
**PRESERVATION OF NUCLEAR TALENTED EXPERTS IN JAPAN BY
COOPERATION OF INDUSTRIES, RESEARCH INSTITUTES AND
UNIVERSITIES**

H. Mori

Japan Nuclear Cycle Development Institute, Japan

K. Miura

Japan Atomic Industrial Forum, Inc. Japan

Email address of main author: mori@hq.jnc.go.jp

Abstract. Japan has enjoyed decades-long successful development of nuclear power generation and has a nuclear generating capacity of about 46,000,000 kilowatts at present. Construction of a commercial reprocessing plant in Rokkasho is nearing completion. The continuation of Japan's nuclear technology and experience, however, and the challenge of securing technically trained human resources for the future, present serious problems. Recognizing this, the nuclear industry, universities and research institutes have joined in new cooperative efforts to find network-oriented solutions.

1. Japan's Nuclear Use Today

Nuclear power provides about 35% of Japan's generated electricity. Strategically, its role in national energy supply is increasingly important. With construction of a commercial-scale reprocessing plant nearing the final stage of testing, realization of a practical nuclear fuel cycle is not far off.

That said the rate of growth of energy demand in Japan has slowed to about the same as other industrial nations. Analysts think nuclear generating capacity in Japan will reach a maximum of 70GWe.

(Table -1 : Nuclear generating capacity in Japan)

Nations of the world are being urged to meet the global-warming targets set at COP3 in Kyoto in 1997. Japan, at COP3, undertook to achieve a 6% reduction in CO2 emissions from the 1990 level by 2010. Unfortunately, this is now seen as extremely difficult.

The Japanese government, in the passage of the Energy Policy Basic Law in 2002 and issuance of the Basic Plan for Energy Supply and Demand in 2003 based on that law, has demonstrated its commitment to important roles for nuclear power generation and the nuclear fuel cycle.

For nuclear energy to play its role in Japan, it is necessary to secure the best possible human resources. The Long-Term Program for Nuclear Research, Development and Utilization, issued by the Atomic Energy Commission, recognizes the importance of young researchers

and technical experts being able to look ahead with dreams and hopes, to find personal and professional fulfillment in their work. It is difficult at present for them to feel this way about a nuclear career. The result is a severe situation when it comes to continuing the technology, and all parties in industry, academe, the research sector and the government must cooperate to overcome it.

2. The Problem of Continuation

Because “nuclear technology” involves the integration of multiple engineering technologies, personnel are needed with a wide range of knowledge and experience. These include experts in plant design, component manufacturing, plant construction, operation, maintenance and nuclear fuel manufacturing. Persons knowledgeable in administration, including government regulations and risk management, are also necessary.

Japan has three broad problems when it comes to continuing its nuclear technology.

The primary one is lack of experience on the part of those working in the field. Fifty-two nuclear power plants have been constructed in Japan, but the number of new plants being built has fallen rapidly since 1995. The trend toward extending operating lives will further affect the number of plants built in the future. (Table -2 : Nuclear power plants commissioned)

Eleven utility companies are responsible for operating and planning the construction of nuclear power plants in Japan. Three manufacturers (Mitsubishi Heavy Industries, Toshiba and Hitachi) supply the nuclear equipment and systems. This is to say, the problem of experience – declining orders for new plants – is felt through a very large pool of talented individuals. In 1990, at the peak, 60,000 persons were engaged in nuclear-related work at utilities and manufacturers; by 2002, the number had fallen to 54,000. (Figure -1 : Nuclear-related workers)

As serious as the problem of “continuation” is in regard to nuclear power plants, it is potentially even more so in terms of the nuclear fuel cycle, as, following completion of the private, commercial reprocessing plant scheduled to open in 2006, there are currently no plans for further construction.

The second problem is the aging of Japan’s nuclear experts themselves. When nuclear development began in Japan in the 1960’s, it attracted the nation’s best scientific and technical people. But even those who were new graduates at the start are nearing retirement now. Successors to them – to receive, maintain and again pass on their extensive store of knowledge and experience – must be found.

The third problem is that young, technically inclined people are not being shown by the industry why a nuclear career can be a challenging one. As a result, they have little interest, compared with other industries, and are drawn more, statistics show, to “futuristic” careers in

information and communications. The nuclear industry is seen as rarely offering new challenges and, indeed, as the subject of a fair amount of social concern. Looked at from the student's point of view, nuclear accidents and scandals, here and abroad, only add to the perceived reasons for avoiding the field.

Moreover, the reality is that only a third of students graduating from nuclear engineering programs can find jobs in the nuclear industry.

(Figure -2 : Employment rate to the nuclear energy field)

One final factor is that, as part of a broader effort toward national administrative reform, national universities (where most nuclear programs are offered) have seen their status changed to that of independent administrative entities, and are expected to find it difficult on their own to generate the investment needed to maintain nuclear education and research facilities.

3. Efforts of the Japan Atomic Industrial Forum

The Japan Atomic Industrial Forum created an exploratory committee in 2002 to review nuclear human-resources issues and consider measures for the future. After two years of work, the committee issued a report outlining three proposals.

(1) Increase job opportunities for new graduates

With fewer new nuclear plants being built, maintenance at existing plants has become the major focus of the nuclear industry. While this has created opportunities for those in, for example, electrical and mechanical engineering, "nuclear engineering" jobs have decreased.

To increase the number of "nuclear" jobs, the industry should endeavor to expand the nuclear-plant export sector, and to promote the industrial uses of radiation in areas beyond power generation.

(2) Offer a challenging future

Nuclear light-water-reactor technology has matured to the present ABWR's and APWR's. It is necessary for the industry to show where it is going next – to identify clear and exciting challenges ahead. For example:

- nuclear energy development expanding users beyond power generation
- strengthening radiation-related industries
- R&D on the fuel cycle, on treatment of high-level radioactive waste, etc.
- R&D contributing to the rationalization of regulations

It should, even more specifically, proceed toward hydrogen production using nuclear energy. And, Japan should be an active participant in international Gen-4 efforts.

(3) Restructure human-resource development systems

Nuclear education/training has long been heavily dependent on on-the-job-training (“OJT”). With the decline in new nuclear construction, however, OJT opportunities, especially for young researchers and technicians, have diminished. Concurrently, those experienced workers who can teach their younger colleagues are becoming fewer in number. The overall development system has simply become inadequate, and a new cooperative one among industry and the academic and research communities is necessary. Such a system is the Nuclear Education System Network, or “NES-net.”

4. NES-net concept

NES-net aims to achieve maximum effectiveness by combining existing educational infrastructure (at universities, research institutes and industrial facilities), additional functions and facilities, and IT technology.

The NES-net concept comprises a program to educate core nuclear experts, together with creation of a maintenance-skills training center, and an education-and-training information center.

(Figure -3 : NES-net concept)

The core nuclear expert course is to educate and train students who will be responsible for nuclear energy research and development in the future. Even now, of course, some cooperation between universities and R&D institutes exists. In the future, under the new concept, such cooperation will involve greater actual use of research facilities, and participation of personnel, at the institutes. The results are expected to include the advancement of nuclear technology, the creation of new technologies, and the emergence of a nuclear industry more attractive and appealing to the next generation.

The purpose of the maintenance-skills training center is to standardize knowledge, techniques, supervision of workers, and so on, in order to realize a maintenance alliance in the future. It will also consider maintenance qualification systems.

The purpose of the education-and-training information center is to share information on what companies and industries have done individually, so that benefits can be obtained mutually.

The information center will complete by 2004 a database available via the Internet within this fiscal year on the content of education and training programs at electric power companies, manufacturers, and research institutes. It is expected that information from about 180 companies will be stored in the database and that more efficient, effective, unified education and training will result.

5. Efforts of the Japan Nuclear Cycle Development Institute (JNC)

As part of a series of administrative reforms being carried out by the government, the Japan Nuclear Cycle Development Institute (JNC) and the Japan Atomic Energy Research Institute (JAERI) are proceeding toward a merger by October, 2005. The new entity will be the

primary nuclear R&D agency in Japan, and its mission as suggest by the government includes important responsibilities in human resource development.

JNC has an established program of human resource development, using its facilities, in cooperation with various university graduate schools. In the future, an association of graduate schools is to be formed, and cooperation will be with that association. As part of this evolution, the idea of making an “innovation incubation center” is now being developed. (Figure -4 : New cooperation system concept)

Also under review at present is creation of an R&D base centered on the prototype FBR “Monju,” to succeed to the development of fast-breeder reactor technology.

6. Changes at Universities

National universities, which have been primary sources of trained people for the nuclear industry, became independent administrative entities in 2004, expected to exhibit strong private management. Research programs are to be evaluated every five years.

This makes it difficult to invest in nuclear research facilities, which are extremely expensive, and, accordingly, difficult for the universities to continue to foster human-resource development in nuclear fields. Additionally, because research reactors at universities are rather old, training is already done using facilities owned by JNC and other research facilities.

At the same time, Fukui University, a national university in Fukui Prefecture (distant from Tokyo), the home of "Monju" and many other nuclear power plants, established a graduate school in April, 2004, specialized in nuclear energy, to supply the human resources needed to secure the safety of nuclear power plants. The school and JNC are cooperating.

Ibaraki University, a national university in Ibaraki Prefecture, the locus of nuclear research and development in Japan, established a graduate school in April, 2004, specialized in nuclear science. As the nucleus of nuclear studies, it will also supply human resources to the many research facilities in the prefecture.

Tokyo University intends to launch a nuclear profession graduate school for experienced people in 2005. It hopes to further educate those already working at utilities, manufacturers, and for regulatory agencies and local governments. JNC and JAERI will cooperate in the use of facilities and in dispatching education and training staff.

7. Conclusion

As the birthrate declines and the elderly portion of the population grows, the problem of securing talented workers and maintaining and continuing technologies arises in various fields. It is most important in the nuclear field, which is tasked with a vital role in securing the nation's energy supply.

At present, many things are being done to attract and retain people in nuclear areas, to educate and train them, but these activities are neither systematic nor adequately organized.

It is necessary to provide means whereby anyone who wants to study nuclear engineering has access to a high level of education, notwithstanding geographical or time considerations. Ideally, the foundation for nuclear understanding should be part of education at the elementary and secondary levels. The trend in Japan, unfortunately, is to eliminate or minimize science courses, and a positive view of nuclear energy is rarely presented as a result of publicity about accidents and other problems. The entire nuclear industry must actively tackle the issue of educating the next generation.

Table -1 Nuclear generating capacity in Japan

	2000 (results)	2010	2030
High case	4,492	5,014	6,795
Reference case			5,798
Low case			5,597

Units: 10,000 kW

"Energy Demand and Supply Outlook in 2030" (interim); 2004.6

Advisory Committee for Energy, Ministry of Economy, Trade and Industry

Table -2 Nuclear power plants commissioned

Period	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990
Number of units	4	8	10	10	7
Period	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015
Number of units	10	3	3	4	4

Fig1 Nuclear-Related Workers

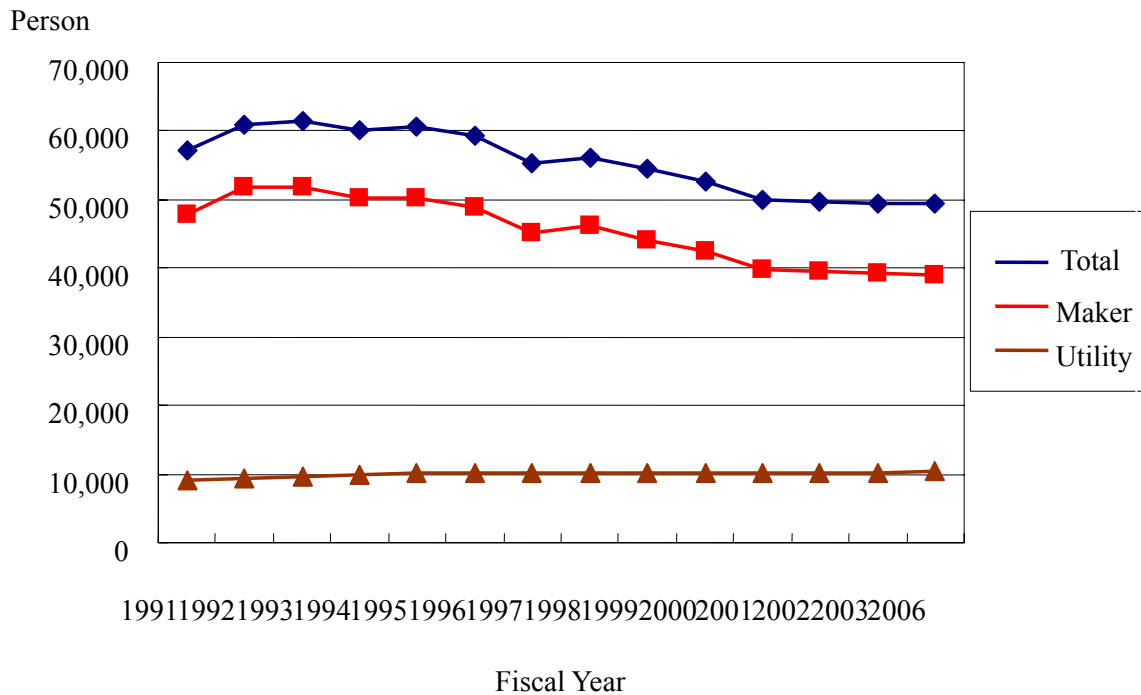


Fig2 Employment rate to nuclear energy field

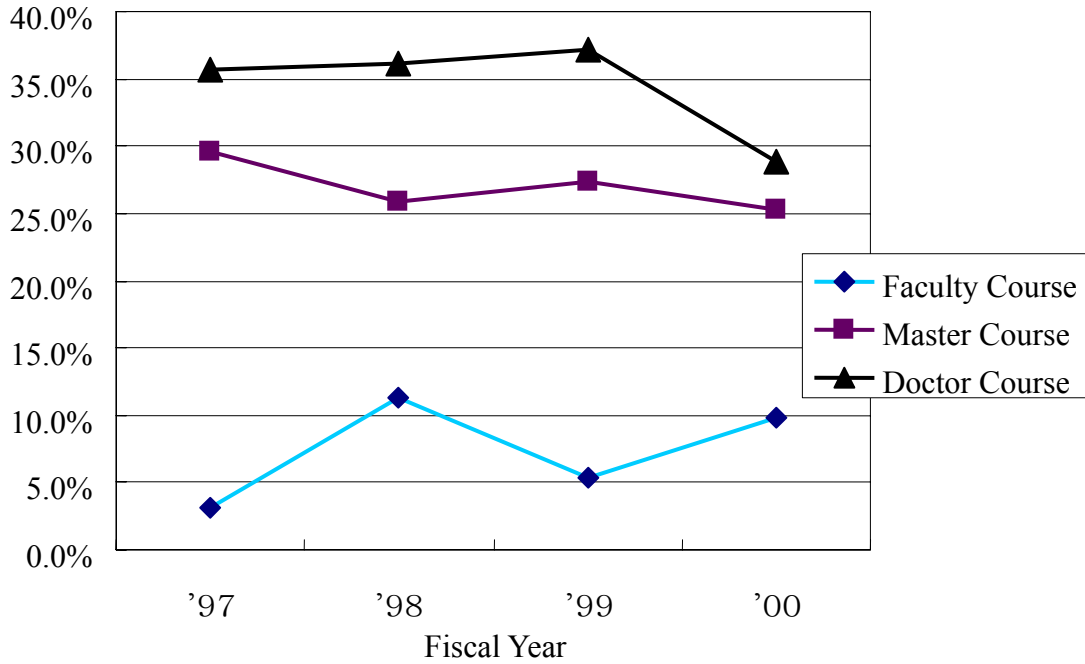


Fig3 Concept of Nuclear Education System network

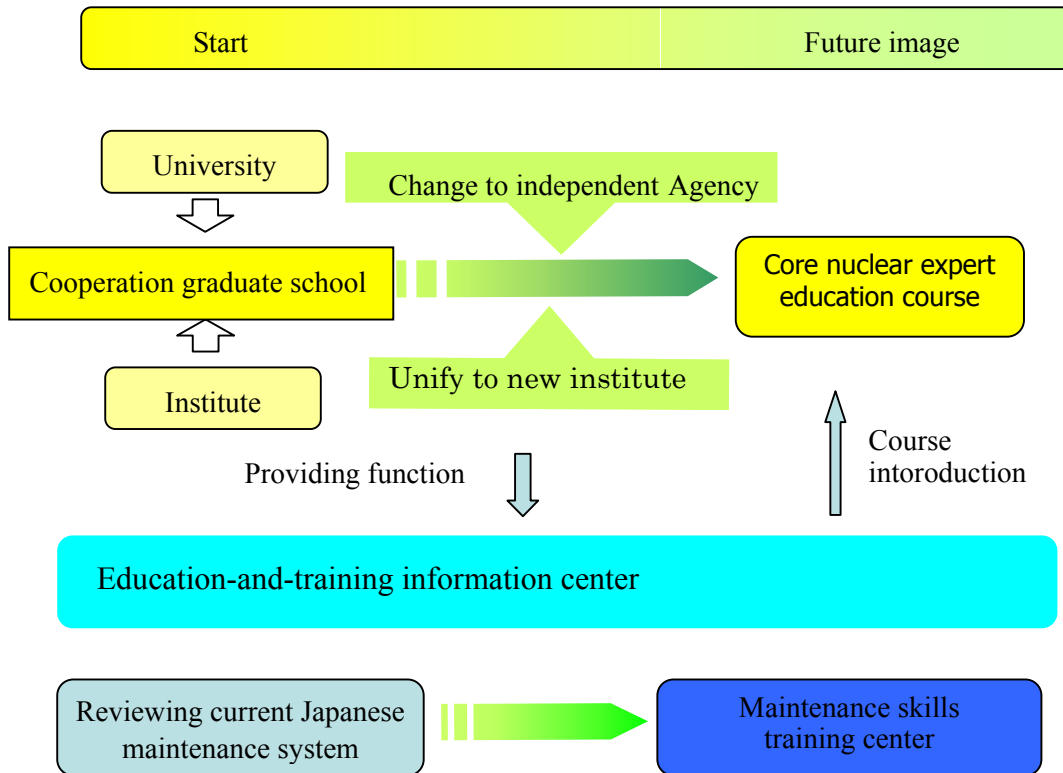
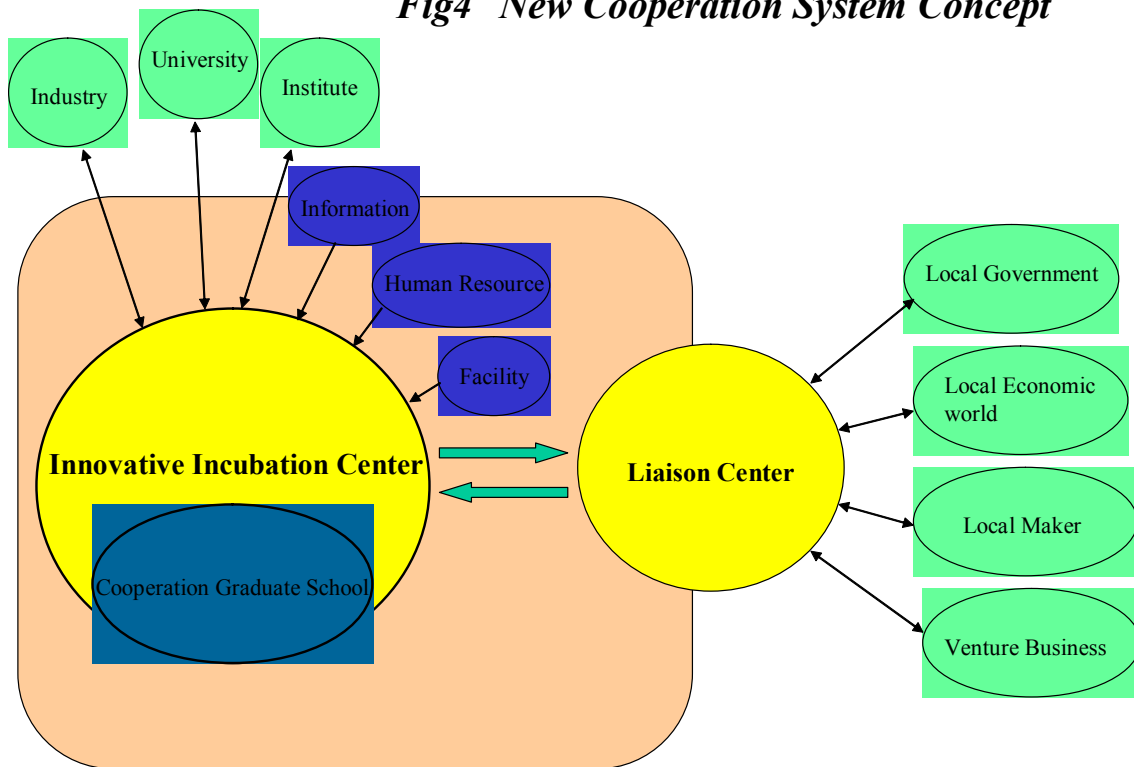


Fig4 New Cooperation System Concept



REFERENCES

- [1] JAPAN ATOMIC ENERGY COMMISSION, The long-term program for research, development and utilization of nuclear energy (2000)
- [2] MINISTRY OF ECONOMY, TRADE AND INDUSTRY, The energy demand and supply outlook in 2030 (interim), advisory committee for energy (2004)
- [3] JAPAN ATOMIC INDUSTRIAL FORUM, Report of human-resources problem subcommittee (2003)
- [4] JAPAN ATOMIC INDUSTRIAL FORUM, Investigation report for the actual conditions of the nuclear industries (2001)
- [5] H. Mori, The method for securing the nuclear experts, Symposium on nuclear technology succession, Tokyo, (2003)