Knowledge Management at the Belgian Nuclear Research Centre: State of the art of a practical KM approach in a scientific environment

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"Most enterprises introduce Knowledge management practices specifically tailored to their needs, environments, and perspectives. Hence there are many varieties of Knowledge Management"
Karl M. Wiig, Knowledge Research Institute.

1. Introduction

Knowledge Management is multidisciplinary business model which covers the systematic management of knowledge, of all kinds, within all levels and types of organisations. The increasingly intense competition of today's economy has resulted in the adoption and application of Knowledge Management for competitive advantage, costs reduction and accelerated time to market in many companies and large private sector organisations. However, only a few R&D institutions have been keen adopters of the principles and practices of Knowledge Management (KM). Given the criticality of Knowledge Management for the entire nuclear environment and the fact that knowledge is the primary and natural asset at the Belgian Nuclear research centre, the challenge is how to address those issues. Therefore we are developing our own practical knowledge management approach relying on basic principles from the knowledge management paradigm but different in a sense that our Centre has an obvious research purpose and mission and isn't devoted to competitive advantage. Some KM pilot projects have already been launched as part of a conscious and planned KM strategy.

2. Knowledge Management in the Nuclear World: major concerns and issues

Conserving what has been achieved in terms of 'nuclear knowledge' is fast becoming a topic of major concern all over the nuclear world for a variety of reasons[1]. This nuclear knowledge consists of volumes of scientific research reports, engineering analysis and models, technical data, codes, maintenance records, QA documents and countless other pieces of technical or scientific information combined with a complex reservoir of people (engineers, physicists, chemists and scientists & technicians of many disciplines) with the required educational background, expertise and acquired insights to apply that knowledge safely and effectively. Therefore Knowledge Management (KM) in the Nuclear fields is critical in order to encourage innovation and to preserve the results of nuclear research and benefits of nuclear applications related to electricity supply, human health, food and agriculture, silicium chips and other industrial applications, for future generations (***preservation of knowledge and institutional memory***).
In recent years, a number of trends have urged the need for effective management of the nuclear knowledge. Foremost the Belgian government has decided to phase-out nuclear power plants. This combined with privatisation and deregulation rules drives the nuclear power to compete in the immediate and near term with other sources of 'green energy' and is likely to result in cost and manpower cutting particularly in the R&D domain and industry. For those reasons fewer young people are studying nuclear science, nuclear engineering or related fields. Furthermore the experienced nuclear workforce is aging. The first generations which were attracted to the nuclear R&D area and industry according their potential growth, approaches or has already reached the retirement age without a corresponding influx of appropriated qualified younger people to replace them (***succession planning***).

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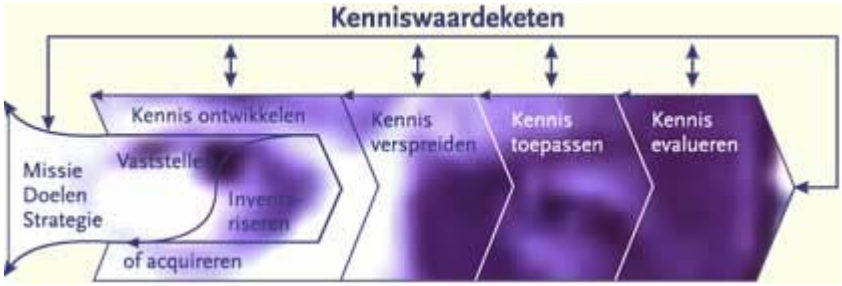
With acknowledgement for the IT related part and the first pilot project to Dr. Ir. Paul Borgermans, SCK-CEN.
[1] The International Atomic Energy Agency (IAEA) organised recently an international meeting on 'Managing Nuclear Knowledge' to increase awareness and understanding of this emerging concern, to share national and international experience, and to recommend steps forward.

3. Setting up a KM programme

Managing the Knowledge Capital is a long term programme, starting from a strategic commitment, involving a correct analysis of Knowledge and Know-How in the company and integrating various operational projects.

3.1. In search of a definition

In our opinion, successful implementation of KM asks firstly for a KM definition, secondly for the alignment of the KM strategy with the organisations objectives and thirdly for a middle-up-down approach addressing the knowledge related needs and problems.



The Knowledge Value Chain of M. WEGGEMAN

Prof. M. Weggeman[2] developed a Knowledge Value Chain where the overall organisational strategy and mission acts as starting points for developing, distributing, applying and evaluating knowledge. Therefore he defines knowledge management as to "*organize and manage operational processes within the knowledge value chain in such a way that realisation of the organisation's collective ambition, objectives and strategy is advanced*." Combining general KM definitions and KM methods we see that, besides knowledge, issues such as knowledge sources (data & information), technology, culture, knowledge processes and their relations play an important role. Our definition of KM is therefore as follows: "*Knowledge Management is the way in which data, information, knowledge are managed with people, technology and processes in one portfolio*". To increase the success of integrated[3] KM approach, we found that this definition should be in line with the strategic objectives of our organisation.

3.2 Underpinning the Knowledge Management approach: a Strategy as knowledge matters

3.2.1. The Knowledge Management strategy

A Knowledge Management approach begins with strategy. Any formal attempt at defining a KM strategy should align with overall organisational strategy and not be seen as a standalone initiative. A strategic vision defines the goals of KM. The old truth is still the best truth: an R&D centre has to decide the kind of value it intends to provide and to whom and should then try and manage its knowledge. Only the organisational strategy can determine the vital intellectual resources for the achievement of its objectives and highlights the critical pieces of knowledge that an organisation must identified, capture and distributed in order to guarantee its survival and growth. On the basis of the inventory of our knowledge assets we can determine a strategy to capture, maintain and utilize those assets more effectively and efficiently. An organisation therefore must, in its totality, support efforts relating to the retainment and exploitation of in-house knowledge and recognize the **core** competencies, skills and capabilities for

[2] Analogous to the Value Chain of M. Porter, Prof W. Weggeman (1997) describes a knowledge value chain consisting of the cyclic phases *determining the necessary knowledge, making an inventory of available knowledge, developing knowledge, sharing knowledge, deploying knowledge and evaluating knowledge.*

[3] An integrated approach should address all components of KM: strategy, culture, processes and technology.

the achievement of its strategic objectives. The Belgian Nuclear research Centre defines her objectives as follows[4]:

"In the scientific field of nuclear safety, radiation protection, the safe treatment and storage of radioactive waste, and the protection against proliferation of nuclear material for purposes other than peaceful, we aim at

- *solving topical problems through research,*
- *remain competent,*
- *support our services by scientific knowledge,*
- valorise our nuclear infrastructure to a maximum".

Capturing and sharing of **critical** knowledge and expertise is therefore extremely crucial in order to build further sustainable development in the nuclear field and to preserve the institutional memory for the next generations. Moreover with straightforward access to common resources an organisation and their employees can execute routine tasks quickly; aggregate previously disconnected pieces of information to facilitate creativity & innovation in working practice and be liberated from the fear of losing important intellectual assets. The value creation objectives of KM will be innovation & knowledge creation, preservation of our knowledge patrimony and turning our knowledge into added value for our stakeholders.

3.2.2. Inventory of our core competencies and capabilities

Knowledge needs to be oriented at core competencies and value contribution. Therefore we had to answer following questions: what are the critical Knowledge Domains for our Centre on which Knowledge Management have to put the efforts? The SCK-CEN's core competencies [5](*Know-What*) reflect a 50-year history on

- the knowledge of the effects radiation on materials and living beings
- 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 (*Know-How*) 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.

3.2.3. Linking the organisational IT strategy to the KM strategy

An IT strategy focuses on the pattern of investments in the infrastructure and application of IT as an enabler for business operations. In contrast, the primary issue in KM is behaviour – getting organizational members to share what they know and to reach out to tap into what others know. Therefore, the KM strategy must focus on culture and behaviour, as well as the knowledge to be shared and managed, and the technology required to enable knowledge search and retrieval."
Seeley,Ch. & Dietrick, B.

The primary role of technology in a KM strategy should act as an enabler, not as a driver. An IT strategy should not direct an organisational strategy nor a KM strategy. However some strategic IT issues should certainly be taken into account when preparing a KM strategy. Traditional IT infrastructure has usually got organisations in an iron grip making

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[4] Those strategic objectives are based on our mission:
"With a view to sustaining development by research and development, training, communication and services, SCK•CEN contributes to:

- nuclear safety and radiation protection;
- medical and industrial applications of radiation;
- the backend of the nuclear fuel cycle

Our mission implies the extension of conventional activities in two important fields:

- the nonenergetic applications of nuclear energy are becoming increasingly more relevant to society, especially in the medical sector;
- sustained development implies that nontechnical aspects, such as social and economical factors, are also taken into account. "

[5] Core or corporate competencies are those distinctive and hard-to-unbundled combinations of individual skills, proprietary information and institutional experiences which together enable an organisation to do certain things better than their competitors and to create sustainable value for their customers (nuclear industry, government, scientific community and academic world).

collaboration and **interoperability** difficult. Leverage open technology standards have the chance to build open infrastructures with still the required security levels.
Furthermore the long term aspects of the research programme and the preservation of knowledge requires a special attention for **'digital longevity**' and a careful evaluation and selection of basic technologies. Since the evolution of the current ICT standards and tools are hard to predict for even a few years in the future, one of the major criteria is therefore the openness and flexibility of the way the information is recorded and handled. Fortunately, this is possible with emerging internet technologies which can be placed under the umbrella of eXtended Markup Language (XML) standards on structured data, data-management and communication protocols. Existing commercial products pose too large risks on dependencies for the core of the system developed, but may be useful in the periphery and information feed. However, most of the typical information entities like documents will need to be converted in a more manageable long-term format as currently developed or implemented in the XML and related vendor neutral standards. Long term usability of information systems requires portability and flexibility through a **three tiers model** making dynamic webpage generation 'on the fly' possible with a Content Management System. Furthermore as web services become the building blocks for composite services that can be used to build composite applications, decentralised stored data should be available as 'web services' using standard communication protocols as XML-RPC or SOAP. (**distributed open infrastructure**).

3.3. Making the Knowledge Management strategy operational: a middle-down-up approach[6]

3.3.1. In search of Knowledge Management adopters and champions

"In the middle-up-down model, top management creates a vision or a dream, while middle management develops more concrete concepts that frontline employees can understand and implement. Middle managers try to solve the contradiction between what top management hopes to create and what actually exists in the real world." – Nonaka & Takeuchi [7]

We adapted this middle-up-down management process to 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 concrete realities front-line knowledge workers are confronted with. Top down leadership continues to be essential for KM because traditional hierarchical structures will not disappear overnight and it will provide the necessary incentives supporting a KM project. Therefore we had to identify the *'Knowledge network'*[8] that could be first involved in a KM pilot project and which is generally tacitly recognised as enthusiastic proponents and which is willing to play the role of early adopter and champion for KM. As embryonic ideas on KM were already present, the Knowledge network in the research and development programme on the geological disposal of radioactive waste seems to be the right test-bed for conducting a pilot project on KM.

3.3.2. In search of existing knowledge processes

Our next step was to analyse if there are existing processes that already capture knowledge (both external and internal), organise and share it throughout our organisation. Some parts of tacit knowledge have been elicited in a simple manner by more or less structured transcriptions. This is the case f.i. in our QA system where

[6] Hubert Saint-Onge, Canadian Imperial Bank of Commerce, describes this strategy as middle-up-down as a way to balance and integrate the best of the top-down & bottom-up method.
[7] Nonaka, I. and Takeuchi, H. The Knowledge-Creating Company, Oxford University Press, New York, NY, 1995, Chapter 5.
[8] Knowledge Network(s): Knowledge resulting from people sharing information with one another formally or informally. Knowledge networking often occurs within disciplines and projects. Those networks can transgress departmental and even organisational borders (e.g. cross border knowledge exchange with stakeholders or scientific community).

traceability, validation and overall professionalism are pursued and where the first rule of quality is "*write what is to be done*". This is also the case with numerous kinds of our publications (so called 'Scientific output') recorded and evaluated through a QA procedure and the redaction of 'secondary documents', which synthesise knowledge included in certain documents. Review reports as e.g. SAFIR[9] 1 & 2 summarize the scientific and technical knowledge acquired during the first and second phase of the methodological research and development programme on the possible final disposal of high-level and/or long-lived waste in deep clay layers. Furthermore all kind of databases related to the R&D work providing elementary knowledge on key parameters and processes.

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

"Researchers estimate that only 20 per cent of the knowledge in an organization is ever captured, leaving 80 percent in the hearts and minds of employees. By incorporating communities, an organization adds value to itself, while enriching community members and increasing the potential of its knowledge assets."
The Knowledge Management Manifesto – KM Review, 2001, p. 137.

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). 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 help each other, engage in joint activities and share information through permeable boundaries[10]. Third a CoP requires a practice: members are able to develop a shared collection of resources.

3.4.1. Knowledge related needs and problems: starting with better Information Management & stimulation for collaboration

We starting our practical KM programme with a better information management trying to bring in more structure, standardisation and cataloguing of the available information in order to ensure better retrieval and access of existing data and documents. This objective coupled with elicitation of tacit knowledge and fostering collaboration through better internal communication channels decide us to set up interactive communities through web-based portals.

3.4.2. A web-based portal as a KM tool

The knowledge management functionalities one could expect from a portal include:

- An on-line community space which offers functionalities like news, calendar, content management with simple information handling tools (versioning, workflow) and discussion forums;
- Explicit knowledge repositories and integration with multiple content sources across servers, platforms networks, etc through a single view.
- A strong search functionality which will help to maximise the benefits obtained from content and to avoid information overload. Furthermore, it will support serendipity by offering a means of connecting people and content that did not previously exist;

[9] SAFIR stands for Safety Assessment and Feasibility Interim Report
[10] CoPs and teams are different kinds of groups. Teams are tightly integrated units with clear boundaries driven by deliverables, defined by managed tasks and bound together by members' collective commitment to results.

- The 'knowledge map' - provides an overall 'living' schema for knowledge classification.
- An expert locator or Yellow Pages (sharing), which will facilitate the identification of experts stimulating knowledge sharing based on 'pull' concepts;
- Annotation facilities indispensable for the evaluation of content and the elicitation of implicit knowledge;
- On-line learning, e-learning. Although this concept is covered by most of the functionalities listed above, we interpret e-learning as a new way of satisfying training and development needs by presenting on-line courses or training material to the end-user.

4. The first pilot project: development of the Waste & Disposal community portal[11]

A first pilot project on building knowledge portals which will be based on the same underlying and replicable toolkit has been started for the Waste & Disposal R&D group. In a first phase, a number of building blocks are developed and implemented inside an Internet standards based portal, including:

- Tools for recording, cataloguing and indexing the readily available information from reports and other publications on the results of the R&D programme;
- Integrating the various databases which have been developed over time, ranging from raw measurement results over structured data and meat-data on fundamental parameters, QA related items such as instrument calibrations, multimedia enabled log-books of geomechanical activities, to annotated bibliographic records;
- The set-up of a permanent review and annotation system on all the data and reports gathered;
- The set-up of community driven entities including internal meeting 'places' for discussion groups and shared documents collections on topic oriented projects and task groups;
- A review system leading 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;
- The use standards for optimising the re-use, searching and annotation of all the information required for a given task.

5. Lessons learned

- Don't install a portal first, and then look for KM issues to resolve.
- Define a clear KM strategy, objectives and a KM approach upfront.
- Determine the strategic IT issues.
- Identify informal knowledge networks and knowledge champions willing to play to role of early adopters for KM.
- Realise the complexities involved in the implementation, the maintenance and above all the acceptance of a portal by the knowledge workers.
- The willingness of employees to share and to contribute what they know and to leverage explicit and implicit content is one of the greatest pitfalls for a successful KM implementation. Integrating portals into the organisation's business processes by finding the right incentives and creating a knowledge culture seems to be the most difficult part.

[11] P. Borgermans, M.-L. Ruyssen, W. Bastiaens, Knowledge management: development of the W&D community portal. Topical Day on recent developments in the Belgian programme on long-lived and high-level waste disposal – Mol, May 21 2002, BLG-914, SCK-CEN.