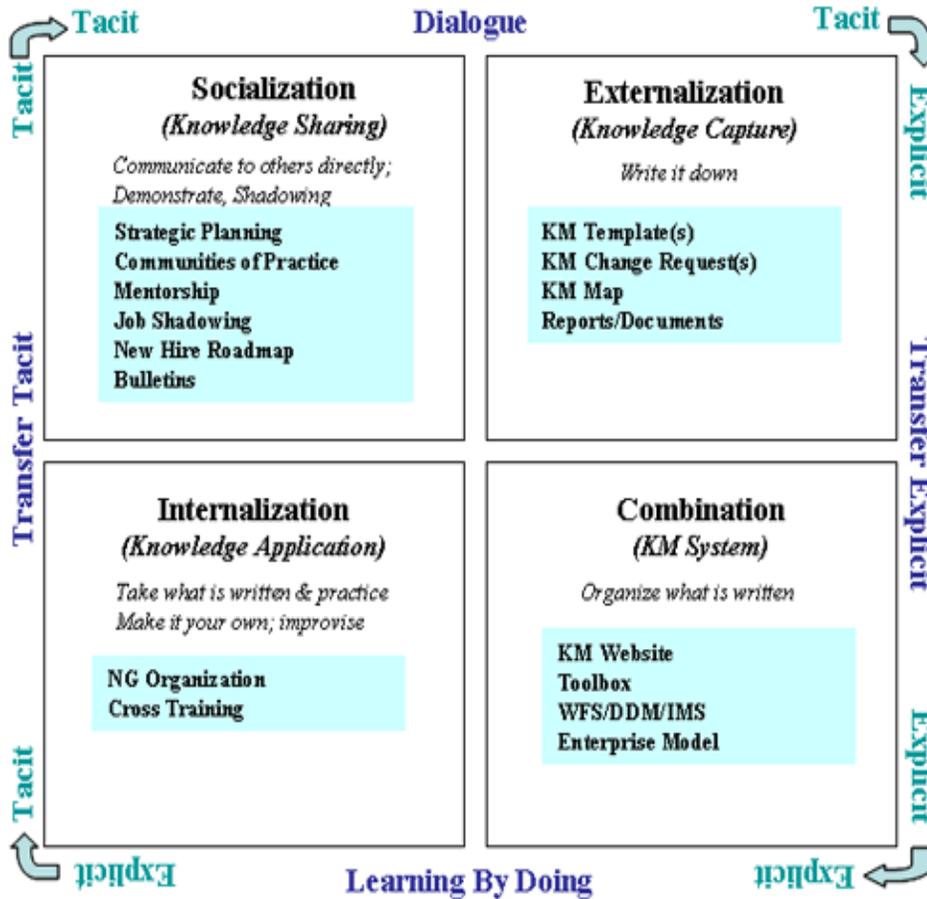
Figure 1: Knowledge Spiral Diagram

3.2   Neutron Generator Organization KM Principles

The SEA KM team was also tasked with developing a principle-based system for KM activities for the RNGPD. The RNGPD community adopted the continuous improvement core principles identified in Lockheed Martin - 21st Century Program (LM21). LM21 is the "how to" guide for cutting cost and improving quality and customer satisfaction. LM21 builds on the five basic

principles of the Lean/Six Sigma methodologies as a set of leadership and decision making mandates that define excellence [5]. These core principles, which have been incorporated into all NG work, are depicted in Figure 2.
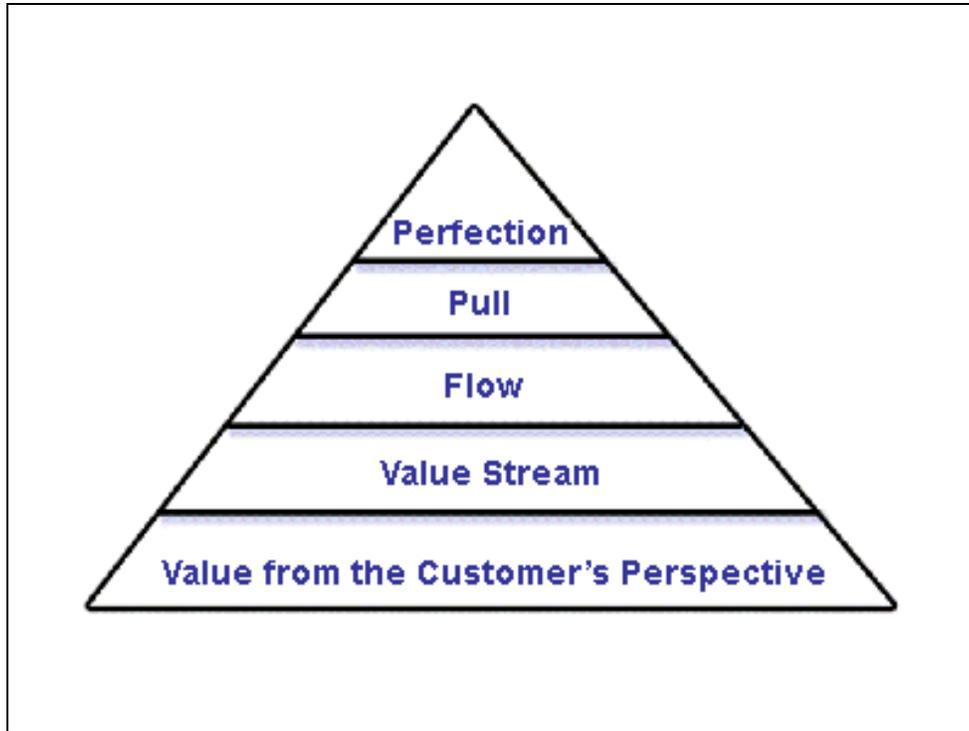
Figure 2: Lockheed Martin - 21st Century Continuous Improvement Core Principles

The SEA KM team created KM principles to coincide with LM21 principles. The mapping of these is provided in Table 1 with descriptions of each principle.

Table 2. Mapping of NG KM Principles to LM21 Lean Principles

| LM21 Lean Principle	KM Principle(s)
Perfection An iterative cycle of continuous improvement. By applying the LM lean principles, a process can be made more efficient, more effective, and can increase the quality of the product being delivered to the customer.	**Improve the effectiveness of the knowledge workers.** Make certain workers see that their work is contributing to the organization.
Pull Supply the customer only when they need it.	**Valuable knowledge is available when needed.** The right knowledge in the right form is easily accessible.
Flow Getting the product to move without stopping.	**Create, acquire, and transfer knowledge.** Knowledge capture is a social activity. It is constructed by the entire organization through their interactions and conversations. Knowledge should flow across the various boundaries in the NG organization (e.g., management vs. staff, value stream vs. project, engineer vs. technicians, and science vs. engineering vs. production). **Encourage and recognize knowledge sharing and documentation**.
Value Stream A series of activities/tasks that make up a process.	**Apply KM principles and the knowledge spiral.** Apply the KM principles along with each phase of the knowledge spiral to achieve a successful KMS. See the KM Spiral section for information on the activities.
Value from customer's perspective	**Align the KMS with the NG business objectives.** Knowledge reveals itself in actions taken to create value.

4.0   SKM PROGRAM RECOMMENDATIONS

This section expands on the original recommendations for the NG organization to implement a SKM program that were made in the SKM Phase I report (SAND2008-1777) [1]. These updated recommendations are more concrete and reflect the additional research and findings described in this document.

4.1   Management Support

KM cannot be a success without management support. The SEA KM team recommends that the NG organization have the following management support:

- A Level II manager or above must be a KM champion

- A Level I manager is the Center Knowledge Officer (CKO)

- The KM champion and CKO lead the Knowledge Leadership Team (KLT), which includes the Knowledge Broker (KB) and Knowledge Leaders (KLs)

- Level I managers are actively involved in reviewing captured knowledge

Figure 3 depicts the structure of the knowledge roles. These roles are defined in the Roles and Responsibilities section below.
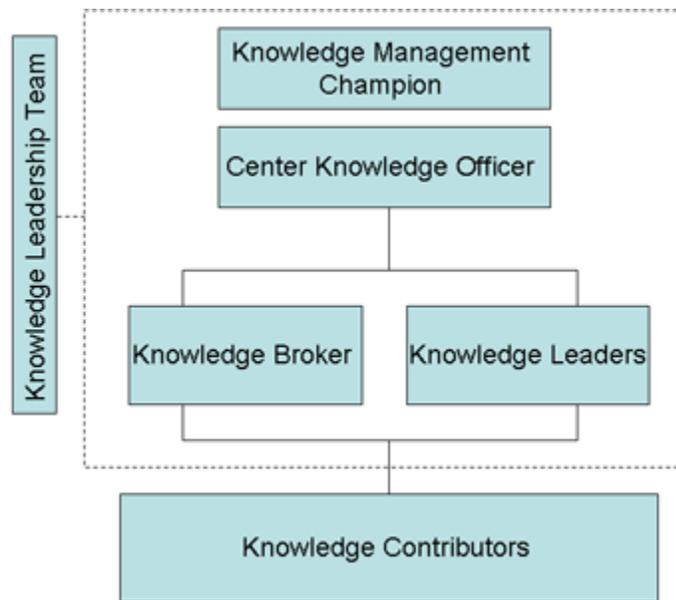
Figure 3: Structure of knowledge roles

4.2   Strategic Planning

The KLT meets annually to assess the current state of knowledge in the organization and to set the KM objectives for the year. During this meeting, the KLT discusses the current state of KM within the organization, the progress achieved during the previous year, and available resources for the current year.

4.2.1   Current State Analysis Questionnaire

The knowledge capture process includes using the Current State Analysis (CSA) Questionnaire to help identify both knowledge that is available and knowledge that is missing. The results of this questionnaire are compiled and presented to the KLT during the strategic planning meeting. The KLT determines what key areas of KM will be captured for the year based on the feedback from the questionnaire. The results of the questionnaire will help the KLT answer the following questions:

- What knowledge is critical to capture for the year?

- How will the NG organization benefit from knowledge capture and sharing?

- Who has knowledge of certain information and who needs to get the knowledge?
- What are the knowledge gaps in the NG organization?
- Where are there opportunities to share knowledge?
- Are there any new problems or experiments that need a COP?

4.2.2   KM Progress

During the strategic planning meeting, the KB presents metrics collected during the previous year to help facilitate the discussion of what is working and what needs to be improved. Suggested questions for measuring KM progress include the following:

- How satisfied are people with the KMS?
- What is the value shown from investing in the KMS?
- How many COPs are active?
- How many COPs have demonstrated value to the organization?
- What do people think of the KM bulletins?
- Are there any KM activities that should be added or removed?

4.2.3   KM Resources

Resources include people, tools, funding, facilities, and other attributes. The strategic planning meeting may address questions such as the following:

- Are there any people retiring soon?
- Are there any new personnel that need a mentor?
- What is the current usage for the tools? Do the tools that support KM activities need to be updated?
- Is there any new training that needs to be done for the KMS?
- What is the budget for KM activities this fiscal year?
- What resources does the KB need?
- Will the NG organization need to hire knowledge consultants to facilitate KM activities?

The KLT reports the outcome of this meeting to the management team and lets the NG organization know the focus for KM activities for the year. Actions resulting from this meeting include the following:

- Create a prioritized list of critical areas that need to be captured and recommendations as to who will be responsible for each critical area. This information will be sent to all the managers to share with employees during Performance Management Form (PMF) evaluations.
- Create presentations that describe the KM objectives for the year to be given to the management team and, ultimately, all the departments.
- Set goals for continuous improvement of the KMS.

4.3 Knowledge Capture Process

It is important that knowledge be captured and preserved for future use. There is a great potential for redundancy and loss of time, which also means loss of money, when information is not captured. It is not that people do not want to document their knowledge, but they do not always know the "how, what, and when" of capturing knowledge. There is currently no standard process for capturing knowledge; however, the following diagram depicts a recommended knowledge capture process. Details of the process are described below.
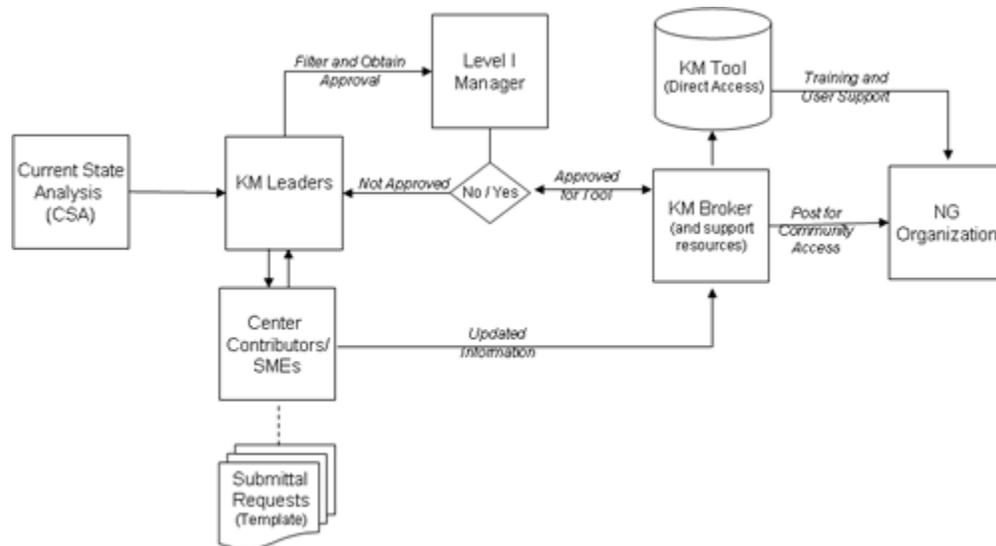
Figure 4: Diagram of the Knowledge Capture Process

4.3.1 Perform a Current State Analysis

The Current State Analysis (CSA) is a way to assess the knowledge in the organization. This process is conducted annually to ensure that knowledge is maintained. The CSA process uses the following steps:

- The KL sends out a mandatory questionnaire to the project/team leads and Level 1 managers prior to the strategic planning meeting.

- The project/team leads and managers send responses to the KLT.

- The KLT prioritizes what information needs to be captured and sends the prioritized information to the managers.

- Managers assign their employees the task of capturing needed knowledge based upon the competencies of each employee.

- Managers ensure that KM contributions are included in each employee's' PMF.

The knowledge capture process begins after the CSA has been determined.

4.3.2   Add New Knowledge

New knowledge consists of knowledge that does not exist in the KMS. The process for adding new knowledge is as follows:

- The KLT distributes templates to KL to identify what critical knowledge needs to be captured.

- The KLs gives templates to the subject matter expert (SMEs) to acquire critical knowledge.

- The SMEs and center contributors submit the template to the KL for final review. The KL submits the information to the Level I manager to obtain approval.

- If approved, the Level I manager sends the information to the KB.

- If not approved, the information is passed back to the KL and the document is revised by the SME.

- The KB posts the information for the NG organization to access.

- The KB notifies the NG organization that new knowledge is in the KMS.

4.3.3   Modify Existing Knowledge

Existing knowledge consists of knowledge that is within the KMS and may need to be modified.

- If the knowledge needs to be updated, the SMEs or center contributors contact the KB.

- The KB sends the change request form to the appropriate KL.

- The KL notifies the SME to verify and make changes.

- The SME documents the changes using a change request form.

- The KL authorizes changes and sends the change request form to the KB for updates.

- The KB posts the information for the NG organization to access.

- The KB notifies the NG organization that updated knowledge is in the KMS.

4.3.4   Archive Outdated Knowledge

Outdated knowledge consists of knowledge that is in the KMS and needs to be archived. The process for outdated knowledge involves the activities described below.

- The NG organization notifies the KB of outdated knowledge.
  Note: Outdated knowledge is also identified during the CSA.

- The KB notifies the NG organization of outdated knowledge and archives the information.

4.4   Integration of KM with Core Competency Team

Under the Sandia "Grow Our People" program, core competencies are defined as the "*knowledge, skills, and abilities that enable individuals to speak and understand an organization's language and to work in an efficient, productive, and successful manner in a specific function within an organization"* [6]. The NG organization's Employee Career Development Plan (EDP) allows for the planning of needed technical, operational and administrative expertise while supporting the staff's growth and development to their fullest potential. Identifying core competencies for an organization can provide guidance in determining what knowledge should be captured within that organization. The following are the SEA KM team's recommendations for actions for the core competency team:

- Make KM application a core competency.
- Make KM development a role-specific competency.

4.5   Roles and Responsibilities

The SEA KM team recommends that the roles and responsibilities identified in Table 3 be used within the NG organization for KM activities.

Table 3. KM Roles and Responsibilities Recommendations

Role	Responsibility	Comment
Knowledge Management Champion (KMC)	• Sponsors the management of KM by setting policy for its use and providing funding for its maintenance. • Promotes the KMS by communicating its importance in the NG organization's business objectives. • Provides upper management support for all KM activities. • Promotes KM messages and activities consistently across organization.	• Should be a Level II manager or above.
Center Knowledge Officer (CKO)	• Ensures KM activities align with business objectives. • Develop an overall framework that guides KM. • Oversee development of KM infrastructure. • Promotes and encourages participation in KM activities.	• Should be Level I manager.
Knowledge Leader (KL)	• Identifies and assess the value of knowledge in the organization. • Collects knowledge from the SME and knowledge workers. • Submits the knowledge to the KB. • Provides templates for team members to capture critical information. • Ensures critical information is captured in a timely and consistent manner. • Facilitates management of information between the SMEs, center contributors, and the KB. • Ensures that information is reviewed by a domain expert or SME. • Collaborates with other project/team leads in the organization to ensure KM activities are consistently practiced.	• Team Lead (such as, the product realization team lead) who is in charge of a domain of knowledge. • There are several KLs within an organization.
Knowledge Broker (KB)	• Manages information in the KMS. • Facilitates knowledge sharing sessions.	• Full-time employee dedicated to KM in the

Role	Responsibility	Comment
	• Trains employees on how to use the KMS. • Identifies all experts and the domains for which they are responsible. • Answers knowledge questions posted by employees. • Posts all questions and information to an archival system. • Monitors the KMS.	NG organization. • Should be an experienced staff member who understands the organization very well.
Knowledge Leadership Team (KLT)	• Develops strategic planning for KM. • Ensures employees are recognized for KM efforts. • Determines critical information that needs to be captured and archived. • Assists in aligning the center towards a common mission. • Finds what is working well and shares with the NG organization. • Plans for continuous improvement of the KMS. • Assists in securing the proper resources needed for the KMS. • Analyzes metrics collected and reports results to all levels of management.	• Team consists of KMC, CKO, KL, and KB.
Subject Matter Expert (SME)	• Provides critical knowledge to be preserved in the KMS.	• Should be an individual with a deep knowledge about a specific domain or topic
Knowledge Workers/Center Contributors	• Plan and practice the KM activities as part of day-to-day work activities. • Manage knowledge effectively. • Assist the SME in providing critical information for the KMS. • Manage information, time, tasks/processes, and goals. • Access, filter, analyze, accumulate, store, communicate, and apply knowledge. • Use communication, collaboration, and information management technologies effectively to navigate the information and knowledge environment.	• Should be all employees.
Knowledge Consultant	• Assists the organization with KM activities. • Develop KM objectives and strategy with the KLT to support organizational KM processes. • Assess existing KM processes and intellectual capital to provide guidance on potential, process improvements. • Educate the organization about KM. • Facilitate KM activities for the organization.	• Individual external to the organization.

4.6   Knowledge Sharing

Knowledge sharing helps individuals develop and continue learning. It also makes employees feel a part of the NG organization. The following are recommendations for how to share and transfer knowledge within the NG organization.

4.6.1   Community of Practice

Community of Practice (COP) consists of a group of employees that form to share what they know and learn from one another. These groups are usually informal with people who voluntarily gather and share their expertise. The NG organization has implemented a COP (i.e., Brain Bank) for over 10 years and it has been very useful to those involved. It is important that employees with a common interest continue to share experiences and critical information. The SEA KM team recommends that COPs be formed in the NG organization to share knowledge and find solutions to specific problems or experiments. A COP lasts until the problem is solved or experiments are completed. This means that COPs are not static but dynamic and situational. COP activities can consist of weekly or bi-weekly meetings or discussions on a collaborative website. The COP process includes the following:

- A KL is notified by the knowledge workers of a problem or an experiment that requires a COP.

- The KL can request a KM consultant to assist in the implementation of the COP.

- The KL forms a small team to scope and define the COP, which then becomes active. This small team includes the KB.

- The KB notifies the NG organization of the new COP. The SMEs and center contributors are invited to become part of the COP.

- The KB posts the results and information to the KMS upon resolution of the problem or completion of the experiment.

4.6.2   Knowledge Map

The KMS should contain information about knowledge, resources, and experts in the NG organization to ensure that employees know who to see and where to find information. KMS mapping ideas include

- the relationships between communities involved in knowledge creation and sharing,

- the relationship of knowledge assets to core business processes,

- network of experts,

- knowledge sources,

- information on skills and expertise (i.e., core competencies), and

- indicators that show with whom and at what point a person should share knowledge.

4.6.3 New Personnel

Currently, people new to the NG organization are placed into a position with minimal training and guidance. It would be highly productive if knowledge was formally transferred to these employees. The following are suggestions for sharing knowledge:

- Provide trained mentors; the KLT will assign new hires to a trained mentor.

- Create a 90-day roadmap with information that will help get new personnel assimilated into the organization; this information can be linked to the center website or KM collaborative website.

- Educate new hires on the KMS; all new personnel should receive a briefing on KM activities in the NG organization.

4.6.4 Bulletins

Bulletins are a good way to advertise KM activities and to share knowledge within the NG organization. The bulletins would include best practices, case studies, or lessons-learned information that needs to be shared with the NG organization. Bulletins are sent bi-monthly via the internal mail to all center employees. These publications are professionally done by the Creative Arts department at Sandia. The bulletins will not only inform the organization of what is going on but they will also market KM services, activities, and tools. The process for generating the bulletins is as follows:

- Email is sent to the NG organization asking if there are any best practices or lessons learned that would like to be featured in the bulletin.

- The knowledge consultants or technical writers collect information for the bulletin.

- Technical writers review the information and format it into a news bulletin format.

- A draft of the bulletin is sent to the Creative Arts department to finalize the bulletin.

- The print shop prints the bulletins and distributes them to members of the NG organization.

Bulletins increase visibility for staff members and showcase the work being done in the organization. These bulletins may also be available to distribute electronically.

4.6.5 Cross Training

Employees in the NG organization are in charge of specific roles, processes, and systems. It is likely that each person is responsible for a specific job. This practice becomes a problem when the employee leaves or goes on vacation because it is likely no one can cover for them if an issue occurs. The SEA KM team recommends that the manufacturing organization consider a "two-in-a-box" or cross training process. A two-in-a-box process means that staff members have overlapping duties and responsibilities to ensure there is more than one person to maintain and capture the knowledge. The two-in-a-box process should be required for critical equipment, products, and processes.

4.6.6   Incentives

Creating a new KM process will be a challenge primarily because it asks the culture of the NG organization to change. There must be an incentive for the staff to accept the process. Providing criteria for incentives will motivate staff to accept and efficiently use the process. The following are some suggested incentives for those who adopt the KM process:

- Provide public recognition for supporting and contributing to the KMS. Being recognized for KM efforts will demonstrate to others the importance of KM.

- Ensure that KM activities are a part of the employee's PMF.

- Maintain a list of employees on a recognition board, which also indicates their contributions to the KMS.

4.6.7   Tools

When people think of KM, they often think of a tool. KM is not a tool; it is the process for capturing and maintaining critical information. KM tools are designed to facilitate work and support KM activities.

At this time, no one tool is being recommended by the SEA KM team for KM activities in the NG organization. However, the team does recommend that corporate supported tools currently being used at Sandia be considered (e.g., Microsoft SharePoint, Wiki, Web FileShare, etc.). The main tool used for KM activities should be a tool that promotes collaboration; such as a discussion board that allows people to talk to each other, pose questions, and learn from each other.

There is no standard KMS that provides an all-in-one solution for managing knowledge in an organization. The following are examples of tools that have been used for KM in major companies and at Sandia:

- Discussion boards
- Portal technology
- MS SharePoint
- Advanced search capabilities (e.g., SAS Enterprise Miner)
- Wiki
- Content management systems
- Mind-mapping tools
- Document repositories

4.6.8   Metrics

Once a KM program is in place, the program needs to be evaluated to ensure that KM activities are successful in the organization. The following are recommendations for possible metrics:

- Results from customer satisfaction surveys.
- Total number of requests sent to the KB over a period of time.

- Total number of active COP groups over a period of time.
- KM tool usage.
- User metrics.
- Success stories.

4.7　Resources

The following are example documents, templates and forms that could be used during the knowledge capture process or in collecting metrics. These example documents can be viewed in Appendix B.

- <u>Current State Analysis Questionnaire:</u> This questionnaire is distributed annually to help determine what information needs to be captured for the year.
- <u>Knowledge Capture Template</u>: This is a template to be used to capture new knowledge that needs to go into the KMS.
- <u>Change Request Form</u>: This form is used to update existing knowledge currently in the KMS.
- <u>Knowledge Management Satisfaction Survey</u>: This is an example survey to collect metrics on the KMS.

5.0　CONCLUSION

The benchmarking effort, including the site visits to Toyota and Halliburton, provided valuable information on how the SEA KM team could incorporate a KM solution for not just the NG community but the entire laboratory. The laboratory needs a KM program that allows members of the workforce to access, share, analyze, manage, and apply knowledge. KM activities, such as COPs and sharing best practices, provide a solution towards creating an enabling environment for KM. As more and more people leave organizations through retirement and job transfer, the need to preserve knowledge is essential. Creating an environment for the effective use of knowledge is vital to achieving the laboratory's mission.

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APPENDIX A: KM DEFINITIONS

Knowledge: Part of the hierarchy of data, information, and knowledge; knowledge is the awareness and understanding of facts, truths or information gained in the form of experience or learning, or through introspection.

Explicit Knowledge: 1) The type of knowledge that can be verbally explained, codified, or written down in specific documents. 2) The formal, recorded, or systematic knowledge in the form of scientific formulae, procedures, rules, organizational archives, principles, etc., which can easily be accessed, transmitted, or stored in computer files or hard copies.

Tacit Knowledge: 1) The type of knowledge that is in people's heads; their experiences. 2) The personal knowledge resident within the mind, behavior, and perceptions of individual members of the organization

Knowledge Capture: The means of acquiring specific intellectual knowledge derived from various sources

Knowledge Domain: A body of knowledge that is often associated with a specialized discipline

Knowledge Management (KM): Identifies, maps, and leverages intellectual assets within an organization; the systematic process of identifying, capturing, managing, and sharing information

Knowledge Management System (KMS): A system for managing knowledge in organizations, supporting creation, capture, storage, and dissemination of information; a KMS not only includes tools, but the people and the processes for sharing, capturing, and applying knowledge.

Knowledge Spiral (KS): Describes the necessary steps an organization goes through to create a successful KMS.

Sustainable Knowledge Management (SKM): An organization's process of sharing and consistently documenting the flow of critical information throughout the product lifecycle

APPENDIX B: Resources

B.1 Current State Analysis Questionnaire

Current State Analysis Questionnaire

This survey is to ensure that all critical data necessary to the continued successful operations of the Neutron Generator community is collected in the knowledge management system. The information you provide should be related to the work you currently do and the information you need to do your job.

Please take a moment to answer the following questions.

1. What types of technical information and critical knowledge do you need to do your job?

For each type of technical information and critical knowledge you specified in the first question …

2. Besides yourself, who else might need this information? Please list their names, roles and/or job titles.

3. How do you use this information and knowledge to produce a valued added benefit to your organization? Please list specific examples.

4. Who are the "experts" in your organization housing the types of information and knowledge that you need? Please list their names, roles, and/or job titles.

5. Who has contacted you for information and/or knowledge that you have, and what was it that they wanted to find? Please indicate roles/responsibilities of these individuals, as well as whether or not they were new or senior members of your organization.

6. What types of questions do you have to which you cannot find answers? How do you attempt to get this information, and to whom might you talk with to find this information?

7. What are some risks or concerns for obtaining information and/or critical knowledge?

8. Additional Comments

About You

Name   Phone

Thank you for your participation

B.2 Knowledge Capture Template

Knowledge Capture Template

You have been identified as a subject matter expert (SME) in a particular domain area. This template is used to facilitate the knowledge capture process by providing us with key areas of information that should be captured in the Knowledge Management System (KMS). Please fill in as much detail as possible.

Date:_____

Contact name:_____ **Phone:** _____

Domain area: _____

Roles and responsibilities:
Describe your role, the roles of others, and the responsibilities associated with these roles in relation to this work.

Topics or categories:
Please provide a list of topics or categories that may be used to break down your current domain area into smaller subsections.

Topic details:
Describe the details of each category provided in the previous section. For example, what are the processes currently used? Are these documented? What were the types of problems/issues you were trying to solve within this domain?

Domain value:
Why was this domain created within the Neutron Generator community? How long has it existed? Within this domain, what critical decisions have been made in the past and why?

Lessons learned:
In your experience, what has gone well and what has not within your domain? What have you learned from this work?

Future direction:
What are the future plans for work within your domain? What are some ideas for future work that may not yet be funded or vetted?

Additional Comments:

B.3 Knowledge Change Request Form

Change Request Form   **Date:**_____

This form is to make a change to the KM website. Please fill out the following information and send back to the knowledge management team.

Requester name: _____

Domain name: _____

Subject matter expert required for review:_____

Do changes need to be made to a document? Y N

If yes, please provide the document name:

Do changes need to be made to content on the Knowledge Management (KM) website? Y N

If yes, please provide the KM website page and section:

Reason for the change:

Change details:

Approved by:_____

Approval date:_____

B.4 Knowledge Management Satisfaction Survey

Knowledge Management Satisfaction Survey

Please indicate your rating for each statement below by checking one of the values on the 5-point scale. A value of 1 indicates "Strongly Disagree" and a value of 5 indicates "Strongly Agree." Please check only one rating per statement.

	Strongly Disagree 1	2	3	4	Strongly Agree 5
1. The Community of Practice (COP) Knowledge Management (KM) activity is useful.	☐	☐	☐	☐	☐
2. The knowledge capture process has helped me preserve knowledge.	☐	☐	☐	☐	☐
3. The knowledge capture process is simple to use.	☐	☐	☐	☐	☐
4. The various functions on the KM website are well integrated.	☐	☐	☐	☐	☐
5. The information on the KM website is consistent.	☐	☐	☐	☐	☐
6. The templates used to capture knowledge contain the right amount of information.	☐	☐	☐	☐	☐
7. The templates used to capture knowledge capture the correct types of information.	☐	☐	☐	☐	☐
8. KM activities are valuable to the organization.	☐	☐	☐	☐	☐
9. I use the KMS to locate information related to my job.	☐	☐	☐	☐	☐

10. Additional Comments:

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