
MANAGING NUCLEAR KNOWLEDGE: A SCK•CEN CONCERN: *STATUS OF A PRACTICAL KNOWLEDGE MANAGEMENT APPROACH*

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Abstract. Preserving and enhancing the institutional memory has become a strategic concern for SCK•CEN. Managing the Knowledge Capital is a long term journey, starting from a strategic commitment and integrating various operational projects. Since 2002, several pilot projects in different areas of expertise have been conducted to set up nuclear knowledge repositories and to sustain interactive research communities. Beyond the establishment of a corporate knowledge sharing culture, dedicated web-based portals based on both well established and emerging open source internet technologies ensure the long term persistence of data and the continuous capture of knowledge by providing on-line tools and related QA procedures.

1. Background

Since its foundation in 1952, SCK•CEN, the Belgian Nuclear Research Centre has always been a nuclear knowledge-oriented organisation aiming at solving topical problems based on experience in the field, model-oriented experiments and fundamental research. Handling knowledge is therefore part of our core business. Our knowledge exists in different forms and formats ranging from dispersed pieces of technical or scientific information on different media to a complex reservoir of know-how accumulated by managers, researchers and technicians with the educational background, expertise and acquired insights required to apply safely and effectively our nuclear knowledge.

In recent years, political, economical and societal trends urged the need for an efficient nuclear knowledge management[1,3]. Foremost, the Belgian government has decided to phase-out nuclear power plants. Privatisation and deregulation rules of the energy market in the European Union drives the nuclear industry to compete in the immediate and near term with other sources of electrical energy. This might result in a reduction of work force and budgets allocated to R&D. These two decisions have as a side effect that fewer young people are attracted by studying nuclear science and nuclear engineering, making the issue of the replacement of the aging nuclear workforce even worse.

This changing environment requires therefore the pro-active retention and preservation of our comprehensive nuclear knowledge. In 2002, we started to develop our own practical knowledge management approach relying on basic principles from the knowledge management paradigm but adapting them to the very specific needs of a nuclear research centre[4,6].

2. Managing Nuclear Knowledge at SCK•CEN

We understand knowledge management as a holistic approach that is oriented to both technology and human resource management. Therefore, Knowledge Management is not primarily a technological phenomenon but comprises apart from “hard” factors also “soft” human factors. Successful knowledge management is based upon different enablers who are in a reciprocal relationship with each other, as schematically depicted in Fig. 1: strategy, people (corporate culture), organization (processes), and technologies.

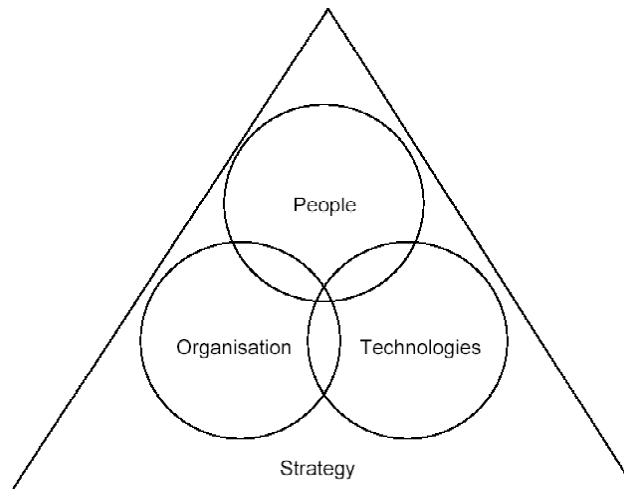


FIG. 1. The KM framework

Managing the knowledge capital is therefore a long term journey, starting from a strategic commitment, integrating various operational projects and gaining trust. In what follows, we discuss why a successful KM implementation asks for the alignment of the KM strategy with the organisational objectives while a middle-up-down approach addresses the knowledge-related needs and problems.

2.1. Underpinning our Knowledge Management approach: a strategy as knowledge matters

Any formal attempt at defining a corporate KM strategy should be aligned with the overall organisational strategy and not be seen as a standalone initiative. Only a clear organisational strategy based on a long-term strategic vision can help to identify the critical pieces of knowledge to be captured and distributed to guarantee its survival and growth.

The SCK•CEN's core competencies reflect a strong 50-year background in nuclear research: advanced nuclear reactor concepts, radiation effects on materials and living beings and on the knowledge on the migration and interaction of radioactive materials in the biosphere, the geosphere, the human body and the food chain. Our core competency areas are supported by key capabilities such as e.g. health-related services covering both radiation protection and medical applications; nuclear safety analysis, site characterization and remediation, analytical chemistry, computational modelling and simulation etc. Capturing and sharing this critical knowledge and expertise is crucial to maintain our core competencies and to preserve the institutional memory for the next generations.

We are pursuing our efforts on preservation and sharing of this critical knowledge and expertise in order to encourage creativity and innovation for our own survival and growth, to preserve the outcome of multidisciplinary research on the long term, to be accountable to different stakeholders (customers, research community, government, national authorities ...)

Additional goals of our KM programme are to generate new knowledge, to ensure sustainable added value to our research work and services and to stimulate the scientific excellence. We therefore stimulate academic courses and trainings in nuclear sciences and nuclear engineering to maintain qualified personnel for safety and security reasons and to keep, despite the rotation of personnel, the knowledge and expertise available in working practices so that routine tasks can be quickly executed [7, 8].

2.2. *Making the Knowledge Management strategy operational*

2.2.1. *A middle-down-up approach*

In this approach, middle managers play an important role by working as a "bridge" between the broad vision of the top management and the realities front-line that knowledge workers are confronted with. Top down leadership continues to be essential for the KM implementation because traditional hierarchical structures will not disappear overnight. They will provide the necessary incentives supporting a KM project. Therefore we had to identify the 'Knowledge networks' that could be first involved in KM pilot projects and that are generally tacitly recognised as enthusiastic proponents. These knowledge networks can play the role of early adopters of KM.

2.2.2. *Practical KM implementation: building on 'what already exists'*

The driving force of our knowledge management programme is the recognition that the knowledge generated nowadays and in the past is a valuable asset for future scientific research because it involved huge investments of scientific, human and financial resources. Our programme started in 2002 with the identification of the different processes already capturing, organising and sharing both tacit and explicit knowledge throughout our organisation:

The QA system is pursuing traceability, validation and overall professionalism. It was already busy eliciting tacit knowledge in a simple manner by structured transcriptions based on "write what is to be done". Our internal and external publications, so-called 'Scientific output', are recorded and evaluated through a QA procedure.

- Researchers share their knowledge through publication in international journals or through participation at conferences, meetings, etc.
- Several R&D databases provide elementary knowledge on key parameters and processes.
- SCK•CEN continuously organise numerous in-house training sessions according to the principle of 'the learning organisation'.

However a co-ordinated approach to Knowledge Management requires an efficient re-use of the recorded knowledge and an effective transfer of the available knowledge. The first objective of the KM programme is therefore the continuous improvement of the information management coupled with the elicitation of tacit knowledge, the stimulation of collaboration and the knowledge transfer.

2.2.3. *Towards a Knowledge sharing culture: gaining trust*

While ICT is clearly a part of the solution, knowledge management is not merely a technology or an IT issue but involves issues of organisational culture. The willingness of knowledge workers to share their expertise and to leverage explicit and tacit content is one of the most important pitfalls. Trust is definitively central to any knowledge sharing process. Knowledge preservation and transfer demands the set-up and the fostering of a proper environment of trust.

At SCK•CEN, we started to gain trust by setting up a library portal. This Knowledge Centre portal was designed as support tool in the daily work of our researchers by offering scientific information services for all users' needs. We integrated quality external scientific information sources with traditional library services. This library portal is evolving towards a knowledge management portal by enlarging his role to the management and safeguarding of the SCK•CEN Scientific Output.

3. Communities of practice: knowledge channels connecting people and content in a web-based portal environment

An internal knowledge management audit revealed that only part of the knowledge and expertise is captured outside the brains of our researchers. Since knowledge can hardly be

separated from its main carrier – the human being – the best environment for developing, capturing, sharing and applying knowledge is one in which people talk and work together. A knowledge network is a good example of a group that might turn into a community of practice (CoP) [9, 10]. This exchange of experiences and ideas allows workers to do their jobs better and more efficiently. There are many shades of definition of this concept, but we define a CoP by three critical components. The first is a domain: the members must share some minimum level of knowledge of the domain, something that distinguishes them from other people. The second is a sense of community: members provide mutual support, exchange and develop knowledge through permeable boundaries. Third a CoP requires a practice: members have a shared practice, engage in joint activities relevant to the organisation.

We therefore decided to set up interactive communities through open source web-based portals to help the elicitation of tacit knowledge while fostering collaboration through better internal communication channels. Those knowledge systems are based on the same underlying content management framework for storage, retrieval and re-use of shared document collections and databases. Those systems offer today such features as personalised interface, editing, version control and collaboration tools for discussion.

3.1. Knowledge related needs and problems: starting with better Information Management

The interaction of this knowledge with the vast amount of documents already available, should facilitate the elicitation and transfer of tacit knowledge in a more systematic way. We therefore initiated our practical KM programme by improving our information management. Bringing more structure, standardisation and cataloguing of the available information should ensure better retrieval and access of existing data and documents. KM also enhances the information objects by adding or linking related additional information and tacit knowledge.

A better information management implies also the choice of an adequate ICT infrastructure that offers user-friendly content publishing tool for easy contribution and take into account preservation in the long haul. In view of the long term aspects of the nuclear research programme and the preservation of its knowledge, special attention has to be paid to the 'digital longevity' of the stored information. One of the major criteria is the openness and flexibility of the way the information is recorded and handled. This is possible with emerging internet technologies that can be placed under the umbrella of eXtended Markup Language (XML) standards on structured data, data-management and communication protocols. The core of the web-based KM system needs to be developed without ties to a specific proprietary systems. However, it is important to point out that commercial products may be useful for an efficient information feed.

4. Knowledge and community portals at SCK•CEN

Web portals act as access points bringing together a large variety of explicit knowledge repositories and integrating multiple content sources through a single view. They offer community tools to easily share information and discuss issues and problems on specific topics or knowledge domains. They provide easy browse interface for navigating through islands of information and a strong search functionality which will help to maximise the benefits obtained from content. Furthermore, it will support serendipity by offering a means of connecting people and content that did not previously exist. They support R&D and management processes by allowing a better internal dissemination of documents and offering annotation facilities indispensable for the evaluation of content and the elicitation of implicit knowledge. We briefly present the KM portals currently in operation at SCK•CEN.

4.1. From the library portal towards a Knowledge Management portal

The Knowledge Centre portal integrated initially external scientific information sources with online library services. We enlarged his KM role to the management of the Scientific Output

(publications, conferences, reports etc.). In order to sustain self-assessment performance of conducted research projects, it offered to the entire SCK•CEN scientific community summarized statistics and dedicated editor interfaces. The developed system allows a web-based registration and review work-flow for storage and dissemination of this scientific output as indicated in Fig.2.

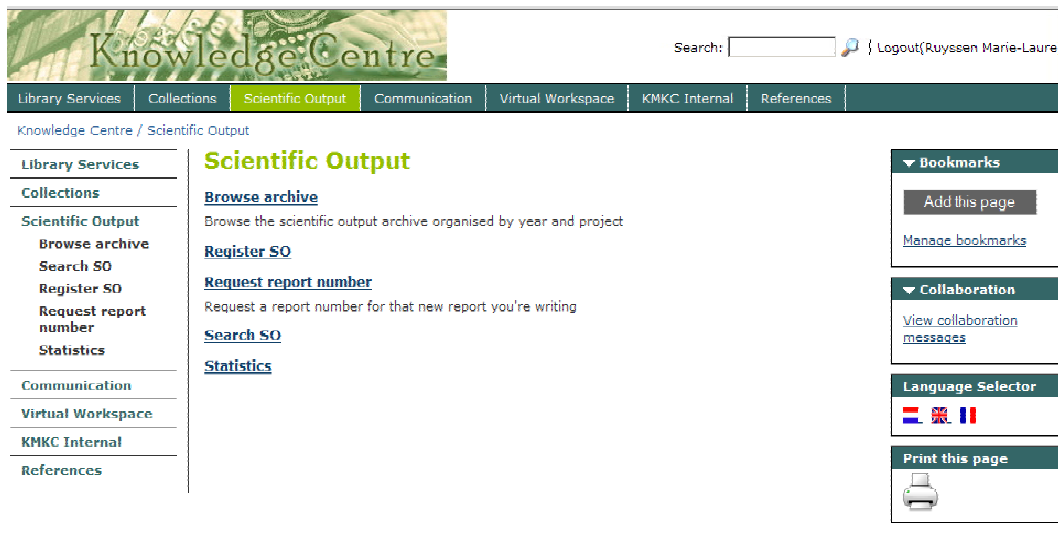


FIG. 2. Screenshot of the Knowledge Centre portal on the Scientific Output information system

This information system will also offer a tool for creating virtual workspaces for cooperation. A researcher will have the possibility to create inside this portal his own virtual workspace giving access to a group of colleagues in order to help its scientific writing process. He will have the possibility to centralise metadata on external and internal publications that he has collected for writing his scientific output. This repository will be integrated with existing desktop tools for reference management with import and export functions to/from BibTeX, RIS and RTF-format.

Furthermore the Scientific Output system will not only open new ways for generating but also promoting SCK research by selecting the most outstanding research results and publish it in “SCK monographies” and on our external website.

4.2. The Waste and Disposal community portal

As embryonic ideas on KM were already present, the Knowledge network in the nuclear waste and disposal R&D programme was the right test-bed for conducting the first KM pilot project at SCK•CEN. The Waste and Disposal portal has become the first community portal on research for nuclear waste disposal. Currently this portal is acting as an access point to shared document collections on topic oriented projects and task groups. Critical databases for performance assessment in the disposal of nuclear waste in the Boom clay have been set up. In 2003, basic Features, Events and Process-catalogue have been completed. This critical database aims to summarise relevant research and gives a current status on performance assessment.

Because knowledge generated in the past is a vital asset for the future, state of the art reports and critical documents are retroactively brought in. This will act as the starting point for a review system. This review system will lead to what we like to call “knowledge tracks” where the tacit knowledge of experts and scientists is recorded on specific topics (or even

simple questions) and which can be regarded as both in depth reviews and state-of-the-art (annotated) reports linking the major concepts and results.

Various databases developed over time, ranging from raw measurement results over structured data and meta-data on fundamental parameters, to QA related items such as instrument calibrations, multimedia enabled logbooks of geo-mechanical activities will be integrated into this portal. In collaboration with the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (NIRAS-ONDRAF), those repositories will be partially coupled to a Geographic Information System for the knowledge domains geology and hydrology.

4.3. The Instrumentation department portal: experiment management system for the gamma-radiation facilities at SCK•CEN

No commercially-available LIMS products can adequately serve the needs of research groups with limited IT budgets and with very specific and complex data structures. We therefore developed a dedicate web portal to help researchers of the Instrumentation department to handle through a graphical user interface all the scheduling and management of experiments involving the SCK•CEN gamma-radiation facilities.

Our researchers can schedule their experiments online (Fig.3). The system checks automatically the available time per facility. Our researchers can negotiate timeslot with their colleagues, change schedules, indicate operation manipulations and timing constraints for every experiment. In the next stage we will provide a per-facility logbook. Once completed, the portal will manage all aspects of the experiment lifecycle: related documents, logbooks and storage of the raw and processed experimental data.

The screenshot displays the 'Instrumentation Department' web portal. The main content area is titled 'Hot Cells' and contains a form for scheduling an experiment. The form includes the following sections:

- Experiment Name:** F077006
- Responsible:** A table with columns Name, Firstname, and Email. The entry is Brichard, Benoit, bbrichar@sckcen.be.
- Task Selection:** Project: F077 FUSION REACTOR INSTRUMENT; Task: F077006 THERMOCOUPLE STUDY.
- Start Date:** Year: 2005, Month: 01, Day: 01.
- End Date:** Year: 2005, Month: 03, Day: 31.
- Schedule:** A table with columns Start Date (Day, Month, Year), End Date (Day, Month, Year), and Type. The entries are:

Start Date	End Date	Type
01/01/2005	14/01/2005	Manipulation Irradiation
15/01/2005	20/01/2005	Manipulation Irradiation
21/01/2005	31/01/2005	Manipulation Irradiation
01/02/2005	05/02/2005	Manipulation Irradiation
06/02/2005	20/02/2005	Manipulation Irradiation
21/02/2005	28/02/2005	Manipulation Irradiation
01/03/2005	10/03/2005	Manipulation Irradiation
- Safety Clearance:** 12
- Administration Cost:** 12
- Dosimetry:** 178.50
- Co = Calculation:**

Buttons at the bottom include 'Send for publishing', 'Store draft', and 'Discard'. A login box is visible on the right side of the page.

FIG. 3. Screenshot of the EMS for the Instrumentation Department

5. Future developments of the SCK•CEN KM programme

5.1. *Projects funded under the Sixth EURATOM Framework programme: new KM challenges for SCK•CEN*

One of the aims of EURATOM FP6 is to focus on the integration process of all nuclear stakeholders at European level making use of the new FP6 instruments (networks of excellence and integrated projects) which have a specific role in the construction of the common nuclear knowledge base [11]. The European Commission is therefore heavily insisting on the use and dissemination of knowledge and the spreading of excellence. Since our KM tool is based on open-source software, it can be freely distributed within a European research community as a handy networking and integration tool. Therefore our KM tools will also help our researchers to generate new knowledge and promote scientific excellence within new European 6th FP projects:

- SCK•CEN will build a Knowledge Centre with the same underlying toolkit as for our internal KM projects for the Network of Excellence on Micro-Optics (NEMO).
- For the Network of Excellence on Actinides (ACTINET), SCK•CEN will bring in his experience in coordinating KM projects. The ICT unit of CEA-Saclay will build the underlying KM infrastructure based on collaborative E-Doc spaces.
- As overall project coordinator of the Integrated Project in the Near Field Key Processes for Nuclear Waste Disposal (NF-PRO), SCK•CEN will implement a web-based portal for Knowledge management, project management and training.

5.2. *Retention of the unique knowledge of our aging experts*

Like other companies and research centres in the nuclear sector, SCK•CEN will have to deal with the issue of personnel aging. The aging workforce in the nuclear world creates attrition problems. To offset impending losses of personnel, new policies and planning approaches are necessary. However knowledge transfer and knowledge retention of retiring experts are still in their infancy. Most organisations maintained their standard training programmes and have not taken a strategic, systematic approach [12]. Also our organisation is partially staffed with senior engineers who will likely retire within the next three to seven years. In order to avoid dramatic loss of knowledge we are recently exploring new paths to capture the documented and undocumented knowledge of employees nearing retirement.

The roadmap, associated tools and HRM support wants to identify and preserve critical and unique knowledge especially those associated with experts reaching the retirement age. The first step is to identify persons where the potential knowledge loss is greatest and most imminent. Secondly a focused questionnaire to collect information and interviews with the expert are undertaken to learn the job's specific 'knowledge content', to identify of corresponding information flows and to define the subject matter expertise. Most of the time, this process requires consultation and communication with various colleagues who both contribute to and benefit from the knowledge of the expert. The next step is considering a host of possible actions:

- The codification of the employee's knowledge implies a review of relevant documentation, an inventory of existing personal paper and electronic files and a pointer system to the most critical knowledge. Sometimes it means documenting or videotaping a work method, a key process, a procedure that's never been written down or how activities get accomplished.
- A "handing over"-scenario might in some cases mean assigning a employee to shadow the employee who's going to retire or cross-training some people who are currently in different jobs, through on-the-job-training, one-to-one coaching etc.

The final step involves incorporating web-based technology into the equation.

6. Conclusions and lessons learned

We conclude this paper by pointing out the practical lessons we have learned from the beginning of our KM program. The KM objectives need to underline the strategic objectives but we realised that third parties (stakeholders, European Commission) may be important triggers. We favoured a bottom up approach versus a top down approach by identification of informal knowledge networks and knowledge champions willing to play to role of early adopters for KM. We try to provide the necessary mechanism in order to increase knowledge flows through the organisation where we keep our focus on really critical expertise for the organisation durability and concentrate our KM efforts on those. The willingness of employees to share and to contribute is one of the greatest pitfalls for implementing KM. Therefore we started from what already exists, tried to build trust taking advantage on 'What's in it for me?'. We keep in mind that ICT is subordinated to KM by integrating portals into the organisation's business processes and keeping it low profile. The imminent retirement of the 'golden sixties'-generation force us to find solutions to succession planning. Knowledge management is essential for a knowledge-based organisation such as a scientific research centre. On the long term, the effective management of nuclear knowledge at SCK•CEN will ensure the continued availability of essential reservoirs of both technical information and qualified people.

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