
An approach to knowledge management for EUROSAFE projects

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Abstract:

The objective of a knowledge management system (KMS) in the field of Nuclear Safety Assessment is to keep competences in expertise and research at the best level. This contribution proposes a diagram of KM organization associated with the Eurosafe Safety Assessment Guide project proposal. The aim of the KM action is to test and bring forward a generic and perennial method of knowledge management adapted to the safety culture. It will be interested to support the access to information useful for the practices of expertise by organizing a knowledge mapping, supporting the exchanges of know-how by the consolidation of a competence network and the externalisation of expert knowledge. This article presents the actions in progress at AVN, GRS and IRSN, and suggests some principles based on experience feedbacks drawn from the literature. It is not supposed to be exhaustive but rather to encourage other Technical Support Organizations to take part in this KM action associated with the technical project. We suggest to organize the KM action in three phases (1) definition of a KM Strategy adapted to the technical project (2) implementation of KM selected actions (actors sensitization, tests of KM methods...) (3) choice and fulfilment of effective and perennial KM solutions.

1 ABOUT KNOWLEDGE MANAGEMENT

The knowledge within an organization is frequently identified as the main source of its competitive advantage [1], [2], [3]. Considering Nuclear Technical Support Organizations (TSO), their production power lies in their intellectual and service capabilities. In that case the knowledge should be considered as a primary resource.

The literature in the field of knowledge management (KM) distinguishes tacit knowledge and explicit knowledge. Tacit knowledge is constructed from individuals own experience [4], it represents the knowledge embodied in the human brain (i.e. skills of employee, know-how) and cannot be separated from the people who possess it [1]. At the opposite, explicit knowledge can be codified, reduced to data and transmitted whatever the media (i.e. technical documents, recordings, videos ...). Because distinguishing knowledge from information or data [5], [6] is not always straightforward, we will simplify our terminology and use the terms knowledge for « tacit knowledge » and information for « explicit knowledge ». From a practical point of view, we would prefer as soon as possible terms like knowledge goals, knowledge acquisition, knowledge sharing, knowledge transfer because they sound more operational and draw knowledge management closer to a concrete activity [7].

From a general point, the stake consists in implementing a sharing culture of knowledge and information at all the levels of organization, from the individual to the corporate network (and reverse for a mutual profit) by using all the modes of knowledge creation [1], (see Figure 1).

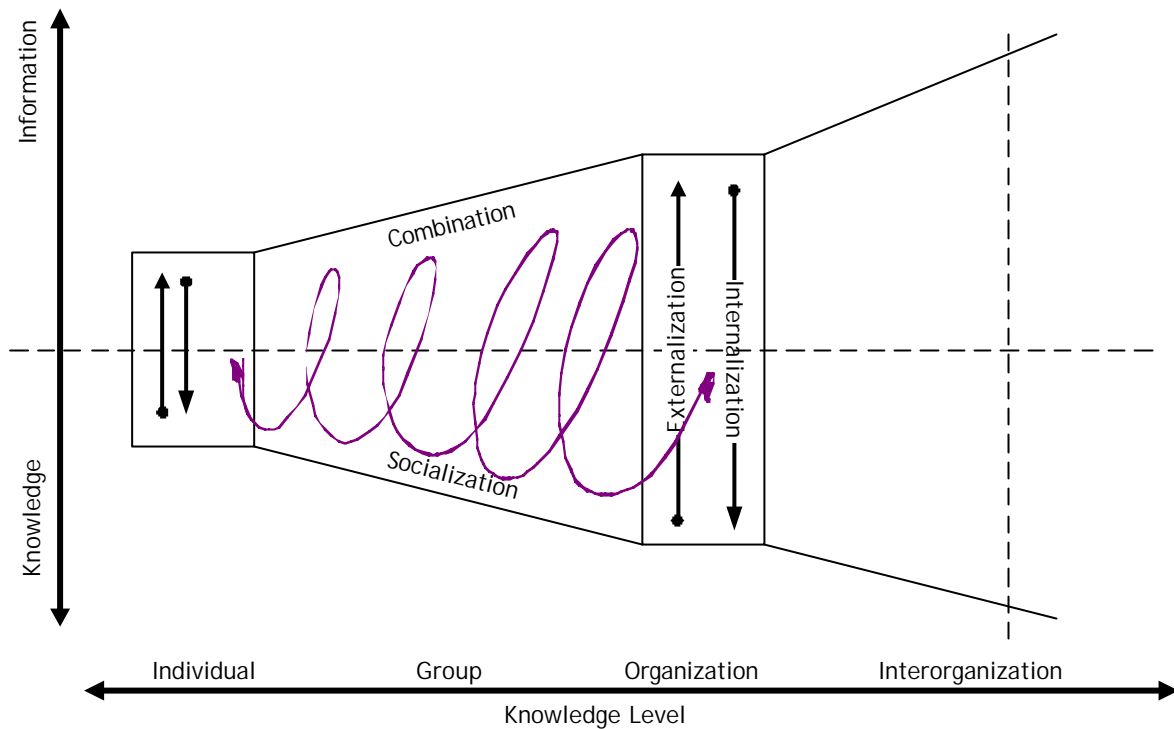


Figure 1 : Spiral of the creation of knowledge and information. Adapted from Nonaka [1]. The externalisation consists of transferring its knowledge into contextual data, i.e. quality process, technical report.... Socialization is a process of knowledge creation by exchange of experience, i.e. mentoring. The internalisation is a process of knowledge creation by a brain treatment of information, i.e. education. The combination is the creation of new information by treatment of existing information, i.e. web search engine. We usually use a mix of these different modes of knowledge creation at the same time.

2 KNOWLEDGE MANAGEMENT AND NUCLEAR SAFETY

The levels of safety reached today, reflected and codified in Safety Standards, are fruit of intensive cooperative efforts nationwide and internationally. They represent the state of the art, agreed upon in expert commissions and in regulatory work. By its nature, the evolution of standards of safety is a dynamic process which is developing over time. Maintaining standards at a high level requires ongoing efforts which counteract the tendencies of decay. Further developments need efforts in excess. A predominant part of these activities is entirely knowledge-based, such as:

- Sharing of knowledge on relevant safety issues. This involves the discussions and exchange of information in working groups, the exchange of recent knowledge on specific topics, the definition of requirements for safety assessment methods, the discussion of cross-cutting issues by multi-disciplinary expert groups (for example the activities on safety margins), the definition of the state of the art, and collective opinions on key safety issues.
- The generation of new scientific information is entirely knowledge-based: the specification of primary research areas and experimental projects, analytical exercises such as benchmarks and international standards, and information collection on safety-relevant events and their evaluation.
- Also knowledge-based is the contribution to competence maintenance: transfer of information to countries with shrinking resources in nuclear safety research, training of young scientists through involvement in national and international research projects, and maintaining unique experimental facilities and capabilities.

- Archiving and distributing information is entirely knowledge-based: document management on joint programmes, the management of experimental data, conducting seminars and conferences, and the release of reports to the public.

It is no coincidence at all that these topics are congruent with knowledge management and may be directly mapped to knowledge management methods. It is not an exaggeration to state that knowledge management lies at the heart of keeping safety standards at a high level.

Whatever the future of nuclear industry stake holders (company, authority, technical support) will always require qualified personnel to ensure the development, the maintenance or the follow-up of the nuclear facilities [8]. The capitalization of information (articles, technical reports, proceedings, safety reports ...) stored in a suitable way in data bases, libraries or files is not identified like the main stake. On the other hand, the lack of appropriate academic formation, the loss of knowledge or know-how in nuclear safety is identified as a risk of loss of competences by the nuclear stake holders [9], [10], [11]. These concerns are the subject of reflexions and permanent experience sharing at the international level¹ and actions like education, training, mentoring, etc. are considered as priority to maintain the qualification level to keep the nuclear safety expertise at the good level [11], [12] .

The part of KM related to education and training will not be considered here. The following chapters limit the presentation to the KM actions implemented at AVN, GRS and IRSN and proposed in the “ Safety Assessment Guide” Eurosafe Project proposal (SAG). The output of the KM tasks as described hereafter should encourage people to go through a process of self-learning and could be efficient inputs for training and education.

The objective of the KM part of the SAG project is to federate all the project partners in order to create the relational network essential to the quality of the exchanges between the technical experts, but also between the persons in charge of the knowledge management in their organizations. The relevance of exchanged information is closely related on human cognitive and social interactions. Thus, the effectiveness of a system of knowledge management (creation, capitalization, interpretation and use) is more a question of strength and confidence of the relations between human beings than a technical question related to the information system.

3 KNOWLEDGE MANAGEMENT IN ACTIONS

3.1 AVN

As Authorised Inspection Organisation for the Belgian nuclear installations, in particular all nuclear power plants, AVN developed activities in this field both internally and in relation with the Belgian Licensee (Electrabel) of the nuclear power plants and its main architect-engineer (Tractebel Engineering).

Within AVN's missions, inspection and safety evaluation of nuclear installations are at the forefront [13]. For such activities, knowledge and expertise have always been and will always be of primary importance.

¹ Knowledge Management Meetings within [AIEA](http://www.iaea.org/km/pages/meetings.html) (http://www.iaea.org/km/pages/meetings.html) from 2002 to 2005; [NEA](#) from 1998 to 2005; [Eurosafe](#) Workshop on [Nuclear Knowledge Management](#), june 2004, Cologne.

3.1.1 Knowledge Management within AVN

The growing importance of KM and the related efforts encouraged AVN to integrate KM visions and activities in a structured framework. For achieving this goal, AVN was inspired by a framework developed in reference [14]. A management document has been established identifying existing and planned activities and processes that contribute to KM. Two aspects (Knowledge development and knowledge retention) are illustrated below.

3.1.1.1 Knowledge development

Presently, an important contribution to knowledge development within AVN comes from the R&D activities. Strategic knowledge goals on KM are defined within the AVN R&D strategy (for a 5 year period) and the yearly R&D Programme. Some important developments were first started with the aid of an external consultant and then further refined and implemented through the R&D Programme.

All technical staff is member of one or more Technical Responsibility Centres (TRCs). These are non-hierarchical networks of (typically) 3 to 6 persons, active in a well-defined technical domain. The TRCs are responsible for developing and maintaining AVN's expertise in their domain.

3.1.1.2 Knowledge retention

At a recent retirement of a staff member who had been in charge of a specific domain the idea was taken up to charge a young engineer to make a structured inventory of past projects and to identify major issues and lessons learned from these past projects. This is a contribution to knowledge retention.

In the framework of the recently introduced Quality Management System, one of the processes aims to introduce better and more structured reporting on safety assessments. For this, different templates of structured documents on work requests and the corresponding reporting are now in use. This should also be beneficial for knowledge retention by allowing better retrieval of safety assessments documentation (combined with the introduction of the new EDMS).

In 2005, a start was made to test an approach for knowledge retention with some engineers foreseen to retire in about 5 years. Through interviews, attention was devoted to aspects as identification of their knowledge, the need for keeping this knowledge and on how to transfer the knowledge to other staff. This approach will be further developed in future.

3.1.2 Knowledge management aspects discussed with Licensee

Presently, some common subjects are being under investigation for all plants within the framework of the Periodic Safety Review. One of these subjects is related to the documentation and knowledge of the design basis of the NPPs.

For these aspects, a methodology was set up to investigate this matter and to foresee the appropriate actions, where needed.

Steps in the methodology (developed by Electrabel and Tractebel Engineering) contain issues such as the identification of the knowledge needs related to the design basis of the NPPs, a structured method to perform a “Risk analysis”, with, as objective, to identify those critical domains where actions seem warranted to improve documentation or knowledge sharing, and finally, defining approaches to improve documentation or knowledge sharing, where needed.

Within the same subject of the PSR the Licensee (Electrabel) is also presenting the Knowledge Management programme developed within its organisation. This covers as well organisational aspects for a better management of knowledge as methodological aspects for specific aspects of KM. These initiatives are then discussed with AVN, partly in respect to the observations made by AVN in its daily inspections in the nuclear power plants.

3.2 GRS

The starting point for the activities of GRS was the realization that due to the retirement of many experts, a loss of knowledge was imminent. Consequently, GRS has initiated a knowledge management program which is in development since 2002.

3.2.1 Basic knowledge model

A simple model [15], has been adopted, describing all stages of knowledge management activities. On a strategic level, the formulation of the knowledge goals has been the indispensable first step. The operational level aims at realizing these goals by identifying, acquiring, developing, disseminating, and deploying knowledge.

3.2.2 Portal

As a prerequisite to achieve the knowledge objectives, an information and document management system had to be put in place. Such a system would collect the information and the documents dispersed in wide variety of file shares, data bases, or internet sites, and should allow fast retrieval by different criteria. It was decided to take benefit from the development of enterprise portals and to adopt Microsoft's Sharepoint Portal Server, which not only implements a document management system, but contains also features to improve cooperation and communication, two characteristics essential to knowledge management. The portal provides a central access point to all documents and information. In particular, each project has an own portal site, where not only the project documents but all information pertinent to a project is stored. The portal contains sites with news which are gathered from different sources, and covers important topical themes in a horizontal structure such as Yellow Pages, Quality Management, Organisation Handbook and many more. Vertically, every organisation unit has its own pages for presenting its activities. For collaboration, team sites have been set up for departments, projects, and particular areas such as Emergency Response, Strategic Programme Groups or ad hoc collaboration.

3.2.3 Knowledge representation and mapping

Methods for capturing knowledge of leaving experts have been thoroughly investigated. The efforts for individual knowledge elicitation are commonly agreed to be very high. As an alternative, knowledge representation methods such as Topic Maps, Concept Maps or Ontologies were investigated. They offer a systematic approach, and result in a controlled

vocabulary set up by experts to describe the domain, as well as visualization and search facilities to navigate the knowledge maps. Prototype applications have been developed with a concept map tool (CMapTools by the Institute for Human and Machine Cognition (IHMC)) in the domain of Component Safety and to represent the knowledge management activities at GRS. A second tool, the Semantic Miner by Ontoprise, has provided the basis for a pilot project aimed at mapping the GRS-knowledge in the domain of Containment.

3.2.4 Process oriented Knowledge Management

One of the strategic goals of knowledge management lies in avoid the need for capturing knowledge of leaving expert for the future. A process-oriented knowledge management trying to capture knowledge as it is being produced in the work process, and to make it available when needed, has been installed with this goal in mind. As at GRS the most important business process is a project, a very simple template was developed which would be adaptable to different project's needs. The template contains a starting point, milestones and an end point. At the start of the project, a state-of-art report should summarize the technical or scientific initial point. At milestones or at the end of the project, a debriefing session should be held with participation of the project controller, the project leader and his team, where a lessons learnt form would be filled. All documents are held in their own project portal.

3.3 IRSN

Recommendations and actions proposal in the field of KM are based on Internal reflexions carried out from 2003 ⁽²⁾. The main KM topics are briefly describe hereafter.

3.3.1 Document management

The objective consists in improving the document management of the Institute in order to answer in a more relevant and reactive way at the requests of information. An assessment of the existing documentary management tools and the definition of document management strategy are in hand. Interworking and semantic search engine would be the structuring elements of the project wich is programmed for 2006.

3.3.2 Employment and competences management

The forecast management of employment and competences ensure the adequacy of competences of the Institute employees and the competences necessary to realize the missions of the Institute. This action, managed by the direction of human resources (DRH), will be completed in 2007. The DRH wishes to build management tools of employment and competences, two of them are of a great interest for the knowledge management (terminological source of information):

- the repertory of standard job will gather the descriptions of the basic posts in terms of activities, necessary competences... ;
- the reference frame of competences describes the competences need to manage IRSN missions: definition, where to find them in the company, how to evaluate them....

² IRSN has been created in 2002 by the fusion of CEA/IPSN (Institute for Nuclear Protection and Safety) and OPRI (Office for Protection against Ionising Rays).

3.3.3 Cartography of competences

The cartography of competences is interested in all the knowledge acquired by an individual from his initial formation to its current employment (approach by the individual), i.e. it uses information contained in documents like curriculum vitae. It should not be confused with the cartography built from the reference frame of competencies described above which represents the state of the competences needed by a company to achieve its missions at a given moment (approach by the function). The restitution in the form of a chart makes it possible to quickly identify the forces, the weaknesses and the potential resources of the company related to its strategic aims. It could also enable the identification of competences needed for a project team... This action began in 2004 by a benchmark on the topic and should be completed in 2006.

3.3.4 Knowledge transfer

The general objective consists to gather and treat on a hierarchical basis information useful to a practice of expertise or a positioning in key fields for the activity of the institute. It consists in formalizing the know-how of experts in a multi-media document, useful for other specialists. These kind of documents give answers to the simple question « from your point, what should we know on this topic? ». The method could be applied in the case of the departure of an employee (retirement, resignation...), the synthesis at the end of a project, general context of decision making process... The methodology was tested in 2005 with an expert of 20 years experience on nuclear waste storage. It consists of a play of questions/answers in the form of recorded and illustrated interview (figures, photographs, tables, graphs...). It was successful regarding the appraisal panel result. The expert was mobilized 3 days for two hours of recording information organized to be useful for end-users. The method will be implemented in 2006.

3.3.5 Community of practice

The communities of practices or informal networks favour the sharing of technical information and know-how between experts. They play an important part in the process of transfer of knowledge according to a peer to peer approach. Their effectiveness depends on the spontaneous character of their creation and the establishment of confidence relations between the members [7]. This condition is essential for a good quality exchange of knowledge on a practice. A first group being interested in the use of the Monte Carlo codes applied to the interactions radiation/matter has been just recognised as a « transverse group », others should follow.

4 KNOWLEDGE MANAGEMENT AND THE EUROPEAN SAFETY ASSESSMENT GUIDE PROJECT PROPOSAL

Considering the knowledge cycle of production, dissemination and exploitation of knowledge for the projects in the 5th and 6th EURATOM Framework Programme, the aspect of exploitation of project results, particularly after the end of a project, is the least developed. While still considering all three aspects, the items described in the following will concentrate on deploying knowledge management methods for utilizing project results, particularly beyond their lifetime.

The role of KM may focus on three aspects (Figure 2):

- KM can provide mappings of knowledge domains in the nuclear field ;
- KM can provide means for enabling or facilitating exchange of expertise between organization's (competence network, know-how externalisation);
- KM can provide common repositories of document bodies shared between organizations (Nuclear Information Data Base).

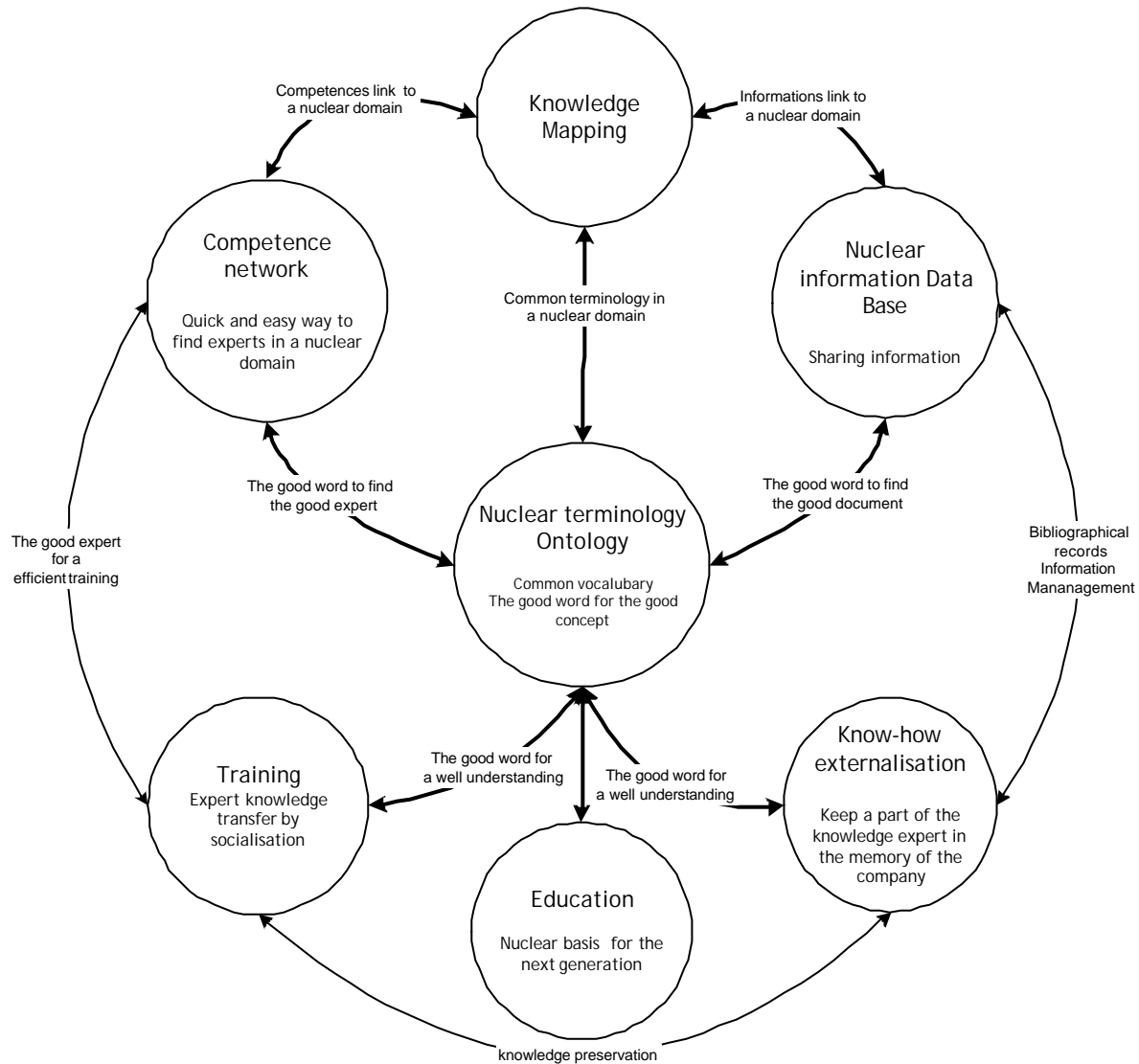


Figure 2 European Nuclear Knowledge Management outline. The project will focus on the Knowledge Mapping associated to Nuclear Ontology, the Competence Network, the Externalization of the Expert Knowledge and Nuclear Information Data Base.

4.1 Knowledge Mapping

The basis of many knowledge-based activities is a representation of the knowledge domain. One of the most promising methods of knowledge representation is known as knowledge mapping. Constructing maps of knowledge domains offers an efficient way of gaining insight into knowledge fields, and enables navigation in knowledge domains, searching for relevant documents and information, improving the effectiveness of full text searches, harvesting knowledge by drawing inferences, or analyzing critical knowledge and its possible loss. By utilizing knowledge representation methods, which are related to the envisaged new generation of the internet, the Semantic Web, the landscape of knowledge represented by different organizations would be modelled.

A review of the main activities would provide a starting point, resulting in a good overview of the domains of expertise in different organizations. Single knowledge domains can then be deepened into more layers of detail, making the resulting models a sound basis for knowledge retention, dissemination and exploitation.

In gathering groups of experts from different organizations, and assigning them the task of developing a knowledge map for a given domain, a controlled, widely accepted vocabulary is eventually established, which helps accessing vast document repositories by structuring the external search processes. Furthermore, knowledge maps offer features for visualizing, navigating and searching the knowledge domains, which greatly improve the understanding of the knowledge structure and thus offer an excellent platform for knowledge transfer and for training purposes.

A knowledge model will contain the most important documents and links for a given topic, making the information immediately available. In addition to this explicit knowledge, the connection of specific topics in the knowledge map with a skill database as described in the next chapter will provide the access to the tacit knowledge of the expert.

4.2 Sharing Expert Knowledge

4.2.1 Competence network

Cooperation between organizations is at the core of EURATOM projects; project partners are often chosen on the grounds of personal connections established in long years. However, a catalogue of the fields of work in different organizations and of expert's skills in these fields would facilitate establishing contacts and cooperation, particularly for the younger generation with fewer relations. Such catalogues are known as skill databases or Yellow Pages, and support the retrieval of the so-called tacit knowledge of the experts.

The aim therefore is to provide Yellow Pages (YP) describing the skills of experts and the main domains of work of institutions working in the nuclear field. This effort may start from the specification of the structure and of the requirements of such YP, accounting for existing skill databases and considering rights and security issues. The parts of the YP which are open to third parties will be indexed, in order to be searchable by an appropriate web or portal site.

4.2.2 Know-how externalization

The expert knowledge makes up the core competence within an organization as human knowledge capital.

Capturing the knowledge before the loss of key individuals as well as capturing the various repositories that they maintain for personal use will reduce the need for performing this effort again or for locating the documents that have been used.

At first, the aim consist of defining TSO's needs and fixed a common objective, then make the state of the art about knowledge externalization tools and their efficiency, formalize, experiment, share results and promote the best practice in response of technical expertise need. These know-how documents, whatever the media, made by experts for experts in the

framework of a nuclear practice, should be an important source of information for education and training (transfer of knowledge by socialisation, [1]).

4.2.3 Sharing Documents

Many organizations hold large bodies of the documents with often identical information. The location of documents is often decentralized; documents may be found on paper, on PC's in form of local files, in personal databases and on company-wide file shares. Often, a central repository is missing, as well as a central index to retrieve these documents from the variety of sources where they reside. A step towards a repository shared by several organizations would consist in defining file locations open to partners, and allow a central indexer to construct a full-text index, which would enable to search on the distributed file repositories. Each organization will hold the rights on the documents they introduce into the common repository, which includes the specification of access rights for each partner.

A repository utilized by different organizations will provide a common, comprehensive document body; references to the documents contained therein will remain stable for long periods of time, thus providing an ideal basis for utilizing documents in knowledge modelling or as training material.

4.3 End-User Benefits

The above mentioned knowledge management methods hold interest for expert's organizations, authorities, utilities and manufacturers. Skill databases and shared document repositories will offer access to locating the expertise in different organizations. This will contribute avoiding double work, encourage and facilitate cooperation (e.g. choosing partners in EURATOM projects), and support decisions as to build own expertise in a field or import such know-how. Representing knowledge in a semi-formalized way as achieved by knowledge modelling techniques provides the basis for retaining, disseminating and exploiting knowledge.

4.4 Recommendations

For an effective diffusion of the project knowledge management we recommend to plan sequences as following [6] [16], Figure 3:

Before the beginning of the SAG technical project:

- KM team should define a KM Strategy and develop a KM System (KMS). The lessons learned from other projects, e.g. SARNET, and the feed back of experience of KM project members should be considered;
- Build up/Set up the KMS in coordination with the chairmen of technical working groups ;
- Work on the organizational culture and structure to facilitate the implementation of the KMS ;
- Persuade and educate people to use the KMS ;

During the technical project:

- Provide people with continuous training and support to encourage their use of KMS ;

- Replace people's old means of accessing knowledge by more appropriate means ;
- Monitor people's usage of the KMS ;
- Keep providing the knowledge that people want in the KMS ;
- Promote best practice ;
- Develop and encourage people's sustained use of the KMS ;

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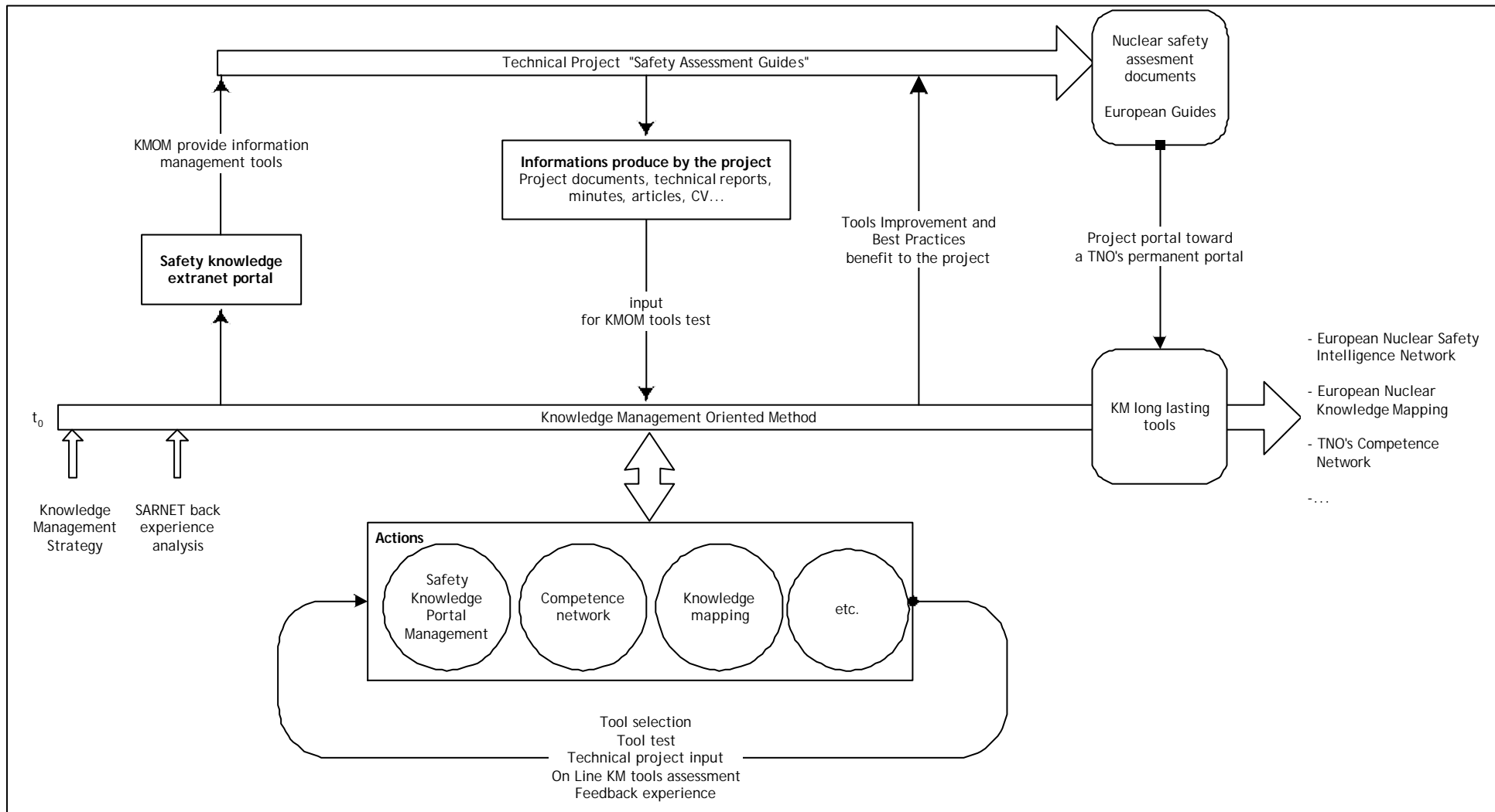


Figure 3 : Links between the Eurosafe SAG Technical Project and the Knowledge Management actions