THE BEST & BRIGHTEST

CONCERN OVER TOMORROW'S WORKFORCE OPENS NEW DOORS FOR EDUCATION & TRAINING IN NUCLEAR FIELDS

No "quick fix" is foreseen to troubling trends, as governments step up efforts to attract -- and retain -- the next generation of scientists, engineers, and specialists in fields of nuclear science and technology. The reasons for action? High among them are an emerging shortfall of specialized expertise, worrying trends in nuclear education at universities and institutes, and public perceptions of a "stagnant" industry with poor career prospects.

Several studies in recent years, and results of international conferences, have served to focus greater attention on the "people" side of nuclear' s future.

■ In 1999, a study by the Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation and Development surveyed 16 of its member countries. *(See box, pages 4-5.)* The study was done to address concerns about downward trends in nuclear education and training at universities. "In most countries, there are now fewer comprehensive, high-quality nuclear technology programmes at universities than before," the study found. "Failure to take appropriate steps now will seriously jeopardize the provision of adequate expertise tomorrow."

■ In the United States, which has the world's largest nuclear programme, a "Blue Ribbon" governmental panel examining nuclear education and research trends issued its report in May 2000, sounding an urgent call for action. The panel urged greater funding, and targeted outreach programmes, to support nuclear engineering and science education, to upgrade training and research reactors at universities, and to refresh an ageing faculty and workforce *(See article, page 7.)*

■ Trends in other regions -- notably Asia and the Pacific where nuclear technologies have firm footing for electricity generation and other applications -- are more difficult to discern. Some insights are gained from reports at international symposia on research and education for nuclear energy. One series has been co-sponsored by Japan's Tokai University Education System and the University of California-Berkeley's Department of Nuclear Engineering. Reports from China, Japan, Thailand and other countries in 1999 and 2000 have focused attention on problems to attract and retain students in nuclear engineering and related specialized fields. *(See box, pages 4-5.)*

■ At their recent General Conferences, IAEA Member States have adopted resolutions calling for measures to strengthen global cooperation

in areas of nuclear education and training, ranging from nuclear safety, radiation protection, and waste management to nuclear applications in hydrology and other fields. *(See related articles in this edition.)*. The General Conference further has requested the Agency to place special emphasis on supporting the development of nuclear applications in Member States "with a view to preserving nuclear knowledge, sustaining nuclear infrastructures, and fostering science, technology and engineering for enhancing nuclear safety."

Common Ground. A number of common threads bind the studies and symposia reviews. In the forefront for most countries surveyed is the need to recruit, attract, and retain the young generation, namely students, junior professionals, and teachers. Key objectives include revitalizing nuclear science and engineering education

programmes, and renewing proactive industry outreach and recruitment campaigns.

The outlook is brighter in France, which relies upon nuclear power for over 75% of its electricity and sees no immediate concern over a shortage of young nuclear graduates. As reported by the NEA, the age breakdown of atomic engineering graduates recruited by the French atomic energy commission shows a relatively young population "capable of keeping its expertise alive for years to come".

Another common thread is the need to address public perceptions that tend to cast nuclear fields in poor light, and influence academic and career choices. In Belgium, among other countries, the NEA study reported that the number of students in nuclear engineering progressively decreased as nuclear power expansion slowed and nuclear's public image fell.

In the USA, a prime objective of education strategies is to restore public confidence and nuclear's image: "The redevelopment of a positive outlook for nuclear energy in the United States will encourage the recruitment and education of a new generation of students to meet the (human resource) needs of the next several decades," the NEA study reported.

To a large extent, perceptions may be tied to wrong impressions, signalling the need for greater investment in public communications programmes. The image of a "stagnant" technology, for example, often goes against the grain.

"Nuclear technology has been applied and is still progressing in a wide area: generation of electric and thermal power, medical diagnosis and therapy, agriculture, non-destructive testing, among other things," the NEA study states. "Nuclear education competence is important...for sensitizing a wider audience to nuclear-energy related issues."

The issue crosses pro- and anti-nuclear lines.

"Whether one supports, opposes, or is neutral about nuclear energy, it is evident that there are important current and long-term future nuclear issues that require significant expertise," the NEA study noted. The issues include safe and economic operation of nuclear power and research facilities, some of which will significantly extend their planned lifetimes; decommissioning plants; environmental protection; waste management; and radiation protection. These needs call for a steady supply of high-quality students and vigorous research.

A third common element is the need for greater collaboration between government, industry, and academic communities at national levels, between developing and industrialized countries, and between international, regional, and non-governmental bodies globally. Through such channels, good national practices, promising initiatives, and "hands-on" internship and fellowship opportunities can be shared and more widely put into practice. *(See box, page 6.)*

Global Initiatives. When its study was done, the NEA set up an international task force on nuclear education and training. The IAEA has participated in this forum as part of its work to review and improve its educational and training programmes. Other Agency activities include projects directed at the "preservation of nuclear knowledge".

As articles in this *IAEA Bulletin* edition report, the range of IAEA-supported education and training opportunities is diverse and closely linked with technical and research programmes serving specific national development goals of the Agency's Member States. Not all areas of the IAEA's work are covered in this edition, and more information is available in the Agency's *Annual Report*, scientific and technical publications, and the *WorldAtom* pages on the Internet (http://www.iaea.org).

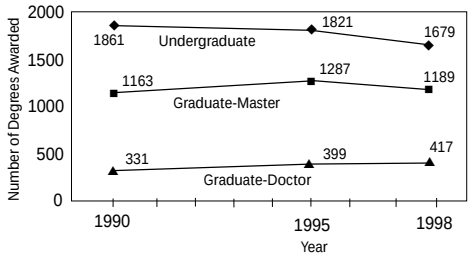
No one yet sees a "crisis point" in nuclear education, and countries are targeting actions on the most pressing concerns. But lead times are long for specialized training and undergraduate and advanced studies, and the goal is to prevent potential repercussions down the line. In the USA, for example, legislation was introduced this year to bolster government funding for nuclear education and research through 2006, and industries are recruiting more actively.

Educational doors and incentives may be opening at the right time. US analysts say that demand exceeds supply in the nuclear job market for the best and brightest minds.--*Lothar Wedekind, IAEA Division of Public Information.*

PROBLEMS & PROSPECTS:
NUCLEAR EDUCATION TRENDS IN SELECTED COUNTRIES

Trends in nuclear education and training vary from country to country, and are closely tied to overall educational patterns in fields of science and technology. The picture largely is drawn from the NEA's study of 16 countries,* *Nuclear Education and Training: Cause for Concern?*, in 2000, and reports at international symposia. Selected reviews follow. For a report from the United States, see the article beginning on page 7.

DEGREES AWARDED IN NUCLEAR SUBJECTS



Notes: Data cover 154 institutes in 16 countries.
Source: OECD/NEA, *Nuclear Education and Training: Cause for Concern?* (2000)

China: Demand for nuclear talent is "huge" because of the development of nuclear power and nuclear technologies in industry, health, and other fields. At the same time, more students are studying computer science, economics and other disciplines rather than nuclear sciences. No "instantaneous effective way to attract brilliant students to nuclear engineering" is seen. But major universities have introduced changes in nuclear engineering programmes, as part of educational reforms, to attract more students, and identifed where more efforts are needed. These include greater on-the-job training opportunties for students in areas of research and development. Of interest is more extensive interaction with foreign universities and institutions associated with nuclear engineering and technology, through professional and information exchange programmes.--*"Nuclear Engineering Education at Tsinghua University in Beijing", Kan Wang and Baoshan Jia, July 2000, and "Nuclear Engineering Education in China", Xu Yuanhui, Institute of Nuclear Energy Technology, Tsinghua University, March 1998, International Symposium on Energy Future in the Asia/Pacific Region, co-sponsored by Tokai University Education System, Japan, and University of California-Berkeley, Department of Nuclear Engineering. Results of the symposia are accessible on the Internet at http://tauon.nuc.berkeley.edu/asia/index.html).*

Thailand: International cooperation in nuclear education and training is necessary to keep the technology at its highest level. Nuclear nations and emerging nations have to agree to network and cooperate seriously in this field. Through various programmes, Thailand has benefited from collaboration with Canada, France, Japan, and the United States, as well as through IAEA projects. Examples include a linkage project involving Canadian and Thai universities; a scientist exchange programme with Japan and Thai nuclear institutes and research laboratories; and cooperation with France for training Thai students and faculty in French laboratories.--*"Nuclear Engineering Education in Thailand: Present Status", T. Sumitra and N. Chankow, Department of Nuclear Technology, Faculty of Engineering, Chulalongkorn University, March 1999, International Symposium on Energy Future in the Asia/Pacific Region, co-sponsored by Tokai University Education System, Japan, and University of California-Berkeley, Department of Nuclear Engineering. Results of the symposia are accessible on the Internet at http://tauon.nuc.berkeley.edu/asia/ index.html).*

Japan: Public perceptions of nuclear technologies, particularly after the Chernobyl accident, have cast a long shadow, influencing educational trends. Nuclear engineering departments, as such, have been replaced in most major universities by newly named departments that emphasize energy, sciences, or systems studies, with nuclear content moved within those curricula. The result has been an increase in graduate students in different specialties and more broad-based research fields. The restructuring of the nuclear industry and the wide varieties of job opportunities in other industries have contributed to problems in recruiting top-class students to join nuclear fields. The impression often prevails among the young generation that there is a lack of future prospects for satisfying careers in nuclear industries. Many actions against these trends have started, involving collaborative efforts between government, industry, and universities.--*"Nuclear Engineering Education in the 21st Century", Prof. Shiori Ishino, Department of Nuclear Engineering, Tokai University, July 2000, International Symposium on Energy*

**Belgium, Canada, Finland, France, Hungary, Italy, Japan, Mexico, Netherlands, Republic of Korea, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.*

Future in the Asia/Pacific Region, co-sponsored by Tokai University Education System, Japan, and University of California-Berkeley, Department of Nuclear Engineering. Results of the symposia are accessible on the Internet at http://tauon.nuc.berkeley.edu/asia/ index.html). OECD Nuclear Energy Study, "Nuclear Education and Training: Cause for Concern?", 2000. Accessible on the Internet at http://www.nea.fr.

Mexico: National authorities have taken steps to train staff in the nuclear field on topics ranging from radiation protection to nuclear reactor safety. Support from the IAEA and other organizations have enabled staff to attend specialized courses abroad. Training in the basics of nuclear technology also has been initiated, as applicants often lack formal knowledge in nuclear engineering. The future of nuclear education is somewhat uncertain, and top-level programmes at universities and technical institutes are facing difficulties, as students opt to study science or mathematics rather than nuclear engineering and faculty members near retirement. Nonetheless, some post-graduate programmes were initiated in the late 1990s. Though initiatives have been taken by government, universities, and professionals, greater investment is needed over a four to five year period to prepare the young generation for careers in the nuclear field.--*OECD Nuclear Energy Study, "Nuclear Education and Training: Cause for Concern?", 2000. Accessible on the Internet at http://www.nea.fr.*

United Kingdom. Nuclear education is not yet at a crisis point in the country but is certainly under stress. While there are no longer any nuclear specific undergraduate courses, the number of undergraduates reported as having a nuclear content in their university education stayed constant during 1990-98, and even may have increased slightly. At the same time, the needs of the industry, both in terms of recruitment and research, have declined as it has reached maturity and as it seeks to be more competitive in a deregulated energy sector. The concern is that nuclear education remains sufficiently robust and flexible to support the nuclear industry as it evolves. Some companies are working more closely with universities, including British Nuclear Fuels Ltd. which has worked with universities to set up a centre of excellence in nuclear chemistry. Regarding recruitment, the nuclear industry historically commanded the best brains because it offered the best resources and facilities and stood on the cutting edge of technical development. The industry perception of many potential graduates, however, has turned negative. The public relations activities companies use to raise their profile have not been specifically geared to recruitment but certainly have helped it.-*OECD Nuclear Energy Study, "Nuclear Education and Training: Cause for Concern?", 2000. Accessible on the Internet at http://www.nea.fr.*

Hungary: Nuclear education and training have been closely linked to the construction, operation and future of the country's nuclear power plant, which meets about 40% of electricity needs. Programmes specializing in nuclear power, radiochemistry, and nuclear measurement techniques, for example, have been offered over the years within the framework of technical and scientific university programmes. With the IAEA's assistance, a nuclear maintenance center was built and a new generation of instructors were trained, as part of a project to improve the nuclear plant's professional training system and conditions. Future training needs are tied to the future nuclear developments, including decommissioning, life extension, and construction of new plants.--*OECD Nuclear Energy Study, "Nuclear Education and Training: Cause for Concern?", 2000. Accessible on the Internet at http://www.nea.fr. (For a report on the training center, see the IAEA's WorldAtom pages at http://www.iaea.org/worldatom/Press/Booklets/TcDevelop/five.html#hungary).*

Canada: Changes to the structure and funding of the nuclear industry could hold adverse effects for nuclear education in the future. In the 1990s, the number of students studying or graduating with degrees having nuclear content stayed relatively constant, as have the number of teaching staff. The future, however, is likely to be less stable because of industry reorganization, the curtailment of some university nuclear research programmes, and the public image of the industry. Entering the 21st century, the job market for new graduates with nuclear engineering background was quite good, mainly because of utility efforts in refurbishing operating reactors. The availability of such graduates is likely to decline until a more positive atmosphere reigns in the industry. This could be helped as governments pay more heed to the Kyoto accord on reducing greenhouse gas emissions and the role that nuclear power can play in helping to meet targets.--*OECD Nuclear Energy Study, "Nuclear Education and Training: Cause for Concern?", 2000. Accessible on the Internet at http://www.nea.fr.*

"BEST PRACTICES" FOR REVITALIZING NUCLEAR EDUCATION & TRAINING

To reverse troubling trends in nuclear education and training, experts participating in national and international studies have recommended actions that can be taken by governments, industries, and academic communities, either singly or together. The NEA study additionally identified "best practices" based on reports from countries participating in the study. The practices urged countries to:

■ Create a pre-interest in the nuclear domain. Include steps such as advertisements aimed at undergraduate candidates, high school "open days" at campuses or research facilities; regular reactor visits and campus tours for students; newsletters, posters, and Web pages; summer programmes; preparation of a resource manual on nuclear energy for teachers; sponsorship of an advanced laboratory for high school students; recruiting trips and nuclear introduction courses for freshmen; and conferences given by industry and research institutes.

■ Add content to courses and activities in general engineering studies. Increase emphasis on nuclear in physics and applied physics courses; organize seminars on nuclear in parallel or in liaison with the existing curriculum using speakers external to the university; set up informational meetings on the nuclear sector, existing graduate programmes, research and thesis topics; discuss employment potential and professional activities; and call attention to the environmental benefits of nuclear (energy from fission, fusion, and renewables in comparison to fossil resources).

■ Change programme content in nuclear science and technology education. Include advanced courses (such as reliability and risk assessment); broaden the programme to include topics such as nuclear medicine and plasma physics; assure that the education covers the full scope of nuclear activities (fuel cycle, waste conditioning, materials behaviour); provide early real contact with hardware, experimental facilities, and industry problems; and provide interesting internships in industry and research centers.

■ Increase pre-professional contacts. Encourage the participation of students in activities of the local nuclear society and its "young generation" network.

■ Provide scholarships, fellowships, and traineeships. In addition to promoting several support activities (mostly technical), industry can participate financially by providing scholarships and, in several instances, has initiated new educational and training schemes. The size of the awards varies widely from one country to another. Academic societies, national research institutes, and governments also can provide financial help. The number of these grants has remained relatively stable.

■ Strengthen nuclear educational networks. Establish and promote national and international collaborations in educational and/or training programmes, e.g. summer school, specialist courses. Provide industry employees with activities that are professionally more interesting and challenging and that pay more than those in the non-nuclear sectors. It has been an exception, rather than the usual case, that a higher salary is used as a means to attract younger graduates.

■ Provide early opportunities for students and prospective students to "touch hardware", interact with faculty and researchers, and participate in research projects.

■ Provide opportunities for high school and early undergraduates to work with faculty and other senior individuals in research situations. Use the Web and other information techniques to proactively develop more personal communication with prospective students.

Photo: Opportunities for training are being offered by the IAEA through a wide range of programmes.