

KNOWLEDGE MANAGEMENT AT ELETRONUCLEAR

W. Lepecki
Consultant, Knowledge Management,
to ELETRONUCLEAR, Brazil

Email address of main author: lepecki@eletronuclear.gov.br

Abstract. ELETRONUCLEAR, a state-owned company responsible for design, construction, ownership and operation of nuclear power plants in Brazil, is applying systematic measures to preserve its essential technological know-how. A special Project called "Determination of Technological Know-How of ELETRONUCLEAR" was established in January 2001 for this purpose. The extent and location of the existing know-how was identified and the gaps in the essential know-how were evaluated. A multidisciplinary team was established to implement the Project. The team interacted with experts both in Brazil and abroad to achieve a sound technical basis as far as knowledge identification and preservation techniques are concerned. The results of this know-how survey were stored in an electronic data bank, which facilitated the creation of several types of reports, according to various criteria. An in-depth analysis of the survey pointed to the gaps in essential know-how. Proposals for solutions to fill in the know-how gaps were set up, comprising both short term, as well as long-term, solutions. This Project was the first work by ELETRONUCLEAR in the field of Knowledge Management. An indirect consequence was the creation of a nucleus of personnel competent in this new discipline, which had a multiplying effect throughout ELETRONUCLEAR, allowing the execution of other new projects in KM.

1. INTRODUCTION

ELETRONUCLEAR, a state-owned company responsible for design, construction, ownership and operation of nuclear power plants in Brazil, has, as a condition for safe and reliable operation, to master this complex, high-level technology.

This technology was absorbed and consolidated along the last 30 years by the Nuclear Engineering Company NUCLEN and the Nuclear Directorate of the Utility FURNAS, and, after 1997, by the new company ELETRONUCLEAR, which resulted from their merging.

Due to aging, the bulk of the technical personnel of ELETRONUCLEAR is foreseen to leave in the next 5 to 10 years (FIG. 1).

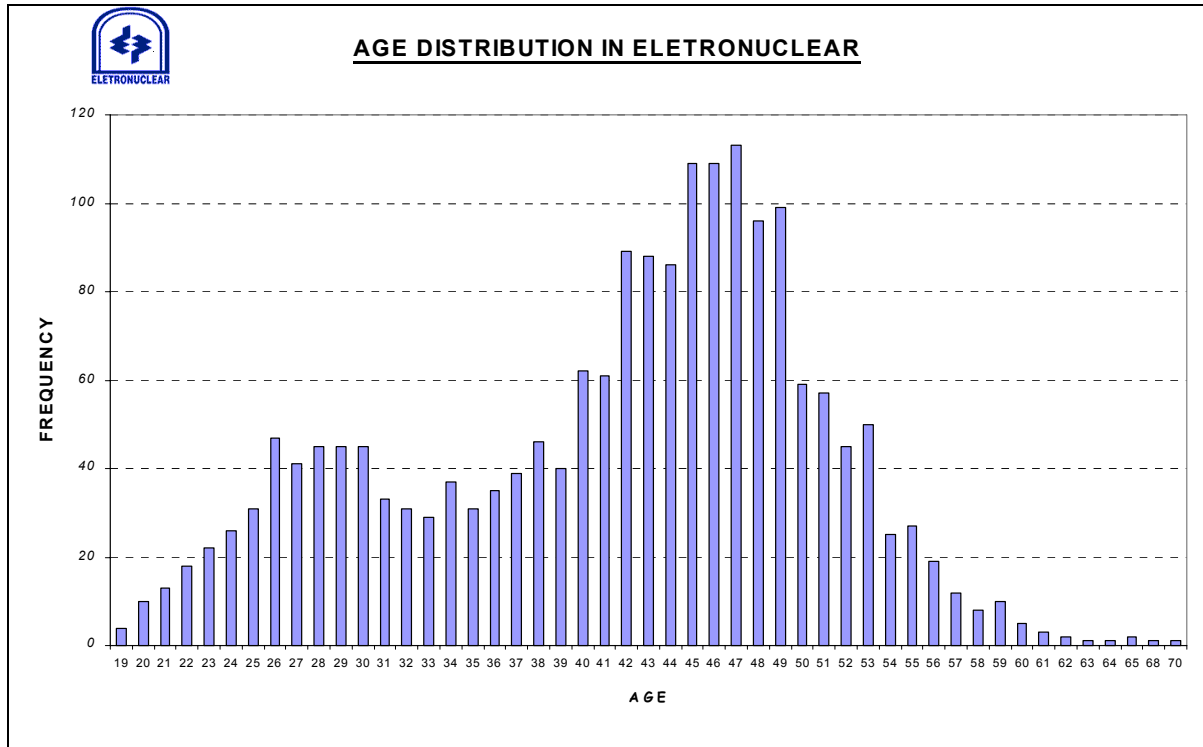


FIG. 1. Age distribution in ELETRONUCLEAR (technical areas-2001).

Therefore, systematic measures were started to be taken in order to preserve the essential technological know-how necessary to operate the existing plants (Angra 1, a 626 Mwe Westinghouse PWR, operating since 1982 and Angra-2, a 1350 Mwe KWU-type PWR, operating since 2000) and to resume the construction of the next plant (Angra 3, identical do Angra-2). A special project was established in January, 2001 for this purpose. Its first aim was to identify more precisely the extent and location of the existing know-how, as it was originally organized by two companies with different methods and cultures. Afterwards, the gaps in the essential know-how should be identified and solutions to fill in these gaps correspondingly proposed, which would comprise both short term, as well as long-term, solutions. A multidisciplinary team was set-up to implement the Project and cooperation established to obtain a sound technical basis, both in Brasil and abroad (especially EPRI, USA).

The methodology adopted is descibed in the following.

A Classification System (taxonomy) was established in order to classify the know-how necessary for the technical activities of the company. Correspondence was established between the items of the taxonomy and the Organizational Units responsible for this know-how item. The managers of these organizational units were asked to evaluate the status of the know-how for the items under their responsibility. For this purpose, know-how was defined as made up of two components: a formal (documented) one and an informal ("in the heads of people") one. An electronic questionnaire was prepared according the above definition and distributed on-line to the responsible managers. The evaluation required the approval of the hierarchical chain. A total of 557 questionnaires were distributed among 41 managers. Each questionnaire correspondend to an item of the taxonomy Of this total, 92% were completely filled in and approved within the allotted time of two months.

The results are stored in a data bank, which allows to issue several types of reports, according to various criteria. Using the data bank, analyses can be performed and proposals for action prepared.

These reports are created on-screen, either by a central administrator - for the whole company - or by the managers -for their respective organizational units. Thus, one can, for instance, identify areas that are weak in documentation or personnel, such identification being very precise as to the nature of the weakness, and the concerned know-how item.

It is to be remarked that in addition to an evaluation of the present status, an estimate for the near future (up to 5 years) was also made, to identify potential cliff-edge effects.

Analysis of the know-how gaps and the necessary measures to solve them followed.

2. METHODOLOGY

2.0. 2.1. Formal and Informal Know-How

The systematic approach adopted to identify the technological Know-How is schematically represented in FIG. 2.

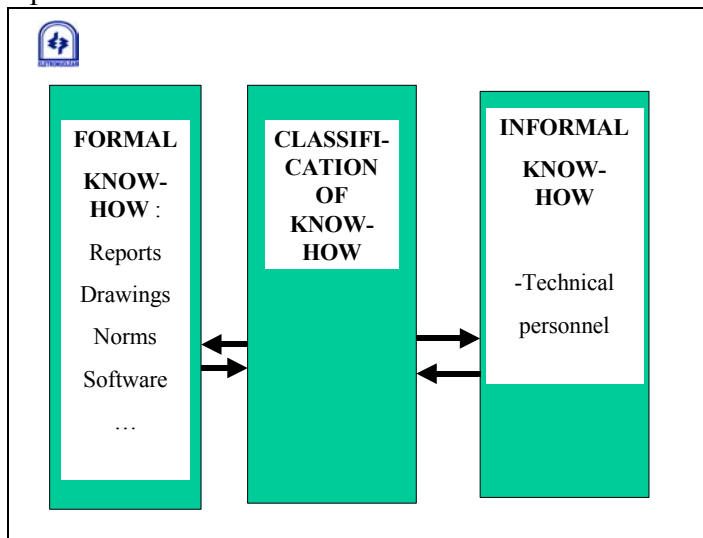


FIG.2. Systematic approach for identification of know-how in ELETRONUCLEAR The Formal Know-How (or Explicit Knowledge) refers to documented technical information and is composed of :

- Reports & Technical Documents
- Drawings
- Norms, Standards & Technical Specifications
- Computer Codes/Software
- Other.

The Informal Know-How (or Tacit Knowledge) depends on the adequate availability of Personnel, both qualitatively as well as quantitatively, to apply the formal Know-How to the activities of the Company.

2.1. 2.2. Know-How Classification System (Taxonomy)

Although there exist in ELETRONUCLEAR several classification systems in use, none was directly applicable to the purpose in mind. Thus, it was preferable to create a new one, with the specific aim of identifying the Know-How needed for the activities of the Company. This was organized in consultation with the Directors, Managers and Specialists. A decimal classification system was used. Calling each decimal point as a "level", at the first level there were four items, viz.:

1. Know-How for Plant Engineering: Plant Design and Support of Plant Operation
2. Know-How for the Physical Execution of the Plant
3. Know-How for Plant Operation
4. Know-How for General Support Activities of the Company.

Within each of these items, other successive levels were defined (Table I).

Table I. Number of items in each level of the Classification System

Level	Number of Items
1	4
2	50
3	238
4	243
5	34
6	2

Thus, for example, the first items of Level 2 of the Classification System look as follows (FIG. 3):



FIG. 3. Example of Classification System down to Level 2.

In this approach, the responsibility for the Know-How is not identified at the individuals' level, but at the level of Organizational Units of the Company. Therefore for each item of the Classification System there was defined a responsible Organizational Unit. It was up to the management hierarchy to assess the Know-How. This correspondence was fixed after detailed discussion and after final approval of the hierarchy up to the top technical level.

3. THE SURVEY

3.1. The Electronic Questionnaire

It was considered that the best method for the Know-How Survey would be through a self-evaluation based on electronic questionnaires to be filled-in on-line, which would form, automatically, a data bank, ready to yield all sorts of reports and analyses.

3.2. Grades and Weights

The Grade assigned to the Know-How level reflects the evaluation made of its situation within the Organization Unit responsible for this item. The Weight reflects the importance of that particular aspect of Know-How (e.g., Reports, Drawings...) for the Taxonomy Item in question. Grades range from 0 to 4 and Weights from 0 to 3, in order of increasing Grade or Weight.

2.4. 3.3. Approval

The Questionnaire is automatically directed on-line to the lowest hierarchical level for filling-in. This is the level that has the most direct feeling of the know-how necessary for its activities. However, this evaluation must be approved by the hierarchy.

The Project Coordinator is able to follow on-line the progress of the survey being filled-in and interfere as needed. The result of the process, after the two months, was that 92% of the questionnaires were filled in and approved.

Table II. Final Status Of The Questionnaires

Not filled-in	10	2%
Filled-in but not approved	10	2%
Partially approved (not by all levels)	22	4%
Totally approved	515	92%
TOTALS	557	100%

4. SURVEY RESULTS

Table II shows the statistical results of the survey. These results (especially the 92% response rate) show that the survey can be trusted as reflecting the evaluation of the plant know-how by the Company management.

2.5. 4.1 Data Storage

The results of the survey are stored in an electronic data bank, accessible by the managers. This allows the creation of a variety of reports, according different criteria, from which analyses can be performed and action proposals can be produced. These reports are created on-line and can be seen directly on the screen of the users, who are the managers at different levels, each viewing the respective Organizational Unit, up to the Director's level.

2.6. 4.2. Data Presentation Formats

There are three formats in which the data are presented:

- The filled-in Questionnaires
- Data bank
- Excel Spread-sheet.

The choice is made by the user, on-screen, through the Intranet.

The *Filled-in and Approved Questionnaires* are important in the sense that they are a record of the original answer. But they are bulky and awkward to handle for analysis purposes.

The *Data Bank* allows to show the data in a more synthetic format, not occupying much physical space on the screen or printed paper. But the most important characteristic of the Data Bank is the screening tool, which allows to screen the data according to pre-established criteria, which are chosen by the user. The following choices can be made:

- Time-horizon: Present or Future (~ 5 years)
- Grades: Maximum or Minimum limits
- Know-How Item: "Reports", "Drawings", "Personnel", etc.

This allows to produce a map of the weak (or strong) points in great detail, the definition of "weak" or "strong" being made by the user as needed. For example, one can show such a selection for weak areas for the item "Norms & Standards", weak meaning , e.g., Grades with a Maximum limit of 1.

In addition, it is possible to assign an index - from 1 to 3 - reflecting the degree of importance of the Taxonomy Item for the Company (how "essential" this particular item of Know-How item is).

The *Excel Spread-sheet* format is used when space is important. The resulting data presentation is in a very compact form..

5. ANALYSIS

In order to identify the gaps of know-how, "gap" was defined as such item of know-how (according the know-how taxonomy) which was evaluated as having a Grade of maximum 1 (scale 0-4), a Weight (for the O.U.) of minimum 3 (scale 0-3), and in addition was assigned by the Directors as having priority 3 for the company (scale min1-max3).

Applying these criteria to the Data Bank, one obtains a mapping of the gaps, which can be represented on the screen or printed out.

Having the Gap Map, it was asked from the managers to suggest solutions to fill in these gaps. The solutions were, e.g., acquisition of reports or computer codes, personnel training, personnel recruitment, etc. A complete Solution Map was thus available for filling in the know-how gaps. The Map was elaborated in two time horizons: situation today and in ~5 years.

6. SUBSEQUENT KNOWLEDGE MANAGEMENT ACTIVITIES

The work described above was the first by ELETRONUCLEAR in the field of Knowledge Management. This created a nucleus of personnel competent in this new discipline, which had a multiplying effect throughout ELETRONUCLEAR. The persons of the original team which executed the Project were trained at the University in Post-Graduation Courses of KM and used for their thesis the issues of interest of ELETRONUCLEAR, viz., Explicit knowledge handling techniques, Determination of detailed personnel necessities through the competence tree method and Tacit Knowledge elicitation methods.

2.7. 6.1 Explicit knowledge handling techniques

The main objective was to organize and make available the explicit knowledge repository coming from the companies which merged to form ELETRONUCLEAR (NUCLEN and FURNAS DN). It was decided to deploy a TDMS (Technical Document Management System) integrated with a Content Search and Classification Engine within a Portal Environment.[1].

2.8. 6.2. Determination of detailed personnel necessities

As a continuation of the basic KM work described above, now applied to the determination of detailed personnel necessities, a method was developed and used called the Competence Tree method [2]. Its objective is to represent, archive and use "intellectual competences". Its structure allows operations that can identify, compare and manipulate individual competences and groups of competences. A computer system prototype was developed to show that the model may be implemented and support a decision making process. The computer system was applied to the practical case of determining personnel needs in the Technical Directorate.

2.9. 6.3. Tacit Knowledge elicitation.

Eletronuclear and EPRI have maintained a close working relationship during the last years during which EPRI created an innovative process and methods for eliciting and capturing valuable undocumented knowledge and ELETRONUCLEAR proceeded with the project described above. Experience was thus exchanged continuously between the two. ELETRONUCLEAR and EPRI intend to launch a joint pilot project to apply in ELETRONUCLEAR the processes and methods for knowledge capture and use developed by EPRI. This will permit Eletronuclear to develop Knowledge Modules (KMs)[3,4] containing valuable expertise that may be used in the future. It is intended, in particular, to use the Concept Map method for this purpose.

7. COOPERATION

This work was the first by ELETRONUCLEAR in the field of Knowledge Management. Although the work was performed with ELETRONUCLEAR's own staff, discussions with persons and institutions acquainted with this relatively new field, especially in the nuclear

area, were very important for the implementation of the Project. In particular, the following institutions' cooperation was very instrumental to the attainment of its objectives:

- CRIE - COPPE , Rio de Janeiro, Brazil (Knowledge Management program at the Engineering Graduate School of the Federal University of Rio de Janeiro);
- EDF, France [5];
- EPRI, Palo Alto, CA, USA;
- IAEA, Vienna;
- TVA, USA [6]

8. CONCLUSIONS

The objective set by ELETRONUCLEAR's Directors, made at the beginning of 2001, of determining which was the status of its Technological Know-How, and what were the risks of losing the essential one, was achieved.

An electronic tool was created and successfully applied. Using this tool, a self-evaluation by the management was made. Cooperation by the managing staff proved to be very good and was, of course, essential for the good results achieved. The corresponding electronic data bank allowed to produce analytical reports according several criteria, pointing to possible solutions for the Know-How bottlenecks which were thus determined. This is the object of work under way. As a result, Knowledge Management will be established as a permanent activity, to assure the most valuable resource of the company, its own knowledge.

The work was executed by ELETRONUCLEAR's own staff, supported by external cooperation, both national and international

9. ACKNOWLEDGMENTS

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