INDUSTRY PERSPECTIVES AND OPPORTUNITIES IN NUCLEAR WASTE MANAGEMENT: WHERE WILL THE PEOPLE COME FROM?

Richard A. Nathan
Group Vice President and General Manager
Nuclear Systems Group
Battelle
505 King Avenue
Columbus, Ohio 43201

ABSTRACT

The new initiatives by the U.S. Department of Energy (DOE) to begin implementing the Environmental Restoration and Waste Management Five-Year Plan have expanded the need for scientific and management experts in fields related to nuclear waste disposal, remediation technology, and project management and control. Battelle, a pioneer in the nuclear field, anticipates that these programs will produce a demand for people qualified in those disciplines that cannot be met unless innovative changes occur.

As part of a study to assess future human resources needs, Battelle has determined that there are current shortages only among chemical engineers and civil engineers. However, future shortages are likely to occur in other scientific and engineering disciplines unless major interventions occur. New demands that can now be anticipated in nuclear waste technology will exacerbate the future needs in fields related to solving those problems.

A further consideration is that even those currently working in the nuclear waste management field will need to enhance their qualifications to meet future requirements in waste technology, management and disposal techniques, environmental safety standards, and institutional complexities. The personnel needed to manage DOE's planned massive restoration and cleanup programs will add to the demand both within DOE and among its contractors for at least the next 50 years.

In anticipation of these shortages, initiatives are being taken by governmental agencies and private companies to meet the human resources needs in nuclear waste technology in the 21st century. It will be crucial that all elements of the nuclear family join together to meet the personnel as well as technical challenges of the next 15 to 30 years. This will require a more formal coalition of forces that can unify and coordinate separate programs already underway.

INTRODUCTION

Nearly a year ago the then newly appointed Secretary of Energy, Retired Admiral James D. Watkins, announced that one of his first priorities would be to strengthen the Department of Energy's (DOE) nuclear waste management activities. These activities include environmental compliance and cleanup, and restoration of the Agency's credibility. This paper will focus on the human resources ramifications of that announcement and summarize several activities and recommendations which should help DOE meet its nuclear waste management challenges.

In the months since his announcement, the Secretary has taken major steps to develop a program to accomplish his waste management goals. He has instituted major reforms within the Agency. He has issued the Environmental Restoration and Waste Management Five-Year Plan, which lays out a road map to begin to cleanup and modernize the nation's nuclear defense production facilities. He has temporarily closed defense production reactors and given personal commitments not to restart these reactors until safe operations can be assured. He has made changes in the operating contractors at defense production facilities and insisted upon accountability from DOE staff and operating contractors. He has postponed opening the Waste Isolation Pilot Plant in New Mexico and delayed site characterization activities at the candidate site for the high-level waste repository at Yucca Mountain, Nevada. He is strengthening independent oversight to help monitor the effectiveness of these actions. And he has initiated a program to ensure excellence in epidemiological research, including an external independent review panel and mechanisms to share the accumulated data on health effects of nuclear production plant workers with qualified researchers.

Secretary Watkins recognized that accomplishing these initiatives will require having additional trained and capable DOE personnel at all levels, in Washington, D.C., as well as in the field. He knew that the initiatives would establish new responsibilities and require different, often more demanding, technical and management skills. DOE analyses indicated that there would be financial as well as human resources implications. The cost of bringing the DOE defense weapons facilities into environmental compliance is estimated to be between $100 billion and $250 billion over a 25-year period. We have seen no estimate of the additional human resources that will be required in nuclear and chemical engineering, physics, environmental sciences, waste management technology, health physics, and many related and support disciplines. However, there is a national consensus that the number of people needed will be greater

than those employed today or those that can now be predicted to be available.

In short, Secretary Watkins has spotlighted a national problem for those of us in the private sector of the nuclear research and waste management business. It comes at a timely point for those of us who are concerned about the future of science and technology. About a year ago, Battelle convened a task force to determine the current supply of scientists and engineers, to predict future capacity, to assess the implications of the survey results for Battelle, and to make recommendations for meeting future needs. The purpose of this paper is to (1) summarize what Battelle's survey and a sampling of other sources have determined, as it relates to nuclear waste management resources; (2) describe samples of the programs to increase the supply of scientists and engineers now being sponsored or planned by DOE, national laboratories, and private companies; and (3) look at some of the programs and recommendations to help us be better prepared with the trained leaders and scientists this nation will need to safely and efficiently manage the nuclear waste management challenge.

THE FINDINGS

It is appropriate for Battelle to participate in this global look at the need for scientists and engineers beyond the year 2000, then to interpret conclusions specifically for nuclear management issues. You might call Battelle the Methuselah of the nuclear business. We have been conducting research and development in atomic energy activities since 1942, beginning in the early days of the Manhattan Project and just 13 years after Battelle opened for business. Our nuclear activities have spanned the gamut--from pure research, the Manhattan project, and operating a private research reactor and plutonium laboratory to assisting DOE in nuclear waste management activities and decontaminating and decommissioning our own facilities.

The findings of our study on future staff capacity relative to nuclear waste management indicate that substantial shortages of scientists and engineers are likely to occur by the year 2000 and beyond, unless action is taken now. This is going to be a critical period for nuclear waste management and defense waste cleanup activities, because current DOE schedules show key milestones in the period from 2000 to 2010 and additional staff needs will exist for the next 50 years of cleanup and waste disposal activities.

Our survey shows that:

- By the year 2000, there will be a shortage of Ph.D.s in all engineering disciplines, exacerbated by the large number of retirements at academic institutions which are expected in the mid-1990s.
- Fewer students indicate an interest in science and engineering, and the number who traditionally pursue science or engineering courses is decreasing, as is the number of physics and math students.
- The number of white males, the demographic group that traditionally pursues science and engineering, is decreasing.
- The increase in minority and women students studying science and engineering has ceased.
- The number of U.S. students receiving doctorates in the physical sciences and engineering continues to decrease (see Fig. 1), and 55 percent of engineering Ph.D.s go to foreign nationals.

The findings of our survey were not surprising, nor did they appear in a vacuum. Last fall it was difficult not to hear or see the headlines about this country's educational crisis. The President held an Education Summit," and most Federal agencies took his lead to review how they could contribute to his general goals. Major media outlets headlined their own analyses of the situation, including several who focused on science education.

Time magazine's A Crisis Looms in Science," (September 11, 1989) told us that American 13-year-olds ranked last in math and nearly last in science among children in six countries. The article also said that only 1.5 percent of all

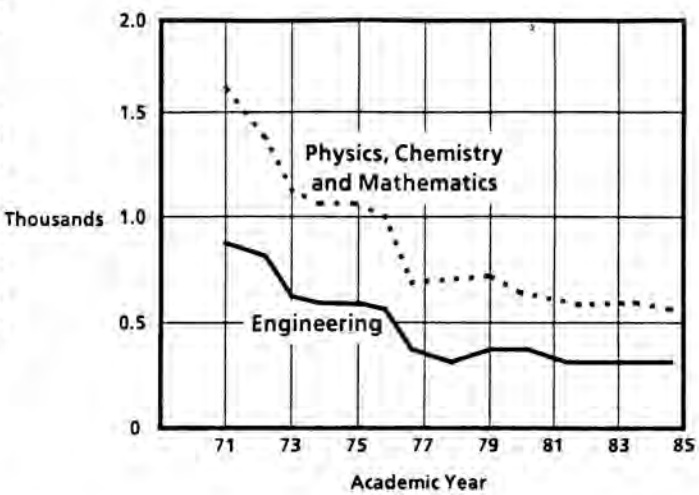

Fig. 1. Doctorates Awarded to U.S. Citizens in Selected Fields Per Thousand U.S. Population, Age 30.

U.S. college freshmen said they would concentrate on physics or chemistry.

That same month, a series of articles in The New York Times (September 26-28, 1989) deplored a U.S. work force unqualified to work" at sophisticated enough levels to keep pace with the advancing technologies and upgraded jobs. A column about careers in The New York Times (August 29, 1989) quoted Professor Ivor L. Preiss, of the Rensselaer Polytechnic Institute as predicting that there would be a serious shortage of graduate students studying to become nuclear or radiochemists. Only a few will be graduated per year in the next five years, he stated, whereas about 100 will be needed.

Such a lack of qualified nuclear experts could leave industry, government, state agencies, and universities facing an acute shortage of expertise. That was the interpretation offered by Nuclear Waste News (August 31, 1989) of Professor Preiss' remarks. Professor Preiss also pointed out that retirements will intensify the shortage because a whole generation will be retiring in 5 to 10 years--those of us who had as mentors the people from the Manhattan Project." Professor Preiss was a participant in a study of manpower training requirements sponsored last year by the National Research Council's Committee on Nuclear and Radiochemistry (CNR).

In an article in the November, 1989, issue of the Journal of the Institute of Nuclear Materials Management, Professor Gregory R. Choppin of Florida State University, concluded that nuclear waste disposal and reclamation of contaminated DOE sites will become a major industry." By contrast, he predicts, present trends suggest there will be essentially no academic training available within a decade in nuclear and radiochemistry.

A report authored by the Federal Task Force on Women, Minorities and the Handicapped in Science and Technology, issued in December of 1989, projected a shortfall in the U.S. of 560,000 scientists and engineers by the year 2010. The report also concluded that the shortfall could be overcome if those in underrepresented groups are encouraged, educated, employed, and advanced.

Similar conclusions were reached at the Math/Science Education Action Conference, co-sponsored in October, 1989, by Secretary Watkins and Nobel Laureate Glenn Seaborg. The conference, which brought together senior representatives from several Federal agencies, Congress, education associations, states, teacher associations, industry, foundations, and national laboratories, focused on how the wealth of available scientific expertise could be mobilized to aid science and math education in elementary and secondary schools.

As the author of an article in CQ magazine succinctly stated: Hardly anyone disagrees there is a problem," or that the U.S. is lagging in science and math training (August 12, 1989).

But enough about alarming statistics and predictions about the widening gap between the needs and predicted capacity. The above list is long enough to reflect a national consensus: we will not have the personnel to meet our technological challenges unless, as stated early in this paper, we intervene. So let's move on to the good news": how DOE, educational groups, and private companies are already working on solutions and innovations to close our people gap.

THE INTERVENTIONS

Examples of what is being done about the predicted gap between need and capacity are as numerous as the evidence that the problem will exist. The limits of this paper require that I select those solutions, innovations, or interventions that are most relevant to the nuclear waste technology needs.

The solutions can be divided into three categories: (1) establish a national priority and focus and coordinate the resources of all entities; (2) adopt innovative approaches to access underutilized groups; and (3) extend the capacity we already have. Here are several examples to illustrate each category.

1. **Establish a national priority**. There is evidence this is occurring at the national level. House Science Chairman Robert A. Roe, U.S. Congressman from New Jersey, recently stated that the quality of science and math education will largely determine the future economic strength of our nation" (CQ, August 19, 1989). Bassam Z. Shakhashiri, chief of the National Science Foundation's education programs, believes it will take a NASA-like approach to turn around the direction of science and math education in the U.S. We need to develop a national will, a national determination," he said, such as occurred in the late 1950s after Sputnik (CQ, August 19, 1989). Although NSF has two major programs aimed specifically at improving science and math education, it is not comparable to resources available after Sputnik, when education spending by the National Science Foundation skyrocketed, he pointed out. However, Congressional interest in science education during last fall's session was described by an NSF representative as again being at a high peak.

The Math/Science Education Conference co-sponsored by Secretary Watkins and Dr. Seaborg was DOE's major initiative to reach a consensus on what the solutions should be. The conference concluded with the formation of working groups and the announcement of three goals: (1) using DOE resources to create a national model for federal and industrial partnerships to revitalize math and science education; (2) encouraging out-of-classroom, hands-on sci-

ence experiences for young people; and (3) augmenting the current math and science teaching force with scientists from national laboratories, businesses, and retired professionals.

There were several immediate results of the conference, including the sponsorship of the Chicago Science Explorers Program by Argonne National Laboratory and Fermi National Accelerator Laboratory, expanded support for precollege science teaching programs by the Oak Ridge National Laboratory in collaboration with the University of Tennessee, and a new program developed by Pacific Northwest Laboratory, called PNL Options, for minority students in middle schools. All three DOE-sponsored programs target populations traditionally underrepresented in science and technology. The Chicago program will have effects beyond the Chicago area, because videos were developed for showing on commercial channels in the state and potentially for telecast nationwide via the Public Broadcasting System.

The report issued by the Federal Task Force on Women, Minorities, and the Handicapped in Science and Technology recommended that the Federal government bring about a more diverse workforce through its $60 billion research and development programs; collect data on participation of underrepresented groups in research and development; establish public awareness programs to present science and engineering as rewarding careers; and establish a national research scholars program for high school students. Secretary Watkins pledged his Agency's cooperation in meeting those recommendations. He immediately directed collection of the requested data, augmentation of outreach programs by the national laboratories, such as those described in the preceding paragraph, and the development of additional activities to implement the Task Force's recommendations.

DOE sponsors summer research appointments for high school and middle school teachers at 13 participating national laboratories in a program called Teacher Research Associates (DOE-TRAC). In 1990 this will give at least 150 teachers opportunities for eight weeks of hands-on scientific work to increase their understanding and enthusiasm. Research areas include nuclear chemistry, particle physics, ecological studies, and materials science.

Secretary Watkins has indicated that he will be supplementing programs that already exist at the national labs, committing resources to reinforce instruction, revitalize teachers, and increase their backgrounds and confidence. Several existing educational programs warrant mention here.

At Pacific Northwest Laboratory (PNL), which Battelle operates for DOE, programs have been developed for students and teachers at every grade level from primary grades to the Ph.D. level. More than 20 different programs sponsored by PNL's Office of Pre-University Education reached more than 5,000 students last year, and hundreds more visited the Laboratory. Programs for teachers include research participation, curriculum enhancement, outreach to schools, and partnerships.

PNL representatives recently participated in meetings focused on improving the quality of engineering, math, and science education in the Northwest. Major problems in science education were discussed by state science coordinators. Higher education faculty from seven northwestern states met to develop a proposal to bring 21st century science and mathematics to rural school districts via satellite technology. School officials from the Tri-Cities worked to develop a plan to mobilize area scientists and engineers who will work with teachers and students. Plans were finalized for the Pacific Science Center's traveling science exhibit, Science Carnival," to be held in the Tri-Cities this spring. A new adopt-a-teacher program was launched this year, giving businesses an opportunity to participate in training teachers in science and professional development opportunities.

Argonne's Division of Educational Programs enables about 3,400 students, teachers, and others to learn about and participate in scientific projects every year. One facet of the program pairs 60 promising undergraduate science students with Argonne research scientists each school semester. An ll-week summer research program accommodated nearly 200 college undergraduates or first-year graduate students.

At Oak Ridge, students can receive on-the-job training, salaries, and college credit via cooperative programs, internships, fellowships, and research grants. The 25-year-old work-study program represents a partnership between area universities, the national lab, and area industries. Programs include experience in the laboratory, remedial action, low-level waste, and waste stabilization.

In October of 1989, DOE broke ground for a new science education center at the Fermi National Accelerator Laboratory near Chicago. The center will provide a centralized home for education programs for students and the community.

In August of 1989, Secretary Watkins announced that 18 universities will receive grants totaling $6 million over the next three years, to be used to help meet the nation's needs in nuclear engineering science and technology. Each grant will include funding for graduate students to pursue advanced degrees in nuclear technology.

In a memo titled Setting the New DOE Course," issued by Secretary Watkins in September of 1989, education and training programs for staff were identified as key items in preparing them for new and higher levels of management responsibility. He stated his intention to revitalize the DOE

intern program to attract high-caliber young professionals into the Department."

Federal grants are available to states targeted specifically to fund programs to improve math and science skills for teachers and students. Some states supplement these funds. In my own state of Ohio, for example, this program provided more than a quarter of a million dollars for such programs as a math education course designed for low-income, pre-college students.

Several government agencies and private companies, including Battelle, sponsor traveling science exhibits, which rotate among museums throughout the nation to awaken children's interest in science. It has been my privilege to serve on the board of Ohio's Center of Science & Industry and to support that museum's Mission to Mars" exhibit, which will begin a 13-city tour of major science and technology centers across the country next January. Battelle is helping to fund the exhibit along with the National Science Foundation, Apple Computer Inc., and participating science museums. This exhibit is expected to bring science to life for 5 to 8 million visitors. There are many interactive devices to motivate children, including one that allows visitors to fly" on a hypothetical mission to Mars.

2. **Adopt innovative approaches to access underutilized groups**. A simple way to say this is that all of us should be looking for ways to attract people into careers in nuclear technology who are not now encouraged to seek that path, specifically women and minority students. You will recall that the Battelle study indicated that the increase we once experienced in women and minority students studying science has ceased. The factors for the decline range from poverty and cultural prejudice to discrimination in salaries and promotional opportunities. Solutions include special programs to seek out and encourage minorities and women to enroll in the scientific disciplines and the abolition of discrimination in the work place. One of our study's findings was that efforts to encourage minorities and women to consider scientific careers had to begin in the elementary schools. Many Federal and state agencies and private companies, including Battelle, have programs designed to encourage minority and women students. Some were noted in previous paragraphs and here are a few other examples.

Just two months ago, Secretary Watkins announced the award of $250,000 in fellowship grants to historically black colleges to help train minority students for careers in environmental restoration and waste management.

At Oberlin College in Ohio, a program for minority science students offers an extensive support system, including a pre-semester orientation session, science faculty mentors, and remedial courses. The results are amazing: 82 percent of the minority students who come to Oberlin to study science and engineering graduate with degrees.

Battelle's Summer Research Intern Program is dedicated to providing minority students with experience in practical research work. For more than 20 years, at our Columbus laboratories we have been selecting about 10 young men and women each summer to work in all of our technology groups, including such nuclear-related areas as risk assessment, air pollution sciences, and transportation. Interns are selected through the National Graduate Engineering Minority Program and in consultation with area minority job training groups.

The College of Engineering at The Ohio State University has a young scholars" program dedicated to low income, gifted grade school students. The program is conducted every summer for sixth graders. Incentives are offered for students who keep their grades up during the ensuing school year. At Marion Labs in Kansas City, a subsidiary of Dow Chemical Company, staff members adopt" classrooms in inner city schools, providing speakers, offering cash incentives for good grades, and college scholarships. The Colgate-Palmolive Company is dealing with changing demographics by providing its managers with courses on how to adapt to cultural diversity among staff members.

Sometimes, very simple changes can make the difference. A researcher from Miami University in Ohio, with funding from the National Science Foundation, found that teachers could encourage more young women to go into science with a few easy techniques. These include stressing the role of creativity in science, using nonsexist language, providing career advice, and making science classrooms more inviting. A warm, inviting atmosphere, rather than a cold science environment, made a difference to girl students, the study found.

3. **Extend the capacity we already have**. This method of meeting resource needs is already being used by all types of private companies. The McDonald's in your neighborhood probably employs mothers during midday hours when their children are in school and many companies, including Travelers Insurance, recall retired staff to meet special needs. Variations on ways to make better use of the capacity we already have can help the nuclear industry meet its challenges.

Someone has said that the half life of a scientist or engineer is shorter than a doctor's. That is another way of saying that keeping up to date in one's field is becoming more difficult. But that is crucial to all of us, especially with the new demands of remediation technology. The National University Continuing Education Association estimates that the time in which half of an engineer's skills become

obsolete ranges from 2.5 years for software engineers to 7.5 years for mechanical engineers.

We can encourage and provide incentives for our staff to seek additional training in the disciplines that we know will have shortages by the year 2000. Most companies encourage staff members to remain current or seek additional expertise through tuition reimbursement programs and encouragement to seek higher degrees. Almost every company provides in-house courses or encourages staff attendance at off-site seminars that will enhance their knowledge. Many companies are changing their human resources regulations and benefits to encourage people with needed expertise to remain active beyond the normal retirement time, rather than penalizing them as may currently be the case.

The University of Tennessee and DOE announced several initiatives to improve math and science education in that state. The one most relevant to this subject is the creation of an Adjunct Teaching Corps" through alternative certification. The focus is on scientists and engineers who want to change careers and become science teachers and retired technical professionals who want to return to the workforce as teachers.

One way of extending our capacity is to be creative in integrating people's efforts. An example is Battelle's Environmental Management Operations (EMO), which was established in 1988 at the direction of DOE's Richland Operations Office. EMO offers a full range of nuclear and hazardous waste remediation services to DOE and other Federal agencies, with Hanford as its first priority. EMO has been organized to conduct site remediation activities using private-sector contractors to supplement the environmental and other technical expertise available from DOE's Pacific Northwest Laboratory. The contractors selected have hands-on experience in hazardous waste management. Merging their expertise with PNL personnel knowledgeable in laboratory and research aspects represents true technology transfer, which will be focused to solve site remediation problems.

CONCLUSION

It is clear from almost everything you read and hear that this nation faces a crisis in the coming decades of not having a workforce trained to compete in the world marketplace. As Bill Wiley, my colleague at Pacific Northwest Laboratory, said a few months ago regarding the crisis in education: Those are not school bells you hear ringing. Those are alarm bells!" We should be listening to those alarm bells too, because we face a microcosm of that problem. There will not be enough scientists and engineers to clean up the nuclear legacy we will leave for our children unless we coordinate and expand our efforts to change that direction. The will and the ideas are there; we need only to implement them.