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40th anniversary 1964 2004

SMR.1589 - 1

Workshop on Managing Nuclear Knowledge

8 - 12 November 2004

Knowledge Management Tools in the IAEA

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These are preliminary lecture notes, intended only for distribution to participants

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8 November 2004, Trieste, Italy

Abstract

The IAEA is an international organization with knowledge management written high on its agenda. International meetings, workshops, seminars, coordinated research projects and technical cooperation projects all serve this aim. But how is knowledge management actually done?

The presentation will look at the three pillars of knowledge management:

- studying (reading and understanding documented information)
- example and explanation from an expert (on-the-job training, tutoring)
- research (observation, discovery, reasoning)

and will investigate how each of them can be supported by the tools and procedures available within the Agency.

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1. Knowledge management in the nuclear context

Knowledge ultimately resides with people, it comprises the information and skills that a *knowledgeable person* commands. In complex systems, knowledge may also exist in a distributed form: A group may be able to succeed in tasks which exceed the knowledge of every one individual member of the group. In the latter case, there must be at least one person who has the additional organizational knowledge of where key subject knowledge resides within the group.

Individual experts may gain knowledge in three ways:

- by studying (reading and understanding documented information)
- by example and explanation from an expert (on-the-job training, tutoring)
- by research (observation, discovery, reasoning)

Research is the only way of creating original knowledge which is either truly novel or has existed before, but was lost without sufficient record. It is also the slowest, most expensive and in some cases (failed experiments) the most dangerous way. However, given time and resources, research work will always enable mankind to regain lost knowledge, however expensive that may be.

While the IAEA has been actively coordinating and fostering nuclear research and development for many years, there are other aspects of nuclear knowledge management which are now gaining in importance, too. In particular the stimulation of interest in the nuclear field in the younger generation and activities associated with succession planning are increasingly recognized as important aspects of knowledge management[1].

Experts who are presently leaving the nuclear field due to retirement, or because of professional re-orientation, have in many cases gained their knowledge by direct research (scientists) or have been instructed by the original researchers (engineers). Ideally, they should now pass their knowledge on to the next generation of nuclear workers. However, because of the generally reduced interest in the nuclear field, the nuclear work force is shrinking in a number of countries and it becomes therefore more and more difficult to extend, or even to maintain, humankind's present knowledge in the nuclear field.

The main effort in nuclear knowledge management must therefore be to support and enhance the existing infrastructure for knowledge transmission. This can be achieved by facilitating access to archived materials (on-line and off-line) and by fostering professional contacts in academic and industrial contexts, by providing a suitable infrastructure and by identifying centres of excellence (universities, institutes, industries) where nuclear knowledge presently resides.

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[1] *M. ElBaradei, Director General of the IAEA, 'Introductory Statement to the 5th Scientific Forum during the 46th Session of the IAEA General Conference '* (http://www.iaea.org/NewsCenter/Statements/2002/ebsp2002n005.shtml)

2. Approaches in nuclear knowledge management

Approaches in nuclear knowledge management can be classified into three major activities:

- giving access *archived materials,*
- providing *locators of active knowledge* and
- facilitating *communication and direct knowledge exchange*.

2.1 Archived information and data

This category includes access to all information and data which have either been instrumental in the initial creation of knowledge, or are compilations which have been created by experts. Examples include:

- documentation of measurements, experimental data
- evaluated data – based on both measurement and theory
- textual descriptions, textbooks, scientific & technical papers
- related speculations, judgemental and historical views
- related observations, operational experience

This list could easily be extended, it comprises all materials that have been recorded, either electronically, on paper or otherwise. For electronic information, direct access can be given in some cases (on-line databases, electronic versions of publications, etc.). All other information, residing in various types of archives, cannot be accessed directly, but meta data can be provided in order to facilitate the finding of such information. Suitable metadata include bibliographic materials, descriptions of databases and directories to related materials on the Internet.

2.2 Locators of active knowledge

As outlined above, knowledge resides with people. In order to access knowledge directly, it is therefore necessary to find people who carry that knowledge. A locator of active knowledge could therefore contain a maintained list of experts. Such a list could draw from a number of sources, such as the author information in bibliographic records or the participants lists for specialized meetings. Experts could also be nominated by academic, professional and industrial organizations.

Another – indirect but important – means of locating active knowledge is by contacting associated institutions such as universities, laboratories and relevant industries. An annotated, searchable index of such knowledge centres would be a valuable means to support the exchange of knowledge between specialists and to help students to find both, centres of excellence for studying and potential places of employment.

2.3 Communication and direct knowledge exchange

Communication and direct knowledge exchange can be facilitated by supporting or organizing meetings, workshops, seminars and conferences. If such events are focused enough to attract experts with an interest in a well defined field, while being liberal enough to kindle open and divers discussions, then effective knowledge transfer between participants can take place and innovative ideas can be born. Additionally, the proceedings of successful meetings are often a valuable means for generating information archives, which help to record and transmit the experts tacit knowledge thru space and time.

3. The main components of IT based knowledge management

As laid out above, knowledge itself can not be stored on computers or other technical data carriers, and from an IT point of view, everything stored is reduced to *data*. The function of IT based knowledge management must therefore be to present numerical, textual and meta data in a suitable way for supporting the human processes of knowledge management and knowledge preservation: studying, communicating, research. IT support to nuclear knowledge management therefore must facilitate the retrieval of:

- factual data
- descriptive materials
- contact information

In each of these three categories, either the actual materials or suitable meta data could be presented.

3.1 Factual data

Factual data are most often associated with computerised data bases. This is, however, to narrow a view: printed tables and viewgraphs are just as suitable to transmit factual data. An illustrative example is the Agency's Fast Reactor Database which is available in print[2] and as an online database[3], diffusing the same data in both cases.

It is characteristic of factual data, that well defined individual data items can be described by a set of coordinates which correspond to an associated taxonomy. For example:

- Specifying the type of reaction, the reaction partners and the energy range will enable a user to access a particular reaction cross-section in a suitable collection of factual data.
- Specifying the name of a country will retrieve the names of all nuclear power stations in that country.
- Specifying an author's name and a subject category will list all scientific publications on the given subject by that author.

Factual data can frequently be formatted for further machine processing, and thus be used to facilitate the creation of derived products without entering the human cognitive process directly.

3.2 Descriptive materials

While graphics, pictures and tables can form an important part of descriptive materials, the defining characteristic is the presence of explanatory text in normal human language.

Descriptive materials are designed for direct human consumption with the possibility for automated processing being (still?) very limited (excepting trivial format conversions and keyword searches). They comprise:

- written texts
- video and audio recordings, multimedia presentations
- e-learning materials

[2] IAEA TECDOC 866
[3] http://www-frdb.iaea.org/index.html

Often, descriptive materials tend to be bulky and are traditionally held in libraries or archives, but they are increasingly becoming accessible electronically, too. Presently there is even a substantial – and increasing – amount of descriptive materials, which are accessible exclusively electronically, usually via the Internet.

Descriptive materials, regardless of their electronic or hardware based distribution form, are time consuming to study, read, watch or listen to. It is therefore particularly important to have good machine-searchable meta descriptions available, in order to enable the efficient location of only the most suitable documents for a given occasion.

3.3 Contact information

Contact information can point either to institutions or to persons.

3.3.1 Institutional listing

An annotated list of institutions involved in nuclear R&D should include academic, governmental and commercial venues. Such a listing will be beneficial to:

- students who seek training in the nuclear field
- professionals looking for employment
- R&D professionals who seek a professional contact or collaboration
- potential customers who look for services or hardware
- universities who want to attract additional students

The listing could have different levels of detail, depending on availability. It is likely that universities and publicly funded laboratories are able to give quite detailed information about their activities whereas governmental and commercial institutions might be reluctant or unable to expose information that could be commercially sensitive or classified. Academic institutions on the other hand, might even want to list the availability of specific lectures and seminars or to mention offers for graduation or PhD projects in the nuclear field.

3.3.2 List of experts

A who-is-who of experts in the nuclear field serves very much the same purpose as the institutional listing, but on a personal level. It is, however, much more expensive to maintain, since individuals change their contact details more often than institutions, and important aspects of personal data protection need to be observed, too.

One source of information about experts is readily available from bibliographic citations. Most bibliographic collections can be used to retrieve author information as the result of a subject oriented search, but the options for displaying and post-processing this information will in most cases need careful consideration.

Furthermore, some experts in commercial or academic R&D might agree to be included in a list of experts on a nuclear knowledge portal. Similarly, experts who are actively collaborating with the IAEA (technical working groups etc.) present a suitable resource. Contact information for some of the latter is even now openly available from the IAEA's web site[4].

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[4] Example: Members of the Technical Working Group on Fast Reactors are listed at: http://www.iaea.org/inis/aws/fnss/twgfr/members.html

4. Domain coverage

Nuclear knowledge management has received considerable attention, lately. This attention is, however, mainly focused on aspects relevant to nuclear power generation at large and on specific aspects of fast reactor engineering, in particular.

The IAEA's mandate, on the other hand, covers all aspects concerning peaceful applications of nuclear R&D. This includes live sciences such as nuclear medicine, and nuclear techniques in animal production as well as industrial applications of nuclear technology and fundamental research, and it stretches to fringe areas like the socio-economic implications resulting from nuclear related activities.

Depending on the discipline, different aspects of knowledge management take priority. While knowledge preservation and succession planning are the dominant factors for some aspects of nuclear power generation, the knowledge transfer from industrialized countries to developing nations takes priority in other areas such as nuclear techniques in agriculture.

The IAEA needs to support knowledge management in different domains with the appropriate tools.

5. The discussion

... is now open. Is the sketched outline of nuclear knowledge management – more or less – what is needed? Are the right components included? How much support, and what resources, are allocated to the task by the IAEA. Which tools are used to manage knowledge?