NUCLEAR KNOWLEDGE MANAGEMENT – THE ROLE OF THE IAEA AND ITS TECHNICAL COOPERATION PROGRAMME

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"Like water, the rising tide of data can be viewed as an abundant, vital and necessary resource. With enough preparation, we should be able to tap into that reservoir – and ride the wave – by utilizing new ways to channel raw data into meaningful information. That information, in turn, can then become the knowledge that leads to wisdom."

L. Alberthal

It is a pleasure to address such an eminent gathering at this International Conference on Nuclear Knowledge Management. I regard this particular conference as more of a 'thinking forum' where we shall together endeavour to clarify our ideas on this somewhat *fuzzy* subject. It is thus entirely appropriate that the Commissariat should have joined hands with IAEA to organize this moot. After all, it was that great Frenchman Descartes who philosophized: cogito, ergo sum (I think, therefore I am).

I. Knowledge

"Our knowledge is the amassed thought and experience of innumerable minds".

Ralph Waldo Emerson

"Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it".

Samuel Johnson

Let us start our thinking process by trying to understand what we mean by knowledge that people seem to have become so interested in managing. I would like to share a pertinent observation that I have come across:

- A collection of data is not information.
- A collection of information is not knowledge.
- A collection of knowledge is not wisdom.

The idea is that information, knowledge, and wisdom are more than simply collections. Rather, the whole represents more than the sum of its parts and

has a sense and synergy of its own. A collection of data for which there is no perceived relationship between the pieces of those data is not information. In other words, data become information after being subjected to analysis. In turn, information represents simply a relationship between data, with great dependence on context for its meaning and with little implication for the future.

Beyond relationship, there is pattern which embodies consistency, continuity and completeness of relations and which, to an extent, creates its own context. When a pattern exists amidst the data and information, the pattern has the potential to represent knowledge. It only becomes knowledge, however, when one is able to understand the patterns and their implications. The patterns representing knowledge tend to create their own context rather than being context dependent to the same extent that information is. A pattern which represents knowledge also provides, when the pattern is understood, a high level of reliability or predictability as to how the pattern will evolve over time, for patterns are seldom static. Knowledge thus has a sense of completeness that information simply does not possess. Furthermore, application of knowledge, where relevant, contributes to its preservation and growth. Finally, when knowledge is value-added through good judgment, we can say that we are truly on the road to the ultimate goal: Wisdom.

An illustration

A ripe apple falls to the ground; a plate slips from the hands and shatters on the floor; a cricket ball, hit however high, eventually returns to the fielder. These are simple pieces of data. The general statement that "unsupported objects fall towards the Earth" – which results from an analysis of data – represents information. When, further the information is

understood as a universal pattern, knowledge is created – in this case as Newton's universal law of gravitation $F = G\ m\ M\ /\ r^2$ which encompasses situations as diverse as the trajectory of a baseball and the orbit of Earth around the Sun. As this knowledge continues to be applied to different phenomena, minute discrepancies are detected, and the knowledge grows and evolves, leading ultimately to the transition from Newton to Einstein.

II. Nuclear Knowledge

Some people believe that nuclear technology is heading towards obsolescence. But, for those of us who have grown with nuclear knowledge and its varied applications, it remains current, virile and fully capable of continuing to make important contributions to supplement efforts to meet the global needs of energy, food, water, better health and well being and in particular of a fast growing population in the Third World. Furthermore, nuclear knowledge is varied and extensive as it encompasses results of nuclear related scientific, technical and engineering research done all over the world; design and operational data of nuclear facilities, the maintenance records and regulatory reviews etc. From its very inception, nuclear technology demanded accuracy and precision, which in turn were reflected in higher standards of acquisition, analysis and reporting of data.

Thus, nuclear knowledge did not remain static but kept on growing whereby newer designs for nuclear facilities were introduced; their plant life extensions and technical upgrades took place. Research in nuclear sciences and techniques continues to add to nuclear information. All this provides knowledge that falls in the domain of what is called explicit knowledge. In addition, there is the tacit nuclear knowledge that is not documented but remains in the minds of nuclear professionals. The richness of nuclear knowledge can be gauged from the fact that all core disciplines such as

Physics, Chemistry, Biology along with Mathematics and Statistics have contributed to nuclear knowledge. Furthermore, modern engineering, medicine, agriculture, geology, seismology, hydrology, industrial research, environmental sciences, information technology, biotechnology, nanotechnology etc. have also been contributing to the growth of nuclear knowledge.

An example from the safety of nuclear power plants will provide yet *another illustration* of how information is transformed into knowledge.

This is done through what we may call "Triple-A" process of **A**ssimilation of information, its **A**daptation and **A**doption for use. IAEA Safety Standards are developed through the cumulative experience of experts, mainly from the developed vendor countries, and constitute a formulation of their knowledge into the Safety Standards. Here we see that knowledge is created by cumulative use of information available to experts and their tacit knowledge through their experience. Once developed, documented and issued and sent to Member States for application, this knowledge arrives essentially as information until it goes through the "Triple-A" process mentioned above which converts information into knowledge in a form ready for use at the receiving end. Knowledge is thus created through the utilization of information and data (explicit knowledge) coupled with the potential of people's skills, competencies, ideas, intuition, commitments and motivation (tacit knowledge). The more a piece of knowledge is used, the more current and valuable it remains. Sharing of knowledge enhances its worth as it is likely to become more and more applicable.

III. Nuclear Knowledge Management

The concept of knowledge management is less than a decade old. It came about when it was realized that knowledge is a very valuable asset. It is far more valuable than wealth or capacity to use force. Sharing as we have seen does not lessen but augment knowledge. It can be created, captured, secured, combined, shared and managed. The concept of knowledge management emerged in the middle of the last decade. It quickly caught up and, within a few years, the term Knowledge Management (KM) became a buzzword like Y2K. Most of the leading industries, research establishments and international organisations took steps to develop their Knowledge Management strategies, and so did the IAEA.

I had the privilege of attending the IAEA meeting of Senior Officials on Managing Nuclear Knowledge held in Vienna in June 2002. Since then the subject has been taken up at the agency's Board Meetings and the General Conferences held in 2002 and 2003. It was also one of the subjects discussed in the 2002 Scientific Forum of the IAEA. A booklet on "Managing Nuclear Knowledge" published by the Agency in October 2003 provides an excellent summary of the subject.

The essentials of a sound knowledge management, and that includes nuclear knowledge management (NKM) should comprise the following elements:

1. Capturing and storing relevant data and information on a worldwide basis with maximum use of latest Information Technology. Maximising Digital Compression of Information.

2. Maximizing conversion of tacit knowledge as explicit knowledge by encouraging senior professionals to write about their contribution in the development of their expertise and training of their juniors; facilitating senior professionals to give recorded seminars, talks and interviews and encouraging mentoring through interaction with their younger colleagues.

3. Helping to build national capacity to use information to develop knowledge e.g. through the "Triple-A" process mentioned earlier as well as skills to apply knowledge.

4. Organizing international information services and ensuring information flow to national networks, especially in the LDCs, through the internet and onward to the end users; digital libraries of world academia should also be made accessible to interested professionals.

5. Encouraging knowledge management culture at local, national and international levels.

IV. Role of the IAEA

The IAEA statutes provide that the Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world and to ensure the peaceful and safe use of the nuclear technology. Making a modest beginning almost five decades ago, the Agency has, over the years, made a valuable contribution in helping the developing countries to use nuclear techniques for increasing agricultural produce, developing water resources, improving industrial activities through quality control and use of nuclear medicine and radiations for diagnosis and therapy.

The IAEA can boast a number of success stories in the applications of nuclear techniques in the above areas in developing countries of Africa, Asia and Latin America. The use of nuclear power to meet the needs of energy in the Third World has, however, remained very limited because of practical difficulties in transfer of technology, small size of national grids, shortage of capital and human resources etc. In addition to promotional activities, the Agency exercises a regulatory role to ensure safe, peaceful and secure use of nuclear technology. As a matter of fact, there is a perceptible tilt towards its regulatory vis-à-vis promotional role.

A quick overview of the various departments of the Agency from the perspective of NKM may be in order here. Understandably the Agency's focal department for Nuclear Knowledge Management is the DEPARTMENT OF NUCLEAR ENERGY which manages INIS for the entire spectrum of Nuclear Knowledge. It is engaged in the all important work of preserving knowledge relating to fast reactors, decommissioning, management of high active waste etc.; and also keeps a tab on developments at the frontier areas of fresh approaches such as innovative designs of fission reactors and utilization of controlled nuclear fusion, etc. The Department also organizes meetings on Nuclear Power and Fuel Cycle.

The DEPARTMENT OF NUCLEAR SAFETY has strengthened its activities considerably after the unfortunate Chernobyl accident. It has developed standards in nuclear safety and guides for radiation protection; helped establish an Asian Nuclear Safety Network (ANSN) for sharing nuclear safety knowledge; all these initiatives have linkage with nuclear safety knowledge management.

In the DEPARTMENT OF SAFEGUARDS, because of inherent confidentiality of verification activities, nuclear knowledge is essentially

inward focused and the sharing of knowledge is somewhat limited to verification. There of course is a realization within the Agency of an effective capture and storage of nuclear safeguards related knowledge.

The NUCLEAR APPLICATIONS DEPARTMENT promotes various nuclear applications and undertakes coordinated research projects enabling growth and sharing of knowledge on specific topics of common interest to groups of Member States. The Department holds topical meetings and conferences and publishes reports and disseminates information. It also directly operates research centres and laboratories.

Finally, the TECHNICAL COOPERATION (TC) Department supervises and manages the Agency's TC programme to promote overall transfer of technology and know-how for development. The TC activates of the Agency have played a key role in development programs in most of the developing world. In the last decade an orientation took place to gear the programs for achieving development goals rather than capacity building on its own. More recently emphasis has been laid on the development of national and regional self-reliance for which it was recognized that developing human resources and more focused capacity building are indeed essential. In other words, development goals can be more effectively met by knowledge sharing. We thus see that all the Departments of the Agency have a commonality of nuclear knowledge sharing and are thus involved in nuclear knowledge management.

V. Technical Cooperation and Nuclear Knowledge Management

Nuclear Technology is highly knowledge intensive. The technical cooperation activity of the Agency should not merely be limited to the funding of projects using nuclear techniques for development. It should

ensure effective nuclear knowledge sharing along with allocation of financial sources. This is all the more necessary for meeting the desire of Member States for self-reliance.

The TECHNICAL COOPERATION DEPARTMENT (TC) of the IAEA has vast and varied experience and has data and information on the needs of the Member States. The TC department along with Nuclear Application Department has a vast store of information of nuclear techniques that have an edge over others. Matching the needs with what nuclear technology can most usefully offer, the TC department is in a position to map the course of technical cooperation and assistance flowing from the Agency to the Member States. There should be an adequate supply of desired technical information along with equipment (and expert service, if needed) for a T.C. project and the availability of manpower which is able to undertake the "Triple-A" type process mentioned earlier. This manpower should be able to use and transform information to knowledge by adaptive research and apply this knowledge for the required applications. Hence the need to support development of high level multidisciplinary nuclear professional on a sustained basis in the developing countries.

Successful completion of a TC project should not only generate knowledge locally but also foster skills to apply knowledge. The feedback from the projects provides inputs for use in similar projects. Thus not only development goals are achieved but there is an enhancement in nuclear knowledge as well.

VI. Strengthening NKM Activities at IAEA

In addition to consolidating NKM-related activities at various departmental levels, there is a need to develop a central focal point, specially

to devise strategies for meeting the expected shortages of young nuclear professionals and enhancing and harmonizing the education and training activities of various departments. Nuclear knowledge can keep growing and thus remain young only if the world's scientific youth are attracted to it. The IAEA should, therefore, accord to this need the priority it deserves. The Agency may, in particular, help develop the World Nuclear University and make it useful by encouraging its linkages with national nuclear educational institutions. Use may be made of remote learning technology and access to Advanced Digital Libraries.

Another area of focused interest at the Agency should be strengthening and modernizing of INIS by way of consolidating its data/information base through state-of-the-art linkages with WANO and similar nuclear information resources. National Nuclear Information Services should be strengthened with active support of INIS. Yet another initiative that can be taken would be for the IAEA to forge a closer relationship with the International Nuclear Society as well as national nuclear societies particularly for sharing of tacit Nuclear Knowledge and its conversion into explicit knowledge. Lastly IAEA should help strengthening NKM culture amongst Member States. Special Nuclear Knowledge Fund may be created to support in-house NKM within the Agency and in Member States.

VII. Looking Ahead.

"Those who cannot remember the past are condemned to repeat it."

George Santoyana.

Let us learn lessons from the past. Nuclear accidents and mishaps have invariably occurred because of lack of nuclear knowledge or its mismanagement. Human errors in accidents are directly or indirectly

traceable to lack of knowledge of the operator or inadequacies in the process and operational system. One may take the case of the surfacing of information about the large number of 'orphan' radiation sources. This is again directly due to lack of proper knowledge, mismanagement and inadequate transparency.

The unwarranted antagonistic media hype in reporting any nuclear incident has led to circumscribing of nuclear knowledge and limited its growth. Disenchantment with the nuclear profession amongst the youth has further aggravated the situation. Nuclear energy has become controversial because of overblown fears of radiation, and unjustified environmental concerns. The positive aspects of nuclear energy – that it is least polluting, eco-friendly and resource conserving – are seldom highlighted. Great advances in the last two decades have helped modify and improve the designs and operational safety of nuclear power plants. In recent years, the economics of nuclear power plants has also improved remarkably. Safer plants provide higher availability factors and are thus more efficient and economically more competitive. Safe management of nuclear wastes is technically feasible. Decommissioning procedures likewise pose no environmental difficulties.

In short, nuclear fission energy already offers a unique option for assured world energy supplies at affordable cost, without burdening the atmosphere with greenhouse gases. Fusion once harnessed will provide sustainability for centuries to come. In order to realize the Nuclear Future, which may be the only viable future for us, *it is essential to manage and mobilize nuclear knowledge*, which is the common heritage of humankind. If mismanaged, nuclear technology can indeed be catastrophic. But the safe, secure and wise use of nuclear knowledge has the potential to reduce the glaring inequities between nations and to alleviate poverty within a country.

This is assuredly the collective responsibility of all those who are truly knowledgeable in nuclear affairs. Let us learn from the experience of this great country where we are meeting: France which has demonstrated that nuclear knowledge, if managed well, can assure a better and brighter future for our planet.

Thank you.

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