Transfer of Nuclear Engineering Knowledge at Hanoi University of Technology: *Lessons Learned and Challenges*

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Abstract. In this paper there are shown main objectives of the nuclear engineering education programme implemented at the Hanoi Unversity of Technology (HUT) since the year 1970 up to now. After presenting three periods of the programme, the authors drew lessons learned from nearly-forty-years runing the programme. At present, transfer of nuclear engineering knowledge at HUT is in new circumstances, especially after the Vietnam's Prime Minister signed (on 3th January 2006) the decision on approval of the strategy of peaceful uses of atomic energy in the country up to the year 2020. However, beside favourable conditions, the programme of transfer of nuclear engineering knowledge at HUT is facing serious challenges which are shown in the paper together with possible measures to overcome them. Upgrading the programme and intensifying co-operation in both national and international frames could be essential contributions to nuclear engineering human resource development of the country.

1. Establishment and main objectives of nuclear engineering education at Hanoi University of Technology

Hanoi University of Technology (HUT) was established in the year 1956 to meet demands on technical human resources of Vietnam. It has been being the most important polytechnic education centre of the country for half a century. A few years after establishment of HUT, Vietnam began to send abroad young people to study nuclear physics. In the early 1960s nuclear physics began to be studied in several institutions in the country, such as HUT and University of Natural Sciences and then Institute of Physics in Hanoi, as well as in Dalat and Saigon University in South of the country. In the years 1967 and 1968 the preparation for establishment of Department of Nuclear Engineering was started at the HUT according to the initiative of the first Minister of Ministry of Higher Education. Since the year 1970, Programme of Education in Nuclear Engineering (PE-NE) was started at HUT right after establishment of the HUT's Department of Nuclear Engineering. The HUT's PE-NE was well supported and steady developed up to the year 1987. After that there was a period of slow down. From the year 1990 to 1999 the HUT's PE-NE could not enroll any students. Since the year 2000 Department changed its education programme to adapt it to the actual circumstances in the country and renamed as Department of Nuclear Engineering and Environmental Physics (DO-NEEP).

The main objectives of the HUT's PE-NE are the same as they were declared since the year 1970, namely:

a). To train up nuclear engineering human resources for development of peaceful uses of atomic energy in Vietnam.

b). To prepare initial nuclear engineering human resources for introduction of nuclear power into the country.

Aiming at these objectives, the programme achieved significant results and had inestimable contributions to developing the atomic energy applications in the country and to providing important parts of engineering human resources for strengthening the nuclear community in the country.

2. Lessons learned

There are 37 years past since the establishment of the Department up to now. This path of implementation of the Programme of Education in Nuclear Engineering at HUT may be considered to have 3 periods of time as follows:

a). The first period: from the year 1970 to 1989;

b). The second period: from the year 1990 to 2000; and

c). The third period: from the year 2001 up to now.

During the first period, the programme was strongly supported by the leadership of the University and the Ministry of Higher Education. The Department made great efforts and successfully developed close co-operation with many related institutions such as Institute of Physics, Vietnam Atomic Energy Research Institute, Research Institute for Labour Protection, several hospitals in Hanoi and nuclear geophysical units as well as several industrial enterprises in North of the country. In this period the Programme enrolled about 10 to 15 new students every year.

It is worth recognizing considerable contributions of the Department in its first period of time, especially in development of NDT radiography method in Vietnam. It was at the Department and directly after its establishment that the NDT radiography method was studied first time in the country. Its staffs applied the NDT method by themselves at many industrial enterprises of high importance, among which there were electric power stations, construction sites, mechanical factories, cement factories and so on. A large number of engineers and technicians were trained up by the Department for NDT radiography applications. Thanks to the greate efforts of the Department, the NDT radiography method was introduced into Vietnam and is now widely used in the country. In this period all students of HUT's PE-NE were sent to practice on using atomic energy at many industrial enterprises for NDT application, at geophysical units for searching natural resources, as well as at many research institutes etc. This resulted in favourable arrangement of appropriate good jobs for young engineers graduated from the Department.

After reunification of the country in the year 1976 there was established Vietnam Atomic Energy Research Institute (VAERI), which gave strong impulse for development of nuclear community in the country. The Department played essential role in providing manpower for the Institute, especially in the first stage of the last one. It is still memorised the active participation of many Department's members in restarting operation of the nuclear research reactor in highland Da Lat after it was abandoned for a decade. At present, most of former students of the Department are working in all the institutes of the VAERI and nearly in all fields of peaceful uses of atomic energy in the country.

In its first period, the Department received many effective supports from its partners at home as well as from abroad. Among the material supports it received at that time, there was the first IAEA TC Project implemented in the early 1980s for strengthening the PE-NE at HUT. It would be a great shortcoming if someone of us did not remember that in this period many Department's staffs were sent abroad to improve their nuclear knowledge. All these supports made together a solid base for development of the Department and they considerably deepened the strong influence of the last one in development of nuclear human resource to meet demands of the country at that time.

The years 1990s of HUT's PE-NE belonged to its second period of time. This period was marked by many serious difficulties which were directly connected with very strong attractions of several other fields such as economy, law, information technology, foreign languages, journalism, tourism and so on. The changes in some socio-economic aspects in this period negatively impacted the co-operation

relations of the Department and made them weaker than they were before. The Department could not gain any considerable supports from the University. The situation at that time was extremely difficult for HUT's PE-NE because in spite of all efforts of the Department there were no students follow the programme. It may also be appropriate to point out that the years 1990s are the most severe time for nuclear education in Vietnam as well as for the Vietnam nuclear community as a whole [1,2]. There observed a considerable decrement of staff number of all the units of Vietnam nuclear community in this period. Concerning the HUT's PE-NE, this was a period of searching the ways for surviving and then for preserving the programme and adapting it to new circumstances in the country.

The most stinging question which raised for many years for the Department in the second period was what to do for overcoming such difficult situation? Being aware of forever close ties between atomic energy applications and environmental problems which were raised and became unfavourable to using nuclear power in many countries, as well as being aware of growing attentions paid to environmental aspects in Vietnam, we submited to the HUT's leadership in the year 1999 a proposal to enlarger field of education programme of the Department by including environmental physics part to the former programme and to rename simultaneously the Department as Department of Nuclear Engineering and Environmental Physics (DO-NEEP). The proposal was finally approved in February 2000 and right in that year the DO-NEEP could enroll a group of students in new stage of Nuclear Engineering Education at HUT. This event has put the end to the second period of HUT's PE-NE. The programme survived from its dangerous period and then it was improved step by step. Since that moment up to now the Programme of Education in Nuclear Engineering and Environmental Physics (PE-NEEP) enrolls continuously from 7 to 12 new students every year.

The present period of transfer of nuclear engineering knowledge at HUT began from the year 2000 with changing education programme from PE-NE into PE-NEEP and with renaming the Department as DO-NEEP. In this period, the peaceful uses of atomic energy in the country in general are being benefited from economic growth of the country and have been being intensified and widened. It is observed the tendency of increment of staff number of all units of the nuclear community in the country. Awareness of necessity of close co-operation is being heightened in the units of the Vietnam nuclear community. From its side, the Department actively participates in the activities of the community, especially in the activities towards project of introducing first nuclear power plant into the country, which have been being forwarded. Distinguished researchers from related institutes are invited to give lectures for Department's students. There appear mixed research groups including members from the Department and other institutions. A multilateral joint lab is under formation. A joint nuclear engineering education programme is under construction. Establishing a conglomeration for education in nuclear engineering and environmental physics at HUT is being forwarded for involving many faculties and institutes in implementing the PE-NEEP at HUT. The Department makes great efforts to establish international co-operation relations and to send best students to study abroad. It gains again strong and effective supports from the University as well as from its partners at home and abroad. The period since the year 2000 up to now may be characterized as a period of searching the ways for developing the HUT's PE-NEEP [3-5].

The lessons that one could draw from the history of 37 years of the programme of education in nuclear engineering at Hanoi University of Technology are as follows:

(i). Establishing proper objectives aiming to satisfy the urgent short-term and/or long-term demands of the country is the most important guarantee for success of the programme.

(ii). Finding out close relation between the courses to be studied and the above-mentioned demands of the country is a very important guarantee for success of the programme.

(iii). Training up teaching staffs of high consciousness of responsibility and of a quality as high as possible is a key guarantee for success of the programme.

(iv). Adapting the programme for providing students knowledge which should be a)- of wide enough profile (for heightening capacities of seeking jobs of graduated students in today

labor market in the country), and b)- of high-enough quality (fore better integration and successful co-operation) is a necessary factor to attract students to the programme.

(v). Developing close contacts and co-operations with the related institutions in the country in order to make the programme suitable and more attractive as well as to get a practical plan of using the young people trained-up by the programme is another necessary factor for its success.

(vi). Establishing and developing effective international co-operations are of extremely high importance in heightening level of teaching staffs knowledge as well as in strengthening technical base for rapid and considerable improvement of the programme quality.

3. Challenges

For the reason that HUT is the most important polytechnic education centre of Vietnam, it will not be a mistake to say that the challenges facing the country in nuclear human resource development are simultaneously the ones that HUT must overcome, and, the favourable circumstances for nuclear engineering education in the country are simultaneously the ones advantageous for the HUT's PE-NEEP.

Transfer of nuclear engineering knowledge at HUT is now witnessing its new situation after the Vietnam's Prime Ministre signed decision No.01/2006/QD-TTg on 3rd January 2006 on approval of the strategy for peaceful uses of atomic energy in the country up to the year 2020. In the strategy, introduction of nuclear power plant (NPP) into the country around the year 2020 was officially pronounced first time [6,7]. This event brings a new strong impulse for transfer of knowledge of nuclear engineering in general and of nuclear power engineering (NPE) in particular at HUT.

Because of NPP's being result of highest-level integration of a large number of fields of high technologies and engineering, NPE can serve as a way for a developing country to heighten synchronously its capacity in many fields, which is important for its economic development. However, on the way of introducing its first NPP, Vietnam has to face serious difficulties among which there are the following:

(i). Lack of sufficient industrial base;

(ii). Lack of sufficient integrity of different technological fields as well as related non-technological fields;

(iii). Lack of sufficient investment; and

(iv). Lack of sufficient and qualified nuclear human resource.

Having sufficient and qualified nuclear human resource is the most important factor because it decides both safe operation and cost-effective operation of NPP.

In Vietnam there is observed steady growth of demands on electricity [8]. These demands are exceptionally high in the country in the dry season which usually lasts half an year. At present Vietnam has already to import electricity to assure its economic development. The situation is calling upon strong efforts of the whole Vietnam's nuclear community, especially in preparation of human resource towards introducing and safely operating the first NPP of the country. This requires Vietnam to be ready to provide nuclear human resource of high quality.

In Vietnam as well as in many developing countries at present there are only specialists on applied nuclear techniques for non-power fields, and, rather diluted nuclear engineering education programmes. To develop human resource for meeting the demands on introducing its first NPP, Vietnam has to overcome big challenges such as follows:

(i). Lack of sufficient knowledge on NPE and nuclear power safety;

(ii). Lack of sufficient knowledge on the preparation steps to be successfully implemented

towards first NPP;

(iii). Lack of sufficient safety culture;

(iv). Lack of suitable NPE education programme;

(v). Lack of experienced educators on NPE and nuclear power safety; and

(vi). Lack of sufficient incentive to involve and to keep people to work for NPE fields.

The first five of these challenges cannot be overcome without transfer of nuclear engineering knowledge.

In order to satisfy the demands of the country on nuclear engineering HRD at present and in near future, transfer of nuclear engineering knowledge at HUT must be combined from two aspects: both nuclear non-power engineering and nuclear power engineering. On this way, HUT has to face a number of challenges to contribute considerably to meeting new demands of the country. Its big challenges may be listed as follows:

(i). Lack of suitable PE-NEEP;

(ii). Lack of sufficient knowledge on nuclear power engineering and nuclear power safety;

(iii). Lack of necessary equipment and teaching material for running the PE-NEEP with high enough quality;

(iv). Lack of experienced educators for running the PE-NEEP; and

(v). Lack of sufficient incentive to involve and to keep people to work for the programme.

In order to overcome such serious challenges, the HUT is trying its best to make every efforts with considering carefully all the lessons learned from the history of its nuclear engineering education. One of its first main efforts in this course is setting up a new PE-NEEP in close co-operation with Vietnam Atomic Energy Commission and other related partners at home and abroad.

During implementation of nuclear engineering knowledge transfer, a developing country like Vietnam, because of lack of sufficient investment, will not be able to send to study abroad all the number of people to be trained up for meeting its urgent need in nuclear HRD. This leads to very important role of training trainers. Obviously, organizing an appropriate conglomeration of the educators mastering relevant competences will play a pillar role which is indispensable for nuclear engineering HRD in a developing country. It is worth emphasizing that lack of experienced educators on PE-NEEP is the reason urging HUT's DO-NEEP to expand and to intensify co-operation with research institutes and other related institutions. It is expected that a close co-operation between HUT's DO-NEEP and these institutions could make the institutes' laboratories open for training purposes and make institutes' researchers actively involved in the programme of transfer of nuclear engineering knowledge. Following the course of expanding and intensifying co-operation, HUT is now trying to set up a suitable conglomeration for consolidating its PE-NEEP by involving in this programme the related units of HUT and related institutions in the country. Such conglomeration may be an unit consisting of several labs which fully belong to HUT and several other joint labs of HUT and its partners. One of such joint labs is multilateral cyclotron centre with five partners including HUT's DO-NEEP. Establishing such a conglomeration will create new propitious conditions for running the HUT's PE-NEEP which serves as a good contribution to nuclear engineering HRD in Vietnam.

Today life fosters our thinking about safety culture aspect as well as about its connection with transfer of nuclear engineering knowledge. Getting sufficient safety culture is a time-consuming process, therefore, it would be reasonable to pay a special attention to transfer of knowledge on nuclear safety and safety culture all through the nuclear engineering HRD programme and right from the beginning of the programme. The lack of knowledge in this aspect will be overcome step by step thanks to close and effective international co-operation.

Increasing need for transfer of nuclear engineering knowledge requires effective international co-

operation and make it indispensable for successful implemention of the PE-NEEP at HUT in particular as well as for nuclear HRD in Vietnam in general. The more effective international co-operation we have the greater achievements we can reach. Every initiatives for this aim should be complementary and in no way competitive or alternative and they should be supported. Being aware of extremely important role of international co-operation, HUT is trying to make every efforts to develop it for the purpose of fruitful implementation of HUT's PE-NEEP.

Every result of co-operation with related partners at home and abroad will be an effective stimulation for young people to follow and to work for the PE-NEEP. HUT tries to take all possible measures for the purpose of strengthening its endogenous capability on transfer of nuclear engineering knowledge for meeting demands in nuclear engineering HRD of the country.

4. Conclusion

There are useful lessons could be learn from implementating the programme of transfer of nuclear engineering knowledge at HUT. These lessons are being carefully considered by HUT for application in order to overcome the challenges which are facing HUT's PE-NEEP in present period of time. The continious efforts in combining the possible measures for the purpose of intensifying endogenous capability on transfer of nuclear engineering knowledge are of high importance. Among these efforts of HUT, to set up a new PE-NEEP and to develop co-operation with the related partners at home and abroad for nuclear engineering education always occupy ones of the central positions. The HUT's efforts aiming at strengthening its PE-NEEP could result in substantial contributions to nuclear engineering HRD in Vietnam.

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