

Knowledge Management for Transferring Nuclear Industry Technical Knowledge to Next Generation

Amid a pressing need to address working style reform and a generation of people in senior roles who are now leaving the workforce, the systematic management of knowledge and skills and the passing on of these to the next generation are recognized as important challenges by many companies. Similarly, the handing on of expertise in nuclear energy is also an urgent issue for Hitachi-GE Nuclear Energy, Ltd., the company responsible for Hitachi's nuclear power business. In response, the company has called on the assistance of external consultants to identify the challenges by means of in-house surveys and to visit benchmarking best-practice organizations in knowledge management both in Japan and overseas, and is introducing knowledge management practices based on the results of this study. This article describes the knowledge management initiative that has been undertaken since 2017 on the basis of “transferring knowledge from person to person,” “connecting people,” and “connecting people with information,” and the plans for the future.

Tadasu Yagi, P.E. Jp.

Yoshinori Terao

Hiroko Morino

Tetsuya Matsui, Ph.D. and P.E. Jp.

Naoki Ogiwara

Koshi Sakata

1. Introduction

Hitachi-GE Nuclear Energy, Ltd. (Hitachi-GE) used an in-house survey and interviews conducted in 2017 to identify the primary challenges surrounding technical knowledge transfer in its internal operational reforms. This found that, while there is a rich store of expertise in the tacit knowledge of individuals, the corporate organization lacks the means to put this knowledge to use in a systematic manner. In

terms of the “socialization, externalization, combination, and internalization” (SECI) model proposed by Ikujiro Nonaka, Professor Emeritus at Hitotsubashi University, the conclusion was that the company as a whole was placing a low priority on “combination” (the process of combining explicit knowledge and generating new explicit knowledge), and was not putting time into achieving this⁽¹⁾. Accordingly, Hitachi-GE set itself an objective of implementing knowledge management (KM) to improve the formalization of knowledge and its systematic sharing and use.

Figure 1 — Roadmap for KM Activities

The roadmap is based on the maturity model used by the American Productivity & Quality Center (APQC), one of the world’s largest knowledge management (KM) organizations.

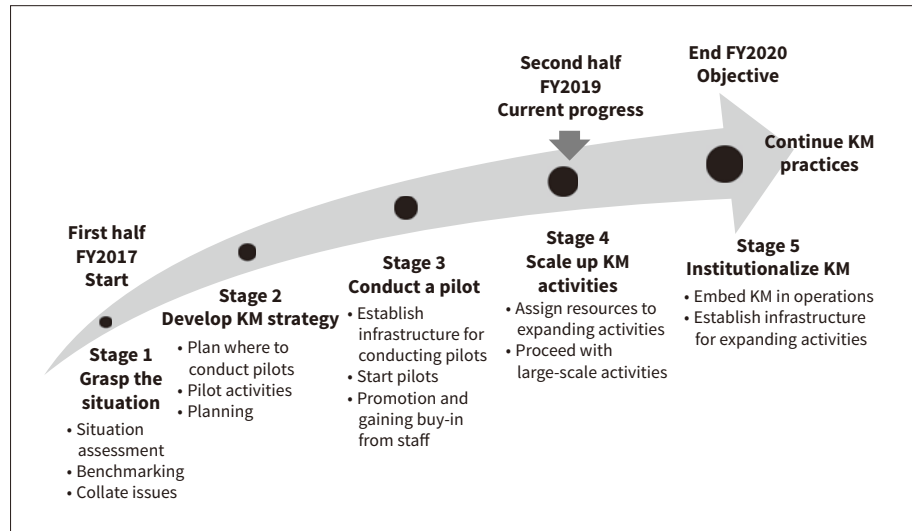


Table 1 — KM Implementation Strategy

The table lists examples of the vision, KPIs, and strategy required for implementing KM.

Vision	Systematically create, accumulate, transfer, and utilize nuclear energy knowledge in order to become capable of designing, building, maintaining, and decommissioning nuclear plants anywhere in the world with absolute certainty.		
KPIs	<ul style="list-style-type: none"> • Reduce risk that important knowledge will be lost • Shorten time taken to resolve problems • Reduce rework 	<ul style="list-style-type: none"> • Shorten time taken to access information • Shorten time taken for new staff to become productive • Shorten time spent by supervisory staff on instruction 	
Activity strategy	<ul style="list-style-type: none"> • Transferring knowledge from person to person Identify key knowledge areas and systematically transfer knowledge from experts to nexperts to maintain and improve organizational technical capabilities. 	<ul style="list-style-type: none"> • Connecting people When confronted with a problem, quickly identify experts who have the best mix of experience and knowledge, and put these people in contact with each other to achieve a speedy resolution. 	<ul style="list-style-type: none"> • Connecting people with information Systematically organize information to provide easy and efficient access, and transfer information across generations.
Tools	<ul style="list-style-type: none"> • Knowledge map • Knowledge transfer program • Storytelling 	<ul style="list-style-type: none"> • Expert locator • Communities of practice • World Café 	<ul style="list-style-type: none"> • Onboarding • Advanced search tools • After action reviews

KPI: key performance indicator
* An abbreviation of “next expert”

2. Learning from International Leaders in KM

While KM experienced a global boom in the early 2000s, there are few reports of companies in Japan that have persisted with it to the present day. At many European and US companies where staff turnover is routine, however, the question of how to retain knowledge within the organization has long been an issue and for this reason KM has become a regular part of business management as a means of achieving this⁽²⁾.

Accordingly, Hitachi-GE embarked on KM by conducting benchmarking against US companies, specifically the American Productivity & Quality Center (APQC), the world’s largest KM organization, and its member companies.

The three keys to successful KM identified by this

study were: (1) Linking KM strategy to business issues, (2) Putting governance measures in place for KM implementation, and (3) Proceeding step by step on the basis of a roadmap. Accordingly, Hitachi-GE’s roadmap for KM was broken into stages, as shown in **Figure 1**. Stage 1 is to grasp the situation, Stage 2 is to develop a KM strategy, Stage 3 is to conduct a pilot, Stage 4 is to scale up KM activities (company-wide rollout), and Stage 5 is to institutionalize KM.

KM at Hitachi-GE was launched after Stage 1 was completed. The next step, Stage 2, was to establish an implementation strategy. In addition to laying out a KM vision and policies for action aimed at achieving its corporate vision and key performance indicators (KPIs) based on “transferring knowledge from person to person,” “connecting people,” and “connecting people with information,” the company also designed specific actions (see **Table 1**). The following

Figure 2— Example Knowledge Map for Nuclear Power Plant

Knowledge mapping provides a formalized method for identifying the knowledge in each technical category and highlighting the priorities for technical knowledge transfer. When there are multiple input and output documents associated with a topic, a resource called a linkage document is produced to list these documents and indicate how they are linked.

Phase 1			Phase 2						Phase 3					
(1) Technical category	(2) Sub-category	(3) Knowledge to be passed on	(4) Person responsible	(5) Expert	(6) Nexpert	(7) Seriousness	(8) Urgency	(9) Priority	(10) Fundamentals	(11) Relevant documents	(12) Document IDs	(13) Means of transfer	(14) Progress	(15) Deadline
Nuclear power plant planning	Plant plan													
	Plant development plan													
	Plant equipment plan													
	Quality assurance plan													
Reactor and major equipment plan	Reactor design													
	Reactor internal design													
Auxiliaries	Fuel handling equipment design													
	Piping and valve design													
	Plant utilities design													
Turbines, generators, and auxiliary equipment	General equipment review													
	Steam turbine design													
	Turbine-generator design													
	Heat exchanger design													
Electrical equipment	Power system design													
Instrumentation and control equipment	Overall system review													
	Plant control design													
Civil engineering equipment	Civil equipment design													
	Construction equipment design													
Seismic design	Review of seismic design importance classifications													
	Earthquake strength calculation													
Construction work	Construction plan review													
	Installation work													
Radiation protection and management equipment	Basic principles review of radiation protection													
	Dose management													
Nuclear fuel cycle	Nuclear fuel cycle design													
	Reprocessing design													

Example linkage document		
Knowledge to be passed on	Input documents	Output documents/ supporting documents
Steam pipe routing design	Power system design specification	Route drawing
	Layout drawings	Steam pipe gradients
	Piping and instrumentation drawings	Steam pipe bend shapes
	Valve drawings	Steam pipe spacing
		Drain port dimensions
		Location of pressure sensor taps

section describes how Hitachi-GE went about creating knowledge maps for transferring knowledge from person to person, an area of particular focus.

3. KM Activities

Critical to the implementation of KM is to identify which technical knowledge is important to the organization and to manage it in a systematic manner. At Hitachi-GE, a key part of Stage 3 was the work done by the design departments on producing knowledge maps (a tool that is also widely used by companies overseas).

3.1

Study into How to Produce Knowledge Maps

As different companies create and utilize knowledge maps in different ways, it was necessary to work out which approach would work best for Hitachi-GE. The key elements that go into knowledge maps at Hitachi-GE are to determine the technical categories and identify who holds the knowledge, and then to prioritize these and decide on a method and deadline for transfer. Figure 2 shows an example Hitachi-GE knowledge map. Note that one of the KM practices used at many of the US companies benchmarked

against is that of identifying and training “nexperts*,” the people who are to be the recipients of the expertise.

3.2

Putting Knowledge Mapping Procedures and Technical Knowledge Transfer into Practice

The knowledge maps were produced by groups of five to ten people, with several such groups in each section. Knowledge identification initially involved the preparation of a draft by the “nexperts” (mostly around 35 years of age) assigned by the section manager. Next, simple workshops were held with experts (primarily senior engineers) and advisers (primarily chief engineers), to confirm and revise the topics identified. These workshops also provide an opportunity for nexperts to acquire knowledge from experts and for the experts to get a sense of the concerns of nexperts and the areas in which their knowledge is inadequate. Given the difficulty of identifying all knowledge map topics at a single workshop, preparation of the maps involves the following three phases.

Phase 1: Identification of the technical categories and knowledge to be passed on

This identifies the technical categories (topics and sub-topics) and the knowledge to be passed on [(1) to (3) in Figure 2].

* An abbreviation of “next expert”

Phase 2: Identification of the person responsible, expert, and nexpert, and setting of priorities

This specifies the experts and nexperts for each topic along with their seriousness, urgency, and priority [(4) to (9) in **Figure 2**].

- Seriousness indicates how important the topic is, with more points given for proprietary expertise and fewer points for peripheral material that is covered by textbooks.
- Urgency indicates how urgent the topic is and involves the mechanical counting of how many people there are with expertise in the topic, with higher points given for knowledge held by only one person. Experts over the age of 55 are counted collectively as only one person.
- Priority is obtained by multiplying seriousness by urgency and is used to prioritize the topics.
- The “person responsible” for each topic is the section manager with responsibility for the knowledge map.

The objective of the activities up to phase 2 was to create the knowledge maps.

Phase 3: Implement a technology transfer program

Having highlighted which areas of expertise are in urgent need of transfer, each group embarked on a technology transfer program [(10) to (15) in **Figure 2**].

- The means of transfer and deadlines are specified for high priority expertise (those with high importance and urgency).
- As the best ways to transfer expertise vary, the work to be done is determined accordingly, including documentation, study groups, simulated exercises, and on-site training, etc.
- In order to transform tacit knowledge into explicit knowledge wherever possible, documentation serves as the main means of transfer (translating knowledge from the heads of experts into documentary form and collating the scattered material held by these experts).
- Prepare lists of input documents (documents derived from reference standards and other information from other departments), output and supporting documents (documents produced within the department, including those for internal use only), and so on. “Linkage documents” (catalogues) are also created that contain details of where each of these documents is held so that they can be accessed quickly.

4. Issues Raised by KM Activities

One lesson learned from benchmarking was the importance of putting governance in place, especially the core organizational infrastructure. Accordingly, the core framework for the governance of KM was established by assigning a senior company manager as sponsor, the chief engineer as advisor, and designers from each technical category to direct the work. Rather than relying on a top-down approach, it was essential that KM activities be integrated widely across the company given the need for staff to recognize the importance of the activities if they were to take place at a company-wide level.

4.1

Obstacles to Knowledge Map Creation

The initial schedule was to use a top-down approach to complete the Phase 2 knowledge mapping [up to step (9) in **Figure 2**] across all design departments over a half-year period. Unfortunately, the percentage of departments that had completed their maps after six months was even less than the planned 50%. What was found when interviews were conducted to assess progress in each section was that an attitude of prioritizing work for customers was making it difficult for people to place a higher priority on KM work. This highlighted the need for all staff to recognize the importance of KM and to make it possible for them to engage in the activities as part of their routine work.

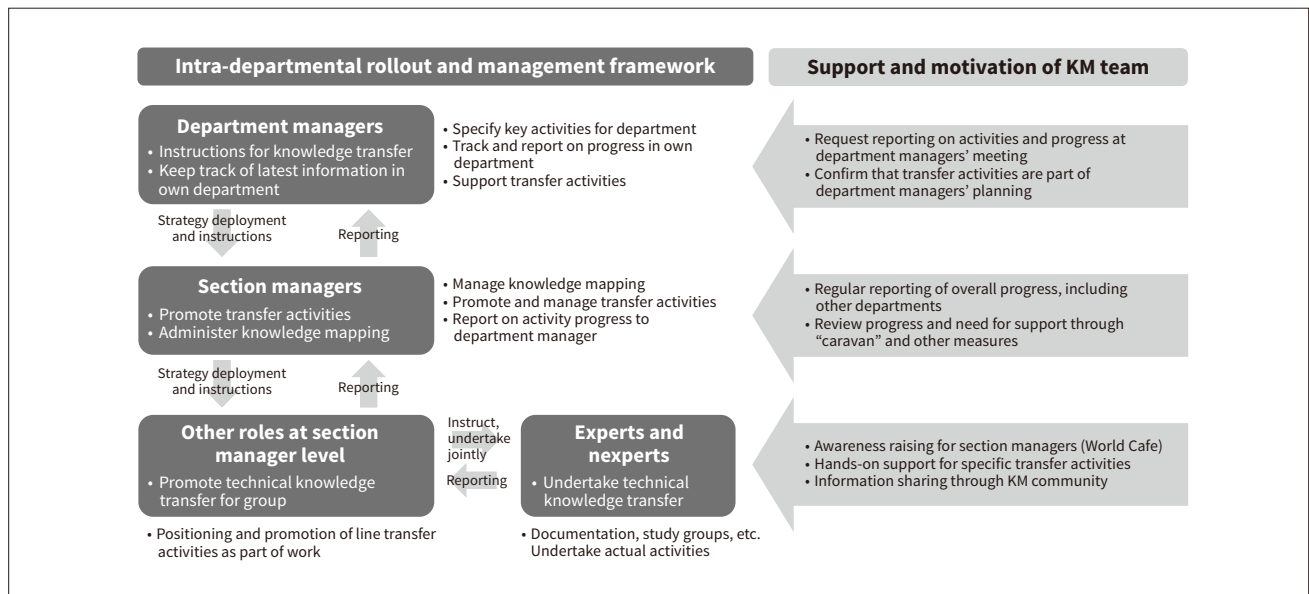
4.2

Example Measures Adopted for Knowledge Mapping

As the concerns raised by KM, like those noted above, vary across the hierarchy, from department managers and section managers to others at the section manager level, experts, and nexperts, the core scheme was designed on the basis that KM needs to be promoted in different ways to people at different levels (see **Figure 3**). (1) Department managers were requested to incorporate the technology transfer program into departmental action plans and to regularly report on progress at monthly department managers’ meetings.

Figure 3 — Core Scheme for Promoting KM

The diagram shows the core scheme for promoting KM throughout the organization. As the organization gets larger, the aim is to make KM activities increasingly integral through an approach that is tailored to different employee roles.



(2) For section managers, checks were made on progress and on what support was required through interviews conducted in each period, with the regular reporting of company-wide progress, including that of other departments.

(3) For other staff at the section manager level, given the large number of people involved and the need to undertake specific technical knowledge transfer programs, World Café events were held as a means of raising awareness of technical knowledge transfer programs and sharing details of how the programs were being undertaken, and any concerns that had arisen. A World Café is a large gathering where people can share details of their progress and concerns regarding the topics they are working on in an environment that encourages such discussion. The first event was attended by more than 200 people.

(4) Experts and nexperts were provided with hands-on support through initiatives such as the facilitation of knowledge mapping workshops. Nexperts representing each section also made use of knowledge communities to share information on best practices for the technical knowledge transfer activities in their departments, challenges that have arisen, and how to deal with them.

These measures proved very effective for getting the technical knowledge transfer programs established within the organization.

4.3

Keeping KM Activities Ongoing

It is believed that activities to date have left staff with a deeper understanding of the importance of KM. Furthermore, the creation of knowledge maps has enabled the identification of existing technical knowledge and their systematic management. Meanwhile, there remains a need to address future technological developments. In this regard, there is a need to embed technical knowledge transfer into the work processes of each section or group and this will be among the challenges of future KM activities.

5. Conclusions

Technical knowledge transfer is recognized as a never-ending task. The nuclear energy sector calls for expertise to be maintained over the century-long timespan from plant construction to decommissioning. Because it takes a lot of time to recover expertise once it has been lost, there is a need to step up KM at an organizational level. While KM activities at Hitachi-GE have to date focused on design departments, the intention is to expand the scope of activities to project and quality assurance departments and on-site work, as laid out in Stage 4 of the roadmap. For the Stage 5 objective of institutionalizing KM, the intention is

to continue expanding the scope by taking current activities to a higher level through measures such as providing systems for coordinating knowledge maps with human resources information, and also by making KM an integral part of operational activities.

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Authors



Tadasu Yagi, P.E. Jp.

Nuclear Business Planning & Management Department, Nuclear Business Planning & Management Division, Hitachi-GE Nuclear Energy, Ltd. *Current work and research:* Knowledge management activities for the entire company. Certifications: Project Management Professional (PMP).



Yoshinori Terao

Nuclear Business Planning & Management Department, Nuclear Business Planning & Management Division, Hitachi-GE Nuclear Energy, Ltd. *Current work and research:* Knowledge management activities for the entire company.



Hiroko Morino

Nuclear Business Planning & Management Department, Nuclear Business Planning & Management Division, Hitachi-GE Nuclear Energy, Ltd. *Current work and research:* Knowledge management activities for the entire company.



Tetsuya Matsui, Ph.D. and P.E. Jp.

Nuclear Business Planning & Management Division, Hitachi-GE Nuclear Energy, Ltd. *Current work and research:* Management of R&D. *Society memberships:* The Atomic Energy Society of Japan (AESJ) and the Japan Society of Maintenology (JSM).



Naoki Ogiwara

Managing Director, Knowledge Associates Japan, Ltd. *Current work and research:* Help public and private sector organizations develop strategies and implement initiatives in the area of knowledge management, innovation management, and change management. Certifications: Served as Senior Knowledge Management Officer, The World Bank; Master of Business Administration (MBA) from Babson College (summa cum laude).



Koshi Sakata

Business Planning & Strategy Division, Energy Business Administration Division, Hitachi, Ltd. *Current work and research:* Planning and execution of medium- and long-term strategies for nuclear business.