

## STRATEGY FOLLOWED BY INDIA IN PROVIDING TRAINED MANPOWER FOR NUCLEAR INDUSTRY

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### **Introduction**

Basic research conducted in the first few decades of the twentieth century laid the foundation for growth of nuclear science and engineering. Immediately after the second world war nuclear research centres were set up either as part of universities or as national laboratories in various countries around the world. There were rapid developments on all aspects related to nuclear science to realise its full potential. These rapid developments provided challenging career opportunities and thereby attracted young scientists and engineers to a profession in nuclear establishments, whether industry or research centres. Opportunities for growth were available to all who entered this field. Obviously young people felt attracted towards a career in nuclear field and getting the best manpower was an easy task. This happened in India as well. Tata Institute of Fundamental Research was first set up in mid-forties and was followed by setting up of Bhabha Atomic Research Centre. For a young person in India looking for academic challenges, these two institutes provided very good opportunities. Over the years, nuclear establishment in India has expanded and now consists of research and development centres, industrial units and agencies for extra-mural funding. Nuclear establishment has developed expertise over the complete range of nuclear fuel cycle and is ably supported by Indian industry for the manufacture of all materials, components and equipment.

In India, until recently a career in science or engineering was the preferred option by a majority of school graduates. However, there has been a change in recent years. Rapid economic development since the beginning of nineties has opened up several career opportunities and a career in science and engineering is no longer as sought after as was earlier. In particular, percentage of students opting for a career in science has declined more sharply as compared to engineering. Further, even within science and engineering, a wide variety of career options are available and as a result there is spurt in the demand for scientists and engineers. A significant percentage of the young people prefer jobs related to information technology and not the jobs related to hard core engineering. However, our large population and its demographic profile (being in favour of working age) have been helpful and we have been able to get needed manpower for the nuclear industry in India. All recent developments as described above have been a wake up call and made us plan strategies to continue to attract good quality manpower. In this paper, I'll summarise strategies followed by us until recently and also new initiatives to attract and train manpower for the nuclear industry.

### **Strategies for training manpower**

In mid-sixties, Department of Atomic Energy in India was set up with the mandate to exploit nuclear science and it had to take over the task of educating the young scientists and engineers, since graduate programmes in science and engineering were just evolving.

The Department accepted this challenge out of necessity and the basic concept evolved for meeting this challenge has proved to be so successful that we are still continuing with it. The main attributes of this concept are the following.

- One of the foremost concerns of a young person is that education and training should make him or her employable. While working life span of an individual extends over about 40 years, employment potential of a given field may not remain constant over such a long period. However, if the basic education received by an individual is broad enough, it is possible for an individual to reequip himself for an alternate field by short retraining. Therefore, the first (or bachelors) degree should cover as broad a field as possible and specialised training should be a part of the second (or Masters) degree.
- Any specialised programme of higher education must be followed by assured placement so as to derive maximum benefit from the investment made in the higher education by the trainee and the agency funding the training.
- In case of a new evolving field, a major portion of the knowledge, to start with, is tacit. A sharp insight and a lot of effort are needed to capture it into a medium such as text books to facilitate its inter-generational transfer. Such knowledge is best transferred by practising professionals, who are not dependant on text books for facilitating knowledge transfer.

Training School set up by the Department of Atomic Energy in India combines all the above three concepts. Young graduates are selected and trained by practising professionals working in the institutions of the Department, and are employed in the institutions of the Department immediately after completion of their training. Training School at Bhabha Atomic Research Centre (BARC) has been so successful that we have set up affiliates of BARC Training School at other institutions of the Department to meet increasing demand of trained personnel.

This concept has its drawbacks as well. One is that the students, even after going through rigorous academic training, do not get any university degree. Second while university teachers traditionally write text books in addition to research papers and monographs, practising professionals normally confine themselves to research publications or reports. Only a few text books have been published by those who teach in the Training School. Both these drawbacks have been recognised and we have already taken initiative, as described later in this paper, to take care of the first drawback. We need to put in efforts to take care of the second drawback and that is very important from the point of view of knowledge management.

### **Recent initiatives**

As already indicated, in view of availability of competing career options to the young graduates, we have to be proactive and provide attractions in addition to what is being provided by other professions which are becoming very popular amongst the young. To a young graduate, the possibility of earning an advanced degree from a prestigious institute is a big attraction. If pursuit of a career can make this possible, there is a possibility to attract better quality graduates. To enable us to do that we have set up an institute under the aegis of the Department of Atomic Energy having the status of a university under

Indian statute. It has been named Homi Bhabha National Institute (HBNI) and was approved by the Government in June 2005 and its academic programmes started in mid-2006. It enables us to confer university degrees on those who successfully complete training programme in the Training School. We hope it will provide enough attraction to young graduates and we will be able to continue to get good quality human resource. The university structure also imposes an additional layer of quality control on the course content and faculty. After a couple of years, we will be able to quantify its effect both on quality of intake and on quality of training.

HBNI is functioning as a graduate university and academic programmes of the following institutions of the DAE are under its fold.

- Bhabha Atomic Research Centre
- Indira Gandhi Centre for Atomic Research
- Raja Ramanna Centre for Advanced Technology
- Variable Energy Cyclotron Centre
- Institute for Plasma research
- Institute of Physics
- Saha Institute of Nuclear Physics
- Harish-Chandra Research Institute
- Institute of Mathematical Sciences
- Tata Memorial Centre

Academic programmes of these institutes cover a wide range viz., physical sciences, chemical sciences, life-sciences including nuclear medicine and oncology, mathematical sciences, engineering sciences and strategic studies.

Some of the institutes under the fold of HBNI have strength in basic research, while others are focussed more sharply on technology development. Coming together of all institutes under a single academic framework provides for possibilities of joint supervision of research scholars by two persons, one having strength in basic sciences and the other in technology development. In case of institutions engaged in technology development, component of institutional knowledge in tacit form can be significant and individuals involved in technology development may or may not have academic credentials to enable a university set up to consider them suitable for being faculty. However, for managing institutional knowledge, it is necessary to tap their expertise. To do so, we have made provision to enable such individuals to be technology advisors for students pursuing Ph.D. or project work forming a part of a masters degree. Therefore, while academic standards of research will be maintained by HBNI faculty, technology component of research will be enhanced by knowledge transfer from technology advisors. Converting tacit knowledge into research papers or report is a difficult task, but transfer of such knowledge by interaction between a technology advisor and a student is always possible.

A large number of students are already enrolled for Ph.D. under HBNI. A significant percentage of students pursuing Ph.D. are employees of the institutes. We expect HBNI to be instrumental in upgrading the quality of employees in the years to come. We also have plans to increase annual intake of students for Ph.D. and other programmes and these will be implemented after constructing additional infrastructure, particularly students' hostels.

Programmes under HBNI also include diploma in nuclear medicine, radiation physics, medical and radioisotope technology and we may add more such programmes in the years to come. Basic idea is to provide training facilities for the complete range of activities related to nuclear science and engineering thereby ensuring transfer of knowledge to the next generation of employees. We also propose to conduct summer/winter schools on a variety of subjects and in May this year we conducted a three week Summer School on Nuclear Law.

Considering that percentage of students who are attracted towards science after completion of schooling are declining, some bold initiatives are needed to reverse this trend. In the field of engineering education and research, Indian Institutes of Technology have been very successful and the Government has decided to replicate the success by setting up similar institutes to impart education in basic sciences. Towards this end, Ministry of Human Resource Development (MHRD) has set up Indian Institute of Science Education and Research (IISER) at three places and to supplement the efforts of MHRD, DAE is setting up one National Institute of Science Education and Research (NISER). This will start functioning from the academic year beginning August this year and will have strong linkage with the research centres of the DAE. We hope that graduates of NISER and also of other IISERs will take up nuclear science as a career and will provide high quality manpower for research.

We expect a large demand for scientists in India in the years to come as many multinationals are setting up research facilities in India to take advantage of availability of skilled and English speaking manpower. Obviously this calls for increasing the number of institutions of higher learning to the maximum possible extent. Board of Research in Nuclear Sciences (BRNS) is an agency of the DAE for providing extra-mural funding for research and we have recently revised its terms of reference to enable it to fund programmes of relevance to nuclear science and engineering. Under the revised terms, it has already taken the first step and a Centre for Basic Research is being set up jointly by BARC and University of Mumbai. It will start functioning from the academic year beginning August 2007. One more university is interested in collaborating with the DAE to set up a centre for studies in nuclear engineering and we are examining the request.

Basic idea of the new initiatives is to make a career in sciences and in particular in nuclear science and engineering more attractive than at present. We hope that these new initiatives will be helpful in providing manpower needed for the nuclear power programme which is set for expansion in a big way in the coming years.

### **Human Resource Development and Knowledge Management**

A document titled, "Managing Nuclear Knowledge" is under preparation by the IAEA and I am associated with preparation of this document. Draft of this document defines

knowledge to include everything from technical information to insights, capabilities and skills embodied in people. Nuclear knowledge is specific to nuclear related activities. Note the emphasis on the fact that **knowledge is embodied in people**. The same document defines nuclear knowledge management as an integrated, systematic approach applied to all stages of the nuclear knowledge cycle, including its identification, sharing, protection, dissemination, preservation and transfer. The processes of sharing, dissemination and transfer are integral parts of human resource development, which can take the form of class room teaching of the subject, supervision of research scholars by experienced researchers or internship. One can see a strong linkage between knowledge management and human resource development and centrality of people in the entire process.

Knowledge transfer can also take the form of technology transfer. In my personal experience, this is a very important element in the process of knowledge management. Whatever technologies are common to nuclear and other industries and do not need to be protected, should be transferred so as to ensure that all such technology products are available to others as well as nuclear industry. The process of technology transfer requires several stages, the most important being the preparation of technology transfer documents. Another important stage is 'on the job' training of individuals who would be implementing the technology transferred. Still another important stage is 'on site consultation' by the technology developers during technology implementation.

We have a fixed upper age for retirement in India. At that age many individuals are still active and can be useful for providing continuity of knowledge. We have schemes to provide fellowships to such individuals and get the benefit of their knowledge for periods as long as 5 years.

### **Concluding remarks**

Strategies for training or for inter-generational transfer of knowledge depends on the type of knowledge viz., explicit or tacit. In case of explicit knowledge, conventional education system has been in existence for centuries and is quite satisfactory for nuclear education as well. However, in case of tacit knowledge, one has to devise mechanisms for its identification, capture and inter-generational transfer. Earlier in this paper, I have outlined some of the strategies followed by us in India to facilitate transfer of tacit knowledge and one of the reasons for the success of these strategies is the fact that nuclear programme in India is slowly and steadily growing. It is not following a 'stop and go' path as has happened in many developed countries. Training School is an important element in this entire process and 50<sup>th</sup> batch of Training School will be graduating this year in August. Due to continuity provided by the Training School, there has not been demographic gaps in the professional work force. Through the mechanism of Training School, we have been able to take care of both the main elements of human resource development viz., inter-generational transfer of knowledge and capacity building. Therefore, nuclear knowledge management in India has not been a problem as it has become in other parts of the world.

I would like to end by saying that it is the people who are the most important in any profession and organization. In the entire process of knowledge management or human

resource development, while technology can be an aid, the centrality of individuals or people has to be fully recognised and reinforced continuously.